WAMBO COAL PTY LTD
2020 ANNUAL REVIEW

1 January – 31 December 2020

Name of operation	Wambo Coal Mine
Name of operator	Wambo Coal Pty Ltd
Development consent /Project Approval #	DA305-7-2003, DA177-8-2004, EPBC 2003/1138, EPBC 2016/7636, EPBC 2016/7816
Name of holder of development consent	Wambo Coal Pty Ltd
Title/Mining lease #	CL365, CL374, CL397, CCL743, ML1402, ML1572, ML1594, ML 1806, A444, EL7211
Name of holder of mining lease	Wambo Coal Pty Ltd
Water licence #	As per **Table 3**
Name of holder of water licence	Wambo Coal Pty Ltd
MOP/RMP start date	1 December 2020
MOP/RMP end date	31 December 2023
Annual Review start date	1 January 2020
Annual Review end date	31 December 2020

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 2020 to 31 December 2020 and that I am authorised to make this statement on behalf of Wambo Coal Pty Ltd.

Note:

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

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

Name of authorised reporting officer	Peter Jaeger
Title of authorised reporting officer	Manager: Environment and Community
Signature of authorised reporting officer	P F Jaeger
Date	29/3/21

Statement of Compliance

Were all conditions of the relevant approval(s) complied with?	
EPL529	No
DA305-7-2003 (Modification 16)	No
DA177-8-2004 (Modification 16)	Yes
EPBC 2003/1138	Yes
EPBC 2016/7636	No
EPBC 2016/7816	Yes
CL365	Yes
CL374	Yes
CL397	Yes
CCL743	Yes
ML1402	Yes
ML1572	Yes
ML1594	Yes
ML1806	Yes
A444	Yes
EL7211	Yes
Water licences (as per **Table 3**)	Yes

Compliance Status Key

Risk Level	Colour Code	Description
High	Non-compliant	Non-compliance with potential for significant environmental consequences, regardless of the likelihood of occurrence.
Medium	Non-compliant	Non-compliance with: • potential for serious environmental consequences, but is unlikely to occur; or • potential for moderate environmental consequences, but is likely to occur.
Low	Non-compliant	Non-compliance with: • potential for moderate environmental consequences, but is unlikely to occur; or • potential for low environmental consequences, but is likely to occur.
Administrative non-compliance	Non-compliant	Only to be applied where the non-compliance does not result in any risk of environmental harm (e.g. submitting a report to government later than required under approval conditions).

Non-Compliances

Relevant Approval	Condition #	Condition Description (summary)	Compliance Status	Comment	Where addressed in Annual Review
DA305-7-2003	B13	Operational Noise Criteria	Non-compliant	Exceedance at N26 on two occasions.	Section 10.1
EPL529	L5.1	Noise Limits			
DA305-7-2003	B45	Air Quality Operating Conditions	Non-compliant	Failure to record continuous air quality data due to weather conditions and technical issues.	Section 10.2
EPL529	M2.2	Air Monitoring Requirements			
EPL529	M2.3	Water Monitoring Requirements	Non-compliant	Representative samples were unable to be collected or were not analysed as required.	Section 10.3
EPL529	M2.3	Surface Water Sampling Requirements	Non-compliant	Due to insufficient water, representative samples were unable to be collected.	Section 10.4
EPBC 2016/7636	3	Management Plans	Non-compliant	The Department was not notified within one month of updated plans being approved.	Section 10.5 and Appendix I

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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 permitted 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.

Operations at the Mine also include a rail spur and loop, coal reclaim and rail loading facility for the Wambo Coal Terminal under the current Development Consent (DA177-8-2004) which was granted in 2004.

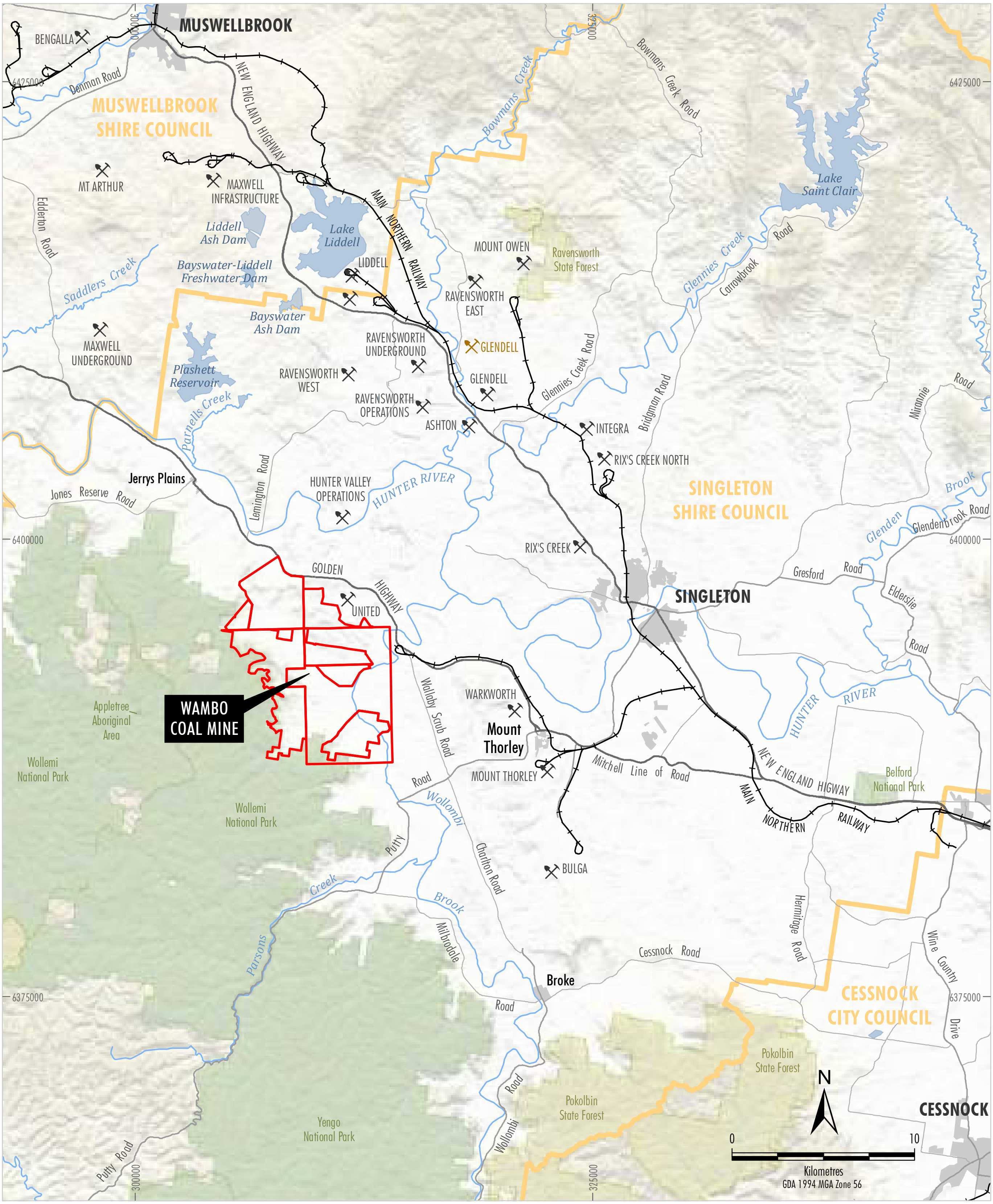
The latest modification to DA305-7-2003 (MOD 16), approved by the Independent Planning Commission of NSW on 29 August 2019, requires development at the Mine to be undertaken in the following stages:

- Phase 1 – open cut mining operations at Wambo open cut mine, underground mining operations at Wambo underground mine and the operation of Wambo mine infrastructure (including minor upgrades to this infrastructure) under DA305-7-2003.
- Phase 2 – underground mining operations at Wambo underground mine, the operation of Wambo mine infrastructure under DA305-7-2003 and associated surface infrastructure.
- Phase 3 – following the cessation of underground mining operations that includes mine closure.

Figure 2 and **Figure 3** show the approved Mine layout including mining lease boundaries, current operational disturbance footprint and Remnant Woodland Enhancement Areas (RWEAs) for Phase 1 and Phase 2, respectively. **Figure 4** and **Figure 5** shows the approved Mine longwall layout for Phase 1 and Phase 2, respectively.

Upon the commencement of Phase 2 under DA305-7-2003 (MOD 16), WCPL and United Collieries Pty Limited (United) (owned 95 per cent by Abelshore Pty Limited, a wholly owned subsidiary of Glencore Coal Pty Limited (Glencore) and 5 per cent by the Construction, Forestry, Mining and Energy Union (CFMEU)) enter into a 50:50 Joint Venture at the open cut mine. United will manage Joint Venture tenements (i.e. open cut operations), and WCPL will continue to operate underground mining operations.

Phase 2 commenced on 1 December 2020, and open cut operations are now covered under SSD 7142. Operations under Development Consent DA177-8-2004 have not changed following the commencement of Phase 2.



WAM-09-15 AR 2020_201A

LEGEND
- Mining and Coal Lease Boundary
- Local Government Area
- National Parks and Wildlife Estate
- State Forest
- Mining Operation
- Proposed Mining Operations (Application Lodged)

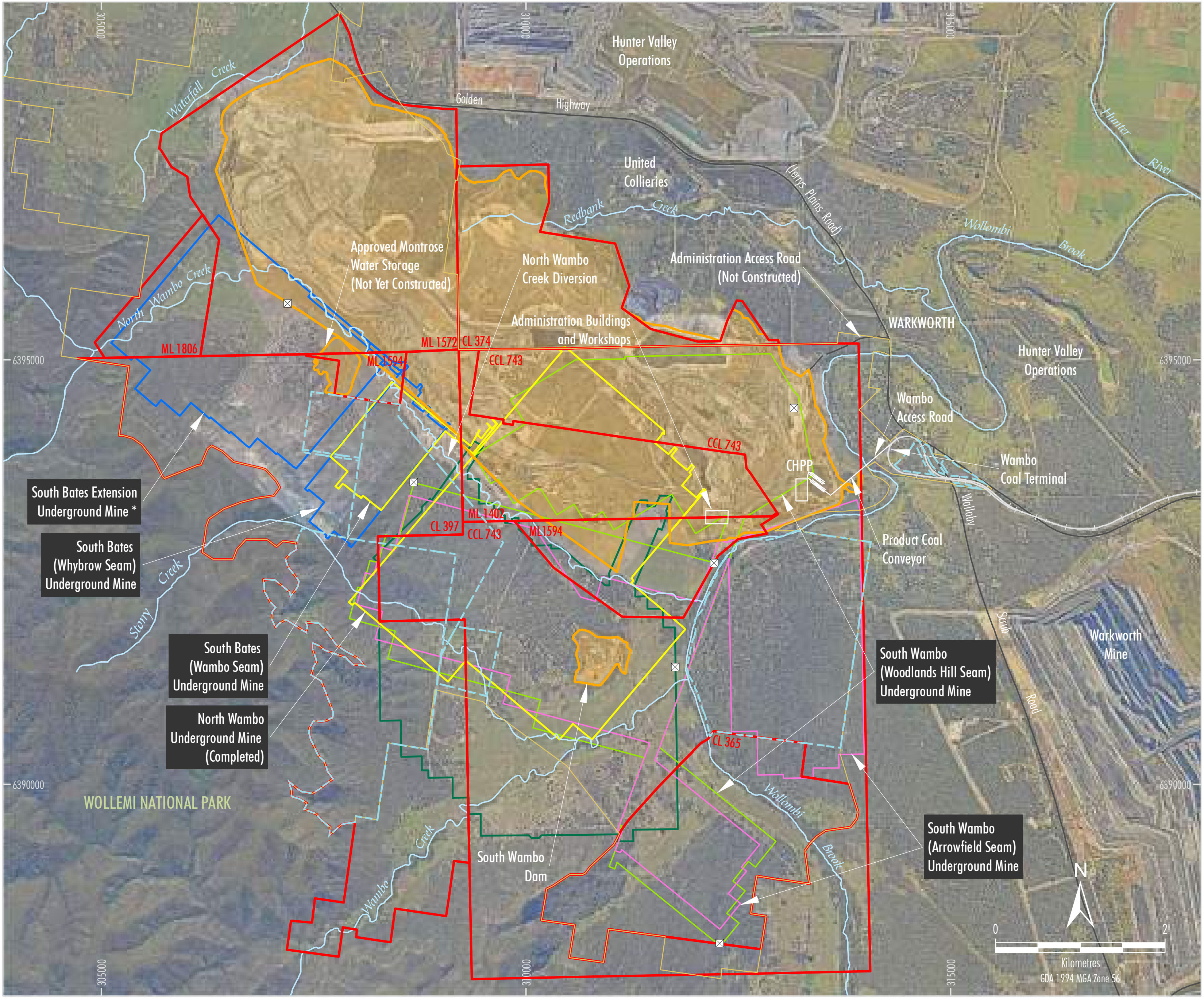
Source: NSW Spatial Services (2021)

Peabody

W A M B O   C O A L   M I N E

Regional Location

Figure 1



LEGEND
WCPL Owned Land
Mining and Coal Lease Boundary
Existing/Approved Surface Development Area (Phase 1)
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

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

Source: WCPL (2021); NSW Spatial Services (2021)
Orthophoto: WCPL (Sept - May 2019)

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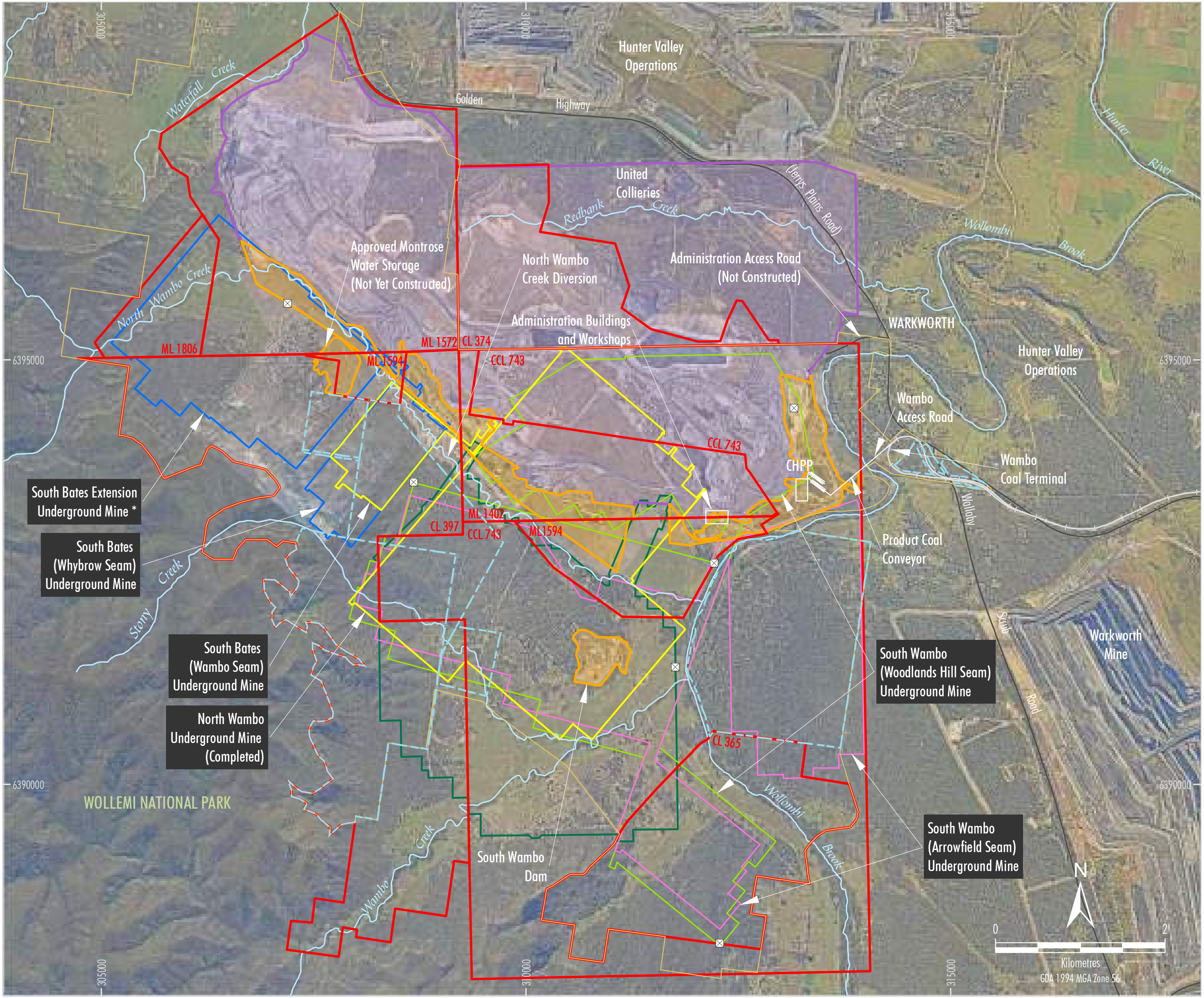
WAMBO COAL MINE

Approved Wambo Coal Mine
Phase 1 General Arrangement

Figure 2

WAM-09-15 AR 2020_202A



LEGEND

- WCPL Owned Land
- Mining and Coal Lease Boundary
- SSD 7142 Operational Area #
- Existing/Approved Surface Development Area (Phase 2)
- 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

Under Phase 2 of mining at Wambo Coal Mine (commenced 1 December 2020), this area is operated by United Colleries Pty Ltd under the United Wambo Joint Venture Project.

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

Source: WCPL (2021); NSW Spatial Services (2021)
Orthophoto: WCPL (Sept - May 2019)

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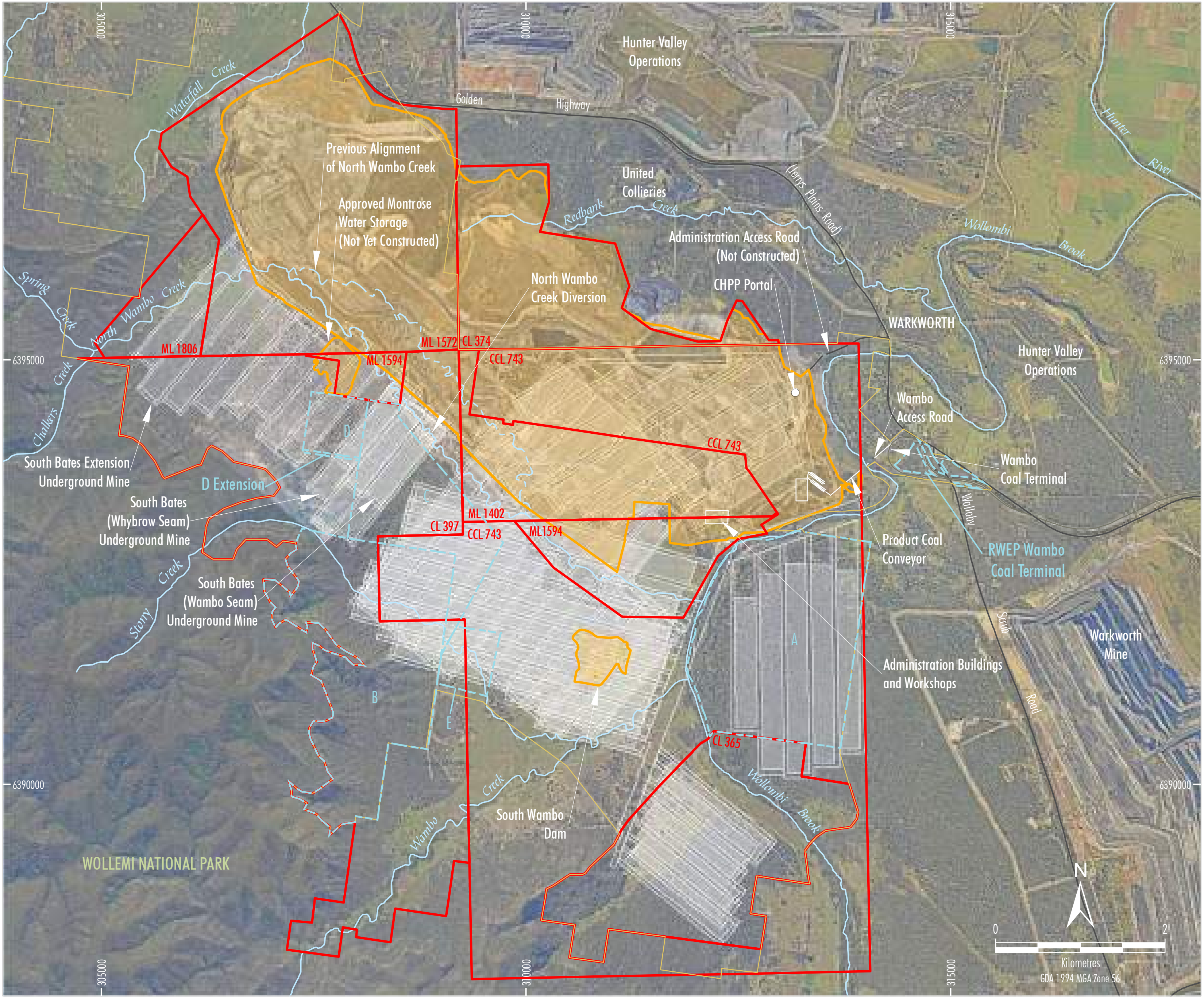
WAMBO COAL MINE

Approved Wambo Coal Mine Phase 2 General Arrangement

Figure 3

WAM-09-15 AR 2020_204A



LEGEND

- WCPL Owned Land
- Mining and Coal Lease Boundary
- Existing/Approved Surface Development Area (Phase 1)
- Approved Underground Development
- Remnant Woodland Enhancement Program (RWEP) Area

Source: WCPL (2021); NSW Spatial Services (2021)
Orthophoto: WCPL (Sept - May 2019)

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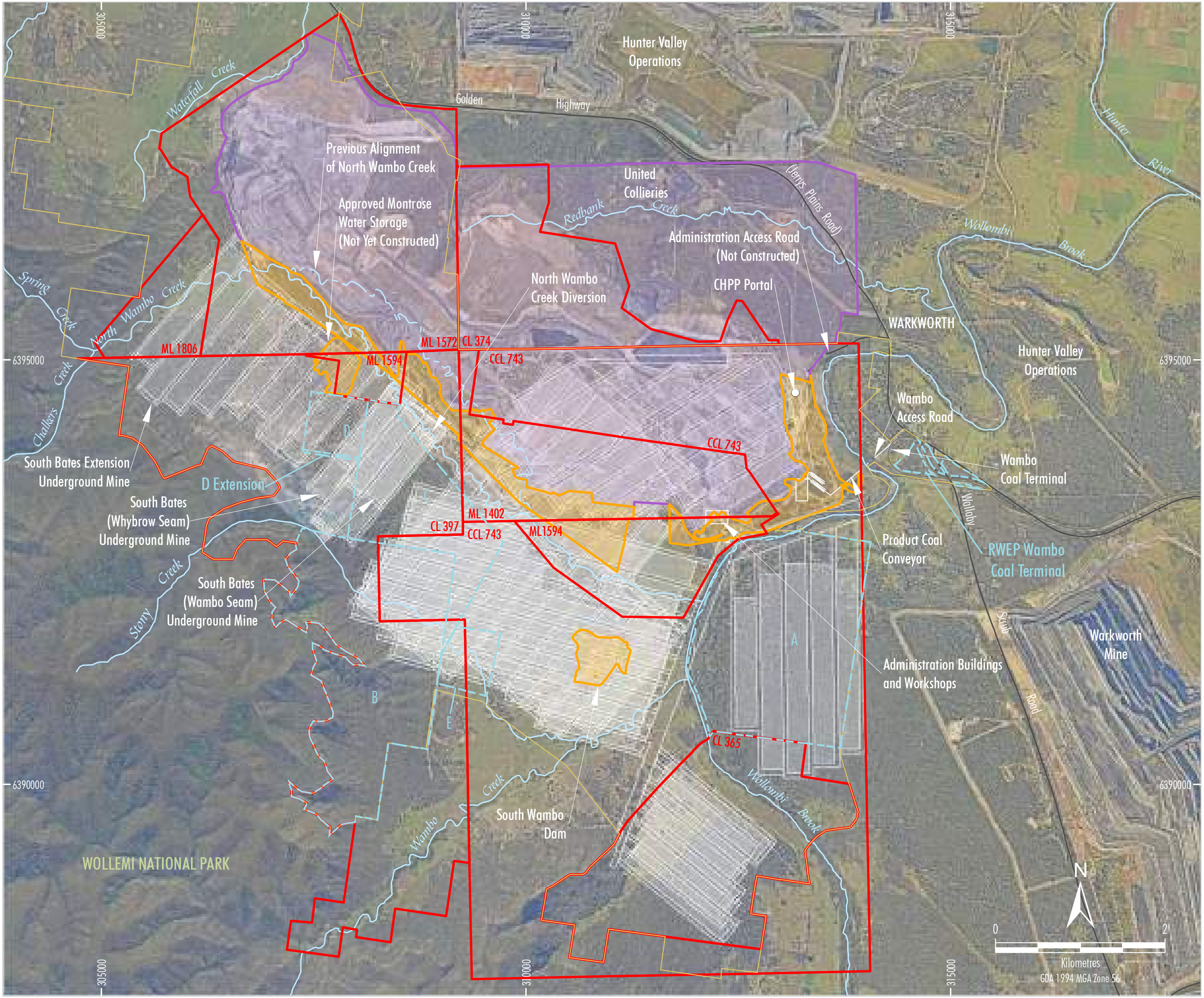
WAMBO COAL MINE

Approved Wambo Coal Mine Layout
Phase 1

Figure 4

WAM-09-15 AR 2020_203A



LEGEND
WCPL Owned Land
Mining and Coal Lease Boundary
SSD 7142 Operational Area #
Existing/Approved Surface Development Area (Phase 2)
Approved Underground Development
Remnant Woodland Enhancement Program (RWEP) Area

Under Phase 2 of mining at Wambo Coal Mine (commenced 1 December 2020), this area is operated by United Colleries Pty Ltd under the United Wambo Joint Venture Project.

Source: WCPL (2021); NSW Spatial Services (2021)
Orthophoto: WCPL (Sept - May 2019)

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WAMBO COAL MINE

Approved Wambo Coal Mine Layout
Phase 2

Figure 5

WAM-09-15 AR 2020_205A

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

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

This Annual Review is distributed to a range of stakeholders including government authorities, Singleton 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.
Michael Alexander	Director Projects & Portfolio Management	(02) 6570 2361
Peter Jaeger	Manager: Environment and Community	(02) 6570 2209

2.0 Approvals

2.1 Current Approvals

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

Table 2: WCPL's Statutory Approvals

Type	Description	Issued By[1]	Issue Date	Expiry Date
Development Approval	DA305-7-2003[2]	DPIE	04/02/2004	31/12/2042
Development Approval	DA177-8-2004[3]	DPIE	16/12/2004	16/12/2025
EPBC Approval[4]	EPBC 2003/1138	AWE	23/11/2004	31/12/2029
EPBC Approval[4]	EPBC 2016/7636	AWE	30/4/2017	01/03/2037
EPBC Approval[4]	EPBC 2016/7816	AWE	4/5/2018	31/12/2039
Mining Lease	ML1402	DRG	23/09/1996	14/08/2022
Mining Lease	ML1572	DRG	21/12/2005	20/12/2026
Mining Lease	ML1594	DRG	01/05/2007	30/04/2028
Mining Lease	ML1806	DPIE	11/08/2020	11/08/2041
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	16/05/2021
Exploration Licence[6]	EL7211	DRG	-	-
Environment Protection Licence	EPL529	EPA	04/02/2021	-
S101 Approval[7]	Approval to discontinue use of the North East Tailings Dam (NETD)	DRG	03/09/2009	-

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

Table 3: WCPL's Water Licences

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

Licence Number[1]	Description	Expiry Date	Entitlement	Category	Access Licence	Nominated Water Supply Work Approval	Expiry Date
WAL 41532 (20BL172156)	Dewatering	Perpetuity	98 unit shares	Aquifer	20AL218994	20MW065010	-
20BL168997	Piezometer	Perpetuity	Groundwater monitoring	NA	-	-	-
20BL168998	Piezometer	Perpetuity	Groundwater monitoring	NA	-	-	-
20BL168999	Piezometer	Perpetuity	Groundwater monitoring	NA	-	-	-
20BL169000	Piezometer	Perpetuity	Groundwater monitoring	NA	-	-	-
20BL170638	Piezometer	Perpetuity	Groundwater monitoring	NA	-	-	-
20BL172237	Monitoring Bore (GW14, GW18, GW21)	Perpetuity	Groundwater monitoring	NA	-	-	-
20BL172238	Monitoring Bore (GW12)	Perpetuity	Groundwater monitoring	NA	-	-	-
20BL172240	Monitoring Bore (GW15)	Perpetuity	Groundwater monitoring	NA	-	-	-
20BL172242	Monitoring Bore (GW16, GW17)	Perpetuity	Groundwater monitoring	NA	-	-	-
20BL172244	Monitoring Bore (GW20)	Perpetuity	Groundwater monitoring	NA	-	-	-
20BL172255	Monitoring Bore (GW22)	Perpetuity	Groundwater monitoring	NA	-	-	-
20BL172256	Monitoring Bore (GW13)	Perpetuity	Groundwater monitoring	NA	-	-	-
20BL172257	Monitoring Bore (GW19)	Perpetuity	Groundwater monitoring	NA	-	-	-

Licence Number[1]	Description	Expiry Date	Entitlement	Category	Access Licence	Nominated Water Supply Work Approval	Expiry Date
20BL172332	Piezometer	Perpetuity	Groundwater monitoring	NA	-	-	-
20BL173290	Monitoring Bore	Perpetuity	Groundwater monitoring	NA	-	-	-
20BL173291	Monitoring Bore	Perpetuity	Groundwater monitoring	NA	-	-	-
20BL173292	Monitoring Bore	Perpetuity	Groundwater monitoring	NA	-	-	-
20BL173293	Monitoring Bore	Perpetuity	Groundwater monitoring	NA	-	-	-
20BL173946	Monitoring	Perpetuity	Groundwater monitoring	NA	-	-	-
20BL173999	Monitoring Bore	Perpetuity	Groundwater monitoring	NA	-	-	5/12/2023
-	Bore	Perpetuity	Stock	Basic Rights	-	20WA214848	-
-	Bore	Perpetuity	Stock	Basic Rights	-	20WA214849	-
-	Bore	Perpetuity	Stock	Basic Rights	-	20WA214850	-
-	Bore	Perpetuity	Stock	Basic Rights	-	20WA214851	-
-	Spearpoints	Perpetuity	Stock/Domestic	Basic Rights	-	20WA215574	-

WAL = water access licence; mm = millimetres.

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

2.2 Changes to Approvals

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

- The Extraction Plan for South Bates Extension Underground Mine Longwalls 21 to 24 was submitted in July 2020. The application for the Extraction Plan is currently pending.
- A new Mining Operations Plan (MOP)/Rehabilitation Management Plan (RMP) (for the period December 2020-December 2023) was lodged with the Resources Regulator (RR) in October 2020 and was approved on 27 November 2020.
- Mining Lease Application (MLA 557) was submitted to RR on 14 May 2018 and approved as Mining Lease 1806 (ML 1806) on 11 August 2020. The expiration date of ML 1806 is 11 August 2041.
- Environmental Protection Licence (EPL) 529 was originally granted by the EPA in 2000. During the reporting period, EPL529 was varied on 27 March, 29 September and 3 December 2020.

In October 2019, WCPL made an Application for a renewal of Exploration Licence EL7211. At the time of preparing this Annual Review, the application is still pending. A444 was renewed on 22 January 2020 with an extended expiry date on 16 May 2021.

On 29 August 2019, the UWJV (State Significant Development [SSD] 7142, DA305-7-2003 [Modification 16] and DA177-8-2004 [Modification 3]) was determined. As described in the UWJV Environmental Impact Statement (EIS) (Umwelt 2016), United (or another Glencore related company) will operate all future open cut mining in the SSD 7142 Operational Area (refer to **Figure 5**). The Wambo Open Cut operated under its existing approvals (i.e. DA305-7-2003 [Modification 16] and DA177-8-2004 [Modification 3]) until the point at which mining operations comprising the UWJV commenced on 1 December 2020 (i.e. Phase 2). At this point, open cut operations fell under regulation by a new development consent for the UWJV (i.e. SSD 7142).

The UWJV utilises the available approved capacity in WCPL's existing Coal Handling and Processing Plant (CHPP) and train loading facilities. WCPL continues to operate these facilities in accordance with the approved throughput provided by its current approvals (and continued as part of the UWJV), with the UWJV delivering ROM coal to these facilities for coal washing, handling and loading coal onto trains for transportation. These facilities continue to be managed and operated under WCPL's existing development consents.

The Wambo Coal Mine underground operations does not form part of the UWJV and continues to be owned and managed by WCPL. The Wambo Coal Mine underground operations continues to use the Wambo CHPP and train loading facility.

To prepare for Phase 2, an updated suite of management plans were prepared and approved by DPIE. These management plans focus on underground mining as part of Phase 2 operations. Management plans for UWJV open cut have been prepared by United.

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 to encompass Phase 2 operations at the Mine. A summary of the status of required management plans is presented in **Table 4.**

Table 4: Status of WCPL's Environmental Management Plans

Management Plan	Status	Approved Version[1]
North Wambo Underground Extraction Plan for Longwalls 8 to 10A (and associated component plans)	Approved – 2015	April 2015
South Bates Underground Mine Extraction Plan for Longwalls 11 to 16 (and associated component plans)	Approved – 2017	July 2017[2]
South Bates Extension Underground Mine Extraction Plan for Longwalls 17 to 20 (and associated component plans)	Approved – 2019	Revision C (June 2019)[3]
South Bates Extension Underground Mine Extraction Plan for Longwalls 21 to 24 (and associated component plans)	Current Application – 2020	Revision B (January 2021)
MOP/RMP	Approved – 2020	MOP December 2020-December 2023 (Nov 2020)
Blast Management Plan[4] (Blast MP)	Approved – 2019	Version 10 (Nov 19)
Environmental Management Strategy	Approved – 2020	Version 7 (Nov 2020)
Air Quality & Greenhouse Gas Management Plan (AQGGMP)	Approved – 2020	Version 8 (Nov 2020)
Noise Management Plan	Approved – 2020	Version 11 (Nov 2020)
Water Management Plan	Approved – 2020	Version 2 (Nov 2020)
Groundwater Management Plan	Approved – 2020	Version 2 (Nov 2020)
Surface Water Management Plan	Approved – 2020	Version 2 (Nov 2020)
United Wambo and Wambo Site Water Balance	Approved – 2020	Version 2 (Aug 2020)
United Wambo and Wambo Water Monitoring Plan	Approved – 2020	Version 2 (Nov 2020)
Erosion and Sediment Control Plan	Approved – 2020	Version 2 (Nov 2020)
Biodiversity Management Plan (BMP) (previously the Flora and Fauna Management Plan)	Approved – 2020	Version 2 (Nov 2020)
Heritage Management Plan	Approved – 2018	Version 5 (July 2018)
Wambo Homestead Complex Conservation Management Plan	Approved – 2019	Version 6 (May 2019)
Pollution and Incident Response Management Plan	Approved – 2019	Version 4 (Jan 2019)

1. Approved version as at the end of the reporting period.
2. On 11 October 2017, DPE (now DPIE) approved the South Bates Underground Mine Longwalls 11 to 16 Extraction Plan with the exception of the Site Water Management Plan (and associated component plans), which were unable to be approved until they were updated in consultation with Department of Industry – Water (DI-Water) (now Department of Primary Industries and Environment – Water [DPIE-Water]). In 2018, the South Bates Extension Underground Mine Longwalls 17 to 20 Extraction Plan (including the Site Water Management Plan which had been updated in consultation with DI-Water [now DPIE-Water]) was approved by DPE (now DPIE).
3. On 4 September 2018, WCPL provided DPE (now DPIE) with correspondence explaining that geological structures had been encountered that may require changes to the main headings and finishing ends of Longwalls 18, 19 and 20. Accordingly, WCPL requested that DPE (now DPIE) approve the Extraction Plan for Longwalls 17 to 20 for extraction of Longwall 17 only. On 7 September 2018, DPE (now DPIE) approved the extraction of Longwall 17 only, on the basis that WCPL would prepare an amended Extraction Plan for Longwalls 18, 19 and 20. On 1 March 2019, WCPL submitted an amended Extraction Plan for Longwalls 17 to 20. DPIE approved the amended Extraction Plan on 4 June 2019.
4. Includes WCPL's Blast Fume Management Strategy (Version 4) which was approved in November 2019. No longer relevant following the commencement of Phase 2 on 1 December 2020.

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

In accordance with Schedule 2, Condition D7 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.

3.0 Operations Summary

3.1 2020 Mining Operations

The Mine operates seven days a week, 24 hours a day on a rotating shift basis. On 19 June 2020, WCPL commenced a 59 day partial shutdown of production in the underground operations. Coal processing and handling activities continued at a reduced rate during this period. Full underground production recommenced 17 August 2020.

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

- South Bates Extension Underground Mine (current longwall mining area):
  - Longwall 19 (completed 18 May 2020); and
  - Longwall 20 (commenced 5 January 2020 and remains active).
- Open cut (as part of Phase 1 operations until 30 November 2020, no open cut operations were undertaken by WCPL from 1 December 2020 [i.e. following the commencement of Phase 2]):
  - Continued mining operations in Homestead (East wall);
  - Continued mining operations in Montrose (Hilldale);
  - Continued mining operations in Montrose (Peabody Peak);
  - Continued mining operations at Montrose West (High wall); and
  - Continued mining operations at Montrose East Crown (End wall).

Table 5 shows the production summary for 2020, compared to the production for 2019 and the forecast production for 2020 and 2021.

Following the commencement of Phase 2 operations on 1 December 2020, production material (including waste rock/overburden, ROM coal/ore, coarse/fine reject and saleable product) from open cut operations is covered under SSD 7142.

Table 5: Production Summary

Material	Unit	Approved limit	2019 reporting period (actual)	2020 reporting period (forecast)	2020 reporting period (actual)	2021 reporting period (forecast)[3]
Waste Rock/ Overburden	bcm	-	37,195,422	36,794,452	33,313,464	0
ROM Coal/ Ore	Mt	14.7[1]	7.98	7.75	6.97	1.9
Coarse Reject	Mt	-	2.54	2.39	1.37	1.2
Fine Reject (Tailings)	Mt	-	0.44	0.42	0.97	0.91
Saleable Product	Mt	15[2]	4.996	4.94	4.64	1.4

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

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

3 under Phase 2 of the UWJV, open cut operations are undertaken by United,underground mining, coal processing and tailings by WCPL .

During the reporting period, a total of 4.64 Mt of product coal was transported off-site via rail (no coal was hauled off-site by trucks). A summary of 2020 daily train movements, required by Schedule 2, Condition B29(b) of DA177-8-2004 is provided in **Appendix B**.

A total of 570 trains were loaded during the reporting period with 48 trains loaded on Friday evening (between 6 pm to 9 pm) and Sunday morning (between 9 am to 12 am). In accordance with Schedule 2, Condition A12 of DA177-8-2004, WCPL took all reasonable steps to minimise train movements within these hours.

During the reporting period, 0.3 Mt less than the predicted saleable product was produced at the Mine. The actual ROM coal production (6.97 Mt) was less than the forecast ROM coal production (7.75 Mt) as the forecast volumes for 2020 were calculated under the assumption that Phase 2 of UWJV would commence in 2019, however Phase 2 of UWJV did not commence until December 2020. The actual waste rock/overburden produced was less than forecast for the same reason (i.e. continued open cut operation at the Mine).

Figure 6 shows the amount of saleable product coal transported off-site on a weekly basis.

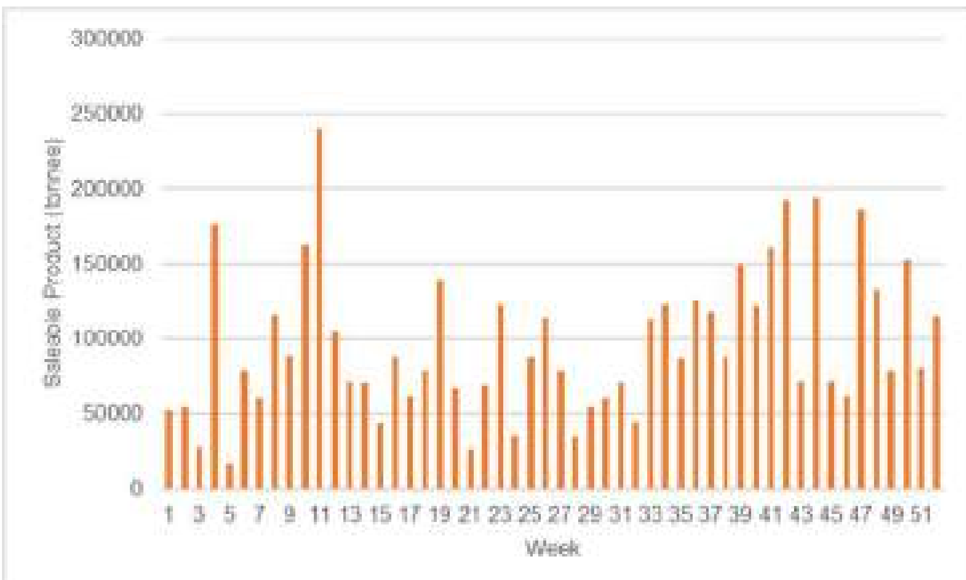


Figure 6: Coal Transported Off-site during the Reporting Period

3.2 Next Reporting Period

Operations during the next reporting period will be undertaken in accordance with the approved relevant Extraction Plan and will include continued mining at the South Bates Extension Underground Mine, including:

- Longwall 20 (commenced 17 August 2020); and
- Longwall 21 (anticipated to commence in April 2021).

4.0 Actions Required from Previous Annual Reviews

A number of actions and improvements have been identified in previous Annual Reviews undertaken by WCPL. Actions and improvements recommended in the 2015 Annual Review, 2016 Annual Review, 2017 Annual Review, 2018 Annual Review and 2019 Annual Review, and their current status are summarised in **Table 6**. In addition, further information/actions requested by DPIE and Resources Regulator are also addressed in these tables.

Table 6: Actions from Previous Annual Reviews

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 Bushfire Management Plan was conducted and sent for review from Singleton Council. WCPL will address any comments received and provide the updated plan to DPIE for approval;	WCPL	A Bushfire Management Plan is no longer required under Development Consents DA305-7-2003 andDA177-8-2004. Hazards reduction and maintenance of fire trails will be conducted as required.	-
A HRSTS system audit will be undertaken if discharges through the HRSTS occur during the next reporting period.		No discharges were recorded during the reporting period.	-
Works associated with the North East Tailings Dam Rehabilitation Strategy (NETDRS), including the construction of a trial abutment and any additional works undertaken (if the trial is successful).		Ongoing. Cone Penetrometer Testing (CPT) occurred in March and April of 2020 of the tailings in both NETD and the HPTD facilities WCPL intends to conduct a trial of capping by the displacement method in Quarter 3 of 2021.	Section 7.1.1
A comprehensive rehabilitation project for the exploration bores (including the remaining 11 exploration holes drilled in the previous reporting period) was planned for commencement in Quarters 1 and 2 of 2020;		Ongoing. Inspections will be undertaken in accordance with Exploration Rehabilitation Management Plan, and necessary amendments will be made to ensure exploration rehabilitation continues to progress.	Section 5.10

Action/Improvement required from previous Annual Review	Requested by	Action taken by the Operator	Where discussed in Annual Review
A description of subsidence remediation activities that are undertaken in areas overlying Longwalls 11 to 16 at the South Bates Underground Mine will be provided.		Ongoing. Temporary repairs were conducted during 2018 with more comprehensive remediation works scheduled for 2019. A subsidence remediation action plan was developed in 2018 proposing to conduct final remediation works over the South Bates Underground Mine and other historical subsidence areas in 2019. In 2019, subsidence monitoring and remediation focused on the South Bates Underground Mine with 37 subsidence sites rehabilitated. The remediation campaign occurred over a three month period in April, May and June 2019. The sites ranged from small potholes to large cracks several meters in length. During 2020, subsidence monitoring and remediation focused on the South Bates Underground Mine with 51 subsidence sites rehabilitated. This included 27 sites in and adjacent to the North Wambo Creek Diversion. Subsidence monitoring will continue to monitor further subsidence, vegetation coverage and weeds in the next reporting period.	Section 5.9.3
An update on the comprehensive rehabilitation project of exploration sites scheduled to be undertaken in March and April 2019.		Ongoing. To date, no holes have been signed off as completely rehabilitated, however a comprehensive rehabilitation project is ongoing. By the end of this rehabilitation project, all sites drilled during the reporting period will have the preliminary rehabilitation completed, and will require a follow up inspection to determine final rehabilitation status.	Section 5.10
WCPL will install replacement bores for GW08 and GW09 in the North Wambo Creek alluvium in areas that are not located above the old Wambo No. 1 Seam workings.		Complete. Monitoring bores GW8.2, GW9.2 and GW10.2 were installed and implemented into the monitoring program during the reporting period.	Section 6.2.3
WCPL will prepare updated management plans to address the modified Development Consent		Complete. The updated suite of Management Plans is available on the WCPL website.	-
WCPL will continue to follow up with BCD to finalise the Conservation Agreement during the reporting period.		Complete. The Conservation Agreement was finalised during the reporting period, with the Registration Notice dated 27 August 2020.	Section 5.6.2

Action/Improvement required from previous Annual Review	Requested by	Action taken by the Operator	Where discussed in Annual Review
The North Wambo Creek Diversion (NWCD) Plan will be revised and submitted to DPE (now DPIE) for approval in April 2019. Within three months of approval of the NWCD Plan, the Action Plan will be incorporated into the MOP/RMP as an appendix.	RR[1]	Complete. The NWCD Plan is no longer required under DA305-7-2003 however it was approved as a component of the Surface Water Management Plan in November 2020.	N/A

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

5.0 Environmental Performance

The latest modification to DA305-7-2003 (MOD 16), approved by the Independent Planning Commission of NSW on 29 August 2019, requires development at the Mine to be undertaken in the following stages:

- Phase 1 – open cut mining operations at Wambo open cut mine, underground mining operations at Wambo underground mine and the operation of Wambo mine infrastructure (including minor upgrades to this infrastructure) under DA305-7-2003 (**Figure 4**).
- Phase 2 – underground mining operations at Wambo underground mine, the operation of Wambo mine infrastructure under DA305-7-2003 and associated surface infrastructure. (**Figure 5**).
- Phase 3 – following the cessation of underground mining operations that includes mine closure.

Accordingly, operations at the Mine were considered to be in Phase 1 from 1 January 2020 – 30 November 2020 and in Phase 2 from 1 December 2020 – 31 December 2020.

Operations under Development Consent DA177-8-2004 are not impacted by the transition from Phase 1 to Phase 2.

5.1 Noise

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

The noise monitoring network during the reporting period consisted of five attended noise monitoring locations (two of which were coincident with real time noise monitors).

During 2020, attended noise monitoring was undertaken monthly at N01, N16, N20A, N21 and N26. For further detail, refer to WCPL's approved NMP.

5.1.1 Approval Criteria/EIS Predictions and Management Plan Requirements

A summary of the approval criteria for noise in relation to sensitive receivers is included in **Table 7** and **Table 8**, for Phase 1 and Phase 2 respectively.

Table 7: Impact Assessment Criteria for Noise DA305-7-2003 Phase 1 Operations

Receiver	Noise Impact Assessment Criteria Applicable from 1 January 2020 to 30 November 2020[1]		
	Day $L_{Aeq,15minute}$ (dB)	Evening/Night $L_{Aeq,15minute}$ (dB)	Night $L_{A1,1minute}$ (dB)
R019	59	59	N/A
R003	40	40	50
R016			
R025			
R029			
R033			
R039			
R042			
R320 (previously 15B)			
R345 (previously 15B)			
R006	39	39	50
R007			
R048			
R343 (previously 37)			
R017	38	38	50
R030 (previously 38)			
R035			
R049			
R075			
R346			
R348			
R379 (previously 91)			
R043	37	37	50
R163			
R344 (previously 137)			
R380 (previously 246)			
R381 (previously 178)	36	36	50
All other privately-owned residences	35	35	50

Note: dB = decibels.

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

Table 8: Impact Assessment Criteria for Noise DA305-7-2003 Phase 2 Operations

Noise Assessment Area	Receiver	Noise Impact Assessment Criteria Applicable from 1 December 2020 to 31 December 2020			
		Day $L_{Aeq,15minute}$ (dB)	Evening/Night $L_{Aeq,15minute}$ (dB)	Night $L_{Aeq,15minute}$ (dB)	Night $L_{A1,1minute}$ (dB)
Area 1 – North Bulga	R003	38	38	38	48
	R007	37	37	37	47
	R379 (previously 91)	37	37	37	47
	All other privately-owned residences	35	35	35	5
Area 2 – South Wambo	R025	39	39	39	49
	R035a	37	37	37	47
	All other privately-owned residences	35	35	35	45
Area 3 Warkworth Village	R019	59	59	59	69
	All other privately-owned residences	44	44	43	53
All other areas	All other privately-owned residences	35	35	35	45

For the entirety of the reporting period (i.e. during Phase 1 and Phase 2 operations), the noise impact assessment criteria in DA305-7-2003 (Modification 16) did not apply under meteorological conditions of:

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

Condition L5.1 of EPL529 includes similar noise emission limits to those identified in DA305-7-2003 for Phase 1 of operations. Conditions L5.5 and L5.6 of EPL529 specify that the noise emission limits identified in Condition L5.1 do not apply under meteorological conditions of:

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

Note, the noise criteria in EPL529 have not been updated to reflect Phase 2 of operations, therefore, the noise criteria in the Development Consent (DA305-7-2003) (which is now more conservative than those in EPL529) have been used to assess compliance in December 2020.

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

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

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

5.1.2 Performance during the Reporting Period

During the reporting period, WCPL complied with all operational requirements detailed in the WCPL NMP. Noise levels from the Mine complied with the relevant Development Consent and EPL criteria at all sites during 2020 attended monitoring, except on two occasions. Further detail is provided in **Section 10.1**.

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

Eighty-three (83) 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 11 of DA305-7-2003 (Condition C1, Schedule 2).

5.1.2.1 Comparison with UWJV EIS Predictions

An annual report summarising the attended noise monitoring data and comparisons against the UWJV EIS noise predictions is included in **Appendix C** (Global Acoustics 2021).

Global Acoustics (2021) compared predicted noise levels from the Year 2 scenario in the UWJV EIS (Umwelt 2016) against the actual noise levels measured during 2020.

The UWJV EIS (Umwelt 2016) uses a cumulative distribution methodology wherein all meteorological conditions are considered and weighted based on how often they occur. In order to compare measured and predicted noise levels, comparison should only occur when noise-enhancing atmospheric conditions are present. Noise-enhancing conditions have been determined for each monitoring location in accordance with the NPfI.

The comparison indicated that:

- At N01, measured noise levels were typically not comparable to Year 2 predictions in the EIS, apart from one instance in which the measured site-only L_{Aeq} was lower than predicted.
- At N16, measured L_{Aeq} noise levels were lower than Year 2 predictions in the EIS when comparable to modelled noise levels. Measured LA1,1minute noise levels were not comparable with Year 2 predictions in the EIS.
- At NA20, measured noise levels were lower than Year 2 predictions in the EIS when comparable to modelled noise levels.
- At N21, measured L_{Aeq} noise levels were typically not comparable with Year 2 predictions in the EIS, apart from one instance in which the measured site-only L_{Aeq} was lower than predicted. When comparable to modelled noise levels, measured LA1,1minute noise levels were higher than predicted in the EIS on two occasions and lower than predicted on three occasions.
- At N26, measured L_{Aeq} noise levels were similar to Year 2 predictions in the EIS. When comparable to modelled noise levels, measured LA1,1minute noise levels were higher than predicted in the EIS on one occasion and lower than predicted on three occasions.

5.1.3 Trends and Key Management Implications

Global Acoustics (2021) considered that noise levels at most monitoring locations increased from 2016 to 2018 as mining operations progressed to the northwest and were initially less shielded. From 2018 to 2020, site noise levels decreased at most monitoring locations, likely due to mining activity being deeper in pit and therefore more shielded from receptors (**Appendix C**).

At N01, site-only L_{Aeq} noise levels were low (either IA, NM, or less than 30 dB) for a large majority of measurements.

At N16, site-only L_{Aeq} noise levels increased from 2016 to 2018, then decreased in 2019 and 2020.

At N20A, N21 and NA26, site-only L_{Aeq} noise levels decreased from 2018 to 2020.

As with previous reporting periods, wind speeds and/or temperature inversion conditions were at levels greater than which the Development Consent and EPL 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.

5.2 Blasting

Air Blast Overpressure Limits and Ground Vibration Impact Assessment Criteria for the Mine are defined in Condition B22, Schedule 2 of DA305-7-2003 and Condition L5 of EPL529. 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 MP are also detailed in these approval documents.

From 1 December 2020 (following the commencement of Phase 2 of the UWJV), no blasting associated with open cut operations is allowed on site. Blasting activities associated with the open cut are managed by United.

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

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

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

1. For St Philip's Church, WCPL shall ensure that ground vibration peak particle velocity generated by the Mine does not exceed 2.5 millimetres per second (mm/s).
2. Additional locations have been included as part of the revised DA305-7-2003 in response to Mod 17 approved 29 August 2019.

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 Blast MP. These requirements include annual reporting on performance against the performance indicators detailed within the approved WCPL Blast MP (**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

A total of 61 blasts were undertaken at the Mine up until 30 November 2020.

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 D**.

Table 11: Blast Monitoring Results 2020

Parameter	Criteria	Results Exceeding Approval Criteria					
		BM02		BM05		BM07	
		No.	%	No.	%	No.	%
Airblast Overpressure Level (dB Lin Peak [dBL])	115	0	0	2	3	1	1
	120	0	0	0	0	0	0
Ground Vibration Peak Particle Velocity (mm/s)	5	1	1	0	0	0	0
	10	0	0	0	0	0	0

Note: dBL = low frequency noise levels.

Less than 5% of all blasts recorded overpressure greater than 115 dBL, and no blasts resulted in overpressure greater than 120 dBL being recorded at BM02, BM05 or BM07.

Less than 5% of all blasts recorded a ground vibration greater than 5 mm/s and no blasts resulted in ground vibration of greater than 10 mm/s being recorded at BM02, BM05 or BM07.

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.

Three (3) complaints were received regarding blasting (i.e. relating to vibrations, dust and fumes) from the Mine during the reporting period (**Section 8.3**).

In November 2020, a neighbouring landowner requested assistance to repair a cracked concrete water tank. The landowner believes the tank has cracked as a result of blasting damage. WCPL engaged a structural engineer to assess damage to the water tank and review relevant blast data. The results of the assessment will be reported in the next Annual Review.

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 2020 Monitoring Data – Blasting

Land Holder	Midpoint Distance to Dwellings[1]	Predicted Levels		Closest WCPL Blast Monitor to Land Holder	Maximum Recorded Level During Report Period	
		Airblast (dB re 20 µPa)	Vibration (mm/s)		Airblast (dB re 20 µPa)	Vibration (mm/s)
2 Lambkin	4,500 m	112 dBL	1.6 mm/s	BM03[2]	104.2	0.2
25 Fenwick	3,300 m	114 dBL	1.9 mm/s	BM03[2]	104.2	0.2
13(B) Skinner	1,000 m	123 dBL	4.0 mm/s	N/A[3]	N/A[3]	N/A[3]
24 Long	600 m	127 dBL	5.4 mm/s	N/A[3]	N/A[3]	N/A[3]

Note: µPa = micropascals.

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

During the reporting period, a maximum airblast overpressure level of 104.2 dBL was recorded at BM03 (11 April 2020), which is located closer to blasting activity than the Fenwick and Lambkin dwellings. This was 9.2 dB below the predicted airblast overpressure level for Fenwick (114 dBL) and 7.2 dB below the predicted airblast overpressure level for Lambkin (112 dBL). For comparison, the overpressure level recorded at the other WCPL blast monitors during this blast was:

- 106.8 dBL at BM01 (approximately 3 km north of BM03 [also located on WCPL land]);
- 99.8 dBL at BM02 (approximately 5 km north east of BM03);
- 99.0 dBL at BM05 (approximately 10 km north west of BM03); and
- 101.7 dBL at BM07 (approximately 10 km north west of BM03).

The maximum ground vibration level recorded at BM03 was 0.2 mm/s (on 20 August 2020). This is well below the predicted levels for both Lambkin and Fenwick.

5.2.3 Trends and Key Management Implications

A total of 61 blasts were recorded during 2020, compared with 90 in 2019, 96 in 2018, 96 in 2017, 106 in 2016, 79 in 2015, 75 in 2014 and 62 in 2013. Air blast overpressure and ground vibration levels recorded during 2020 were similar to those recorded in the previous reporting periods.

Two blasts during the reporting period resulted in an exceedance of the criteria for overpressure (115 dBL) at BM05, on 19 March 2020 and 16 July 2020. The corresponding ground vibration for these blasts were 0.77 mm/s and 0.19 mm/s, respectively. As less than 5% of blasts exceeded the 115 dBL criteria, operations remained in compliance with the relevant criteria. There were no exceedances of the 120 dBL criteria for overpressure.

One blast during the reporting period resulted in an exceedance of the criteria for ground vibration (5 mm/s) at BM02, on 21 January 2020. The corresponding overpressure for this blast was 83.3 dBL. As less than 5% of blasts exceeded the 5 mm/s criteria, operations remained in compliance with the relevant criteria. There were no exceedances of the 120 dBL criteria for overpressure.

During the reporting period, blasting was undertaken within 2 km of the WHC on one occasion (26 March 2020). With regards to this event:

- In accordance with Condition B22, Schedule 2 of DA305-7-2003, ground vibration and air blast levels were recorded for each event.
- Condition B33, Schedule 2 of DA305-7-2003 requires that blasting on the site does not cause exceedances of 120 dBL (overpressure) or 5 mm/s (vibration) at the WHC.
- No exceedances of these criteria were identified during the reporting period.
- Blasting was undertaken in accordance with the approved WCPL Blast MP and results of monitoring undertaken at the WHC indicated compliance with all criteria.
- The results of these blasts are discussed further in the Wambo Homestead 6-month Blasting Assessments which were provided to the NSW Heritage Branch in accordance with Condition B35, Schedule 2 of DA305-7-2003.

WCPL achieved a data capture rate of 100% for overpressure and 100% for vibration during the reporting period[1].

5.2.4 Implemented or Proposed Management Actions

During the next reporting period, blasting conducted for open cut operations will continue to be managed by United under Phase 2 operations of the UWJV.

5.3 Air Quality

Air quality criteria for the Mine are defined in Table 6 of DA305-7-2003 (Condition B42, Schedule 2) and EPL529 (Condition M2.2). 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.

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

5.3.1 Approval Criteria/EIS Predictions and Management Plan Requirements

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

Table 13: Approval Criteria for Air Quality

Pollutant	Averaging Period	Criterion
Particulate Matter <10 µm (PM_{10})	Annual	[a,c] 25µg/m^3
	24 hour	[b] 50 µg/m^3
Particulate Matter < 2.5 µm ($PM_{2.5}$)	Annual	[a,c] 8 µg/m^3
	24 hour	[b] 25 µg/m^3
TSP matter	Annual	[a,c] 90 µg/m^3

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

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

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

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

Following the determination of the UWJV, the appropriate EIS documentation to refer to is the UWJV EIS (Umwelt 2016) in regard to air quality predictions.

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

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

5.3.2 Performance during the Reporting Period

Air quality monitoring was undertaken during the reporting period, in accordance with the approved WCPL AQGGMP. A review of the air quality monitoring data for the reporting period was undertaken by Jacobs (2021) and is included in **Appendix E.**

During the reporting period, WCPL complied with all statutory conditions relating to air quality, excluding continuous data monitoring at AQ01 which stopped on one occasion, AQ02 which stopped on three occasions, AQ03 which stopped on 13 occasions and AQ04 which stopped on four occasions. The lapse in continuous monitoring, resulting from storms, Ausgrid maintenance, power outages and equipment failures, resulted in a non-compliance with Condition M2.2 of EPL529 (**Section 10.2**).

Notwithstanding, data capturing for the reporting period was above 90%, generally considered acceptable for air quality monitoring networks (Jacobs 2021).

On-site $PM_{2.5}$ data was available from late June 2020 onwards, following installation of the monitors (D5 and D4). All sites achieved greater than 90% data capture for the July to December period. WCPL complied with all additional air quality requirements detailed in the WCPL AQGGMP.

Early 2020 coincided with a period of unprecedented bushfires in Australia, predominantly across southeast Australia. These bushfires adversely affected air quality across many parts of NSW, including the Hunter Valley, and a total of 24 days in 2020 were considered to be extraordinary events for the purposes of determining compliance with the Development Consent (DA305-7-2003) criteria.

Noted in DA305-7-2003, determination of compliance against the impact assessment criteria is to exclude "extraordinary events such as bushfires, prescribed burning, dust storms, fire incidents or any other activity agreed by the Planning Secretary". Therefore, the results have been calculated without extraordinary events.

Jacobs (2021) concluded that:

- In relation to PM_{10}:
  - Including extraordinary events, there were 43 instances (over 24 days) when the 24-hour average concentration exceeded 50 µg/m3 at one or more monitoring locations.
  - Excluding extraordinary events, there were three instances when the 24-hour average concentration exceeded 50 $\mu g/m^3$ at one or more monitoring locations. For each of these instances, the site contribution from the Mine was determined, and it was concluded that the incremental impact from the Mine was below the criteria.
  - The annual average PM_{10} concentration, excluding data from days considered extraordinary events, did not exceed the 25 $\mu g/m^3$ criterion.
  - The monitoring demonstrates compliance with DA 305-7-2003 in terms of particulate matter as PM10.
- In relation to $PM_{2.5}$:
  - Including extraordinary events, there were no instances when the 24-hour average $PM_{2.5}$ concentration exceeded 25 $\mu g/m^3$ at monitoring locations.
  - The annual average $PM_{2.5}$ concentration, excluding data from days considered extraordinary events, did not exceed the 8 $\mu g/m^3$ criterion.

No (0) complaints were received regarding air quality, odour or greenhouse gases from the Mine during the reporting period (**Section 8.3**).

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

On 20 October 2020, WCPL received a request for information in relation to visible dust at the CHPP on 2 October 2020. WCPL provided the requested information to the EPA on 30 October 2020. There were no other incidents relating to air quality, odour or greenhouse gases during the reporting period.

5.3.2.1 Comparison with UWJV EIS Predictions

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

A summary of the predicted cumulative annual average TSP and PM_{10} levels for the Year 2 and six scenarios at the WCPL air quality monitoring sites assessed in the UWJV EIS (Umwelt 2016) air quality assessment, is provided in **Table 14**. The annual average TSP and PM_{10} levels recorded during the reporting period are also provided in **Table 14**. The UWJV EIS (Umwelt 2016) did not provide predictions for $PM_{2.5}$ at the Singleton monitoring site. Two $PM_{2.5}$ monitors were installed in June 2020, on the north-eastern and north-western sides of the operation which reflects the dominant wind directions and sensitive receivers.

Table 14: Comparison of UWJV EIS Predictions and 2020 Monitoring Data – Air Quality

Parameter	UWJV EIS Predictions			2020 Monitoring
	Site	Year 2 (2022)	Year 6 (2026)	
Annual Average TSP (µg/m³)[1]	HV01	66	63	57.6
	HV02	51	51	48.5
	HV03	52	51	36.4
	HV04	57	54	51.5
Annual Average PM_{10} (µg/m³)	AQ01 (PM01) [2]	34	33	19
	AQ02 (PM02)	16	16	16
	AQ03 (PM03)	17	16	12
	AQ04 (PM04)	22	21	17

Source: After Umwelt (2016) and Jacobs (2021).

1. TSP is estimated from PM_{10} monitoring data based on the relationship that 33% of TSP is PM_{10}.
2. Monitoring location AQ01 (PM01) has been relocated to 'Kelly' residence following the variation to EPL529 in November 2020.

The annual average TSP concentrations were below the predicted cumulative TSP concentrations at all monitoring locations.

The annual average PM_{10} concentrations were below the predicted cumulative annual average PM_{10} concentrations at all monitoring locations.

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.

On four occasions in 2020, one on one training was conducted with dispatch personnel/Open Cute Examiners (OCEs) regarding the real time noise and air quality procedures.

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

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

5.3.3.1 TSP

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

The long-term average ratio of PM_{10} to TSP over the four co-located monitoring sites at the Mine over a six year period was 33% (or equivalently, TSP concentrations are approximately three times PM_{10} concentrations). Using this ratio, TSP levels during the reporting period were lower than those previously recorded in 2018 and 2019, as shown in **Table 15** and **Figure 7**. The data shows there was a general increase in recorded TSP levels from 2011 to 2014, with a dip in 2015 and 2016, before increasing again in 2017 and 2018 and then decreasing again in 2019 and 2020.

Table 15: TSP Annual Averages (µg/m^3) (2011-2020)

HVAS	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
HV01	56.7	64.8	61.0	66.0	54.8	47.8	68.8	77.1	60.0	46.3
HV02	48.8	61.4	62.0	58.0	51.5	47.7	61.6	70.8	62.5	46
HV03	49.0	38.9	41.0	48.0	40.6	39.5	50.0	55.8	45.0	40.5
HV04	41.0	58.6	49.0	63.0	60.6	56.6	64.1	75.3	62.5	46.8

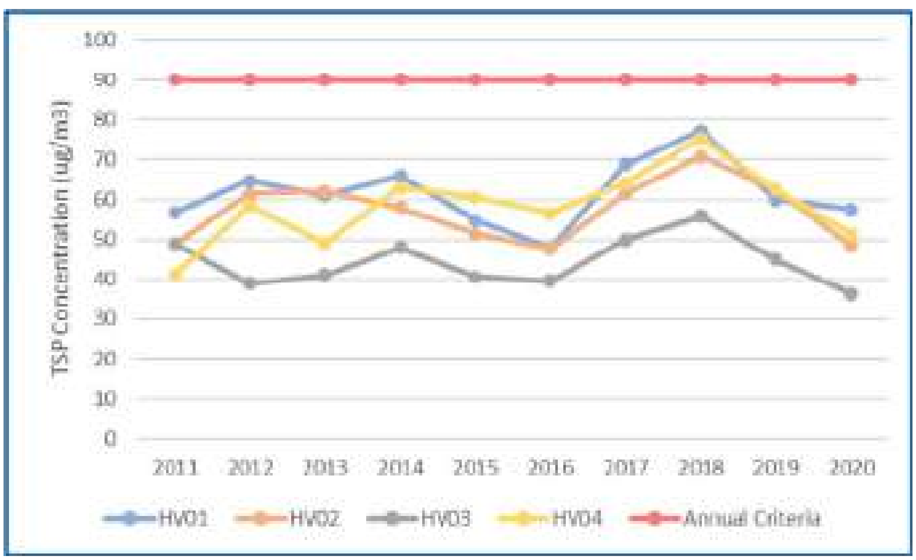


Figure 7: TSP Annual Averages (2011-2020)

5.3.3.2 PM_{10}

PM_{10} concentrations recorded by WCPL's four Tapered Element Oscillating Microbalance Analyser (TEOMs) during the reporting period are shown in **Table 16** and **Figure 8**. The data shows that PM_{10} concentrations remained relatively consistent from 2011 to 2017, with the highest concentrations recorded to date observed in 2018. This is considered to be due to open cut mining moving to a more exposed location in the Montrose Open Cut Pit during 2018.

Table 16: PM_{10} Annual Averages ($\mu g/m^3$) (2011-2020)

TEOM	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020[2]
Annual Average in $\mu g/m^3$										
AQ01 (PM01)	16.8	21.0	19.3	18.0	15.7	15.6	20.6	25.7	24.1	21.6
AQ02 (PM02)	17.2	21.1	22.3	19.0	16.0	17.5	19.1	23.6	18.8	19.2
AQ03 (PM03)	16.7	16.6	16.5	15.3	12.9	14.1	14.6	18.6	25.1	14.7
AQ04 (PM04)	16.2	18.3	16.8	17.7	16.5	16.3	17.2	25.1	25.1	19.8
Maximum 24-hour Average in $\mu g/m^3$										
AQ01 (PM01)	49	47	65	55	52	49	66	151.9[1]	59	106.1
AQ02 (PM02)	83	76	97	70	55	49	52	163.5[1]	54	132.5
AQ03 (PM03)	43	47	71	51	43	39	39	143.8[1]	64	137.8
AQ04 (PM04)	43	45	65	56	71	44	49	125.0[1]	73	131.4
Number of Days Above 24-hour Average Criteria										
AQ01 (PM01)	0	0	4	2	1	0	5	15	9	13
AQ02 (PM02)	2	7	20	2	3	0	2	9	1	13
AQ03 (PM03)	0	0	1	1	0	0	0	6	9	9
AQ04 (PM04)	0	0	3	1	2	0	0	12	6	9

1. If the results on 22 and 23 November 2018 are discounted as they were the result of a state-wide dust storm, the maximum 24-hour averages are; 80.6 $\mu g/m^3$ at AQ01, 66.0 $\mu g/m^3$ at AQ02, 58.70 $\mu g/m^3$ at AQ03 and 70.9 $\mu g/m^3$ at AQ04.
2. Results shown are inclusive of "extraordinary days".

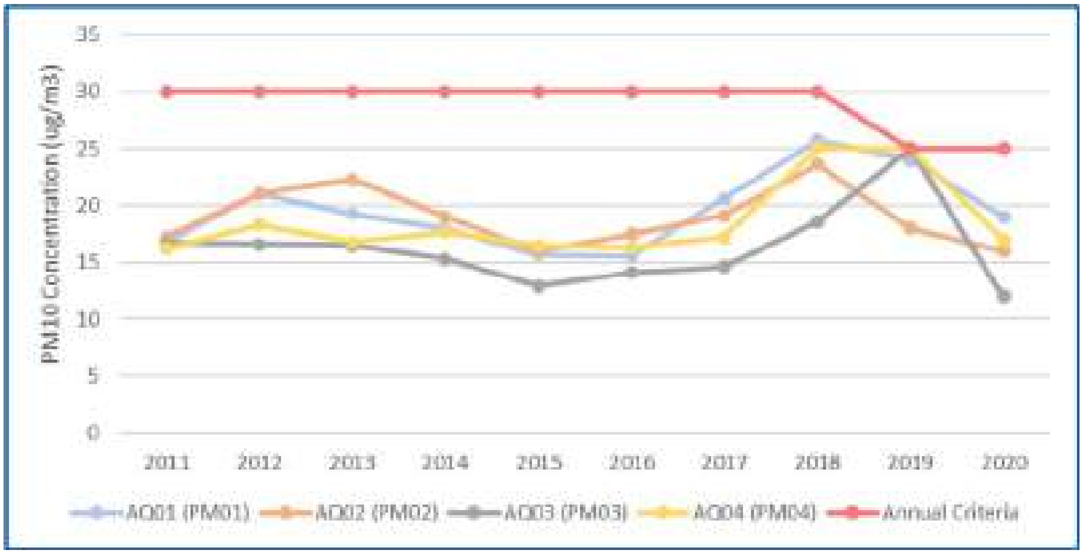


Figure 8: PM_{10} Annual Averages (2011-2020)

A review of the PM_{10} data for 2020 was completed by Jacobs (2021) and is included in **Appendix E**. The review estimated the contribution from WCPL on each day where 24-hour PM_{10} concentrations exceeded 50 µg/m³. 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.

There were no exceedances of PM_{10} concentrations exceeding the 24-hour average criterion with the site-only contribution (i.e. incremental contribution).

5.3.3.3 $PM_{2.5}$

On-site $PM_{2.5}$ data was available from late June 2020 onwards, following installation of the monitors. All sites achieved greater than 90% data capture for the July to December period. Results of monitoring during the reporting period are presented in **Table 17.**

Table 17: $PM_{2.5}$ Monitoring Results

Statistic	All Data		All Data Except Extraordinary Events	
	D5 (PM06)	D4 (PM07)	D5 (PM06)	D4 (PM07)
1 Jan to 31 Dec (365 days)				
Days of data available	195	177	193	175
Maximum 24-hour average (µg/m³)	15	17	15	17
Number of days above 25 µg/m³	0	0	0	0
Annual Average (µg/m³)	**5.2**	**4.2**	**5.2**	**4.2**

Previously, data has been measured at the Singleton Monitoring Station, approximately 18 km away from the Mine, and therefore previous results are not comparable to 2020 results from the installed monitoring locations more proximal to the Mine.

Twenty-four days during the reporting period were considered extraordinary. Notwithstanding, inclusive of these days, there were no (i.e. zero) unique days when the 24-hour average $PM_{2.5}$ concentration exceeded 25 µg/m^3 at monitoring locations.

5.3.4 Implemented or Proposed Management Actions

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

WCPL will continue to implement the approved WCPL AQGGMP, which was revised late 2020 to reflect the underground only and coal processing and handling activities at the Mine.

5.4 Greenhouse Gas

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

5.4.1 Approval Criteria/EIS Predictions and Management Plan Requirements

A summary of the EIS predictions for carbon dioxide (CO_2) emissions is included in **Section 5.4.2**, along with WCPL's performance against these predictions from 2014 to 2020. 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 18** below is for the period 1 July 2019 to 30 June 2020. Data for the second half of the 2020 reporting period will be included in the 2021 Annual Review.

A total of 156,883 tonnes of carbon dioxide equivalent (CO_2-e) was emitted by the Mine's ventilation systems in 2020 compared to the predicted 2,644,503 tonnes. The emissions predictions in the 2003 EIS were based on the assumption that there would be simultaneous mining of two longwalls (Arrowfield and Bowfield) in conjunction with Arrowfield/Bowfield gas drainage occurring during 2020. During this reporting period, only one longwall was operational which accounts for actual emissions only being approximately 15% of the predicted volumes.

A total of 512,284 tonnes CO_2-e of was emitted from the operation from all other sources. This is higher than the predicted 120,393 tonnes of CO_2-e due to the inclusion of 270,118 tonnes of CO_2-e from the decommissioned North Wambo Underground Mine. Ventilation emissions have been gradually decreasing over the years due to the change from methane rich coal seam gas to CO_2 rich coal seam gas, as the Mine has progressed from the North Wambo Underground Mine to the South Bates (Whybrow and Wambo Seam) Underground Mine. This change is part of a regional gas change that happens to occur across the Wambo lease.

Table 18: Comparison of EIS Predictions and Monitoring Data – Greenhouse Gas

Parameter	Monitoring Point	Monitoring Frequency	Emissions Calculated	Calculated CO_2-e tonnes for 2014 – 2015	Calculated CO_2-e tonnes for 2015 – 2016	Calculated CO_2-e tonnes for 2016 – 2017	Calculated CO_2-e tonnes for 2017 – 2018	Calculated CO_2-e tonnes for 2018–2019	Calculated CO_2-e tonnes for 2019– 2020	EIS predicted CO_2-e tonnes for 2020[1]
Ventilation Systems										
Methane (CH4)	Main Ventilation Shaft	Real-time continuous	Emission factor to convert from tonnes of CH4 to tonnes of CO_2-e	703,596	618,127	137,521	227,824	145,110	82,427	
Carbon Dioxide (CO_2)	Main Ventilation Shaft	Real-time continuous	Tonnes of CO_2-e	26,750	30,552	33,184	43,471	41,007	26,004	
Total				**730,346**	**648,679**	**170,705**	**270,295**	**186,117**	**156,883**	**2,644,503**
Other (Diesel and Electrical Power)										
Diesel Use	Calculated from invoices	Annually	Emission factor to convert from kL use to tonnes of CO_2-e	92,935	97,983	97,274	92,034	101,556	108,790	
Oil Use	Calculated from invoices	Annually	Emission factor to convert from kL use to tonnes of CO_2-e	280 (plus 321 kL not combusted)	339 (plus 104 kL not combusted)	44 (plus 206 kL not combusted)	163 (plus 643.5 kL not combusted)	23	15	
Grease Use	Calculated from invoices	Annually	Emission factor to convert from kL use to tonnes of CO_2-e	0 (plus 63 kL not combusted)	0 (plus 42 kL not combusted)	0 (plus 26 kL not combusted)	0 (plus 67.1 kL not combusted)	0	0	
Electricity Use	Calculated from invoices	Annually	Emission factor to convert from kWh use to tonnes of CO_2-e	78,576	76,506	63,435	64,185	63,213	59,017	
ROM Coal Production	Calculated from weight meter and survey	Monthly	Fugitive emissions factor based on ROM production[3]	59,124 (UG Stockpile residual emissions) 31,899 (OC Fugitives)	80,543 (UG Stockpile residual emissions) 24,634 (OC Fugitives)	69,202 (UG Stockpile residual emissions) 518,263 (closed mine calculation) 45,227 (OC Fugitives)	45,880 (UG Stockpile residual emissions) 472,331 (closed mine calculation) 18,231 (OC Fugitives)	46,992 (UG stockpile residual) 355,759 (closed mine calculation) 6,212 (OC Fugitives)	48,402 (UG Stockpile residual emissions) 270,118 (closed mine calculation) 25,942 (OC Fugitives)	
Gas Drainage[4]	-	Annually	Tonnes of CO_2-e	-	-	-	145	0	0	
Sub-Total (Scope 1 and 2)				**262,814**	**280,005**	**793,445**	**692,969**	**573,755**	**512,284**	**120,393**
Total				**993,160**	**928,684**	**964,150**	**963,264**	**759,872**	**669,167**	**2,764,896**

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

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

The 2019-2020 financial year was the fourth National Greenhouse and Energy Reporting (NGER) year that Wambo had emissions from a decommissioned mine due to North Wambo Underground Mine closing in April 2016. The total emissions emitted from the Mine during the reporting period (669,167 tonnes of CO_2-e) is less than in previous reporting periods (**Table 18**).

5.4.3 Trends and Key Management Implications

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

5.4.4 Implemented or Proposed Management Actions

WCPL did not undertake any targeted energy saving projects during 2020, 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 Condition B50 of Schedule 2 (DA305-7-2003) and EPL529 (Condition M4), using the specified units of measure, averaging period, frequency and sampling method described in the tables.

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

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

Table 19 summarises the annual rainfall, temperature and wind direction data for 2020, compared to previous reporting periods.

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

Table 19: Environmental Performance – Meteorology (2014-2020)

Parameter	2014	2015	2016	2017	2018	2019	2020
Rainfall (mm)	556.44	789.49	721.18	442.50	536.2	387.4	966.6
Maximum Temperature (°C)[1]	45.3 (Nov)	40.8 (Nov)	41.6 (Dec)	46.8 (Feb)	43.8 (Jan)	44 (December)	45 (January)
Minimum Temperature (°C)[1]	-1.7 (June)	-0.85 (June)	-3.4 (July)	-3.5 (July)	-5.5 (July)	-2.9 (August)	-1.5 (July)
Mean Temperature (°C)[1]	18.1	19.2	18.4	18.5	18.7	19.2	17.9
Predominant Wind Direction	E/SE (summer) W/NW (winter)	S/SE (summer) W/SW (winter)[2]	S/SE (summer) SW (winter)	S/SE (summer) W/SW (winter)	S/SE/E (summer) NW (winter)	E/SE (summer) WNW/NW (winter)	SE (summer) NW (winter)

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

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

5.6 Biodiversity

During the reporting period, WCPL updated the Biodiversity Management Plan (BMP) (previously called the Flora & Fauna Management Plan [FFMP]) prior to the commencement of Phase 2 of the UWJV. The BMP encompasses the extraction of Longwalls 17 to 20 and Longwalls 21 to 24. It also addresses the requirements within the Voluntary Conservation Agreements (VCA) prepared under Condition B75 (g), Schedule 2 of DA305-7-2003, and the requirements of the EPBC Act 1999 approvals (EPBC 2003/1138, EPBC 2016/7636 and EPBC 2016/7816). The BMP was approved 30 November 2020.

The BMP 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 BMP has been developed to:

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

The BMP also meets the requirement for a Biodiversity Management Plan under Condition B7(f), Schedule 2 of DA305-7-2003 in support of the Extraction Plan for the South Bates Extension Underground Mine Longwalls 17 to 20 and the Extraction Plan for the South Bates Extension Underground Mine Longwalls 21 to 24.

5.6.1 Approval Criteria/EIS Predictions and Management Plan Requirements

Performance measures for subsidence impacts on biodiversity are detailed in Condition B1, Schedule 2 of DA305-7-2003 (**Section 5.9.1.2**). WCPL are required to monitor and report on biodiversity in accordance with the conditions of DA305-7-2003, DA177-8-2004, EPBC 2003/1138, EPBC 2016/7636, EPBC 2016/7816 and the approved BMP.

As part of the development of the BMP, 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 20** and **Table 21**, respectively**.**

Table 20: LFA Target Scores

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

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

Table 21: Floristic Performance Criteria for Plant Community Types in RWEAs and Performance Targets for Older Woodland Areas and Rehabilitation Sites

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

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

5.6.2 Performance during the Reporting Period

VCAs for the offset areas were drafted in consultation with the Office of Environment and Heritage (OEH) (now the Biodiversity Conservation Division [BCD]) during 2015 and were registered in 2017, in accordance with Condition B75 (g), Schedule 2 of DA305-7-2003. WCPL applied to revise the VCAs to include RWEA E in December 2017. The revised VCA was finalised during the reporting period and WCPL received a Registration Notice on 27 August 2020.

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 October 2020 across both remnant woodland and post-mining rehabilitation areas. A copy of the 2020 Annual Flora and Fauna Monitoring Report (Eco Logical 2021) is included in **Appendix F**.

Remnant woodland sites within the RWEAs are generally performing well. High diversity of native flora species and an increase in native ground cover was recorded, likely in response to the above average rainfall. Fauna habitat features such as fallen logs and hollow bearing trees remain present.

An increase in cover of exotic species was also recorded within some Plant Community Types (PCTs) although this was generally driven by annual species responding to the wetter conditions. Exotic plant cover exceeding performance criteria and VCA targets was recorded in RWEA A and RWEA Rail Loop, particularly in riparian woodland where historic disturbance has been greatest. Increased weed management is recommended to control exotic cover and allow native diversity and cover to increase in these areas. Plantings of canopy species could be considered in the open grassland areas on the Wollombi Brook floodplain in RWEA A, where natural regeneration is unlikely to occur in a reasonable timeframe. Plantings may also assist weed control through establishment of a shading canopy.

Bird survey results from remnant woodland sites reflected the good condition of these woodland areas with the RWEAs continuing to support a large diversity of birds including several threatened species. Bird diversity and communities were largely consistent with the data available from previous monitoring years. Successful breeding of the threatened Dusky Wood-swallow was recorded in RWEA D (Eco Logical 2021).

As reported previously, the NWCD has not yet met completion criteria for landscape function and this area will require continued active management actions to ensure that all completion criteria and other commitments are met in the near future. Gully erosion and areas of bare soil exceeding completion criteria were recorded. Major remediation works were completed during the reporting period in a section of the NWCD to improve drainage, erosion and establishment of native plant communities (**Figure 9**). Remediation works will continue in the next reporting period.

Riparian condition scores for North Wambo Creek, South Wambo Creek and Stony Creek increased in 2020 following the drought and in response to the reduction/exclusion of grazing. Understorey vegetation cover has increased following higher rainfall in 2020, although a high proportion of ground cover contribution is from exotic species, owing to the agricultural disturbance history within these systems. Cattle should continue to be excluded from riparian areas, or fencing of the lower reaches of Stony Creek should be considered. Planting native trees in over-cleared areas, such as sections of the middle and lower reaches of Stony Creek, to facilitate more rapid regeneration will also be considered.

Subsidence was observed in several locations across the site including RWEA C and RWEA D and the NWCD, however no significant effects on flora and fauna or performance criteria exceedances were recorded. Monitoring will continue to document and assess subsidence impacts across the site, with repairs conducted as required.

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 BMP, and is next scheduled for 2021.

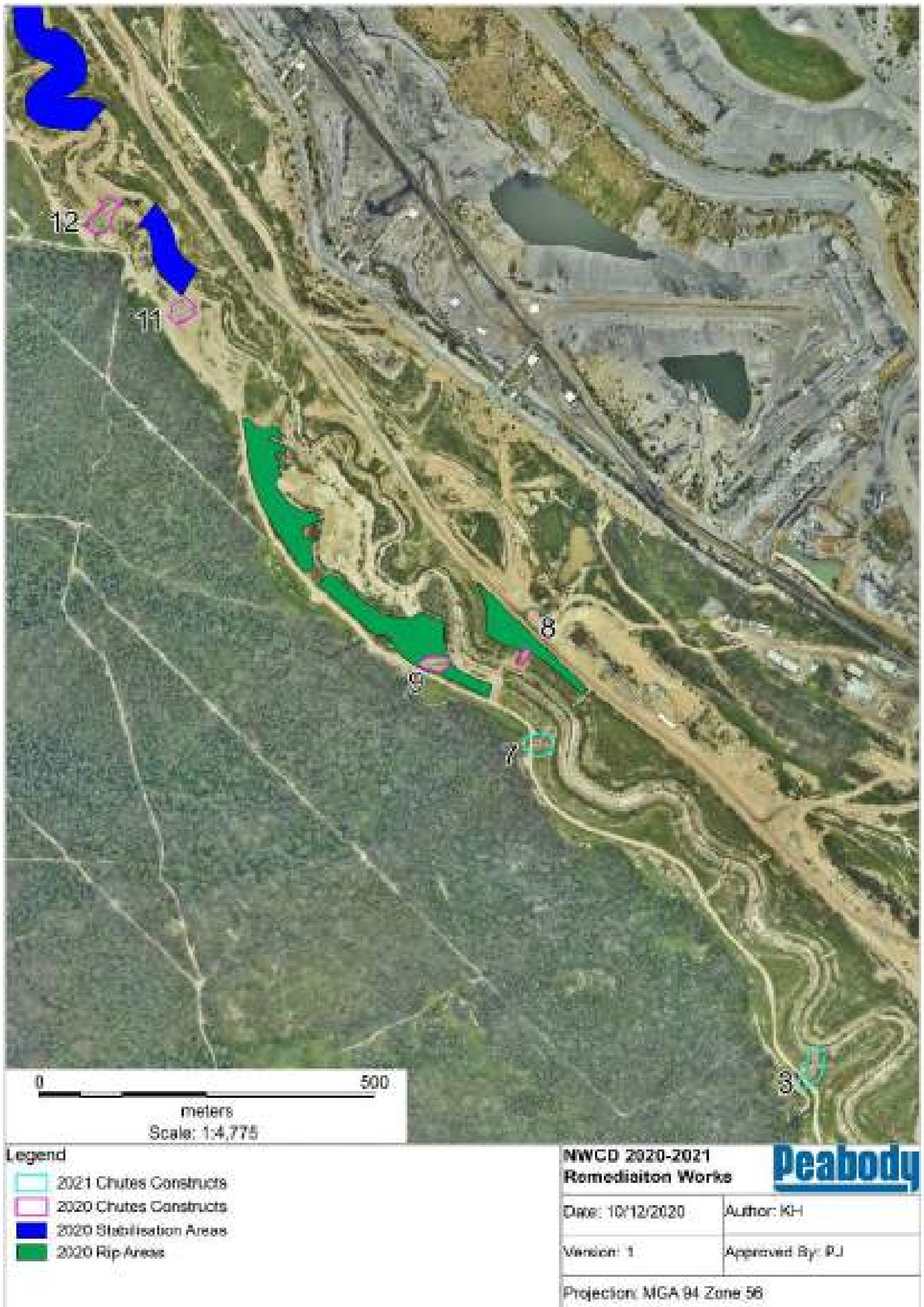


Figure 9: NWCD Remediation Works Conducted in 2020

5.6.3 Trends and Key Management Implications

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

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

The number of native species generally increased from the previous year and was the highest to date in several PCTs. The 2020 results appear to confirm that some lower scores for native species diversity recorded in recent years were a result of the dry conditions, with the increase this year likely in response to higher rainfall. Climatic conditions are considered to be a major factor in the fluctuation of results observed over time. Monthly rainfall data from 2020 from Bulga (Down Town) (Bureau of Meteorology 2020) reveals that above average rainfall was recorded in the months of February, March, July, August, September and October, and the annual average rainfall total was reached by the end of October 2020. This follows below average rainfall for 2017, 2018 and 2019.

Rough-barked Apple - Narrow-leaved Ironbark - Blakely's Red Gum - Bull Oak - Coast Banksia woodland (in RWEA A) appears to be suffering from *Banksia integrifolia* die-off in the mid-storey, first observed in 2019 and continuing this year. This was the only community to record a decrease in the average number of native species in 2020 and higher exotic covers were also recorded at some locations. This community occurs on sandy soils, and it is possible the soils suffered more significant drying during the recent dry years than other areas and the rainfall to date has not been sufficient to recharge the soil. This community is listed as a CEEC under the EPBC Act, future monitoring will continue to record the condition of this community and increased weed control will be applied.

RWEA and other remnant woodland sites at WCPL continue to support a large diversity of bird species and no introduced bird species were detected within RWEA areas. Although the abundance of birds per survey was lower in 2020, the recorded value was not significantly lower than previously recorded and bird species diversity remains high. Surveys were undertaken slightly later in spring than in previous years which may have contributed to lower detectability due to less advertising calls following breeding. Future surveys will continue to monitor abundance to ensure the lower abundance recorded in 2020 is not the beginning of a decline.

As vegetation and habitat attributes in RWEA areas have remained relatively stable over time, variability in diversity and abundance between years is likely explained by a combination of factors such as varying numbers of nomadic and migratory bird species, weather and climate, sampling methods, differences in the skill of observers, the timing of surveys and surveys coinciding with the flowering of trees and also broader landscape scale and seasonal changes across the Hunter Valley. The total number of bird species detected each year has varied over time and the 86 species recorded during 2020 is within the range of previous years.

Comparison of numbers of individuals of threatened species during the 2015-2020 monitoring periods and the number of sites they were recorded at during the 2009 and 2014 to 2019 monitoring periods was undertaken. The Grey-Crowned Babbler was recorded at the most sites ever (6), although higher numbers of individuals have been recorded previously. Speckled Warbler was recorded from seven sites with a total of 11 individuals, which are the equal lowest scores for this species. Varied Sittella was recorded from only one site with three individuals which are also the lowest scores for this species. Results for Dusky Woodswallow and Brown Treecreeper are within the range of previously recorded values.

In 2018, 50 nest boxes were installed in five clusters within RWEAs B, C and D. The first inspections were undertaken during the 2020 monitoring. Five (10%) of the nest boxes were occupied when inspected, each containing a single Common Brushtail Possum (*Trichosurus vulpecula*). An additional 18 (36%) nest boxes showed signs of use. Three nest boxes had fallen to the ground and will be re-erected/replaced during the next reporting period.

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

5.6.4 Implemented or Proposed Management Actions

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

Rehabilitation works for the NWCD, including rehabilitation of subsidence effects, have been completed in areas overlying, and downstream of, Longwall 16. Development of a detailed rehabilitation plan for NWCD upstream of Longwall 16 is not considered practical at this time due to the number of current and future underground mining activities. Some of those activities may also impact areas overlying, and downstream of, Longwall 16, and their influence was considered as part of the proposed rehabilitation actions for that section of the diversion.

In late 2018, WCPL commissioned Alluvium Consulting Australia Pty Ltd (Alluvium) to prepare a detailed five (5) Year NWCD Rehabilitation and Maintenance Plan. **Table 22** provides an outline of the rehabilitation and maintenance works proposed.

The NWCD Rehabilitation and Maintenance Plan is updated annually, based on the results of the annual monitoring conducted by Alluvium.

Table 22: Outline of NWCD Rehabilitation and Maintenance Plan

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

In 2019, WCPL commissioned Soil Conservation Services (SCS) to commence a program of remediation works which built on the modelling, research and NWCD Rehabilitation and Maintenance Plan produced by Alluvium.

Works completed in 2020 included (**Figure 9**):

- consultation with relevant stakeholders for the revised NWCD Plan;
- NWCD Plan approved 30 November 2020 (attached as Appendix to the Wambo Surface Water Management Plan);
- diversion and subsidence monitoring;
- collection of native grass species for revegetation works, including the ripping and seeding of approximately 2.5 hectares;
- construction of batter chutes 8, 9; 11 and 12;
- implementation of the Revegetation Strategy; and
- review and further assessment of other areas of instability.

Work proposed for 2021 is currently being finalised, however will likely include (**Figure 9**):

- quarterly vegetation monitoring and maintenance in the 2020 remediation areas;
- dismantling and reconstruction of Batter Chutes 3 and 7;
- construction of Road Crossing Protection on Diversion Road;
- road re-alignment and ripping between Batter Chute 7 and Batter Chute 9;
- amelioration and revegetation; and
- bench reprofiling.

5.7 Aboriginal Heritage

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

In 2016, WCPL developed a Heritage Management Plan (HMP) for the Mine, to consolidate all statutory requirements into one document and assist in the management of Aboriginal cultural heritage on-site. The HMP was approved in June 2018 with the Extraction Plan for Longwalls 17 to 20 at the South Bates Extension Underground Mine.

The HMP was updated in July 2020 for inclusion with the Extraction Plan for Longwalls 21-24 at the South Bates Underground Mine and is currently being assessed.

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.

South East Archaeology conducted Aboriginal Heritage Due Diligence Studies on proposed seismic investigation and drilling locations in January and February 2020. No salvage operations were conducted by WCPL 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 Condition B90, Schedule 2 of DA305-7-2003. The current CMP (Version 6) was approved in May 2019.

Maintenance work continued during the reporting period guided by the Preventative and Cyclic Maintenance Program outlined in Table 15 of the WHC CMP. In April 2020, an application was made to Heritage NSW under section 60 of the *Heritage Act 1977* for approval to undertake stabilisation works to the Servant's Wing building. Heritage NSW issued the approval on 23 September 2020 and the necessary work was undertaken.

In an effort to improve access to studies, reports, plans and surveys that have been prepared for the WHC, WCPL has created a platform on the Peabody website, specific to the WHC. Content includes '*Wambo Homestead-an artist's impression'* by Vivian Dwyer 2007, an outline of the history of the WHC, a drone fly-over video and black and white archive photographs. The website can be accessed at:
https://www.peabodyenergy.com/Operations/Australia-Mining/New-South-Wales-Mining/Wambo-Homestead

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

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

5.9 Subsidence

During the reporting period, underground mining occurred at Longwalls 19 and 20 of the South Bates Extension Underground Mine.

Subsidence monitoring was undertaken in the reporting period for Longwalls 18, 19 and 20.

5.9.1 Relevant Extraction Plans

Longwall mining during the reporting periods was undertaken in accordance with the relevant Extraction Plan, in accordance with Condition B9, Schedule 2 of DA 3095-7-2033. A summary of the Extraction Plan reporting requirements related to subsidence is provided in the subsection below.

5.9.1.1 Extraction Plan for South Bates Extension Underground Mine Longwalls 17 to 20

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

- Incident Report – to be prepared as required and submitted (by email) to DPIE (Manager, Mining Projects), NSW Resources Regulator (Subsidence Executive Officer), Subsidence Advisory NSW (District Manager) and other regulators as specified in management plans.
- Subsidence Management Status Reports – to be updated fortnightly and submitted (by email) if new impacts are identified or upon request, to DPIE (Manager, Mining Projects) and NSW Resources Regulator (Subsidence Executive Officer).
- Six Monthly Report – to be updated annually for the period 1 January to 30 June and submitted (by email) to DPIE (Manager, Mining Projects) and NSW Resources Regulator (Subsidence Executive Officer).

- Annual Review – to be updated annually for the period 1 January to 31 December and submitted (by email and/or post) to DPIE (Manager, Mining Projects), NSW Resources Regulator (Subsidence Executive Officer), NSW Resources Regulator (Manager Environmental Sustainability), Subsidence Advisory NSW (District Manager), BCD/EPA (General Contact), DPIE-Water (Water Regulation), Singleton Council (General Manager) and CCC Members.

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

5.9.1.2 Extraction Plan for South Bates Extension Underground Mine Longwalls 21 to 24

During the reporting period, an Extraction Plan for Longwalls 21 to 24 was prepared and submitted in July 2020. Approval for this Extraction Plan is pending.

5.9.2 Approval Criteria/EIS Predictions and Management Plan Requirements

In accordance with Conditions B1 and B4 of the Development Consent (DA305-7-2003), WCPL must ensure that there are no exceedances of the Subsidence Impact Performance Measures detailed in Tables 1 and 2 of the Development Consent (**Table 23**).

Underground mining was undertaken at South Bates Extension Underground Mine Longwalls 19 and 20 during the reporting period. Longwall 20 is still active and is not considered in this Annual Review.

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

South Bates Extension Underground Mine Longwall 19 was mined at a minimum distance of 170 m of the NWCD during the reporting period.

Longwalls 19 and 20 are offset from the base of the Wollemi National Park escarpment by a minimum 26.5 degree angle of draw. No impacts to the escarpment were observed during the reporting period (**Section 5.9.3**).

WCPL 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.

Table 23: Subsidence Impact Performance Measures

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

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

5.9.3 Performance during the Reporting Period

5.9.3.1 Subsidence Surveys

During the reporting period, WCPL undertook longwall mining in the South Bates Extension Underground Mine Longwalls 19 and 20 (**Section 3.1**). Subsidence monitoring was undertaken in accordance with the approved South Bates Extension Underground Mine Longwalls 17 to 20 Extraction Plan. Subsidence monitoring was undertaken for Longwalls 18 and 19 at the South Bates Extension Underground Mine (within 10 months of the longwalls being competed). Results for Longwall 20 will be reported in the next Annual Review.

Table 24 summarises the actual versus predicted subsidence results for Longwall 18 and 19 at the South Bates Extension Underground Mine. The monitoring shows that the actual maximum subsidence recorded for both sets of longwalls are generally similar but less than the predicted values. This could be partly attributed to the average mining height of Longwall 19 being less than (2.4 m) the subsidence model of 2.8 m and 3.0 m.

Table 24: Subsidence Monitoring – Actual versus Predicted for South Bates Underground Mine Longwalls 18 and 19

Monitoring Line ID	Predicted S_{max} (mm)[1]	Actual S_{max} (mm)[1]	Difference (mm)	Consistent with Predicted Range
8XL-Line	1950	1393	557	Y
CL17B-Line	1800	1300	500	Y

1. *South Bates Extension Underground Mine Subsidence Review Report for the South Bate Extension Underground Mine WYLW18* and *WYLW19* (Mine Subsidence Engineering Consultants [MSEC] 2020).

5.9.3.2 LiDAR Surveys

The changes in surface level due to mining at the South Bates Extension Underground Mine have been measured using Light Detection and Ranging (LiDAR) surveys. The changes in surface level due to the mining of WYLW17 to WYLW19 have been determined by taking the differences between the surface levels measured in the LiDAR surveys carried out in May 2018 (before the commencement of WYLW17) and May 2020 (during the bolt-up phase for WYLW19).

It should be noted that LiDAR surveys have an accuracy in the order of ±50 to ±150 mm. The accuracy of the observed changes in surface levels (i.e. the difference between the two surveys), therefore is in the order of ±100 to ±300 mm.

LiDAR survey results for Longwalls 18 and 19 (MSEC 2020) are as follows:

- The measured changes in surface level are greater than predicted above the south-western ends of WYLW18 and WYLW19. This is partly due to the effects of the steep slopes beneath the escarpment on the LiDAR surveys.
- The measured changes in surface level are also slightly greater than predicted above the north-eastern end of WYLW18.
- The measured profile is slightly flatter than that predicted, with the differences being in the order of accuracy of the LiDAR surveys.
- It is considered that the ground movements measured using the LiDAR surveys are consistent with the predictions provided in the Extraction Plan for Longwalls 17 to 20.
- The subsidence model appears to be providing conservative predictions based on single-seam mining conditions.
- No changes to the subsidence model are recommended based on the measured subsidence effects from the LiDAR surveys.

5.9.3.3 Visual Inspections

Visual inspections were carried out by WCPL during and after the extraction of Longwalls 18 and 19 at the South Bates Extension Underground Mine. The surface cracks were mapped by SLR Consulting Pty Ltd (SLR).

The largest surface deformations occurred adjacent to the maingates and tailgates, towards the finishing (i.e. north-eastern) ends of each longwall, due to the shallower depths of cover. More isolated cracking was recorded towards the commencing (i.e. south-western) end of the longwalls due to the higher depths of cover and less accessible terrain limiting mapping of the surface.

The recorded surface crack widths above Longwalls 18 and 19 typically ranges between 25 mm and 50 mm, with localised crack widths up to approximately 400 mm. Potholes have developed in some locations due to erosion of the larger cracks. Compression heaving has also developed with heights in the order of 100 mm to 300 mm.

More isolated surface cracking developed above the central and south-western ends of both longwalls, with widths typically between 10 mm and 50 mm, and localised crack widths up to approximately 100 mm. Potholes have also developed along the steep slopes in some locations.

The total length of the mapped surface cracking due to Longwalls 18 and 19 is approximately 1.4 km.

The recorded crack widths for Longwalls 18 and 19 are generally less than 40 mm (i.e. for 84% of cases). In 16% of cases, crack widths are between 40 mm and 100 mm, and cracks are greater than 100 mm in less than 1% of cases. The maximum crack width is approximately 400 mm where localised potholing occurred.

It is considered that the observed surface deformations above Longwalls 18 and 19 are typically within the range predicted in the Extraction Plan for Longwalls 17 to 20. While surface cracking up to approximately 400 mm occurred in isolated locations, these impacts represent less than 1% of the total length of mapped surface cracking above the mining area.

The Cliffs Associated with the Wollemi Escarpment were visually inspected using drones. The cliffs were inspected in October 2018 (before the extraction of Longwall 17), August 2019 (after the extraction of Longwall 17), January 2020 (after the extraction of Longwall 18) and August 2020 (after extraction of Longwall 19). No cliff instabilities were identified along the escarpment from these surveys.

5.9.3.4 Bi-annual Audits of Subsidence Impacts

Bi-annual audits (May and November) of subsidence impacts were undertaken by SLR during the reporting period to identify new subsidence impacts over the South Bates Extension 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 land use, or are they deteriorating in condition).

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

In 2019, subsidence monitoring and remediation focused on the South Bates Underground Mine with 37 subsidence sites rehabilitated. The remediation campaign occurred over a three month period in April, May and June 2019.

During 2020, subsidence monitoring and remediation focused on the South Bates Underground Mine with 51 subsidence sites rehabilitated. This included 27 sites in and adjacent to the North Wambo Creek Diversion. The remediation of sites occurred throughout the year and consisted of a combination of targeted subsidence campaigns and reactive subsidence remediation. The sites ranged from small potholes to large cracks several meters in length.

The methodology used continues to be fine-tuned with remediation of sites primarily including:

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

Bi-annual detailed subsidence monitoring will continue to monitor further subsidence, vegetation coverage and weeds in the next reporting period.

5.9.3.5 Remediation of Subsidence Impacts to 'Kharlibe'

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

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

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

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

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

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

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

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

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

During the reporting period, Phase 4 works were undertaken across the Kharlibe property. These works included remediation works within Stony Creek (Site 99) between 3 – 24 March 2020. Further Phase 4 remediation works were undertaken throughout each quarter of 2020 with both newly treated areas and maintenance works on previously remediated sites occurring. Detailed quarterly reports have been provided to the Resources Regulator detailing remediation activities and monitoring results throughout each quarter.

In 2021, scheduled works on the Kharlibe property include:

- Maintenance of rehabilitated sites;
- Rehabilitation of newly identified sites; and
- Commencement of South Wambo Creek remediation works.

5.9.3.6 Visual Inspections of Wollemi Escarpment (via Drone)

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

The cliffs associated with the Wollemi Escarpment were visually inspected using drones that were flown in January 2016, June 2016, February 2017, September 2017, October 2018 August 2019, January 2020 and August 2020. There were no cliff instabilities identified along the escarpment from these surveys.

5.9.4 Trends and Key Management Implications

It is considered by MSEC (2020) that the observed ground movements for South Bates Extension Underground Mine Longwalls 18 and 19 were consistent with predictions. It is also considered that the impacts on the natural and built environment are similar to those assessed and predicted.

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 Extension Underground Mine Longwalls 17 to 20 and Longwalls 21 to 24 (once approved).

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

5.10 Exploration

During the reporting period, 51 exploration holes were drilled in WCPL's exploration licence and mining lease areas. Of these holes 29 were non-core, 12 were partially cored holes, 8 were ground monitoring boreholes, and 2 were mine services boreholes.

No boreholes were drilled within EL7211 and A444. Eight of these holes were drilled as part of a groundwater/alluvial investigation in the vicinity of North Wambo Creek. The remainder were drilled within WCPL's mining leases and were managed under WCPL's Surface Disturbance Permit system and the September 2019 to December 2020 MOP.

Rehabilitation of exploration sites is undertaken continuously throughout the exploration program and begins immediately after holes are geophysically logged. Of the 51 holes drilled, 45 holes have been grouted to surface and preliminary rehabilitation has commenced on all sites.

To date, no holes have been signed off as completely rehabilitated, however a comprehensive rehabilitation project is planned to continue in 2021. By the end of this rehabilitation project, all sites drilled during the reporting period will have the preliminary rehabilitation completed, and will require a follow up inspection to determine final rehabilitation status.

Overall, 28 boreholes have been rehabilitated. The boreholes associated with the 2020 program were rehabilitated first, followed by boreholes associated with older drilling programs.

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

5.11 Waste

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

- segregation of waste at the source;
- expansion of recycling capabilities;

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

During the reporting period, a total of 4,915,262 kilograms (kg) of waste was generated by the Mine. Of this, 4,522,262 kg was taken off-site for disposal or recycling (i.e. 95.00%). Of the waste disposed off-site, 84.7% was recycled.

The total waste sent off-site by the Mine in 2020 (4,552,262 kg) was similar to 2014 (4,860,142 kg), and more than in 2019 (3,711,628 kg), 2018 (3,989,905 kg), 2017 (3,298,988 kg), 2016 (2,709,881 kg), 2015 (2,252,922 kg) and 2013 (1,615,289 kg) (**Figure 10**).

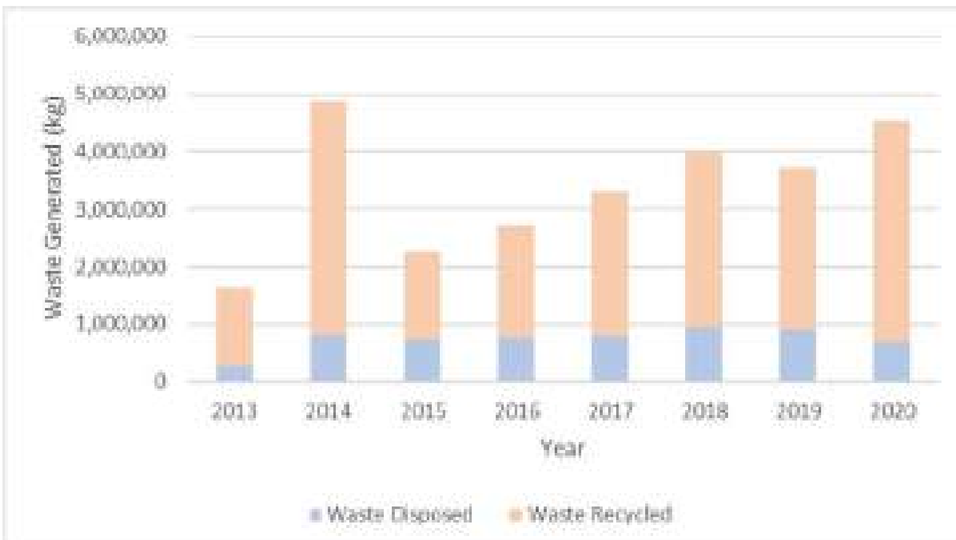


Figure 10: Waste Volumes (2013-2020)

It should be noted that:

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

The overall recycling rate for 2020 (84.7%) was more than that reported in 2019 (75.15%), 2018 (75.8%), 2017 (75.7%), 2016 (71.8%),2015 (67.9%), 2014 (82.8%) and 2013 (82.1%).

5.12 Visual Amenity and Lighting

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

There were twelve (12) complaints received during the reporting period relating to lighting impacts from WCPL's mining operations (**Section 8.3**). In response, lights on the back of excavators were repositioned and/or dimmed.

5.13 Contaminated Land

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

5.14 Topsoil Management

During the reporting period, WCPL undertook an inventory of topsoil stockpiles on-site, including location, volume and condition. This inventory (at the end of Phase 1 [i.e. 30 November 2020]) is summarised in **Table 25** below.

During Phase 2 operations at the Mine (i.e. from 1 December 2020), topsoil management will be undertaken by United as a component of the UWJV.

Table 25: Topsoil Inventory (as at 30 November 2020)

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

Note: m^3 = cubic metres.

5.15 Weed and Pest Management

WCPL commissioned REM to undertake management and control of weed species within the rehabilitation and offset areas of the Mine during 2020. Weed management techniques included spraying and manual removal (cut and paint). During the reporting period, a total of 31 days of weed control work at the Mine was undertaken by a two person crew (REM 2020).

Weed management along the North Wambo Creek Diversion is ongoing with specific targets including Galenia and Boxthorn. A summary of the total areas of specific weeds treated by REM (2020) is provided in **Table 26** and shown in **Figure 11**.

Table 26: Approximate Area of Weeds Treated at the Mine during 2020

Weeds Treated	Comment	Area (ha)
African boxthorn (cut & painted)	RWEP Wambo Coal Terminal and Wollombi Brook Paddock	1.60
African olive (cut & painted)	REM A	0.18
Individual Bridal creeper	REM A	0.002
Galenia, thornapple, blue heliotrope and saligna	Wambo stockpile areas	3.39
Lantana	REM A	0.13
Mother of millions	Fire Trails & RWEA tracks	14.87
Prickly pear, African boxthorn, lantana and bridal creeper	RWEP Wambo Coal Terminal and Wollombi Brook Paddock	30.09
Prickly pear (scattered)	Fire Trails & REM A tracks	29.60
Total		**79.86**

Note: ha = hectares.

During the reporting period, WCPL undertook a vertebrate pest management program as part of the Hunter Local Land Services Pest Species Management program, along with other mines in the area, in Autumn (March to May) and Spring (October and November), targeting wild dogs, cats and foxes. A combination of baiting and trapping was used throughout the year.

The results of the baiting program were considered to be positive due to the high rate of baits being taken by the target species. A total of 57 bait locations were set up with a baiting efficiency of 58% in Autumn and 50% in Spring. During the Autumn baiting period, 12 soft jaw traps were also set with 1 feral dog and 1 feral cat captured in the traps. During the next reporting period, WCPL intends to continue to work with Local Land Services and neighbouring land owners and participate in coordinated pest control programs.

WCPL prepared an Annual Weed Treatment Plan in 2019 which guided weed management activities in 2020, and will continue to do so into the future. Pest and weed management will continue as required on-site and on agistment managed properties throughout the next reporting period.

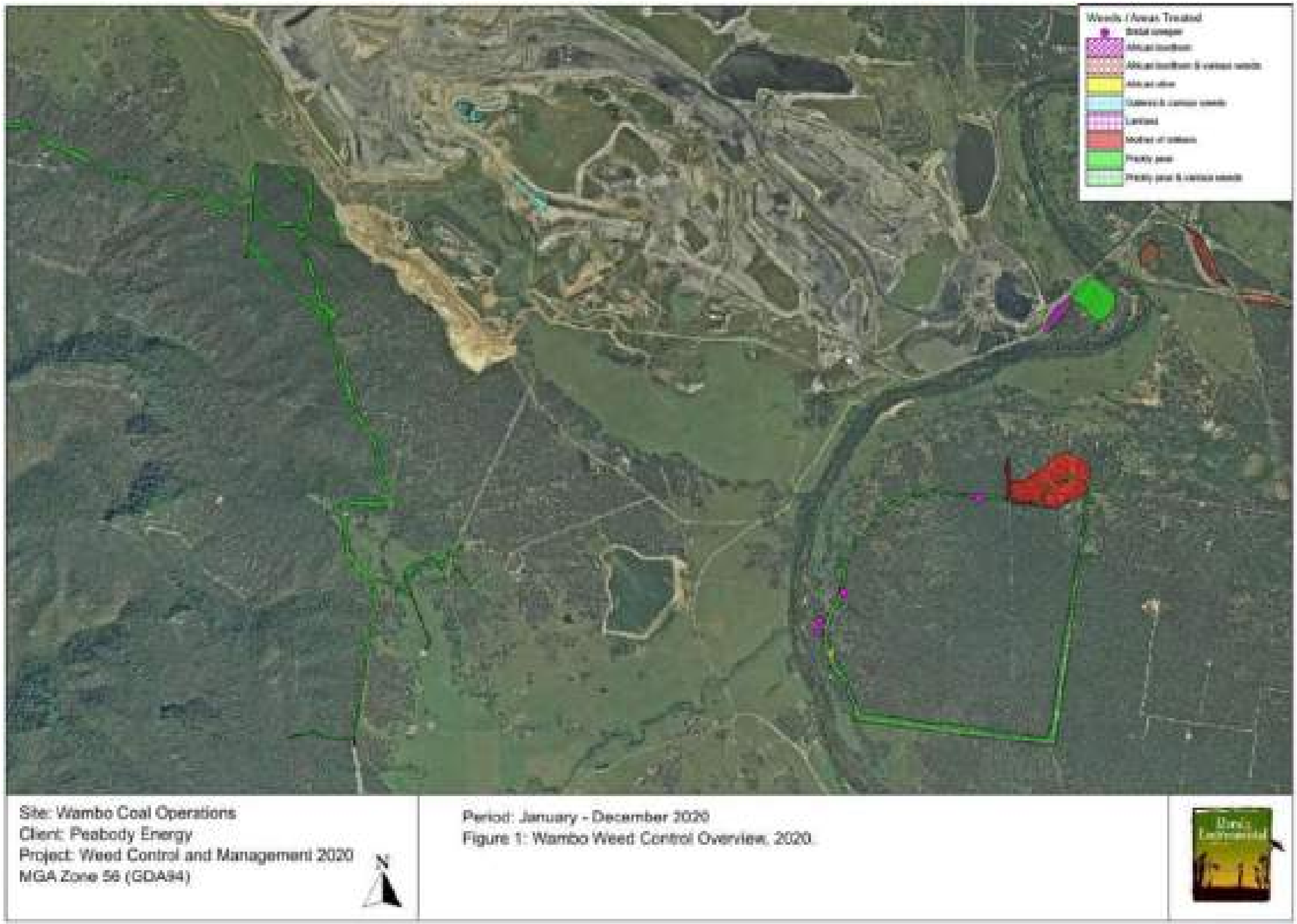


Figure 11: Weed Control Overview for the Mine (REM 2020)

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.

Development Consents DA305-7-2003 and DA177-8-2004, no longer require a Bushfire Management Plan. Notwithstanding, hazard reduction and maintenance of fire trails will continue to be conducted as required.

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 CHPP).

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

6.0 Water Management

Water management performance measures for the Mine are defined in Table 8 of Condition B62, Schedule 2 DA305-7-2003 and Condition L2 of EPL529. 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 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 Management Plan (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 prepared in 2020 in preparation for Phase 2 operations and Version 2 of the SWMP was approved in November 2020. For this reason, the previous Surface Water Monitoring Plan (SWMonP) (Version 12) was applicable for the period between 1 January 2020 to 20 November 2020.

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 2).

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

Applicable criteria are included in **Table 27** and **Table 28.** Triggers for the local ephemeral creeks in the approved SWMP (Version 2) 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 Flow Impact Assessment Condition[1]

Watercourse and Flow Monitoring Site	Daily Rainfall when Flow Commenced on 80% of Recorded Occasions	
	SWMonP (Version 12)	SWMP (Version 2)
Stony Creek (FM13)	20 mm	
South Wambo Creek (FM15)	20 mm	
North Wambo Creek (FM4)	20 mm	-[2]
North Wambo Creek (FM1)	-	100 mm

1. From Table 14, Version 2 of the WCPL SWMP.
2. Streamflow measurements in North Wambo Creek daily rainfall data from stations adjacent to the catchment have been analysed and indicated a total depth of continuous rainfall depth of approximately 100 mm (can occur over more than one day) is required to generate surface flow in North Wambo Creek upstream of the diversion. Further analysis of flow data is being undertaken to reinstate an appropriate surface water flow impact assessment condition for FM4.

Table 28: Surface Water Quality Impact Criteria[1,2]

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

1. From Table 15, Version 2 of the WCPL SWMP.
2. An exceedance occurs when water quality results exceed the 80th Percentile Trigger Value (**Table 28**) after three consecutive sampling events.
3. EC = electrical conductivity, TSS = total suspended solids, µS/cm = microSiemens per centimetre, mg/L = milligrams per litre.
4. Low flow condition based on 80th percentile of recorded concentrations and high flow criteria based on maximum recorded concentrations.

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 28**) after three consecutive sampling events.

6.1.2 Performance during the Reporting Period

An exceedance of the surface water quality triggers is considered to have occurred when water quality results exceed the 80th Percentile Trigger Value (**Table 28**) for three consecutive sampling events.

WCPL recorded exceedances of the surface water quality impact assessment criteria during the reporting period, at SW02 (for pH). pH at SW02 exceeded the 80th percentile trigger value from April to December, which resulted in exceeding the surface water quality triggers from June to December (i.e. over three consecutive sampling events).

In accordance with the TARP for Impacts on Surface Water Quality in the SWMP, WCPL implemented the Level 1 response management measure and fortnightly sampling commenced in October 2020. Further investigations will continue to determine contributing factors.

If the results of the preliminary investigation indicate further works are necessary, WCPL will:

- engage a suitably qualified ecologist or similar to investigate the aquatic environment; and
- develop corrective/preventative actions based on the outcomes of the investigation and/or additional monitoring.

WCPL reported to the EPA that, due to dry conditions, water quality samples were unable to be collected at monitoring locations SW01, SW02, SW03, SW04, SW05, SW06, SW07, SW08, SW15, SW27a, SW32a, SW39, SW40, and SW41 during the reporting period, resulting in a non-compliance with Condition M2.3 of EPL529 (**Section 10.4**).

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

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

The WCPL stream flow monitoring system consists of (**Figure 12**):

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

On 4 August 2020, backup pressure sensors were installed at existing monitoring locations in North Wambo Creek, including at FM1, US-FM1, FM2, and FM3. During the reporting period, no issues were encountered with the stream monitoring network.

Table 30 presents a summary of flow events observed at the relevant streamflow monitoring stations on the days during the reporting period when 20 mm or greater rainfall was recorded at the WCPL meteorological station.

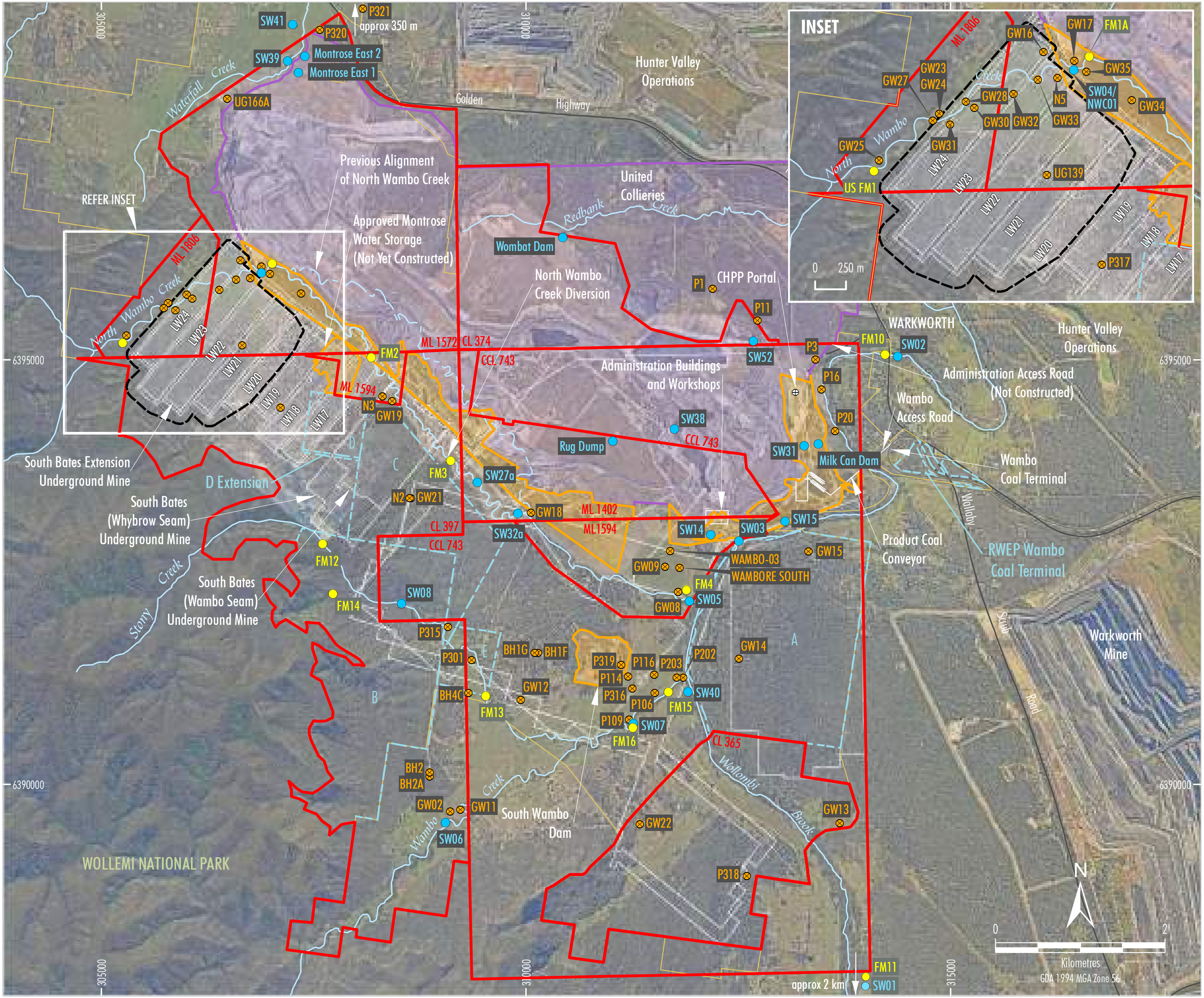
Table 30: Surface Water Flow Results

Date of Rainfall Event	Rainfall at WCPL Station (mm)	FM4[1]	FM15 (previously FM5)	FM13
6/02/2020	21.4	No flow event.	No flow event.	No flow event.
8/02/2020	33.0	No flow event.	No flow event.	No flow event.
9/02/2020	57.6	Flow event from 9/02 to 11/02.	Flow event from 9/02 to 12/02.	Flow event from 9/02 to 14/02.
5/03/2020	31.0	No flow event.	No flow event.	No flow event.
26/03/2020	26.6	No flow event.	Flow event from 26/03 to 22/04.	Flow event from 26/03 to 14/04.
3/04/2020	20.0	No flow event.		
26/07/2020	37.6	No flow event.	No flow event.	No flow event.
10/08/2020	20.2	No flow event.	No flow event.	Flow event on 10/08.
24/10/2020	45.6	No flow event.	No flow event.	No flow event.
13/11/2020	42.6	No flow event.	No flow event.	No flow event.
15/12/2020	28.8	N/A	No flow event.	No flow event.
17/12/2020	27.4	N/A	No flow event.	No flow event.
21/12/2020	34.6	N/A	No flow event.	No flow event.
28/12/2020	36.4	N/A	No flow event.	Flow event from 28/12 to 29/12.

1 Not applicable from 21 November 2020.

As flow was not recorded at FM1, FM15 or FM13 at the anticipated frequency (i.e. 80% of rainfall events of 20 mm or greater are expected to generate flow), the performance indicator was exceeded.

WCPL is undertaking further investigation of the triggers of the performance indicator in accordance with the SWMP.



LEGEND

- WCPL Owned Land
- Mining and Coal Lease Boundary
- SSD 7142 Operational Area
- Existing/Approved Surface Development Area (Phase 2)
- Approved Underground Development
- Remnant Woodland Enhancement Program (RWEP) Area
- Extraction Plan Application Area
- Groundwater Monitoring Site
- Surface Water Quality Monitoring Site
- Surface Water Flow Monitoring Site

Source: WCPL (2021); NSW Spatial Services (2021)
Orthophoto: WCPL (Sept - May 2019)

Peabody

W A M B O   C O A L   M I N E

Locations of Surface Water and Groundwater Monitoring Sites

Figure 12

WAM-09-15 AR 2020_206A

6.1.3 Trends and Key Management Implications

WCPL will undertake a preliminary investigation of the surface water quality (pH and EC) results recorded at SW02 and will review the flows observed at FM1, FM13 and FM15 during the next reporting period.

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

There were no other trends or key management implications identified.

6.1.4 Implemented or Proposed Management Actions

During the next reporting period, WCPL will continue to implement the approved SWMP (Version 2). If management actions are required as a result of the required preliminary investigations, WCPL will implement the actions accordingly.

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

6.2 Groundwater Monitoring

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

The GWMP was prepared in 2020 as part of the transition to Phase 2 operations and Version 2 of the GWMP was approved in November 2020. For this reason, the previous Groundwater Monitoring Plan (GWMonP) (Version 12) was applicable for the period between 1 January 2020 to 20 November 2020.

In 2019, the Wambo groundwater model was updated to include greater temporal variability to better capture groundwater conditions along North Wambo Creek. This was further refined in the South Bates Extension LW21-24 Extraction Plan modelling undertaken by SLR (2020). The modelling noted that the alluvium and shallow weathered rock are less broadly saturated following the construction of the NWCD and interception of alluvial material by the Montrose open cut.

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) 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 2) and consistent with the previous GWMonP (Version 12), is included in **Table 31**. In order to avoid false triggering, as a trigger would be initiated 20% of the time due to natural causes, triggers for groundwater level are defined to occur when two consecutive bi-monthly observations (over a 2-month interval) exceed or fall below the specified depth to groundwater.

In addition to the groundwater monitoring triggers detailed in **Table 31,** WCPL is also required to meet additional requirements, in accordance with the approved GWMP, Extraction Plan for North Wambo Underground Mine Longwalls 8 to 10A, Extraction Plan for the South Bates Underground Mine Longwalls 11 to 16 and Extraction Plan for the South Bates Extension Underground Mine Longwalls 17 to 20. These requirements include annual reporting on performance against the performance indicators detailed within the approved WCPL GWMP (**Table 32**)**.**

Table 31: Water Quality and Level Trigger Values – Shallow Bores

	Depth to Groundwater (mBTOC[1])		Conductivity (µS/cm)	pH	
Bore	Min (10th percentile)	Max (90th percentile)	Maximum (Three Consecutive Bi-Monthly Exceedances)	Minimum (Two Consecutive Bi-Monthly Exceedances)	Maximum (Two Consecutive Bi-Monthly Exceedances)
P109	4.6	6.7	595	6.5	7.6
P301	N/A	N/A	9200	6.1	7.2
P315	NA5	NA	552	6.0	7.4
GW08.2[2]	ND[4]	ND3	NA	NA	NA
GW09.2[2]	ND[4]	ND3	NA	NA	NA
GW15	10.4	11.1	730	6.7	7.2
GW16[3]	NA	NA	NA	NA	NA
GW17[3]	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. GW08.2, GW09.2 and GW10.2 have been installed within unconsolidated strata near North Wambo Creek to serve as replacement bores to GW08 and GW09. Trigger levels for these bores will be established following the collection of baseline data and based on predicted drawdown from the revised groundwater model to be complete in Q4 2020.
3. 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.
4. Insufficient baseline data to develop meaningful trigger level.
5. NA – trigger level not appropriate for assessing Wambo mining impact at this location.

Table 32: Groundwater Monitoring Program Performance Indicators

Performance Indicator
The performance indicators will be considered to have been exceeded if Wambo receives complaints from groundwater users.
The performance indicators will be considered to have been exceeded if monitoring data suggests significant divergences away from the modelled groundwater.
The performance indicators will be considered to have been exceeded if the groundwater levels in alluvial bores exceed the groundwater level criteria listed in Table 9 of the GWMP.
The performance indicators will be considered to have been exceeded if the groundwater quality in alluvial bores exceeds the groundwater quality criteria listed in Table 10 of the GWMP.
Wollombi Brook
The performance indicators will be considered to have been exceeded if the groundwater levels in alluvial bores exceed the groundwater level criteria in the GWMP (Table 31).
The performance indicators will be considered to have been exceeded if the impacts observed on riparian, aquatic or groundwater dependent ecosystems are beyond negligible.

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 GWMonP (Version 12) and GWMP (Version 2).

A number of bores within the monitoring program from GWMonP (Version 12) are no longer included in the monitoring program for the current GWMP (Version 2), justification is provided in **Table 33.**

Table 33: Bores No Longer Assessed Against Groundwater Trigger Levels

Bore	Justification
P106	Bore obstructed and no longer providing meaningful data.
P114	Bore screened across both alluvial and Permian strata, inconsistent with Minimum Construction Requirements for Water Bores in Australia (National Uniform Driller Licensing Committee [NUDLC] 2012). Bore removed from monitoring network and replaced by P316.
P116	Bore screened across both alluvial and Permian strata, inconsistent with Minimum Construction Requirements for Water Bores in Australia (NUDLC 2012). Bore removed from monitoring network and replaced by P316.
P301	Not shallow alluvial/regolith bore, used as Permian bore.
GW02	Landholder well with pumping equipment installed/ nearby, not appropriate to assess Wambo mining impacts at these locations. Replacement monitoring-only site recommended by SLR.
GW11	Landholder well with pumping equipment installed/ nearby, not appropriate to assess Wambo mining impacts at these locations. Replacement monitoring-only site recommended by SLR.
GW12	Bore constructed within shallow/weathered Permian strata after the commencement of NWU mining. Length of baseline period not suitable for development of trigger. Bore removed from monitoring network with P315 to provide supplementary data for Stony Ck alluvium.
GW13	Bore screened within weathered to fresh Permian strata containing coal seams. Bore also shows impacts associated with the approaching Warkworth Open Cut and is distant from current Wambo mining activity.

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

A number of trigger level exceedances were recorded for groundwater levels during the reporting period (**Table 34**). These exceedances are summarised in **Section 6.2.3** and discussed further in the report *Wambo – 2020 Annual Review Groundwater* (SLR 2021) (**Appendix G**).

Hydrographs for relevant groundwater monitoring bores were assessed to determine whether observed trends were due to climatic conditions or mining, and shallow bores were assessed for compliance with the groundwater level and water quality performance indicators (SLR 2021).

No bores were decommissioned during the reporting period.

Table 34: Groundwater Trigger Level Exceedances

Bore	Depth to Groundwater (mBTOC[1])		Conductivity (µS/cm)	pH	
	Min (10th percentile)[1] (Two Consecutive Bi-Monthly Exceedances)	Max (90th percentile)[2] (Two Consecutive Bi-Monthly Exceedances)	Maximum (Three Consecutive Bi-Monthly Exceedances)	Minimum (Two Consecutive Bi-Monthly Exceedances)	Maximum (Two Consecutive Bi-Monthly Exceedances)
P109		**Y**			
P301	N/A	N/A			
P315	N/A	N/A			
GW08.2	ND				
GW09.2	ND				
GW02	N/A	N/A			
GW15		**Y**			
GW16	N/A				
GW17	N/A				
P16		**Y**		**Y**	
P20		**Y**			

Source: *Wambo – 2020 Annual Review Groundwater* (SLR 2021).

N/A = Not applicable

ND = insufficient baseline data to develop meaningful trigger level

1 Minimum depth-to-water is equivalent to maximum groundwater level (mAHD)

2 Maximum depth-to-water is equivalent to minimum groundwater level (mAHD)

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 31**) by SLR (2021).

The 90th percentile trigger for depth to groundwater allows identification of anomalously deep depths to groundwater. During the reporting period, exceedances of the 90th percentile level were recorded at P109, GW15, P16 and P20.

No exceedances of triggers for EC or pH occurred during the reporting period (SLR 2021), with the exception of two pH readings at P16.

The pH at P16 fell below the minimum pH trigger of 7.0 in April 2020 (6.97) and in June 2020 (6.92), less than 0.1 pH units. With the change in pH being so minimal, it is not considered to have caused or be likely to cause a long-term, negative impact to the groundwater quality in the vicinity of these bores. In addition, pH rebounded back into the acceptable range for the last three measurements taken at the end of 2020 (August, October, and December).

Hydrographs of observed groundwater levels were reviewed by SLR in combination with a review of subsidence parameters and WCPL's groundwater model. SLR (2021) concluded that the groundwater model performs well and remains fit for purpose to predict the timing and magnitude of impacts to groundwater caused by the Mine. There are ongoing updates scheduled for completion in mid-2021 to keep the model predictions current and to address the outstanding issues from the above points. Additional detail is available in **Appendix G**.

SLR conducted an assessment against the performance indicators and relevant subsidence impact performance measures for North Wambo Underground Longwalls 8 to 10A, South Bates Underground Mine Longwalls 11 to 16 and South Bates Extension Underground Mine Longwalls 17 to 20.

The following further investigation was recommended for GW15:

- Confirmation of the validity of data collected at GW15 and to check if the bore is obstructed or compromised.
- This should include consideration of groundwater level collected in the Wollombi Brook/ Warkworth Sands alluvium at other nearby mine sites, the Wollombi Brook water elevation, P16 and P20 groundwater level observations, and South Wambo Boxcut floor elevation and fill level.
- Confirmation of the nature of the material (alluvial or weathered sandstone) intersected by GW15.

No further investigation was recommended at P109, P16 or P20. Groundwater model performance was found to be consistent with previous Annual Review assessments. Predicted and inferred groundwater inflow volumes were within limits of alluvial and rock water licences.

WCPL will continue to conduct monitoring in accordance with the approved GWMP.

6.2.4 Implemented or Proposed Management Actions

SLR (2021) recommended:

- Replacement of P109 to supplement data from both P109 and P106.
- Removal of GW02 and GW11 from future revisions of the GWMP if pumping is proposed to continue for both bores. A replacement monitoring bore may be useful in a nearby location.
- VWP locations identified with persistent poor-quality data should be removed from the monitoring network.

- Top of Casing and ground elevation should be surveyed at recently installed standpipe monitoring bores (GW08.2, GW09.2, GW10.2(a), P316(a,b,c), SW30).
- Text within the GWMP should be updated to consider P316a a Wambo Creek Alluvium bore.
- Text within the GWMP should be updated to consider P325a (SW30) a Wollombi Brook Alluvium bore.
- Investigation is recommended for GW15 to determine whether this bore is accurately representing the groundwater levels in the surrounding aquifers and whether low groundwater level observations are related to Wambo mining activity or the approaching Warkworth Open Cut.
- A review of trigger levels at P16 is recommended. This should consider model results from the South Wambo Boxcut Groundwater Assessment (HydroSimulations, 2016b).
- Review of the model assumptions near GW09, to be addressed in model updates due for completion in mid-2021.

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

6.3 HRSTS Discharges

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

- notification from DPIE-Water of discharge opportunity must be received;
- flow of water in Wollombi Brook at the DPIE-Water Bulga Gauging Station (FM11) needs to be more than 500 megalitres per day (ML/day);
- pH and turbidity 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 during discharge and sent to the lab for analysis.

WCPL held 51 credits under the HRSTS until 30 June 2020, after which WCPL retained 21 credits. An additional 9 credits were obtained in 2020, bringing WCPL’s balance to 30 credits.

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 35**.

Table 35: 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 or LDP No. 19.

6.3.3 Trends and Key Management Implications

There were no discharge events in 2020 compared with none in 2019, none in 2018, none in 2017, eleven in 2016, six in 2015 and one in 2014. The total volume of water discharged in 2020 (0 ML) was the same as in 2019 (0 ML), 2018 (0 ML), 2017 (0 ML) and less than in 2016 (416 ML), 2015 (140.1 ML) and 2014 (9.6 ML).

6.3.4 Implemented or Proposed Management Actions

A written report of the activities undertaken by WCPL under the HRSTS (for the period 1 July 2019 to 30 June 2020) was submitted to the EPA on 28 August 2020, in accordance with Condition R4 of EPL529.

The HRSTS discharge system was reviewed during 2016. This review consisted of updating the communication hardware in consultation with WaterNSW, continued regular calibration of instrumentation and development of operating procedures. A guideline for a HRSTS system audit was completed in 2018. The audit was unable to be completed as WCPL was unable to discharge through the HRSTS in 2020, 2019 or 2018. During the next reporting period, WCPL will undertake the HRSTS system audit if discharges through the HRSTS occur.

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

6.4 North Wambo Creek Diversion Discharge Flows

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

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

- US-FM1, approximately 1 km upstream of FM1 (installed in December 2017);
- FM1, upstream of the NWCD;

- FM2, middle of the NWCD, downstream of FM1;
- FM3, middle of the NWCD, downstream of FM2; and
- FM4, downstream of the NWCD.

A review of the flow events at each monitoring site during the reporting period was undertaken by AECOM (2021) and a summary is provided in **Table 36**. Flow monitoring data is included in the AECOM report (**Appendix H**).

Table 36: NWCD Discharge Flow Monitoring – 2020

Flow Monitoring Station	No. of Flow Events Recorded	Maximum Stream Height Recorded (m)	Maximum Theoretical Flow Rate Recorded (ML/day)
US-FM1	7	0.68	282
FM1*	2	0.13	54.1
FM2	19	0.55	153
FM3	20	0.42	126
FM4	1	0.42	159

* flow at FM1 was detected through the back-up sensor FM1BU.

6.5 Water Take

WCPL maintains a variety of WALs under the *Water Management Act 2000* which consist of High, General and Supplementary securities, as detailed in **Table 37**.

During the 1 July 2019 to 30 June 2020 water year, WCPL extracted a total of 2,041.6 ML of water from the Hunter River (1,000 ML under WAL 718 and 1,041.6 ML under WAL 8600), 302.8 ML of water from Wollombi Brook (under WAL 929), 70 ML of groundwater from Wollombi Brook alluvials (under WAL 23897) and 1,420.2 ML from porous rock groundwater sources (under WAL 42373). As show in **Table 37**, all water take during the 2019-2020 water year was less than the allowable limits under the relevant WALs.

No water was used for irrigation purposes between 1 July 2019 to 30 June 2020 (from licence 20WA200632).

Table 37: Environmental Performance – Water Take (1 July 2019 to 30 June 2020)

Licence Number[1]	Description	Expiry Date	Entitlement	Category	Passive take/ inflows (ML)	Active pumping (ML)	Total (ML)
Hunter Regulated River Water Source							
WAL 718 (20SL060212)	Hunter River Pump	Perpetuity	1,000 unit shares (high security)	Regulated River (high security)	0	1,000	1,000
WAL 8599 (20SL061206)	Hunter River Pump	Perpetuity	6 unit shares (high security)	Regulated River (high security)	0	0	0
WAL 8600 (20SL061206)	Hunter River Pump	Perpetuity	868 unit shares (general security)	Regulated River (general security)	0	1,041.6[3]	1,041.6[3]
WAL 8604 (20BL061206)	Hunter River Pump	Perpetuity	240 unit shares (supplementary water)	Supplementary Water	0	0	0
Hunter Regulated River Water Source – Shared with United Colliery							
WAL 929 (20SL050661)	Other Pump	Perpetuity	3 unit shares	Domestic and Stock	0	0	0
WAL 1369 (20SL060416)	80 mm CP	Perpetuity	15 unit shares (supplementary water)	Supplementary Water	0	0	0
WAL 15459 (20SL204246)	80 mm CP	Perpetuity	21 unit shares (general security)	Regulated River (general security)	0	0	0
Hunter Unregulated and Alluvial Water Sources (Lower Wollombi Brook Water Source)							
WAL 18437 (20SL033872)	Wollombi Brook Pump	Perpetuity	350 unit shares	Unregulated River	0	302.8	302.8
WAL 23897 (20BL167737)	Well No. 2	Perpetuity	70 unit shares	Aquifer	70 (open cut seepage)	0	70
North Coast Fractured and Porous Rock Groundwater Sources (Sydney Basin - North Coast Groundwater Source)							
WAL 42373[2]	-	Perpetuity	1,549 unit shares	Aquifer	90 (underground seepage) 184 (open cut seepage)	1,146.2 (dewatering Bores 2A and 4C)	1,420.2
WAL 41532 (20BL172156)	Dewatering	Perpetuity	98 unit shares	Aquifer	0	0	0

1. 20BL prefix bore licences with allocations have been replaced with WALs.
2. WAL 42373 was issued in 2019 to consolidate six of WCPL's previous WALs under the North Coast Fractured and Porous Rock groundwater Sources (Sydney Basin – North Coast Groundwater Source) including WAL 39735, WAL 39738, WAL 39803, WAL 41494, WAL 41528 and WAL 41520.
3. The remaining balance from the previous water year (217 ML) was carried forward.

6.6 Compensatory Water

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

6.7 Site Water Balance

WCPL reviewed the Site Water Balance at the end of the reporting period, in accordance with the requirements of the WCPL Water Management Plan. A summary of the WCPL site water balance for the period 1 January to 31 December 2020 is provided in **Table 38**.

Table 38: Site Water Balance (1 January to 31 December 2020)

Water Sources	Volume (ML)
Hunter River	992
Wollombi Brook	336
United Collieries	10
Rainfall/Runoff	2,034
Underground Seepage	90
Dewatering Bores 2A and 4C	904
Open Cut Seepage	70
Total Water Inputs	**4,437**
Water Usage	**Volume (ML)**
Dust Suppression	862
CHPP Consumption	3,380
Underground	120
United Collieries	99
CHPP/UG Potable Water	16
Domestic Usage	0
Total Water Usage	**4,478**
Water Loss	**Volume (ML)**
Evaporation – Mine Water & Tailings Dam	503
HRSTS Discharge	0
Seepage	0
CHPP Process (washdown)	196
Total Losses	**699**
Storages	**Volume (ML)**
Initial (January 2020)	321
Final (December 2020)	809
Change in Storage	**+488**
Water Balance (ML)	**-1,229**

A total of 992 ML was extracted from the Hunter River and 336 ML was extracted from the Wollombi Brook during the reporting period. This total is above the EIS forecast annual average extraction volume of 106 ML (Resource Strategies 2003).

As only 10 ML of water was sourced from the United Collieries during the reporting period, this brings the total volume of water imported to approximately 30.1% of the total water input. This is considerably higher than the EIS forecast of an average of 2.6% (Resource Strategies 2003).

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

A total of 2,034 ML of runoff from rainfall was intercepted during the reporting period, 1,432 ML more than intercepted during 2019 (602 ML).

Underground seepage represented 2% of total supply compared to the 2003 forecast of 13.8% (Resource Strategies 2003), this is consistent with seepage in 2019 and down from 7.3% of total supply during 2018. The MOD17 Groundwater Assessment (HydroSimulations 2017) predicted that there would be an average seepage of 212 ML per annum (ML/a) and a maximum seepage of 376 ML/a from the combined sources of the South Bates Underground Mine and South Bates Extension Underground Mine. The underground seepage recorded during the reporting period (90 ML) is considerably lower than these predictions and is likely influenced by the dry conditions leading up to, and continuing during, 2020.

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

6.7.1 Salt Balance

WCPL reviewed the Salt Balance at the end of the reporting period, in accordance with the requirements of the WCPL Water Management Plan. A summary of the WCPL salt balance for the period 1 January to 31 December 2020 is provided in **Table 39**.

Table 39: Salt Balance (1 January to 31 December 2020)

Inputs	Salt (t)
Raw water- Hunter	404
Raw water- Wollombi	137
Runoff	2,034
Groundwater (ROM coal)	1,594
Groundwater (Bores)	5,767
Groundwater (Seepage)	1,021
Total	**10,958**
Outputs	
Product Coal	3,532
Dust suppression	3,795
Release to HRSTS	0
Total	**7,327**
Balance	**3,631**

6.8 Erosion and Sediment Control

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

6.8.1 Performance during the Reporting Period

During the reporting period, WCPL complied with all requirements detailed in the ESCP (Version 10) under DA305-7-2003 (Modification 17) from 1 January 2020 to 30 November 2020, and all requirements un the ESCP (Version 2) under DA305-7-2003 (Modification 17) from 1 December 2020 to 31 December 2020.

No complaints were received relating to erosion and sediment control.

6.8.2 Trends and Key Management Implications

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

6.8.3 Implemented or Proposed Management Actions

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

7.0 Rehabilitation

7.1 Rehabilitation Performance during the Reporting Period

Proposed rehabilitation and disturbance activities for the reporting period are detailed in WCPL's approved MOP (September 2019 to December 2020). During the reporting period, WCPL prepared a new RMP/MOP (December 2020 to December 2023). DPIE approved the RMP/MOP (December 2020 to December 2023) in November 2020.

7.1.1 Status of Disturbance and Rehabilitation

A summary of the proposed and actual rehabilitation activities undertaken in 2020 is provided in **Table 40**.

Table 40: Actual versus Proposed Rehabilitation Activities (2020)

	2020 Proposed	2020 Actual (at 30 November)	2020 Actual (at 31 December)	2021 Proposed
Total Disturbance (ha)	59.56	60.88	21.52	0
Total Rehabilitation (ha)	45.26[1]	5.04	0	0
Cumulative Rehabilitation (ha)	730.16	692.47	121.9	121.9

1. Consists of 8.6 ha at RL160, 18.52 ha at Waterfall Ramp and 18.14 ha at Montrose East.

During Phase 2, open cut activities (including rehabilitation) for the SSD 7142 Operational Area are the responsibility of United. Therefore, WCPL is responsible for rehabilitating the remaining surface area and activities related to the Mine's approved underground activities. Due to the nature of this disturbance, there will be minimal progressive rehabilitation reported by WCPL over the coming years (i.e. as the disturbed surface area will be required for the life of the underground mine).

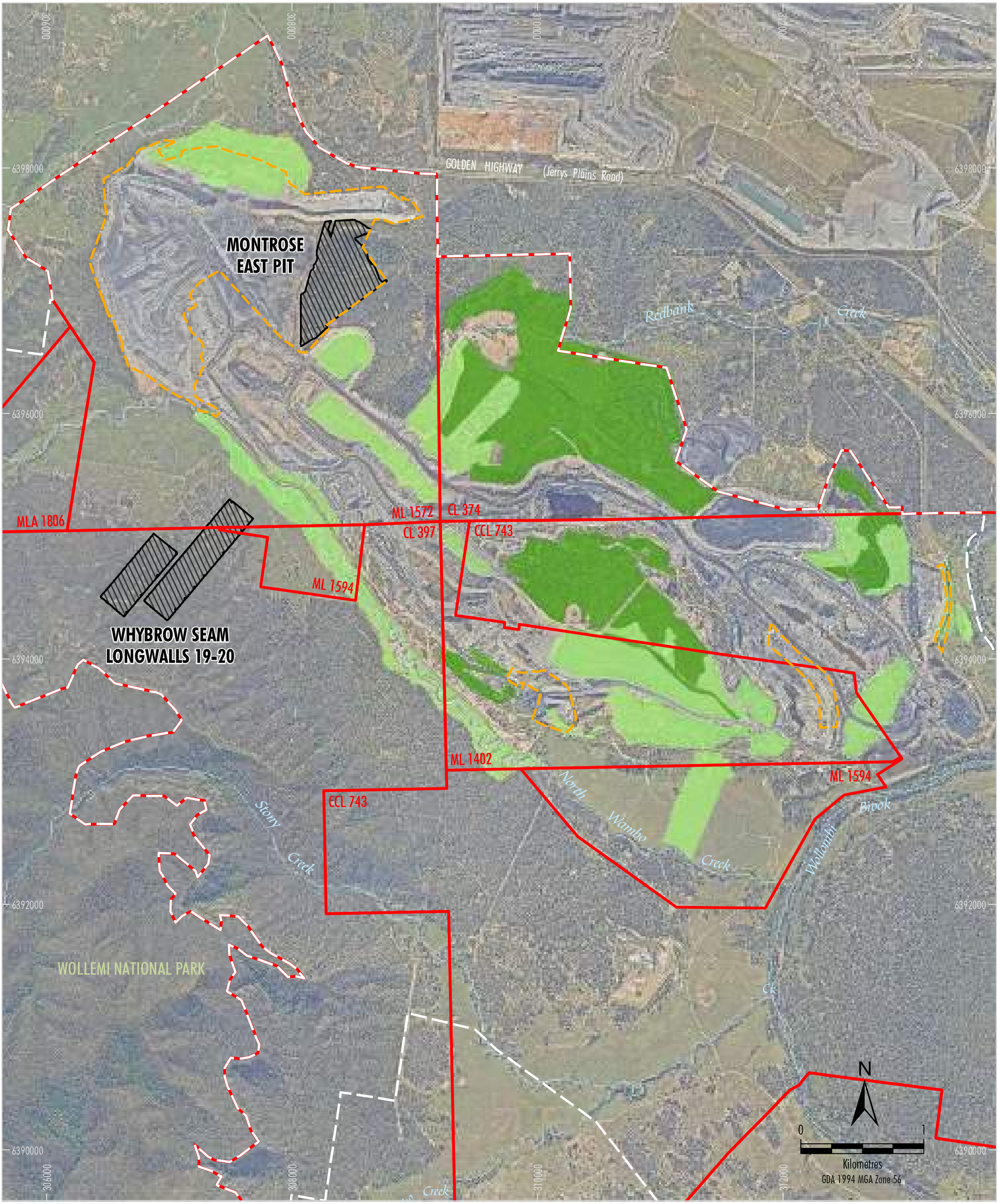
Note, the disturbance as at 31 December 2020 reduced due to the commencement of Phase 2 of the UWJV (and the transfer of operational responsibility of much of the disturbance/rehabilitation areas to United).

Details of mining operations completed at the Mine during the reporting period are included in **Section 3.1**.

Prior to the commencement of Phase 2 operations, WCPL was actively mining in the following areas (**Figure 13**):

- Homestead (East wall);
- Montrose (Hilldale);
- Montrose (Peabody Peak);
- Montrose West (High wall); and
- Montrose East Crown (End wall).

Phase 2 mining operations within these areas are now conducted by United in accordance with SSD 7142.



LEGEND
- Mining and Coal Lease Boundary
- DA 305-7-2003 Boundary
- MOP 2019-2020 – Extent of Open Cut Mining (Applicable from September 2019 to 30 November 2020)
- Mining Activities (Undertaken from 1 January to 30 November 2020)
- Woodland Corridor
- Mixed Pasture/Woodland

Source: WCPL (2021); NSW Spatial Services (2020)
Orthophoto: WCPL (May 2019)

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WAMBO COAL MINE

Status of Mining and Rehabilitation (as at 30 November 2020)

Figure 13

On 27 June 2016, WCPL was issued with a condition requiring the development of a rehabilitation strategy for the NETD to the satisfaction of the Minister for Industry, Resources & Energy (for inclusion in a MOP). WCPL finalised and submitted the NETDRS to DRG (now RR) on 22 November 2016. In March 2017, the DRG (now RR) 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 (now RR) to resubmit the NETDRS by the 31 May 2017.

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

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

As recommended by WCPL's tailings consultant (Fitton Tailings Consultants 2017), CPT occurred in March and April 2020 to inform WCPL's understanding of the geotechnical characteristics of the tailings over the full depth of the facility, over a multiple location testing regime in both the NETD and HPTD facilities.

Upon evaluation of the additional CPT results, WCPL undertook an options analysis study considering the use of unflocculated tailings vs flocculated tailings in the intermittent disposal methodology mentioned above. Based on the findings of this study, WCPL intends to proceed with capping of HPTD in a two stage construction process:

- The first stage in the capping process will involve the intermittent discharge of unflocculated tailings slurry in 200 mm layers across the HPTD surface. Each layer will be left to dry before the next layer is placed on top. This will continue for approximately 2 years, to build up a crust of 2.5 m total thickness; and
- The second stage in the capping process will involve the use of earthmoving equipment to mechanically place mine spoil material on top of the TSF in horizontal layers of progressively increasing thickness.

Regarding the capping of NETD, WCPL has sought advice from Professor David Williams of the University of Queensland as well as Fitton Tailings Consultants regarding capping by the displacement method. This method involves displacing water and tailings with coarse spoil end dumped or dozed over a tip head into wet tailings. A broad tipping front is required to reduce the depth of penetration of spoil into the tailings mass as the tailings will undergo some consolidation and strengthening. The coarse material will penetrate the wet tailings to a depth that provides support, with the mixing zone underlain by consolidating tailings and overlain by clean fill. WCPL intends to conduct a trial using this capping method in Quarter 3 of 2021

The first stage of the 2020 HPTD capping strategy and the displacement method capping trial in NETD are scheduled to commence in Quarter 2 and Quarter 3 of 2021, respectively.

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/RMP (December 2020 – December 2023). The final landform for WCPL proposes a balanced rehabilitation outcome which recognises the alternative land uses that exist in the region, and therefore aims to establish the potential for both sustainable agriculture and endemic woodland habitat. The proposed design of final landforms and the revegetation strategy are described in the MOP/RMP (December 2020 – December 2023) and in United's RMP.

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

7.1.3 Key Rehabilitation Performance Indicators

Table 41 summarises WCPL's rehabilitation status at the end of the reporting period, compared to the previous reporting period.

As outlined above, WCPL is responsible for rehabilitating the remaining surface area and activities related to the Mine's approved underground activities. As such, there will be minimal progressive rehabilitation reported by WCPL over the coming years.

7.1.4 Renovation or Removal of Buildings

No buildings were renovated or removed during the reporting period.

7.1.5 Other Rehabilitation Activities

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

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

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

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

Table 41: 2020 Rehabilitation Status and Forecast

Mine Area Type	2019 (Actual) (ha)*	2020 (Forecast) (ha)	2020 Actual (at 30 November) (ha)	2020 Actual (at 31 December) (ha)	2021 (Forecast) (ha))
A. Total mine footprint[1]	1,881.8	1,881.8	1,894.0	323.21	323.21
B. Total active disturbance[2]	1,174.8	1,189.1	1,201.53	201.31	201.31
C. Land being prepared for rehabilitation[3]	0	0	5.04	0	0
D. Land under active rehabilitation[4]	684.9	730.16	687.43	121.9	121.9
E. Completed rehabilitation[5]	0	0	0	0	0

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

7.1.6 Trials, Research Projects and Other Initiatives

The following rehabilitation trials were undertaken during the reporting period:

- CPT was undertaken to improve WCPL's understanding of the geotechnical characteristics in both NETD and the HPTD facilities.
- Subsidence repair trials (based on the program of works being developed by WCPL following the subsidence impact audit).
- Remediation of approximately 1 km of the NWCD, as guided by the NWCD Rehabilitation and Maintenance Plan, including the application of gypsum to improve soil sodicity and structure beneath newly constructed rock chutes.

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

7.1.7 Variations in Activities Proposed in the MOP/RMP

During the reporting period, rehabilitation was undertaken in accordance with the activities proposed in the approved MOP (2019-2020) and approved MOP/RMP (December 2020 - December 2023).

7.1.8 Key Issues That May Impact Successful Rehabilitation

During Phase 2, open cut activities (including rehabilitation) for the SSD 7142 Operational Area are the responsibility of United. Therefore, WCPL is responsible for rehabilitating the remaining surface area and activities related to the Mine's approved underground activities.

Due to the nature of this disturbance, there will be minimal progressive rehabilitation reported by WCPL over the coming years (i.e. as the disturbed surface area will be required for the life of the underground mine).

7.2 Actions for the Next Reporting Period

7.2.1 Rehabilitation Trials, Research Projects and Other Initiatives

The following key project milestones are proposed by WCPL regarding the capping method for both the NETD and HPTD:

- The first stage of the 2020 HPTD capping strategy to commence in Quarter 2 of 2021.
- Commencement of displacement method capping trial in NETD in Quarter 3 of 2021.

7.2.2 Proposed Rehabilitation in the Next Reporting Period

Following the commencement of Phase 2 of the UWJV, rehabilitation activities for open cut operations is managed by United. Therefore, no rehabilitation work is proposed for the next reporting period by WCPL.

8.0 Community

WCPL operates a 24 hour Community Enquiry Line (02 6570 2245), 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 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 7 April;
- Tuesday 4 August (held remotely via email); and
- Monday 7 December.

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

8.1.2 Newsletters

No newsletters were published by WCPL during the reporting period.

One newsletter was published by United on 6 August 2020 regarding updates on the UWJV.

8.1.3 Other Community Engagement Activities

Two Community Information Session were held on Wednesday 19 February and Wednesday 9 September 2020.

These sessions were both information sessions regarding the commencement of the UWJV.

8.2 Community Contributions

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

- Singleton PCYC Youth Boxing Sponsorship for 2020;
- Hunter Coal Festival Sponsorship (postponed to 2021); and
- Singleton Business Chambers – Excellence Award Sponsorship;
- Wildlife Aid;
- Jerry's Plains Cricket Club; and
- 2020 Wambo Hall of Fame.

8.3 Community Complaints

WCPL received a total of 98 community complaints during the reporting period, including three (3) for blasting, zero (0) for dust, twelve (12) for lighting and eighty-three (83) for noise (**Figure 14**).

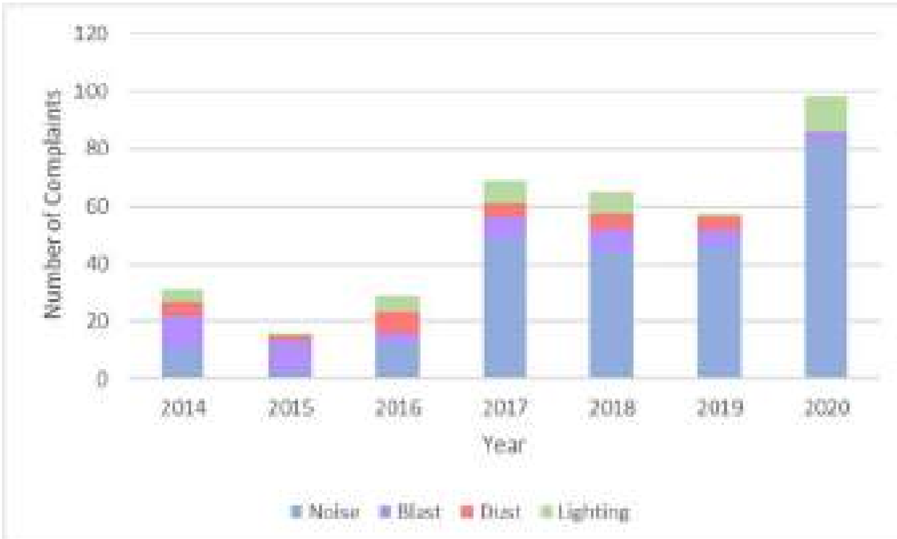

Figure 14: Community Complaints (2014-2020)

Complaints relating to blasting have reduced, with three (3) complaints recorded during 2020 (two [2] for blast fume and one [1] for vibration), compared to six (6) complaints recorded during 2019 (five [5] for vibration and one [1] for blast fume), eight (8) complaints in 2018 (one [1] for blast fume, four [4] for vibration and three [3] for dust), seven (7) in 2017 (one [1] for blast fume, four [4] for vibration, one [1] for dust and one [1] general), four (4) in 2016 (three [3] for vibration and one [1] for fume), eleven (11) in 2015 (all for vibration), and twelve (12) in 2014 (three [3] for blast fume, seven [7] for noise and vibration, one [1] for dust and [1] general).

The number of noise complaints increased to eighty-three (83), compared to forty-six (46) in 2019 and forty-four (44) in 2018. All complaints were reviewed, noise levels assessed against available data and followed up with as soon as possible.

During the reporting period, the number of dust complaints reduced, with no (0) dust complaints received in 2020, compared to (4) complaints received in 2019, compared with six (6) in 2018, five (5) in 2017, seven (7) in 2016, two (2) in 2015, and five (5) in 2014.

Twelve (12) complaints were received relating to lighting in 2020, compared with two (2) in 2019, seven (7) in 2018, and nine (9) in 2017. The complaints typically related to impacts from lighting plants operating in the open cut pit at night.

When requested, detailed reports on WCPL operations at the time of the complaints were provided to DPIE and EPA. A summary of the detailed reports provided to the DPIE and EPA in response to the complaints is provided in **Section 11.0**.

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9.0 Independent Audits

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

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

The report was finalised in June 2015 and submitted to DPIE. **Table 42** summarises the recommendations from this audit and WCPL's progress against these recommendations.

Table 42: Outstanding Action from the 2015 IEA for South Bates Underground Mine Longwalls 11 to 13 Extraction Plan

No.	Recommendation	Action Plan Progress
Groundwater		
8	It is recommended that Wambo investigate the cause(s) of the water level and water quality changes at GW08 and GW09, and if appropriate recommend response actions.	Complete. Monitoring bores GW8.2, GW9.2 and GW10.2 were installed and implemented into the monitoring program during the reporting period.

9.2 2016 Independent Rehabilitation Audit for Annual Environment Management Report

In 2015, WCPL commissioned GHD to undertake an independent audit (GHD 2016) of the rehabilitation at the Mine to identify any potential deficiencies of the rehabilitation and improvement strategies. The audit report was finalised in June 2016 and submitted to DRG. **Table 43** provides an update on the status of the audit recommendations, including:

- Matters that have been addressed in MOP/RMP 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).

Table 43: Actions from the 2016 Rehabilitation Audit

No.	Recommendation	Action Plan Progress
21	Incorporate seed germination testing in the MOP and ensure that certificates for all seed collected or supplied by an external contractor is obtained. This provides quality assurance of seed and expected germination rates.	Complete. Please refer to Table 21 of MOP/RMP (approved November 2020).

9.3 2017 Independent Environmental Audit

An IEA was undertaken by Hansen Bailey (2017) in November and December 2017 to assess compliance against DA305-7-2003 (Modification 17) and DA177-8-2004 (Modification 2).

The audit also assessed compliance against EPL529 and ML1572. The audit report was finalised in December 2017 and submitted to DPIE in accordance with Condition 7, Schedule 6 (now Condition D11, Schedule 2) of DA305-7-2003. Following review of the IEA, DPIE advised their agency requirements had not been addressed in the audit and requested the IEA be revised to include them. The revised IEA was submitted to DPIE on 19 September 2018 and approved 31 January 2019. A copy of the audit report is available on the Peabody Energy website (www.peabodyenergy.com).

Thirty-six (36) non-compliances, comprised of 25 issues, were identified during the audit, including thirteen (13) which were classed as "administrative". The non-compliances were risk ranked. No high risks were identified during the audit. Eleven issues were identified as low risk and one issue as medium risk. The report also included numerous recommendations for improvement. **Table 44** and **Table 45** summarise WCPL's actions taken to address the non-compliances and continual improvement recommendations, respectively.

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

An IEA was undertaken by Cumberland Ecology in 2019 to assess compliance against EPBC Approval 2003/1138, the Biodiversity Offset Strategy (BOS), and the commitments made in WCPL's BMP. The audit report was finalised in January 2020 and submitted to DPIE in accordance with Condition 4 of EPBC 2003/1138 and Condition 50, Schedule 4 of DA305-7-2003 (no longer a requirement under the Development Consent following approval of MOD 16). A copy of the audit report is available on the Peabody Energy website (www.peabodyenergy.com).

Seven (7) non-compliances and three (3) items that were unable to be verified were identified during the audit. **Table 46** summarises the outstanding recommendations from this audit and WCPL's progress against the action plan developed to address these recommendations. There is no longer a requirement for WCPL to undertake an IEA for EPBC 2003/1138 under DA305-7-2003. As required by Condition 4 of EPBC 2003/1138 future audits will be undertaken every five years.

9.5 2020 Independent Environmental Audit

An IEA was undertaken by GHD in November of 2020 to assess compliance against DA305-7-2003 (Modification 16) and DA177-8-2004 (Modification 2) and other relevant environmental approvals and licences. The audit was conducted for the period beginning September 2017 to end of November 2020. The audit report was finalised in December 2020 and submitted to DPIE in accordance with Condition D11, Schedule 2 of DA305-7-2003. will be made available on the Peabody Energy website (www.peabodyenergy.com) once approved by DPIE.

There were no medium or high risk non-compliances identified during the audit. Thirty-one (31) non-compliances were identified, including ten (10) which were classified as "administrative", the remaining twenty-one (21) were classified as "low". The report also included recommendations for improvements. **Table 47** and **Table 48** summarise WCPL's proposed actions to address the non-compliances and continual improvement recommendations, respectively.

Table 44: Non-Compliances Identified in the 2017 IEA for DA305-7-2003 and DA177-8-2004

Ref	Audit Finding / Risk	Description	WCPL Response	Timing
Previous Audit Non-Compliances				
5.8, 5.18, 5.24	-	Review actions recommended by previous audit which have not been completed. Update management plans as required to address recommendations that are relevant to contemporary operations Refs 4.5 – 4.9). • North Wambo Creek Diversion Plan not yet revised to include the required section on mechanism for the return of intercepted groundwater;	Noted. The design for the return of intercepted groundwater remains in draft. This condition has been included in the 2019 revision of the North Wambo Creek Diversion Plan. The NWCD Plan was submitted for consultation 24 April 2019. WCPL is currently updating the NWCD Plan to address comments. This condition has been removed from the consent following determination of the UWJV (i.e. Modification 16).	N/A
DA305-7-2003 (MOD 17) Non-Compliance Recommendations				
Schedule 4, Condition 8 and Condition 9	Low	Recommend that documented coordination with nearby mines and an agreed protocol is developed to manage cumulative noise impacts to the satisfaction of the Secretary.	A cumulative noise impact protocol has been outlined in the Noise Management Plan as per 2017 IEA recommendations.	Complete.
Schedule 4, Condition 30 and 30A	Administrative	Site Water Management Plan should be updated to include the predicted salt balance.	Included in Section 5.0 of the United Wambo Open Cut and Wambo Underground Site Water Balance.	Complete.

Table 45: Continual Improvement Recommendations Made by the 2017 IEA for DA305-7-2003 and DA177-8-2004

Ref	Description	WCPL Response	Timing
DA305-7-2003 (MOD 17) Continual Improvement Recommendations			
Schedule 4, Condition 22	The Reject Emplacement Strategy (RES) should be submitted to DRG (not DPIE) and followed up to approval. It is noted that the plan is likely to require review following any positive determination of the United and Wambo Open Cut Coal Mine Project.	This condition no longer exists as part of the DA305-7-2003.	Complete.
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.	It is not practicable to directly measure groundwater flows with current technology. The updated Site Water Balance (SWB) included monitoring of groundwater inflows measures using flow metering (active take), estimated based on groundwater model (passive take).	Complete.
Schedule 4, Condition 34	Update GWMP to include Montrose Dam prior to its construction.	The GWMP will be updated prior to construction of Montrose Dam.	Complete.
Schedule 4, Condition 34	Consideration should be made to directly monitor the quality of groundwater seepage reporting to the underground and open-cut workings.	Direct measures of groundwater quality of seepage are generally not practicable. The SWB identifies that salinity will be measured using groundwater EC or TDS, including seepage quality where practicable.	Complete.
Schedule 4, Condition 40	Offset area E is required to be secured under a conservation agreement by December 2017 and included in the Biodiversity Management Plan and MOP. A draft has been sent to OEH. This should aim to finalise by the due date.	Review of relevant documentation indicated compliance with the requirements of this condition. No additional offsets have been identified as being required under Condition B3, Schedule 4 of DA DA-7-2003 (Modification 16). Review of the 2017 IEA recommendation indicated it was not achieved, with a non-compliance (administrative) found against Condition B72, Schedule 4 of DA DA-7-2003 (Modification 16). The conservation agreement has now been finalised.	Complete.
Schedule 4, Condition 47	Recommend that identification of 'Acacia anuera' is finalised and amended in the development consent to Acacia pendula at next modification, if required.	This condition no longer exists as part of DA305-7-2003.	Complete.
Schedule 4, Condition 56	Seek to recover this contribution if regulators confirm that it has not been expended, or if it has seek the documented outcome of the Trust Fund.	This condition no longer exists as part of DA305-7-2003.	Complete.
Schedule 4, Condition 71	Consistent with previous audit, recommend consultation occurs and correspondence received from RMS is sought confirming the new intersection is not required or they are satisfied for inclusion in next IEA.	This condition no longer exists as part of DA305-7-2003.	Complete.

Ref	Description	WCPL Response	Timing
Schedule 4, Condition 94A	Recommend soil surveys are undertaken the Soil Management Protocol is updated for any remaining areas to be stripped showing specific depths for specific areas.	While this condition no longer exists as part of the DA305-7-2003, the Soil Management Protocol was identified as having been updated during the 2018 reporting period.	Complete.
DA177-8-2004 (MOD 2) Continual Improvement Recommendations			
Schedule 4, Condition 6	Reviewed Australian Rail Track Corporation (ARTC) EPL 3142 and email from Matt Pearce of Aurizon dated 12/09/13. Email confirms that locomotives are required to be tested by the rail operator for compliance with noise requirements. Recommend that this is updated to remain contemporary.	On August 5, 2020, Rolling Stock Operators in NSW were issued with EPLs, which state that the "licensee must only operate locomotives on a Licensed Rail network that are in a class of locomotive listed on the Locomotive Class Register on the EPA's website".	Complete.
Schedule 4, Condition 23	Recommend this condition is revised to remove at next modification as Correspondence with RMS no longer required as Mount Thorley Warkworth have approval to mine through Wallaby Scrub Road.	This condition was not removed and remains a consideration for the consent.	Ongoing.
Schedule 4, Condition 32	The following are recommendations for the ESCP: • A description of the existing as-built ESC arrangements for each sediment-affected catchment would enhance the current understanding of the site ESC arrangements; and • A description of the known issues and actions would be useful in demonstrating that the ESCP is operating effectively and areas for improvement. Additionally, the ESCP structure and text would benefit from a review to improve the general readability of the document. This could involve ensuring that the plan structure is logical, the scope and progression of each section is clear, and overly lengthy or repetitious text is rationalised.	To be addressed in the next review of the ESCP.	Complete.
Other			
N/A	• The diversion management program should be implemented to improve the operation of the diversion;	Agreed. The revised NWCD Plan contains a detailed rehabilitation plan including: • Table 13: 5 Year NWCD Rehabilitation and Maintenance Plan. • Appendix C – Detailed Rehabilitation Plan.	2020 works complete. SCS has completed stability
N/A	• Ongoing management is required in order to ensure that soil erosion is minimised and ground cover is given adequate opportunity to become established; and		

Ref	Description	WCPL Response	Timing
N/A	• Rehabilitation of subsided areas of the diversion is required in accordance with an Extraction Plan (or SMP), including repairing surface subsidence cracks and undertaking subsidence remediation where necessary in areas where the diversion has been subsided.		assessment and remediation proposal for 2021, with works scheduled to commence Q2 2021.
N/A	The area in RWEA B is rehabilitated to prevent further damage and reduce risks to the surrounding Central Hunter Grey Box-Ironbark Woodland Endangered Ecological Community (EEC) as per Ecological Australia's recommendations.	Most appropriate method of rehabilitation to be determined, in order to reduce impacts if rehabilitation is undertaken with machinery.	Ongoing.
N/A	Subsidence affected sites identified as 'intolerable' by SLR Consulting should be remediated to an acceptable standard as per SLR's recommendations. Photos of completion should be kept within the database along with a report checklist with date and signature demonstrating works were completed.	Most appropriate method of rehabilitation to be determined, in order to reduce impacts if rehabilitation is undertaken with machinery.	Ongoing.

Table 46: Outcomes of 2019 IEA for EPBC Approval 2003/1138 and Biodiversity Management Plan

Ref	Audit Finding	Description	WCPL Response	Timing
EPBC Approval 2003/1138				
Condition 2	Non-compliant	The approved plan must be implemented.	See detailed responses below.	Ongoing.
Biodiversity Management Plan Commitments (Appendix E of the Audit)				
Section 6.3.1	Non-compliant	**Fencing, gates and signage** • Boundary fence integrity will be inspected quarterly and maintained during all management periods. • New fencing erected within or on the boundary of the RWEAs will use post and two or three strand non-barbed (plain) wire only. If required boundary fences to these areas may use a top barbed wire (or electric fencing). • Existing fencing within the boundaries of the Domains will be removed in areas where it is providing no benefit to revegetation outcomes.	Whilst fencing inspections were not completed or documented in accordance with the BMP, fencelines continue to be well maintained. Fencelines were audited by a registered surveyor in 2016 and 2019. WCPL spent in excess of $25,000 on RWEA fencing in 2019. **WCPL Remedial/Improvement Actions** 1. Quarterly inspections of fencelines have resumed and documentation has been improved. 2. WCPL is seeking an amendment to the BMP to include a commitment for a three (3) yearly fence line audit (next scheduled for 2022) to replace the quarterly inspection. Periodic fence line inspections will continue and maintenance will be conducted as required. A copy of the updated BMP will be provided to DPIE for review.	Complete. BMP was revised to include three (3) yearly fence line audit (next scheduled for 2022) to replace the quarterly inspection. (Approved November 2020).
Section 6.3.2	Non-compliant	**Seed collection and propagation** • WCPL has implemented a native seed collection and propagation program. • The collection of locally sourced native seed will be carried out annually by a licensed provider with the Florabank guidelines used to guide the seed collection process. • The seed collection program will take into account seasonality of seed availability and the specific target seed lists.	Whilst there is no evidence of seed collection during the 2015-2018 period, rehabilitation activities were undertaken using the approved seed species list contained in Appendix G of the BMP. Seed was purchased from a local supplier and included some locally sourced species. Seed collection at WCPL was undertaken in summer 2019 and a report provided by the seed collection contractor. **WCPL Remedial/Improvement Actions** 1. Seed collection will continue annually.	Complete.

Ref	Audit Finding	Description	WCPL Response	Timing
Section 6.3.2.2	Non-compliant	**Weed management** • WCPL's weed management program will involve six monthly inspections of the RWEAs and Revegetation Areas. • An annual routine weed management program will be implemented whereby herbaceous weed species are treated to prevent further spread. • Treatment of all weeds will be undertaken by suitably qualified and experienced personnel.	Whilst evidence was not located for six monthly inspections, a weed control program has been undertaken every year and reported in the Annual Review. WCPL completes Annual Flora and Fauna monitoring in accordance with the requirements of the BMP which reports on weed management. The new Weed Management Treatment Plan will improve the strategic approach to weed management. The weed survey conducted in 2019 will be conducted annually and the Weed Management Treatment Plan updated to provide the framework for weed treatment in the following year. **WCPL Remedial/Improvement Actions** 1. Six monthly inspections of the RWEAs and Revegetation Areas will be reinstated. 2. WCPL will update the BMP to reference the Weed Management Treatment Plan (2019) and remove the requirement for six monthly weed inspections. This commitment will be replaced with inspections completed during weed control activities and the weed survey conducted during the Annual Flora and Fauna Monitoring.	Complete. BMP (approved November 2020) was revised to reference the weed treatment plan. Inspections are conducted annually during the flora and fauna monitoring program and prior to the update of the weed treatment plan.
Section 6.3.2.3	Non-compliant	**Vertebrate pest management** • The WCPL operated pest control program is complemented by a year round agister-managed pest control program. • The agister-managed program primarily targets feral pigs on grazing and buffer lands surrounding WCPL's open cut mine site. • The agister-managed program utilises WCPL-owned night vision cameras to monitor the movement of pest species. • Humane trapping and shooting practices are employed to capture and euthanize targeted feral species.	Non-compliance relates to the agister managed program and a lack of documentation in this regard. **WCPL Remedial/Improvement Actions** 1. As recommended by Cumberland Ecology, the BMP will be revised to detail biannual vertebrate pest management, consistent with the requirements of the relevant Conservation Agreements. 2. Documentation for the agister-managed pest control program will be improved.	Complete. BMP (approved November 2020) has been revised to detail the biannual vertebrate pest management.

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

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

Table 47: Non-Compliances Requiring Action Identified by the 2020 IEA for DA305-7-2003 and DA177-8-2004

Ref	Audit Finding / Risk	Description	WCPL Response	Timing
B103 of DA305-7-2003	Low	Ensure relevant items which remain open, as detailed in Peabody's response to the Resources Regulator on 30 November 2020, are closed out in consultation with and to the satisfaction of the Resources Regulator.	All actions recommended to ensure the safe management of explosives on site have been undertaken by WCPL. The UWJV is now responsible for explosives management at the Mine.	Complete.
B105 of DA305-7-2003 and B26 of DA177-8-2004	Low	The method for assessing rehabilitation performance using LFA monitoring should be reassessed in line with Tongway and Hindley (2005). TARP and Completion Criteria should be updated in the MOP.	Section 8.1.1 of the RMP (approved 25 November 2020) states 'Over the RMP term, WCPL will review the use of LFA as a monitoring method and transition to alternative monitoring methods for rehabilitated landscape establishment which may include soil monitoring. Biometric Vegetation Assessment and visual assessments. The TARP and Completion criteria will be updated accordingly.	During next MOP/RMP review (current MOP/RMP approved to 31 December 2023).
B108 of DA305-7-2003	Administrative	The MOP should be updated to include relevant programs and activities to address care and maintenance and mine closure requirements.	Agreed.	During next MOP/RMP review (current MOP/RMP approved to 31 December 2023).
B110 of DA305-7-2003	Low	Where a variation to rehabilitation activities detailed in the approved RMP/MOP is planned to be undertaken, ensure this is undertaken in consultation with the NSW Resources Regulator and other relevant agencies detailed in Condition B108.	Noted.	No action required.
C4 of DA305-7-2003 and C2 of DA177-8-2004	Administrative	Provide copies of relevant resident tenancy agreements to the Planning Secretary to confirm satisfaction that the intents of this condition of been met.	Agreed.	By 31 March 2021.
EPL529 Condition M2.3	Administrative	When PM_{10} samplers (TEOM) stop logging data, report the duration and the 24 hour average concentration to see if the downtime would likely of resulted in an exceedance.	Agreed.	As required.

Table 48: Continual Improvement Recommendations Made by the 2020 IEA for DA305-7-2003 and DA177-8-2004

Ref	Description	WCPL Response	Timing
B42 of DA305-7-2003	Calculation of the site incremental impact, and contributions during extraordinary events such as bushfires is undertaken as required for elevated 24 hour concentrations and on an ad-hoc basis for annual averaged concentrations. The site can investigate a method to better capture extraordinary events such as bushfires and exclude this from the data on a regular basis. Increase in site annual averages shows this may be an issue moving forward with climate related events such as bushfires and droughts.	This matter will be discussed with WCPL's appointed air quality expert and an appropriate method to better capture extraordinary events and exclude this from the data will be determined.	By 30 June 2021.
B66 of DA305-7-2003	Figure 10 of the ESCP would benefit from flow direction arrows indicating is satisfaction of detailed plans for water run-off diversions and catch drains and any reinstated drainage networks on rehabilitated areas of the site.	Agreed.	31 March 2021.
B90 of DA305-7-2003	The CMP should be resubmitted to the Heritage Branch for endorsement/verification of satisfaction, to ensure compliance with the modified requirements of DA305-7-2003.	Agreed.	31 March 2021.
EPL529 Condition M.2	Rather than the current text which reads 'Enquiries or complaints can be lodged at – WamboCommunity@peabodyenergy.com', the Wambo website should be revised to give details for the 24 hour Community Enquiry Line being available to make complaints.	Noted.	Complete.

9.6 2020 Pollution Monitoring Data EPA Desktop Audit

As part of the EPA state wide compliance audit program focusing on the requirements for licensees to publish pollution monitoring data, a desktop audit was conducted by the EPA on 11 May 2020. A copy of the audit report is available on the Peabody Energy website (www.peabodyenergy.com).

A number of administrative non-compliances were identified for EPL529 regarding pollution monitoring data. **Table 49** summarises WCPL's actions taken to address the non-compliances. All non-compliances identified by the audit have been addressed.

Table 49: Non-Compliances Requiring Action Identified by the Pollution Monitoring Data EPA Desktop Audit

Ref	Audit Finding / Risk	Description	WCPL Response	Timing
EPL529 Condition 3.2.1	Administrative	The EPA requirements specify that a meaningful summary of the monitoring data must be published for each sampling period and must include information regarding when and to what extent the pollutant discharge limits specified in the licence were not met and why. The licensee publishes a monthly summary report for noise monitoring and a monthly environmental monitoring report containing data for surface water, groundwater, air, blasting and weather monitoring. However, the licensee has not published an annual summary of the blasting data.	An annual summary of blasting data was made available on the Peabody website (www.peabodyenergy.com) including data from the previous monitoring period.	Complete.
EPL529 Condition 3.8.1	Administrative	Requirements states that where the limit relates to a period longer than a month, an additional table that summarises the data relevant to that period must also be included to allow comparison with the performance limit. The licence specifies blasting limits that apply to the yearly reporting period and therefore an annual summary of that monitoring data must be published as well as the monthly summaries. The 100 percentile limits (as opposed to the yearly limits) have been included in the monthly reports however the blast limit was exceeded on 21/9/19 but there is no indication in the monthly environmental monitoring report that it was exceeded or why (as required). This information must be included in the monthly summary.	This information has been made available on the Peabody website (www.peabodyenergy.com).	Complete.
EPL529 Condition 3.3	Administrative	Any data that is obtained as a result of a monitoring condition on a licence that relates to air, water (surface or groundwater), noise and/or land pollution. Limited to data that relates to pollutants generated, discharged or emitted from the licensed premises. Data has not been published for water quality at Point 4 (outlet from Eagles Nest Dam), Point 18 (STP discharge), Point 19 (outlet from Wambo Dam), Point 42 (STP discharge to utilisation area) and Point 52 (STPD2 discharge). (Points 19, 42 and 52 were added to the licence in December 2019).	This information has been made available on the Peabody website (www.peabodyenergy.com).	Complete.

Ref	Audit Finding / Risk	Description	WCPL Response	Timing
EPL529 Condition 3.3	Administrative	The recent Annual Return for the January to December 2019 reporting period indicates that there were discharges from Point 18 during that period but there were no discharges from Point 4. For locations with occasional or intermittent sampling conditions, section 3.8 of the Requirements for publishing pollution monitoring data states that "For those months or years when no discharge occurs, a note stating that no discharge has occurred is sufficient. This should be included either at regular intervals (i.e. at the time of publishing other monitoring data for the premises or on a monthly basis if there is no other monitoring required) or in an upfront note as outlined in section 3.7.8." The licensee has not included a note with the monthly monitoring reports or an upfront note to explain the missing data for Point 4 or Point 19, 42 and 52 (if discharges have also not occurred from these points) and has not published monthly data for Point 18. Monitoring is required quarterly during discharge at Points 42 and 52 and therefore as a quarterly period has passed, results for these points should have been published or a statement that there were no discharges. This information must be provided with the monthly summaries or on the website as an upfront note. An example of an upfront note given in 3.7.8 is: *Where no data has been published for point [x or list of points] for a particular month, it indicates that either:* • *the level of pollutant was below the detection level of the measurement* • *instrument, or* • *there has been no discharge from that point/s for the month.* Although the licensee is not required to publish meteorological data as it is considered ambient data, weather data is used when determining compliance with noise limits. The licensee has published a monthly summary of the continuous weather data however two of the parameters, wind direction at 10 metres (degrees) and sigma theta (degrees) have not been included in the data. The licensee should ensure that these parameters are also being measured and consider publishing the results with the other weather data.	This information has been made available on the Peabody website (www.peabodyenergy.com).	Complete.

Ref	Audit Finding / Risk	Description	WCPL Response	Timing
EPL529 Condition 3.4	Administrative	The EPA requirements specify that the meaningful summary must be published within 14 days of the data being obtained for the last sample collected for the monthly period. The licensee has not published all meaningful summaries within 14 days of the data being obtained. It is unclear what date the monthly environmental monitoring reports are published however for each data set within the reports, the dates sampled, obtained and published are provided (except for surface water sampling). The dates that the data is listed as being published is not always within 14 days of the results being obtained. For example, in the January 2020 environmental monitoring report, the blasting results are listed as Date obtained: continuous and Date published: 15 April 2020. As these are the results for January and the results have been published on 15 April, this is not within 14 days of the results being obtained. However, in the same report, the PM_{10} data is stated as published on 13 February. It is unclear how the data has been published on different dates when they are in the same report. The date on the report is March 2020. For the monthly noise monitoring reports, the monitoring dates and report dates are provided but it is unclear what date the reports have been published.	This information has been made available on the Peabody website (www.peabodyenergy.com).	Complete.
EPL529 Condition 3.7.1	Administrative	• The environment protection licence number of the facility, • the licensee's name and address (as they appear on the licence) and • a link to the EPA's Public Register must be published or provided with the pollution monitoring data. The licensee has not published a link to the EPA's Public Register with the pollution monitoring data. The licensee has published the licence number and licensee's name and address with the data.	This information has been made available on the Peabody website (www.peabodyenergy.com).	Complete.

Ref	Audit Finding / Risk	Description	WCPL Response	Timing
EPL529 Condition 3.7.2	Administrative	The location (or general description) of each sampling or monitoring point to which the pollution monitoring data applies (including the point numbers identified in the licence) must be published or provided with the data. The licensee has not published the point numbers identified in the licence, with the pollution monitoring data. The licensee has also not given a general description of all monitoring and sampling points. A description and map have been published for the noise monitoring locations but not for the other monitoring/sampling locations.	This information has been made available on the Peabody website (www.peabodyenergy.com).	Complete.
EPL529 Condition 3.7.4	Administrative	If a link to the EPA's Public Register is not provided, then the pollution monitoring data published or provided by a licensee must also include the units of measure, metric, scale or descriptor prescribed in the relevant licence condition. Any abbreviations used should be noted in full. A link to the EPA's Public Register has not been provided (see 3.7.1). The licensee has published abbreviated units of measure with most data but has not noted these in full, except for noise monitoring where an explanation of the units of measure has been provided.	This information has been made available on the Peabody website (www.peabodyenergy.com).	Complete.

10.0 Incidents and Non-compliances during the Reporting Period

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

- Failure to comply with relevant noise criteria for two incidences during the reporting period (**Section 10.1**).
- Failure to continuously monitor PM_{10} levels at four sites (**Section 10.2**).
- Failure to collect water discharge samples and conduct analysis at required frequency (**Section 10.3**).
- Failure to collect surface water samples at required frequency (**Section 10.4**).
- Failure to notify AWE within one month that management plans were updated and approved at the end of November 2020 (**Section 10.5**); and
- Incident relating to the construction of the upcast ventilation shaft which was suspended due to borehole collapse (**Section 10.6**).

10.1 Noise Exceedances

During the reporting period, non-compliances with Condition L5.1 of EPL529 and Condition B13 of DA305-7-2003 were recorded on two occasions at N26 (EPL Monitoring Point 23).

At 10:00 pm on 8 September 2020, operations at WCPL exceeded the $L_{Aeq(15\ minute)}$ noise limit of 38 dB by 3 dB (including a 2 dB low frequency penalty) at N26. Operational changes were made prior to re-measurement which occurred within 75 minutes and complied (27 dB) with the relevant criteria.

A follow up measurement was conducted at 10:03 pm on 10 September 2020. The operation exceeded the $L_{Aeq\ (15\ minute)}$ noise limit of 38 dB by 3 dB (including a 2 dB low frequency penalty) at N26. Operational changes were made prior to re-measurement which occurred within 75 minutes and complied (27 dB) with the relevant criteria.

No noise complaints were received during these periods.

The EPA was notified of the exceedance by email on 15 September 2020. An investigation report regarding the exceedances was submitted to EPA and DPIE on 10 October 2020.

10.2 PM_{10} Monitoring

During the reporting period, PM_{10} readings were not obtained on 21 occasions. The lapse in continuous monitoring resulted in a non-compliance with Condition M2.2 of EPL529.

Continuous data monitoring at AQ01 stopped on one occasion, AQ02 stopped on three occasions, AQ03 stopped on 13 occasions and AQ04 stopped on four occasions.

The PM_{10} monitors ceased logging for varying lengths of time. These breaks in continuous monitoring were a result of storms, Ausgrid maintenance, power outages, equipment failure and replacement units being installed and were addressed as quickly as possible following identification of the issue.

All monitoring stations are remotely controlled by internal contractor equipment minimising the likelihood of data being lost as a result of faults/communication errors/ power outages. Regular preventative maintenance will continue on all four PM_{10} monitors during the next reporting period.

10.3 Discharge Point Sampling

Condition M2.3 of EPL529 requires quarterly discharge point sampling from sewage treatment plant locations, however samples at Point 18, Point 42 and Point 52 were unable to be collected. Ten samples were required over the reporting period for these locations, only five samples were obtained.

Point 18 was not utilised as a discharge point during the reporting period and therefore was dry.

EPL529 was varied and issued on 27 March 2020. EPL Point 42 and Point 52 were added to the monitoring program in July 2020.

During the next reporting period, the requirements of monitoring at Point 52 will be reviewed as this location is for the Sewage Treatment Plant, not a discharge location.

Sampling at Point 42 and Point 52 are now routinely monitored.

10.4 Surface Water Sampling

Condition M2.3 of EPL529 requires surface water quality samples to be collected at a number of locations, however, due to dry conditions in some locations, adequate samples were unable to be collected at monitoring locations SW01, SW02, SW03, SW04, SW05, SW06, SW07, SW08, SW15, SW27a, SW32a, SW39, SW40, and SW41.

The non-compliance is considered to be a result of dry conditions, insufficient water to sample and restricted access to sampling locations.

WCPL will continue to implement the SWMP and monitoring on a monthly basis.

10.5 EPBC Notification of Approval of Revised Management Plans

Condition 3 of EPBC approval 2016/7636 requires notification to the Department within one month of the approval of management plans, programs, strategies and reviews. WCPL revised a number of management plans, which were approved by the Secretary of the NSW Department of Planning, Industry and Environment (or nominee of the Secretary) in November 2020.

The non-compliance is the result of the Department not being notified within one month (see Appendix I).

10.6 Ventilation Shaft Construction

In April 2020 WCPL commenced construction of the South Bates Extension Underground upcast ventilation shaft, approved under DA305-7-2003 (Modification 17). Construction of the shaft was suspended due to borehole collapse in May 2020. Stabilisation and recovery works were undertaken with the successful retrieval of the drill rig, in consultation with DPIE-Resources Regulator.

The shaft collapse is considered an incident.

11.0 Regulator Requests for Information

During the reporting period the DPIE, RR and EPA made a number of requests for information relating to WCPL operations. On each occasion, WCPL conducted a review of relevant monitoring data and operational activities and provided a summary to DPIE and/or EPA.

An overview of the information requested and actions taken is provided in **Table 50**.

Table 50: Regulator Requests for Information

Date of Request	Relevant Agency	Comment
6 January	EPA	On 6 January, EPA requested information relevant to the five-year review of EPL529. WCPL provided the requested response. On 21 February EPA requested clarification on some of the information provided, which included the location of N26 noise monitoring locations. WCPL provided the requested clarification.
30 March	EPA	On 30 March, the EPA requested WCPL investigate a noise complaint received on 30 March by the EPA and provide a response. WCPL provided an investigation report to the EPA 28 March 2020.
6 August	EPA	On 6 August, the EPA issued a S191 Notice to Provide Information and/or Records regarding compliance with noise conditions. Noise and meteorological monitoring data and information around operational activities/locations for periods in May, June and July 2020 was requested. WCPL provided a response on 4 September 2020.
25 August	DPIE	On 25 August, DPIE considered the actions proposed within the Response to Audit Recommendations for the 2020 IEA as satisfactory, and requested a status update for the actions provided. WCPL provided the requested response.
28 September	EPA	On 28 September, EPA requested additional information regarding the Administration Sewage Treatment Plant, specifically around high faecal coliforms results and ponding of effluent which was reported in the 2019 Annual Return. WCPL provided this information on 28 October 2020.
20 October	EPA	On 20 October, the EPA requested additional information regarding visible dust observed at the CHPP on 2 October, including activities undertaken, weather conditions and dust control measures implemented from 3 pm to 4 pm on 2 October 2020. WCPL provided this information on 30 October 2020.
26 November	RR	On 26 November, RR requested further information regarding the Rehabilitation Management Plan for Phase 2 of the UWJV. WCPL provided this information to RR and the RMP/MOP was approved.
22 December	EPA	The EPA requested emission data for the environmental monitoring levy for the Upper Hunter Air Quality Monitoring Network. WCPL provided the information on 22 December 2020.

12.0 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:

- scheduled works on the Kharlibe property including:
  - Maintenance of rehabilitated sites;
  - Rehabilitation of newly identified sites; and
  - Commencement of South Wambo Creek remediation works.
- re-erect/replace the three nest boxes which had fallen to the ground;
- structural engineer to review blast data and assess cracking of concrete water tank on neighbouring property.
- undertake a preliminary investigation of the surface water quality (pH) results recorded at SW02;
- review the flows observed at FM13 and FM15;
- investigate a better method for capturing extraordinary events impacting air quality;
- planned 2021 NWCD rehabilitation and maintenance works;
- investigate GW15 to determine whether the bore is accurately representing the groundwater levels in the surrounding aquifers and whether low groundwater level observations are related to Wambo mining activity;
- implementation of ongoing groundwater model updates; and
- a HRSTS system audit will be undertaken if discharges through the HRSTS occur during the next reporting period.

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

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APPENDIX A

APPROVAL CONDITIONS SPECIFICALLY RELATING TO THE ANNUAL REVIEW

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

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

Approval	Condition	Description	Where Addressed
EPBC 2016/7816	Condition 5	By 31 March of each year after the commencement of the action, the person taking the action must: publish a report on their website addressing compliance with each of the conditions of this approval, including implementation of any management plans and strategies required by conditions 22, 22C, 220 and 23 - 39 of Schedule 4 the state development consent over the previous calendar year; and provide documentary evidence providing proof of the date of publication to the Department, by email to EPBCMonitoring@environment.gov.au (or another email address as stipulated by the Department). The person taking the action must continue publishing annual compliance reports and make all reports available on their website for the life of the approval, unless agreed in writing by the Minister.	Appendix I
S101 Approval (NETD)	Condition (h)	The North East Tailings Dam shall be reported on within the Annual Environmental Management Report for Wambo Coal. Consideration shall also be given to the rehabilitation performance for this site.	Sections 7.1.6 and 7.2.1
CL365, CL397 ML1806	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/RMP; (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/RMP; b) report on progress in respect of rehabilitation completion criteria; c) report on the extent of compliance with regulatory requirements; and d) have regard to any relevant guidelines adopted by the Director-General.	This Annual Review

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

APPENDIX B

2020 DAILY TRAIN MOVEMENT SUMMARY

Table B1: Daily Train Movements

Date	Trains per Day	Date	Trains per Day	Date	Trains per Day
3/01/2020	2	6/03/2020	3	29/04/2020	2
4/01/2020	4	7/03/2020	2	2/05/2020	1
6/01/2020	2	8/03/2020	2	3/05/2020	5
7/01/2020	3	9/03/2020	4	4/05/2020	2
8/01/2020	1	13/03/2020	4	5/05/2020	1
17/01/2020	1	14/03/2020	5	10/05/2020	3
18/01/2020	2	15/03/2020	4	11/05/2020	1
19/01/2020	2	16/03/2020	1	13/05/2020	1
20/01/2020	2	17/03/2020	2	16/05/2020	3
21/01/2020	5	18/03/2020	2	18/05/2020	1
22/01/2020	1	19/03/2020	1	22/05/2020	1
23/01/2020	3	21/03/2020	2	23/05/2020	1
24/01/2020	4	22/03/2020	1	24/05/2020	1
25/01/2020	3	23/03/2020	1	25/05/2020	3
26/01/2020	1	25/03/2020	2	26/05/2020	4
27/01/2020	1	27/03/2020	2	27/05/2020	1
2/02/2020	2	28/03/2020	2	1/06/2020	5
3/02/2020	1	29/03/2020	3	2/06/2020	2
4/02/2020	3	30/03/2020	1	3/06/2020	6
6/02/2020	1	3/04/2020	2	5/06/2020	1
7/02/2020	2	4/04/2020	2	8/06/2020	2
9/02/2020	1	6/04/2020	1	10/06/2020	1
10/02/2020	1	7/04/2020	1	12/06/2020	1
11/02/2020	2	8/04/2020	1	14/06/2020	1
14/02/2020	2	9/04/2020	1	15/06/2020	2
15/02/2020	1	10/04/2020	1	16/06/2020	2
16/02/2020	3	12/04/2020	4	17/06/2020	1
18/02/2020	3	13/04/2020	1	18/06/2020	1
21/02/2020	2	14/04/2020	1	19/06/2020	1
22/02/2020	5	15/04/2020	1	20/06/2020	2
23/02/2020	2	16/04/2020	1	21/06/2020	5
25/02/2020	2	17/04/2020	1	22/06/2020	1
26/02/2020	1	18/04/2020	1	24/06/2020	1
27/02/2020	2	20/04/2020	2	25/06/2020	3
29/02/2020	3	21/04/2020	1	26/06/2020	3
1/03/2020	3	22/04/2020	1	28/06/2020	3
2/03/2020	4	23/04/2020	1	29/06/2020	2
3/03/2020	3	25/04/2020	2	30/06/2020	4
4/03/2020	2	26/04/2020	4	12/07/2020	1
5/03/2020	1	28/04/2020	2	13/07/2020	2
16/07/2020	1	17/09/2020	1	08/11/2020	3
24/07/2020	1	19/09/2020	1	09/11/2020	2
25/07/2020	4	20/09/2020	4	11/11/2020	1

Date	Trains per Day	Date	Trains per Day	Date	Trains per Day
26/07/2020	2	21/09/2020	3	12/11/2020	1
28/07/2020	2	25/09/2020	1	14/11/2020	1
31/07/2020	1	26/09/2020	2	16/11/2020	1
1/08/2020	2	27/09/2020	4	17/11/2020	2
2/08/2020	2	28/09/2020	1	20/11/2020	1
3/08/2020	3	29/09/2020	1	21/11/2020	3
7/08/2020	3	30/09/2020	2	22/11/2020	2
10/08/2020	2	1/10/2020	3	23/11/2020	1
11/08/2020	1	02/10/2020	3	24/11/2020	1
12/08/2020	1	03/10/2020	2	25/11/2020	3
14/08/2020	1	04/10/2020	5	26/11/2020	6
16/08/2020	2	05/10/2020	3	27/11/2020	3
17/08/2020	4	06/10/2020	1	28/11/2020	6
18/08/2020	3	07/10/2020	2	29/11/2020	4
20/08/2020	1	08/10/2020	3	30/11/2020	7
21/08/2020	2	11/10/2020	1	01/12/2020	1
22/08/2020	1	12/10/2020	2	02/12/2020	1
23/08/2020	5	13/10/2020	4	04/12/2020	2
24/08/2020	4	14/10/2020	2	09/12/2020	2
25/08/2020	1	15/10/2020	3	10/12/2020	4
28/08/2020	2	16/10/2020	4	11/12/2020	3
29/08/2020	2	17/10/2020	2	15/12/2020	1
30/08/2020	4	18/10/2020	3	16/12/2020	5
31/08/2020	1	19/10/2020	3	17/12/2020	4
2/09/2020	1	20/10/2020	2	18/12/2020	3
3/09/2020	2	21/10/2020	4	19/12/2020	4
4/09/2020	1	22/10/2020	2	21/12/2020	3
5/09/2020	1	23/10/2020	4	22/12/2020	1
7/09/2020	2	24/10/2020	4	23/12/2020	4
8/09/2020	2	25/10/2020	4	26/12/2020	1
9/09/2020	1	31/10/2020	3	27/12/2020	2
10/09/2020	2	01/11/2020	3	28/12/2020	5
11/09/2020	3	02/11/2020	5	29/12/2020	3
12/09/2020	4	03/11/2020	5	30/12/2020	2
13/09/2020	5	04/11/2020	3	31/12/2020	1
14/09/2020	4	05/11/2020	3		
15/09/2020	1	06/11/2020	1		

Table B2: Train Movements within Sensitive Service Hours

Date	Time	Date	Time
Friday, 3 January 2020	7:48 PM	Sunday, 30 August 2020	12:00 AM
Sunday, 19 January 2020	1:50 AM	Sunday, 13 September 2020	5:59 AM
Sunday, 26 January 2020	4:19 AM	Sunday, 20 September 2020	1:57 AM
Sunday, 2 February 2020	3:57 AM	Sunday, 20 September 2020	7:54 AM
Sunday, 16 February 2020	2:21 AM	Sunday, 27 September 2020	2:30 AM
Sunday, 16 February 2020	6:44 AM	Sunday, 27 September 2020	5:36 AM
Sunday, 1 March 2020	2:57 AM	Sunday, 4 October 2020	1:45 AM
Sunday, 8 March 2020	2:25 AM	Sunday, 11 October 2020	7:00 AM
Sunday, 15 March 2020	12:26 AM	Sunday, 18 October 2020	3:41 AM
Sunday, 15 March 2020	8:34 AM	Sunday, 25 October 2020	12:55 AM
Friday, 27 March 2020	8:17 PM	Sunday, 25 October 2020	5:43 AM
Sunday, 29 March 2020	1:31 AM	Sunday, 25 October 2020	8:41 AM
Sunday, 12 April 2020	2:23 AM	Sunday, 1 November 2020	3:07 AM
Sunday, 26 April 2020	2:02 AM	Sunday, 1 November 2020	6:41 AM
Sunday, 26 April 2020	5:09 AM	Sunday, 8 November 2020	12:01 AM
Sunday, 3 May 2020	2:20 AM	Sunday, 8 November 2020	4:51 AM
Sunday, 3 May 2020	6:09 AM	Friday, 20 November 2020	6:01 PM
Friday, 8 May 2020	8:14 PM	Friday, 27 November 2020	6:24 PM
Sunday, 10 May 2020	5:30 AM	Sunday, 29 November 2020	2:30 AM
Sunday, 21 June 2020	1:45 AM	Sunday, 29 November 2020	5:39 AM
Sunday, 21 June 2020	4:49 AM	Friday, 11 December 2020	7:40 PM
Sunday, 28 June 2020	8:00 AM	**Total**	**48**
Sunday, 26 July 2020	7:59 AM		
Friday, 31 July 2020	7:44 PM		
Sunday, 2 August 2020	2:54 AM		
Friday, 7 August 2020	7:32 PM		
Sunday, 23 August 2020	2:13 AM		

APPENDIX C

ANNUAL NOISE MONITORING REPORT

Wambo Coal Mine

Annual Environmental Monitoring Report 2020

Prepared for

Wambo Coal Pty Ltd

Global Acoustics

Noise and Vibration Analysis and Solutions

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Wambo Coal Mine

Annual Environmental Monitoring Report 2020

Reference: 20320_R01
Report date: 10 February 2021

Prepared for

Wambo Coal Pty Limited
PMB 1
Singleton NSW 2330

Prepared by

Global Acoustics Pty Ltd
PO Box 3115
Thornton NSW 2322

Prepared:	Jesse Tribby Consultant	QA Review:	Ryan Bruniges Consultant

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

EXECUTIVE SUMMARY

Global Acoustics was engaged by Wambo Coal Pty Ltd to provide an Annual Environmental Monitoring Report for 2020, in order to compare noise monitoring results against both relevant criteria and predictions in the most recently approved Environmental Impact Statement (EIS) for the United Wambo project.

This report summarises monthly attended noise monitoring surveys conducted at five monitoring locations around Wambo Coal Mine (WCM) during the reporting period 1 January to 31 December 2020. The purpose of the surveys was to quantify and describe the acoustic environment around the site and compare results with specified limits.

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

January to December 2020 Compliance

Noise levels from WCM complied with the relevant development consent and EPL criteria at all sites during 2020 attended monitoring, except on two occasions. The following exceedances of EPL criteria were measured during 2020 monitoring:

- On the night of 8/9 September 2020, WCM exceeded the L_{Aeq} criterion at N26 by 3 dB. A low-frequency modifying factor of +2 dB was applicable to the site-only L_{Aeq}. A re-measure was undertaken with resulting levels below the relevant limits; and
- During the follow-up measurement on the night of 10/11 September 2020, WCM exceeded the L_{Aeq} criterion at N26 by 3 dB. A low-frequency modifying factor of +2 dB was applicable to the site-only L_{Aeq}. A re-measure was undertaken with resulting levels below the relevant limits.

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

Long-Term Noise Trends

During the 5-year period analysed, WCM noise levels at most monitoring locations increased from 2016 to 2018 as mining operations progressed to the northwest and were initially less shielded. From 2018 to 2020, site noise levels decreased at most monitoring locations, likely due to mining activity being deeper in pit and therefore more shielded from receptors.

From 1 December 2020, open cut mining is no longer undertaken by WCM and noise emissions are expected to decrease significantly.

EIS Comparison

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

- At N01, measured noise levels were typically not comparable to Year 2 predictions in the EIS, apart from one instance in which the measured site-only L_{Aeq} was lower than predicted .
- At N16, measured L_{Aeq} noise levels were lower than Year 2 predictions in the EIS when comparable to modelled noise levels. Measured $L_{A1,1minute}$ noise levels were not comparable with Year 2 predictions in the EIS.
- At NA20, measured noise levels were lower than Year 2 predictions in the EIS when comparable to modelled noise levels.
- At N21, measured L_{Aeq} noise levels were typically not comparable with Year 2 predictions in the EIS, apart from one instance in which the measured site-only L_{Aeq} was lower than predicted. When comparable to modelled noise levels, measured $L_{A1,1minute}$ noise levels were higher than predicted in the EIS on two occasions and lower than predicted on three occasions.
- At N26, measured L_{Aeq} noise levels were similar to Year 2 predictions in the EIS. When comparable to modelled noise levels, measured $L_{A1,1minute}$ noise levels were higher than predicted in the EIS on one occasion and lower than predicted on three occasions.

Global Acoustics Pty Ltd

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Appendices

1 INTRODUCTION

1.1 Background

Global Acoustics was engaged by Wambo Coal Pty Ltd to provide an Annual Environmental Monitoring Report (AEMR) for 2020, in order to compare noise monitoring results against noise modelling predictions and relevant noise criteria.

This report summarises monthly attended noise monitoring surveys conducted at five monitoring locations around WCM during the reporting period 1 January to 31 December 2020. The purpose of the surveys was to quantify and describe the acoustic environment around the site and compare results with specified limits.

1.2 Monitoring Locations & Frequency

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

Table 1.1: WAMBO COAL ATTENDED MONITORING LOCATIONS[1]

Site Reference	EPL 529 ID	Description	Representative Addresses[2]
N01	N/A	North Bulga	3, 7, 379
N16	20	Jerrys Plains Road	Privately owned residences near Jerry's Plains
N20A	21	Redmanvale Road Central	Privately owned residences near Jerry's Plains
N21	22	South Wambo	25, 35a
N26	23	Redmanvale Road South	Privately owned residences near Jerry's Plains

Notes:

1. *Sourced from the NMP – WA-ENV-MNP-503, November 2020; and*
2. *Representative address numbering is from Appendix 4 of DA 305-7-2003.*

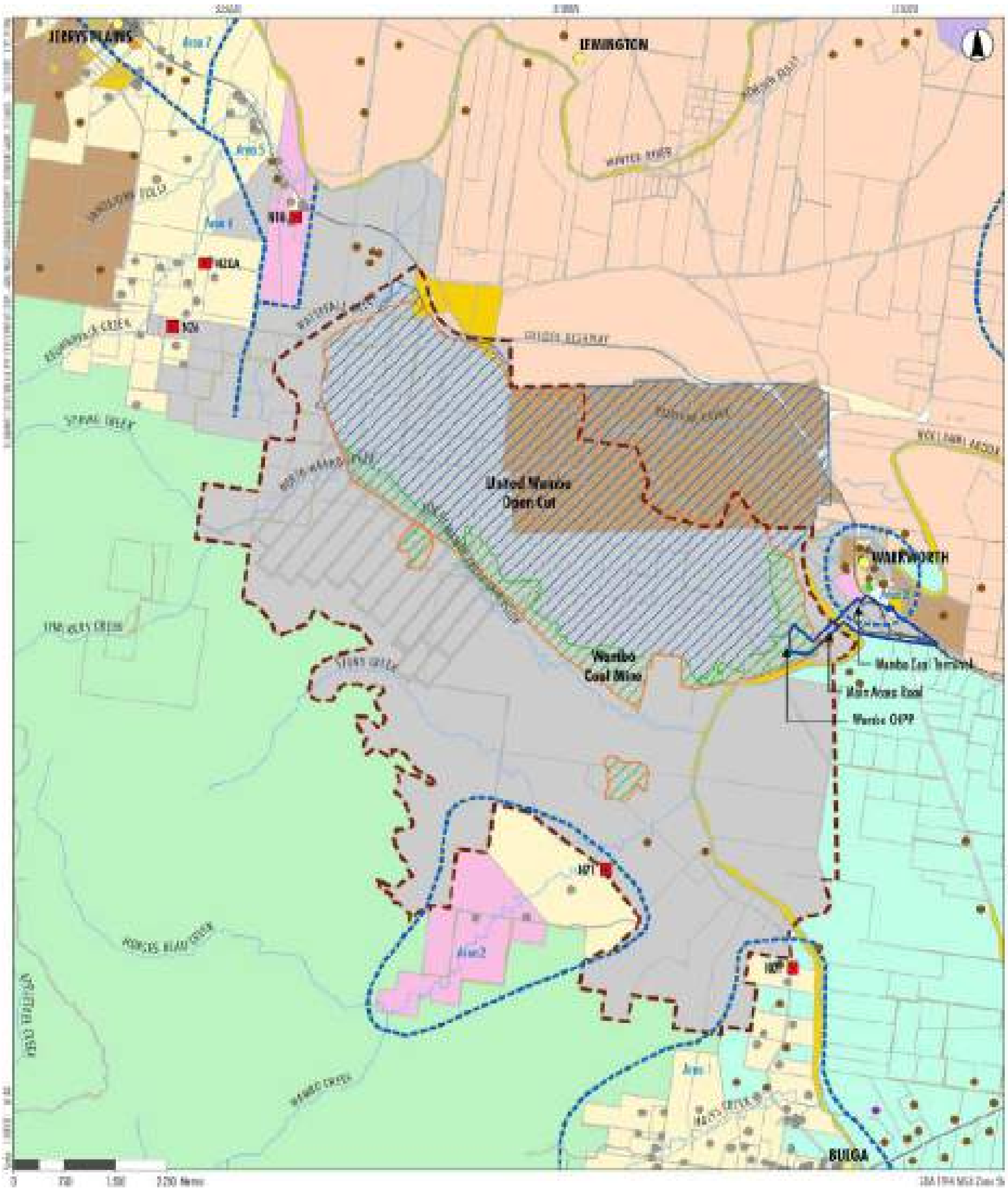

Figure 1: WCM Attended Noise Monitoring Locations

1.3 Terminology & Abbreviations

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

Table 1.2: TERMINOLOGY & ABBREVIATIONS

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

2 REGULATOR REQUIREMENTS AND NOISE CRITERIA

2.1 WCM Development Consent

The most current development consent for WCM is DA 305-7-2003 (MOD 16, 29 August 2019). Schedule 2, Part B of the WCM consent details specific conditions relating to noise generated by WCM.

2.2 Environment Protection Licence

WCM holds Environment Protection Licence (EPL) No. 529 issued by the Environment Protection Authority (EPA) most recently on 3 December 2020.

2.3 Noise Management Plan

Noise monitoring requirements are detailed in the *Wambo Coal Noise Management Plan WA-ENV-MNP-503* (NMP, November 2020), prepared in accordance with the WCM consent.

2.4 Noise Criteria

Phase 1 noise criteria detailed in Table 2.1 have been adopted for each monitoring location based on of the development consent (MOD 16). Phase 1 noise criteria were applicable through 30 November 2020.

Table 2.1: WCM NOISE CRITERIA, dB(A)

Location	Day $L_{Aeq,15minute}$	Evening/Night $L_{Aeq,15minute}$	Night $L_{A1,1minute}$
N01[1]	40	40	50
N16	40	40	50
N20A	40	40	50
N21	40	40	50
N26	38	38	50

Notes:

1. *Noise criteria for the nearest privately-owned property (R003 – Birrell) have been adopted.*

From 1 December 2020, Phase 2 noise criteria detailed in Table 2.2 have been adopted for each monitoring location based the development consent (MOD 16) and NMP.

Table 2.2: WCM NOISE CRITERIA, dB(A)

Location	Day $L_{Aeq,15minute}$	Evening/Night $L_{Aeq,15minute}$	Night $L_{A1,1minute}$
N01[1]	38	38	48
N16	35	35	45
N20A	35	35	45
N21[2]	39	39	49
N26	35	35	45

Notes:

1. *Noise criteria for the nearest privately-owned property (R003) have been adopted; and*
2. *Noise criteria for the nearest privately-owned property (R025) have been adopted.*

EPL noise criteria have not been updated for Phase 2 and 3 of operations. As noise criteria in the development consent and NMP are now more conservative than those in the EPL, they have been adopted in Table 2.2.

2.5 Meteorological Conditions

Meteorological conditions required for noise criteria to apply are consistent between the consent and EPL.

2.5.1 Development Consent

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

APPENDIX 5 NOISE COMPLIANCE ASSESSMENT

Applicable Meteorological Conditions

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

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

2.5.2 Environment Protection Licence

Condition L5.5 of the EPL details meteorological conditions required for noise limits to apply:

L5.5 The noise limits set out in condition L5.1 apply under all meteorological conditions except for the following:

a) Wind speeds greater than 3 metres/second at 10 metres above the ground level;
b) Stability category F temperature inversion conditions and wind speeds greater than 2 metres/second at 10 metres above ground level; or
c) Stability category G temperature inversion conditions.

Condition L5.5 is consistent with stability category conditions outlined in Appendix 5, 1.(b) of MOD 16.

2.6 Modifying Factors

The EPA 'Noise Policy for Industry' (NPfI, 2017) was approved for use in NSW in October 2017. For assessment of modifying factors, the NPfI immediately superseded the 'Industrial Noise Policy' (INP, 2000), as outlined in the EPA document 'Implementation and transitional arrangements for the Noise Policy for Industry' (2017). Assessment and reporting of modifying factors has been undertaken in accordance with Fact Sheet C of the NPfI.

3 METHODOLOGY

3.1 Overview

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

3.2 Attended Noise Monitoring

During this survey, monthly attended monitoring was undertaken during the night period at each location. The duration of each measurement was 15 minutes. Atmospheric condition measurement was also undertaken at each monitoring location.

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

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

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

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

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

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

Often extraneous noise events (for example, road traffic pass-bys and dogs) interfere with the measurement of site noise levels in the frequency range of interest. Where required, the sound level meter is paused during these occurrences to aid in quantification of the site only $L_{Aeq,15minute}$ level.

3.3 Meteorological Data

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

3.4 Modifying Factors

All measurements were evaluated for potential modifying factors in accordance with the NPfI. Specific methodology for assessment of each modifying factor is outlined in Fact Sheet C of the NPfI.

Assessment of modifying factors is undertaken at the time of measurement if the site was audible and directly quantifiable, such that the site-only L_{Aeq} was not "NM" or less than a maximum cut off value (e.g. "<20 dB" or "<30dB").

If applicable, modifying factors have been reported and added to measured site-only L_{Aeq} noise levels when meteorological conditions satisfied requirements for site noise criteria to be applicable. Low-frequency modifying factors have only been applied to site-only L_{Aeq} levels if WCM was the only contributing low-frequency noise source.

3.5 Comparison with United Wambo EIS Model Predictions

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

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

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

Table 3.1: APPLICABLE METEOROLOGICAL CONDITION DEFINITIONS

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

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

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

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

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

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

Table 3.2: APPLICABLE METEOROLOGICAL CONDITION DEFINITIONS

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

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

4 RESULTS

4.1 January 2020

4.1.1 Total Measured Noise Levels

Overall noise levels measured at each location during attended measurement in January 2020 are provided in Table 4.1.

Table 4.1: MEASURED NOISE LEVELS – JANUARY 2020[1]

Location	Start Date and Time	L_{Amax} dB	L_{A1} dB	L_{A10} dB	L_{Aeq} dB	L_{A50} dB	L_{A90} dB	L_{Amin} dB
N01	20/01/2020 22:37	46	44	38	35	33	30	27
N16	20/01/2020 23:11	42	36	31	29	28	27	26
N20A	20/01/2020 22:37	49	39	33	29	25	23	21
N21	20/01/2020 22:08	47	34	30	29	28	27	25
N26	20/01/2020 22:06	46	45	44	43	43	41	37

Notes:

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

4.1.2 Modifying Factors

Measured site-only levels were assessed for the applicability of modifying factors in accordance with the NPfI and methodology described in Section 3.4.

There were no modifying factors, as defined in the NPfI, applicable during the survey.

4.1.3 Attended Noise Monitoring

Table 4.2 to Table 4.3 detail noise levels from WCM in the absence of other noise sources. Noise criteria are applicable if weather conditions during the measurement were within parameters outlined in the WCM development consent.

Table 4.2: $L_{Aeq,15minute}$ GENERATED BY WCM AGAINST PROJECT APPROVAL METEOROLOGICAL CONDITIONS – JANUARY 2020

Location	Start Date and Time	Wind Speed m/s	Stability Category[1]	Criterion $L_{Aeq,15min}$ dB	Criterion Applies?[2]	WCM $L_{Aeq,15min}$ dB [3,4]	Exceedance [4,5]
N01	20/01/2020 22:37	0.4	F	40	Yes	25	Nil
N16	20/01/2020 23:11	0.4	F	40	Yes	<20	Nil
N20A	20/01/2020 22:37	0.4	F	40	Yes	<25	Nil
N21	20/01/2020 22:08	0.3	F	40	Yes	25	Nil
N26	20/01/2020 22:06	0.3	F	40	Yes	IA	Nil

Notes:

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

Table 4.3: $L_{A1,1minute}$ GENERATED BY WCM AGAINST PROJECT APPROVAL METEOROLOGICAL CONDITIONS – JANUARY 2020

Location	Start Date and Time	Wind Speed m/s	Stability Category[1]	Criterion $L_{A1,1min}$ dB	Criterion Applies?[2]	WCM $L_{A1,1min}$ dB [3,4]	Exceedance [4,5]
N01	20/01/2020 22:37	0.4	F	50	Yes	27	Nil
N16	20/01/2020 23:11	0.4	F	50	Yes	26	Nil
N20A	20/01/2020 22:37	0.4	F	50	Yes	<25	Nil
N21	20/01/2020 22:08	0.3	F	50	Yes	26	Nil
N26	20/01/2020 22:06	0.3	F	50	Yes	IA	Nil

Notes:

1. *Stability Class calculated using sigma theta method provided by NPfI;*
2. *Noise emission limits identified in the above table apply under all meteorological conditions except wind speeds greater than 3 m/s at 10 metres above ground level; or stability category F temperature inversion conditions and wind speeds greater than 2 m/s at 10 metres above ground level, or stability category G temperature inversion conditions;*
3. *Site-only $L_{A1,1minute}$ attributed to WCM;*
4. *Bold results in red indicate an exceedance of relevant criterion; and*
5. *NA in exceedance column means atmospheric conditions outside conditions specified in development consent, therefore criterion was not applicable, or there is no applicable criterion.*

4.2 February 2020

4.2.1 Total Measured Noise Levels

Overall noise levels measured at each location during attended measurement in February 2020 are provided in Table 4.4.

Table 4.4: MEASURED NOISE LEVELS – FEBRUARY 2020[1]

Location	Start Date and Time	L_{Amax} dB	L_{A1} dB	L_{A10} dB	L_{Aeq} dB	L_{A50} dB	L_{A90} dB	L_{Amin} dB
N01	19/02/2020 22:51	53	50	48	46	45	42	38
N16	19/02/2020 23:13	47	38	34	32	32	30	28
N20A	19/02/2020 22:40	51	38	35	33	32	30	27
N21	19/02/2020 22:26	53	50	48	45	45	41	36
N26	19/02/2020 22:12	46	40	38	36	35	33	30

Notes:

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

4.2.2 Modifying Factors

Measured site-only levels were assessed for the applicability of modifying factors in accordance with the NPfI and methodology described in Section 3.4.

There were no modifying factors, as defined in the NPfI, applicable during the survey.

4.2.3 Attended Noise Monitoring

Table 4.5 to Table 4.6 detail noise levels from WCM in the absence of other noise sources. Noise criteria are applicable if weather conditions during the measurement were within parameters outlined in the WCM development consent.

Table 4.5: $L_{Aeq,15minute}$ GENERATED BY WCM AGAINST PROJECT APPROVAL METEOROLOGICAL CONDITIONS – FEBRUARY 2020

Location	Start Date and Time	Wind Speed m/s	Stability Category[1]	Criterion $L_{Aeq,15min}$ dB	Criterion Applies?[2]	WCM $L_{Aeq,15min}$ dB [3,4]	Exceedance [4,5]
N01	19/02/2020 22:51	1.7	E	40	Yes	IA	Nil
N16	19/02/2020 23:13	2.5	D	40	Yes	28	Nil
N20A	19/02/2020 22:40	1.3	F	40	Yes	IA	Nil
N21	19/02/2020 22:26	1.6	F	40	Yes	IA	Nil
N26	19/02/2020 22:12	2.5	E	40	Yes	IA	Nil

Notes:

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

Table 4.6: $L_{A1,1minute}$ GENERATED BY WCM AGAINST PROJECT APPROVAL METEOROLOGICAL CONDITIONS – FEBRUARY 2020

Location	Start Date and Time	Wind Speed m/s	Stability Category[1]	Criterion $L_{A1,1min}$ dB	Criterion Applies?[2]	WCM $L_{A1,1min}$ dB [3,4]	Exceedance [4,5]
N01	19/02/2020 22:51	1.7	E	50	Yes	IA	Nil
N16	19/02/2020 23:13	2.5	D	50	Yes	40	Nil
N20A	19/02/2020 22:40	1.3	F	50	Yes	IA	Nil
N21	19/02/2020 22:26	1.6	F	50	Yes	IA	Nil
N26	19/02/2020 22:12	2.5	E	50	Yes	IA	Nil

Notes:

1. *Stability Class calculated using sigma theta method provided by NPfI;*
2. *Noise emission limits identified in the above table apply under all meteorological conditions except wind speeds greater than 3 m/s at 10 metres above ground level; or stability category F temperature inversion conditions and wind speeds greater than 2 m/s at 10 metres above ground level, or stability category G temperature inversion conditions;*
3. *Site-only $L_{A1,1minute}$ attributed to WCM;*
4. *Bold results in red indicate an exceedance of relevant criterion; and*
5. *NA in exceedance column means atmospheric conditions outside conditions specified in development consent, therefore criterion was not applicable, or there is no applicable criterion.*

4.3 March 2020

4.3.1 Total Measured Noise Levels

Overall noise levels measured at each location during attended measurement in March 2020 are provided in Table 4.7.

Table 4.7: MEASURED NOISE LEVELS – MARCH 2020[1]

Location	Start Date and Time	L_{Amax} dB	L_{A1} dB	L_{A10} dB	L_{Aeq} dB	L_{A50} dB	L_{A90} dB	L_{Amin} dB
N01	23/03/2020 22:57	49	39	37	35	34	33	31
N16	23/03/2020 23:02	44	41	39	37	37	35	34
N20A	23/03/2020 22:30	44	39	38	36	36	34	32
N21	23/03/2020 22:30	43	35	33	31	31	30	27
N26	23/03/2020 22:00	45	41	39	38	37	36	34

Notes:

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

4.3.2 Modifying Factors

Measured site-only levels were assessed for the applicability of modifying factors in accordance with the NPfI and methodology described in Section 3.4.

There were no modifying factors, as defined in the NPfI, applicable during the survey.

4.3.3 Attended Noise Monitoring

Table 4.8 to Table 4.9 detail noise levels from WCM in the absence of other noise sources. Noise criteria are applicable if weather conditions during the measurement were within parameters outlined in the WCM development consent.

Table 4.8: $L_{Aeq,15minute}$ GENERATED BY WCM AGAINST PROJECT APPROVAL METEOROLOGICAL CONDITIONS – MARCH 2020

Location	Start Date and Time	Wind Speed m/s	Stability Category[1]	Criterion $L_{Aeq,15min}$ dB	Criterion Applies?[2]	WCM $L_{Aeq,15min}$ dB [3,4]	Exceedance [4,5]
N01	23/03/2020 22:57	1.4	F	40	Yes	IA	Nil
N16	23/03/2020 23:02	1.4	F	40	Yes	33	Nil
N20A	23/03/2020 22:30	2.5	E	40	Yes	35	Nil
N21	23/03/2020 22:30	2.5	E	40	Yes	IA	Nil
N26	23/03/2020 22:00	2.4	D	40	Yes	35	Nil

Notes:

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

Table 4.9: $L_{A1,1minute}$ GENERATED BY WCM AGAINST PROJECT APPROVAL METEOROLOGICAL CONDITIONS – MARCH 2020

Location	Start Date and Time	Wind Speed m/s	Stability Category[1]	Criterion $L_{A1,1min}$ dB	Criterion Applies?[2]	WCM $L_{A1,1min}$ dB [3,4]	Exceedance [4,5]
N01	23/03/2020 22:57	1.4	F	50	Yes	IA	Nil
N16	23/03/2020 23:02	1.4	F	50	Yes	41	Nil
N20A	23/03/2020 22:30	2.5	E	50	Yes	40	Nil
N21	23/03/2020 22:30	2.5	E	50	Yes	IA	Nil
N26	23/03/2020 22:00	2.4	D	50	Yes	42	Nil

Notes:

1. *Stability Class calculated using sigma theta method provided by NPfI;*
2. *Noise emission limits identified in the above table apply under all meteorological conditions except wind speeds greater than 3 m/s at 10 metres above ground level; or stability category F temperature inversion conditions and wind speeds greater than 2 m/s at 10 metres above ground level, or stability category G temperature inversion conditions;*
3. *Site-only $L_{A1,1minute}$ attributed to WCM;*
4. *Bold results in red indicate an exceedance of relevant criterion; and*
5. *NA in exceedance column means atmospheric conditions outside conditions specified in development consent, therefore criterion was not applicable, or there is no applicable criterion.*

4.4 April 2020

4.4.1 Total Measured Noise Levels

Overall noise levels measured at each location during attended measurement in April 2020 are provided in Table 4.10.

Table 4.10: MEASURED NOISE LEVELS – APRIL 2020[1]

Location	Start Date and Time	L_{Amax} dB	L_{A1} dB	L_{A10} dB	L_{Aeq} dB	L_{A50} dB	L_{A90} dB	L_{Amin} dB
N01	08/04/2020 22:38	55	44	41	39	39	37	34
N16	08/04/2020 22:59	54	51	47	44	42	39	36
N20A	08/04/2020 22:29	51	42	38	36	35	34	32
N21	08/04/2020 22:13	57	55	54	52	52	50	45
N26	08/04/2020 22:00	59	38	36	35	34	32	30

Notes:

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

4.4.2 Modifying Factors

Measured site-only levels were assessed for the applicability of modifying factors in accordance with the NPfI and methodology described in Section 3.4.

There were no modifying factors, as defined in the NPfI, applicable during the survey.

4.4.3 Attended Noise Monitoring

Table 4.11 to Table 4.12 detail noise levels from WCM in the absence of other noise sources. Noise criteria are applicable if weather conditions during the measurement were within parameters outlined in the WCM development consent.

Table 4.11: $L_{Aeq,15minute}$ GENERATED BY WCM AGAINST PROJECT APPROVAL METEOROLOGICAL CONDITIONS – APRIL 2020

Location	Start Date and Time	Wind Speed m/s	Stability Category[1]	Criterion $L_{Aeq,15min}$ dB	Criterion Applies?[2]	WCM $L_{Aeq,15min}$ dB [3,4]	Exceedance [4,5]
N01	08/04/2020 22:38	1.1	F	40	Yes	IA	Nil
N16	08/04/2020 22:59	1.2	F	40	Yes	37	Nil
N20A	08/04/2020 22:29	1.1	F	40	Yes	35	Nil
N21	08/04/2020 22:13	1.0	F	40	Yes	IA	Nil
N26	08/04/2020 22:00	1.3	F	40	Yes	33	Nil

Notes:

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

Table 4.12: $L_{A1,1minute}$ GENERATED BY WCM AGAINST PROJECT APPROVAL METEOROLOGICAL CONDITIONS – APRIL 2020

Location	Start Date and Time	Wind Speed m/s	Stability Category[1]	Criterion $L_{A1,1min}$ dB	Criterion Applies?[2]	WCM $L_{A1,1min}$ dB [3,4]	Exceedance [4,5]
N01	08/04/2020 22:38	1.1	F	50	Yes	IA	Nil
N16	08/04/2020 22:59	1.2	F	50	Yes	46	Nil
N20A	08/04/2020 22:29	1.1	F	50	Yes	44	Nil
N21	08/04/2020 22:13	1.0	F	50	Yes	IA	Nil
N26	08/04/2020 22:00	1.3	F	50	Yes	37	Nil

Notes:

1. *Stability Class calculated using sigma theta method provided by NPfI;*
2. *Noise emission limits identified in the above table apply under all meteorological conditions except wind speeds greater than 3 m/s at 10 metres above ground level; or stability category F temperature inversion conditions and wind speeds greater than 2 m/s at 10 metres above ground level, or stability category G temperature inversion conditions;*
3. *Site-only $L_{A1,1minute}$ attributed to WCM;*
4. *Bold results in red indicate an exceedance of relevant criterion; and*
5. *NA in exceedance column means atmospheric conditions outside conditions specified in development consent, therefore criterion was not applicable, or there is no applicable criterion.*

4.5 May 2020

4.5.1 Total Measured Noise Levels

Overall noise levels measured at each location during attended measurement in May 2020 are provided in Table 4.13.

Table 4.13: MEASURED NOISE LEVELS – MAY 2020[1]

Location	Start Date and Time	L_{Amax} dB	L_{A1} dB	L_{A10} dB	L_{Aeq} dB	L_{A50} dB	L_{A90} dB	L_{Amin} dB
N01	07/05/2020 22:53	59	44	32	34	30	29	27
N16	07/05/2020 23:17	63	59	46	45	32	29	26
N20A	07/05/2020 22:42	47	36	32	30	30	28	25
N21	07/05/2020 22:24	56	41	37	36	35	33	31
N26	07/05/2020 22:11	49	33	26	25	24	22	20

Notes:

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

4.5.2 Modifying Factors

Measured site-only levels were assessed for the applicability of modifying factors in accordance with the NPfI and methodology described in Section 3.4.

There were no modifying factors, as defined in the NPfI, applicable during the survey.

4.5.3 Attended Noise Monitoring

Table 4.14 to Table 4.15 detail noise levels from WCM in the absence of other noise sources. Noise criteria are applicable if weather conditions during the measurement were within parameters outlined in the WCM development consent.

Table 4.14: $L_{Aeq,15minute}$ GENERATED BY WCM AGAINST PROJECT APPROVAL METEOROLOGICAL CONDITIONS – MAY 2020

Location	Start Date and Time	Wind Speed m/s	Stability Category[1]	Criterion $L_{Aeq,15min}$ dB	Criterion Applies?[2]	WCM $L_{Aeq,15min}$ dB [3,4]	Exceedance [4,5]
N01	07/05/2020 22:53	0.1	F	40	Yes	28	Nil
N16	07/05/2020 23:17	0.5	F	40	Yes	IA	Nil
N20A	07/05/2020 22:42	0.5	F	40	Yes	IA	Nil
N21	07/05/2020 22:24	0.8	F	40	Yes	34	Nil
N26	07/05/2020 22:11	0.4	F	38	Yes	IA	Nil

Notes:

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

Table 4.15: $L_{A1,1minute}$ GENERATED BY WCM AGAINST PROJECT APPROVAL METEOROLOGICAL CONDITIONS – MAY 2020

Location	Start Date and Time	Wind Speed m/s	Stability Category[1]	Criterion $L_{A1,1min}$ dB	Criterion Applies?[2]	WCM $L_{A1,1min}$ dB [3,4]	Exceedance [4,5]
N01	07/05/2020 22:53	0.1	F	50	Yes	32	Nil
N16	07/05/2020 23:17	0.5	F	50	Yes	IA	Nil
N20A	07/05/2020 22:42	0.5	F	50	Yes	IA	Nil
N21	07/05/2020 22:24	0.8	F	50	Yes	41	Nil
N26	07/05/2020 22:11	0.4	F	50	Yes	IA	Nil

Notes:

1. *Stability Class calculated using sigma theta method provided by NPfI;*
2. *Noise emission limits identified in the above table apply under all meteorological conditions except wind speeds greater than 3 m/s at 10 metres above ground level; or stability category F temperature inversion conditions and wind speeds greater than 2 m/s at 10 metres above ground level, or stability category G temperature inversion conditions;*
3. *Site-only $L_{A1,1minute}$ attributed to WCM;*
4. *Bold results in red indicate an exceedance of relevant criterion; and*
5. *NA in exceedance column means atmospheric conditions outside conditions specified in development consent, therefore criterion was not applicable, or there is no applicable criterion.*

4.6 June 2020

4.6.1 Total Measured Noise Levels

Overall noise levels measured at each location during attended measurement in June 2020 are provided in Table 4.16.

Table 4.16: MEASURED NOISE LEVELS – JUNE 2020[1]

Location	Start Date and Time	L_{Amax} dB	L_{A1} dB	L_{A10} dB	L_{Aeq} dB	L_{A50} dB	L_{A90} dB	L_{Amin} dB
N01	23/06/2020 22:53	39	37	31	28	26	24	22
N16	23/06/2020 22:59	59	54	40	41	26	25	23
N20A	23/06/2020 22:28	46	32	29	28	28	26	25
N21	23/06/2020 22:23	44	34	30	29	28	27	24
N26	23/06/2020 22:00	49	47	41	38	35	31	29

Notes:

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

4.6.2 Modifying Factors

Measured site-only levels were assessed for the applicability of modifying factors in accordance with the NPfI and methodology described in Section 3.4.

There were no modifying factors, as defined in the NPfI, applicable during the survey.

4.6.3 Attended Noise Monitoring

Table 4.17 to Table 4.18 detail noise levels from WCM in the absence of other noise sources. Noise criteria are applicable if weather conditions during the measurement were within parameters outlined in the WCM development consent.

Table 4.17: $L_{Aeq,15minute}$ GENERATED BY WCM AGAINST PROJECT APPROVAL METEOROLOGICAL CONDITIONS – JUNE 2020

Location	Start Date and Time	Wind Speed m/s	Stability Category[1]	Criterion $L_{Aeq,15min}$ dB	Criterion Applies?[2]	WCM $L_{Aeq,15min}$ dB [3,4]	Exceedance [4,5]
N01	23/06/2020 22:53	3.0	D	40	Yes	24	Nil
N16	23/06/2020 22:59	3.1	D	40	No	IA	NA
N20A	23/06/2020 22:28	3.1	D	40	No	<20	NA
N21	23/06/2020 22:23	3.1	D	40	No	<25	NA
N26	23/06/2020 22:00	2.9	E	38	Yes	IA	Nil

Notes:

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

Table 4.18: $L_{A1,1minute}$ GENERATED BY WCM AGAINST PROJECT APPROVAL METEOROLOGICAL CONDITIONS – JUNE 2020

Location	Start Date and Time	Wind Speed m/s	Stability Category[1]	Criterion $L_{A1,1min}$ dB	Criterion Applies?[2]	WCM $L_{A1,1min}$ dB [3,4]	Exceedance [4,5]
N01	23/06/2020 22:53	3.0	D	50	Yes	29	Nil
N16	23/06/2020 22:59	3.1	D	50	No	IA	NA
N20A	23/06/2020 22:28	3.1	D	50	No	22	NA
N21	23/06/2020 22:23	3.1	D	50	No	34	NA
N26	23/06/2020 22:00	2.9	E	50	Yes	IA	Nil

Notes:

1. *Stability Class calculated using sigma theta method provided by NPfI;*
2. *Noise emission limits identified in the above table apply under all meteorological conditions except wind speeds greater than 3 m/s at 10 metres above ground level; or stability category F temperature inversion conditions and wind speeds greater than 2 m/s at 10 metres above ground level, or stability category G temperature inversion conditions;*
3. *Site-only $L_{A1,1minute}$ attributed to WCM;*
4. *Bold results in red indicate an exceedance of relevant criterion; and*
5. *NA in exceedance column means atmospheric conditions outside conditions specified in development consent, therefore criterion was not applicable, or there is no applicable criterion.*

4.7 July 2020

4.7.1 Total Measured Noise Levels

Overall noise levels measured at each location during attended measurement in July 2020 are provided in Table 4.19.

Table 4.19: MEASURED NOISE LEVELS – JULY 2020[1]

Location	Start Date and Time	L_{Amax} dB	L_{A1} dB	L_{A10} dB	L_{Aeq} dB	L_{A50} dB	L_{A90} dB	L_{Amin} dB
N01	22/07/2020 23:11	46	38	36	34	34	31	29
N16	22/07/2020 22:56	51	46	36	34	31	27	24
N20A	22/07/2020 22:26	45	31	27	24	22	19	17
N21	22/07/2020 22:40	44	41	38	36	35	33	30
N26	22/07/2020 22:00	40	32	26	23	20	18	17

Notes:

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

4.7.2 Modifying Factors

Measured site-only levels were assessed for the applicability of modifying factors in accordance with the NPfI and methodology described in Section 3.4.

There were no modifying factors, as defined in the NPfI, applicable during the survey.

4.7.3 Attended Noise Monitoring

Table 4.20 to Table 4.21 detail noise levels from WCM in the absence of other noise sources. Noise criteria are applicable if weather conditions during the measurement were within parameters outlined in the WCM development consent.

Table 4.20: $L_{Aeq,15minute}$ GENERATED BY WCM AGAINST PROJECT APPROVAL METEOROLOGICAL CONDITIONS – JULY 2020

Location	Start Date and Time	Wind Speed m/s	Stability Category[1]	Criterion $L_{Aeq,15min}$ dB	Criterion Applies?[2]	WCM $L_{Aeq,15min}$ dB [3,4]	Exceedance [4,5]
N01	22/07/2020 23:11	0.0	F	40	Yes	31	Nil
N16	22/07/2020 22:56	0.0	F	40	Yes	30	Nil
N20A	22/07/2020 22:26	0.5	F	40	Yes	<25	Nil
N21	22/07/2020 22:40	0.3	E	40	Yes	36	Nil
N26	22/07/2020 22:00	0.9	D	38	Yes	NM	Nil

Notes:

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

Table 4.21: $L_{A1,1minute}$ GENERATED BY WCM AGAINST PROJECT APPROVAL METEOROLOGICAL CONDITIONS – JULY 2020

Location	Start Date and Time	Wind Speed m/s	Stability Category[1]	Criterion $L_{A1,1min}$ dB	Criterion Applies?[2]	WCM $L_{A1,1min}$ dB [3,4]	Exceedance [4,5]
N01	22/07/2020 23:11	0.0	F	50	Yes	37	Nil
N16	22/07/2020 22:56	0.0	F	50	Yes	35	Nil
N20A	22/07/2020 22:26	0.5	F	50	Yes	<25	Nil
N21	22/07/2020 22:40	0.3	E	50	Yes	44	Nil
N26	22/07/2020 22:00	0.9	D	50	Yes	NM	Nil

Notes:

1. *Stability Class calculated using sigma theta method provided by NPfI;*
2. *Noise emission limits identified in the above table apply under all meteorological conditions except wind speeds greater than 3 m/s at 10 metres above ground level; or stability category F temperature inversion conditions and wind speeds greater than 2 m/s at 10 metres above ground level, or stability category G temperature inversion conditions;*
3. *Site-only $L_{A1,1minute}$ attributed to WCM;*
4. *Bold results in red indicate an exceedance of relevant criterion; and*
5. *NA in exceedance column means atmospheric conditions outside conditions specified in development consent, therefore criterion was not applicable, or there is no applicable criterion.*

4.8 August 2020

4.8.1 Total Measured Noise Levels

Overall noise levels measured at each location during attended measurement in August 2020 are provided in Table 4.22.

Table 4.22: MEASURED NOISE LEVELS – AUGUST 2020[1]

Location	Start Date and Time	L_{Amax} dB	L_{A1} dB	L_{A10} dB	L_{Aeq} dB	L_{A50} dB	L_{A90} dB	L_{Amin} dB
N01	24/08/2020 22:49	50	43	30	30	26	24	22
N16	24/08/2020 23:13	58	54	47	43	36	32	29
N20A	24/08/2020 22:40	45	41	38	34	32	29	26
N21	24/08/2020 22:22	34	32	27	25	24	22	20
N26	24/08/2020 22:09	44	40	32	30	28	25	22

Notes:

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

4.8.2 Modifying Factors

Measured site-only levels were assessed for the applicability of modifying factors in accordance with the NPfI and methodology described in Section 3.4.

There were no modifying factors, as defined in the NPfI, applicable during the survey.

4.8.3 Attended Noise Monitoring

Table 4.23 to Table 4.24 detail noise levels from WCM in the absence of other noise sources. Noise criteria are applicable if weather conditions during the measurement were within parameters outlined in the WCM development consent.

Table 4.23: $L_{Aeq,15minute}$ GENERATED BY WCM AGAINST PROJECT APPROVAL METEOROLOGICAL CONDITIONS – AUGUST 2020

Location	Start Date and Time	Wind Speed m/s	Stability Category[1]	Criterion $L_{Aeq,15min}$ dB	Criterion Applies?[2]	WCM $L_{Aeq,15min}$ dB [3,4]	Exceedance [4,5]
N01	24/08/2020 22:49	0.6	F	40	Yes	<25	Nil
N16	24/08/2020 23:13	1.0	D	40	Yes	35	Nil
N20A	24/08/2020 22:40	0.1	F	40	Yes	34	Nil
N21	24/08/2020 22:22	0.7	F	40	Yes	25	Nil
N26	24/08/2020 22:09	0.1	F	38	Yes	27	Nil

Notes:

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

Table 4.24: $L_{A1,1minute}$ GENERATED BY WCM AGAINST PROJECT APPROVAL METEOROLOGICAL CONDITIONS – AUGUST 2020

Location	Start Date and Time	Wind Speed m/s	Stability Category[1]	Criterion $L_{A1,1min}$ dB	Criterion Applies?[2]	WCM $L_{A1,1min}$ dB [3,4]	Exceedance [4,5]
N01	24/08/2020 22:49	0.6	F	50	Yes	<25	Nil
N16	24/08/2020 23:13	1.0	D	50	Yes	37	Nil
N20A	24/08/2020 22:40	0.1	F	50	Yes	43	Nil
N21	24/08/2020 22:22	0.7	F	50	Yes	34	Nil
N26	24/08/2020 22:09	0.1	F	50	Yes	32	Nil

Notes:

1. *Stability Class calculated using sigma theta method provided by NPfI;*
2. *Noise emission limits identified in the above table apply under all meteorological conditions except wind speeds greater than 3 m/s at 10 metres above ground level; or stability category F temperature inversion conditions and wind speeds greater than 2 m/s at 10 metres above ground level, or stability category G temperature inversion conditions;*
3. *Site-only $L_{A1,1minute}$ attributed to WCM;*
4. *Bold results in red indicate an exceedance of relevant criterion; and*
5. *NA in exceedance column means atmospheric conditions outside conditions specified in development consent, therefore criterion was not applicable, or there is no applicable criterion.*

4.9 September 2020

4.9.1 Total Measured Noise Levels

Overall noise levels measured at each location during attended measurement in September 2020 are provided in Table 4.25.

Table 4.25: MEASURED NOISE LEVELS – SEPTEMBER 2020[1]

Location	Start Date and Time	L_{Amax} dB	L_{A1} dB	L_{A10} dB	L_{Aeq} dB	L_{A50} dB	L_{A90} dB	L_{Amin} dB
N01	8/09/2020 22:00	49	43	41	38	38	36	33
N16	8/09/2020 23:37	56	41	37	34	33	30	27
N20A	8/09/2020 23:09	39	37	32	30	29	27	23
N21	8/09/2020 22:48	55	51	41	40	37	35	32
N26	8/09/2020 22:00	48	45	43	41	40	38	35
N26[2]	8/09/2020 22:37	48	43	40	36	33	28	23
N26[3]	10/09/2020 22:03	50	46	42	40	40	38	36
N26[4]	10/09/2020 22:53	49	44	42	39	38	36	33

Notes:

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

4.9.2 Modifying Factors

Measured site-only levels were assessed for the applicability of modifying factors in accordance with the NPfI and methodology described in Section 3.4.

Modifying factors, as defined in the NPfI, were applicable in two measurements during the survey and are detailed in Table 4.26.

Table 4.26: MODIFYING FACTOR ASSESSMENT – MARCH 2018

Location	Start Date and Time	Measured WCM Only L_{Aeq} dB	Intermittency Modifying Factor?	Tonality Modifying Factor?	Frequency of Tonality [1]	Low-frequency Modifying Factor?	Maximum Exceedance of NPfI Reference Spectrum [1,2]	Total Penalty dB [2]
N26	8/09/2020 22:00	39	No	No	NA	Yes	3 dB @ 125 Hz	**2**
N26	10/09/2020 22:03	39	No	No	NA	Yes	2 dB @ 125 Hz	**2**

Notes:

1. *NA denotes 'not applicable'; and*
2. *Bold results indicate that application of NPfI modifying factor/s is required.*

4.9.3 Attended Noise Monitoring

Table 4.27 to Table 4.28 detail noise levels from WCM in the absence of other noise sources. Noise criteria are applicable if weather conditions during the measurement were within parameters outlined in the WCM development consent.

Table 4.27: $L_{Aeq,15minute}$ GENERATED BY WCM AGAINST PROJECT APPROVAL METEOROLOGICAL CONDITIONS – SEPTEMBER 2020

Location	Start Date and Time	Wind Speed m/s	Stability Category[1]	Criterion $L_{Aeq,15min}$ dB	Criterion Applies?[2]	WCM $L_{Aeq,15min}$ dB [3,4]	Exceedance [4,5]
N01	8/09/2020 22:00	0.7	D	40	Yes	30	Nil
N16	8/09/2020 23:37	1.0	E	40	Yes	33	Nil
N20A	8/09/2020 23:09	0.4	F	40	Yes	IA	Nil
N21	8/09/2020 22:48	0.4	F	40	Yes	34	Nil
N26	8/09/2020 22:00	0.7	D	38	Yes	**41**	**3**
N26[6]	8/09/2020 22:37	0.9	D	38	Yes	27	Nil
N26[7]	10/09/2020 22:03	1.5	E	38	Yes	**41**	**3**
N26[8]	10/09/2020 22:53	1.9	E	38	Yes	38	Nil

Notes:

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

Table 4.28: $L_{A1,1minute}$ GENERATED BY WCM AGAINST PROJECT APPROVAL METEOROLOGICAL CONDITIONS – SEPTEMBER 2020

Location	Start Date and Time	Wind Speed m/s	Stability Category[1]	Criterion $L_{A1,1min}$ dB	Criterion Applies?[2]	WCM $L_{A1,1min}$ dB [3,4]	Exceedance [4,5]
N01	8/09/2020 22:00	0.7	D	50	Yes	40	Nil
N16	8/09/2020 23:37	1.0	E	50	Yes	36	Nil
N20A	8/09/2020 23:09	0.4	F	50	Yes	IA	Nil
N21	8/09/2020 22:48	0.4	F	50	Yes	38	Nil
N26	8/09/2020 22:00	0.7	D	50	Yes	45	Nil
N26[6]	8/09/2020 22:37	0.9	D	50	Yes	29	Nil
N26[7]	10/09/2020 22:03	1.5	E	50	Yes	41	Nil
N26[8]	10/09/2020 22:53	1.9	E	50	Yes	40	Nil

Notes:

1. *Stability Class calculated using sigma theta method provided by NPfI;*
2. *Noise emission limits identified in the above table apply under all meteorological conditions except wind speeds greater than 3 m/s at 10 metres above ground level; or stability category F temperature inversion conditions and wind speeds greater than 2 m/s at 10 metres above ground level, or stability category G temperature inversion conditions;*
3. *Site-only $L_{A1,1minute}$ attributed to WCM;*
4. *Bold results in red indicate an exceedance of relevant criterion;*
5. *NA in exceedance column means atmospheric conditions outside conditions specified in development consent, therefore criterion was not applicable, or there is no applicable criterion;*
6. *Remeasure;*
7. *Follow-up monitoring; and*
8. *Follow-up monitoring remeasure.*

4.10 October 2020

4.10.1 Total Measured Noise Levels

Overall noise levels measured at each location during attended measurement in October 2020 are provided in Table 4.29.

Table 4.29: MEASURED NOISE LEVELS – OCTOBER 2020[1]

Location	Start Date and Time	L_{Amax} dB	L_{A1} dB	L_{A10} dB	L_{Aeq} dB	L_{A50} dB	L_{A90} dB	L_{Amin} dB
N01	14/10/2020 22:53	57	46	44	42	41	38	32
N16	14/10/2020 23:41	50	46	39	38	37	36	34
N20A	14/10/2020 22:43	67	48	39	41	37	36	34
N21	14/10/2020 22:26	47	37	34	32	32	31	29
N26	14/10/2020 22:09	48	41	39	38	38	36	33

Notes:

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

4.10.2 Modifying Factors

Measured site-only levels were assessed for the applicability of modifying factors in accordance with the NPfI and methodology described in Section 3.4.

Modifying factors, as defined in the NPfI, were applicable in two measurements during the survey and are detailed in Table 4.30.

Table 4.30: MODIFYING FACTOR ASSESSMENT – OCTOBER 2020

Location	Start Date and Time	Measured WCM Only L_{Aeq} dB	Intermittency Modifying Factor?	Tonality Modifying Factor?	Frequency of Tonality [1]	Low-frequency Modifying Factor?	Maximum Exceedance of NPfI Reference Spectrum [1,2]	Total Penalty dB [2]
N20A	14/10/2020 22:43	36	No	No	NA	Yes	1 dB @ 125 Hz	+2
N26	14/10/2020 22:09	36	No	No	NA	Yes	1 dB @ 80 Hz	+2

Notes:

1. *NA denotes 'not applicable'; and*
2. *Bold results indicate that application of NPfI modifying factor/s is required.*

4.10.3 Attended Noise Monitoring

Table 4.31 to Table 4.32 detail noise levels from WCM in the absence of other noise sources. Noise criteria are applicable if weather conditions during the measurement were within parameters outlined in the WCM development consent.

Table 4.31: $L_{Aeq,15minute}$ GENERATED BY WCM AGAINST PROJECT APPROVAL METEOROLOGICAL CONDITIONS – OCTOBER 2020

Location	Start Date and Time	Wind Speed m/s	Stability Category[1]	Criterion $L_{Aeq,15min}$ dB	Criterion Applies?[2]	WCM $L_{Aeq,15min}$ dB [3,4]	Exceedance [4,5]
N01	14/10/2020 22:53	0.9	E	40	Yes	IA	Nil
N16	14/10/2020 23:41	0.6	E	40	Yes	NM	Nil
N20A	14/10/2020 22:43	0.9	E	40	Yes	38	Nil
N21	14/10/2020 22:26	1.0	F	40	Yes	IA	Nil
N26	14/10/2020 22:09	1.1	F	38	Yes	38	Nil

Notes:

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

Table 4.32: $L_{A1,1minute}$ GENERATED BY WCM AGAINST PROJECT APPROVAL METEOROLOGICAL CONDITIONS – OCTOBER 2020

Location	Start Date and Time	Wind Speed m/s	Stability Category[1]	Criterion $L_{A1,1min}$ dB	Criterion Applies?[2]	WCM $L_{A1,1min}$ dB [3,4]	Exceedance [4,5]
N01	14/10/2020 22:53	0.9	E	50	Yes	IA	Nil
N16	14/10/2020 23:41	0.6	E	50	Yes	NM	Nil
N20A	14/10/2020 22:43	0.9	E	50	Yes	43	Nil
N21	14/10/2020 22:26	1.0	F	50	Yes	IA	Nil
N26	14/10/2020 22:09	1.1	F	50	Yes	41	Nil

Notes:

1. *Stability Class calculated using sigma theta method provided by NPfI;*
2. *Noise emission limits identified in the above table apply under all meteorological conditions except wind speeds greater than 3 m/s at 10 metres above ground level; or stability category F temperature inversion conditions and wind speeds greater than 2 m/s at 10 metres above ground level, or stability category G temperature inversion conditions;*
3. *Site-only $L_{A1,1minute}$ attributed to WCM;*
4. *Bold results in red indicate an exceedance of relevant criterion; and*
5. *NA in exceedance column means atmospheric conditions outside conditions specified in development consent, therefore criterion was not applicable, or there is no applicable criterion.*

4.11 November 2020

4.11.1 Total Measured Noise Levels

Overall noise levels measured at each location during attended measurement in November 2020 are provided in Table 4.33.

Table 4.33: MEASURED NOISE LEVELS – NOVEMBER 2020[1]

Location	Start Date and Time	L_{Amax} dB	L_{A1} dB	L_{A10} dB	L_{Aeq} dB	L_{A50} dB	L_{A90} dB	L_{Amin} dB
N01	04/11/2020 22:50	56	53	52	50	50	47	42
N16	04/11/2020 23:14	47	44	41	39	38	36	33
N20A	04/11/2020 22:25	60	55	48	46	43	40	34
N21	04/11/2020 22:23	57	53	49	47	46	43	40
N26	04/11/2020 22:00	54	50	46	43	42	40	35

Notes:

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

4.11.2 Modifying Factors

Measured site-only levels were assessed for the applicability of modifying factors in accordance with the NPfI and methodology described in Section 3.4.

There were no modifying factors, as defined in the NPfI, applicable during the survey.

4.11.3 Attended Noise Monitoring

Table 4.34 to Table 4.35 detail noise levels from WCM in the absence of other noise sources. Noise criteria are applicable if weather conditions during the measurement were within parameters outlined in the WCM development consent.

Table 4.34: $L_{Aeq,15minute}$ GENERATED BY WCM AGAINST PROJECT APPROVAL METEOROLOGICAL CONDITIONS – NOVEMBER 2020

Location	Start Date and Time	Wind Speed m/s	Stability Category[1]	Criterion $L_{Aeq,15min}$ dB	Criterion Applies?[2]	WCM $L_{Aeq,15min}$ dB [3,4]	Exceedance [4,5]
N01	04/11/2020 22:50	0.5	F	40	Yes	31	Nil
N16	04/11/2020 23:14	0.6	E	40	Yes	32	Nil
N20A	04/11/2020 22:25	0.4	F	40	Yes	IA	Nil
N21	04/11/2020 22:23	0.4	F	40	Yes	28	Nil
N26	04/11/2020 22:00	0.9	E	38	Yes	IA	Nil

Notes:

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

Table 4.35: $L_{A1,1minute}$ GENERATED BY WCM AGAINST PROJECT APPROVAL METEOROLOGICAL CONDITIONS – NOVEMBER 2020

Location	Start Date and Time	Wind Speed m/s	Stability Category[1]	Criterion $L_{A1,1min}$ dB	Criterion Applies?[2]	WCM $L_{A1,1min}$ dB [3,4]	Exceedance [4,5]
N01	04/11/2020 22:50	0.5	F	50	Yes	37	Nil
N16	04/11/2020 23:14	0.6	E	50	Yes	39	Nil
N20A	04/11/2020 22:25	0.4	F	50	Yes	IA	Nil
N21	04/11/2020 22:23	0.4	F	50	Yes	31	Nil
N26	04/11/2020 22:00	0.9	E	50	Yes	IA	Nil

Notes:

1. *Stability Class calculated using sigma theta method provided by NPfI;*
2. *Noise emission limits identified in the above table apply under all meteorological conditions except wind speeds greater than 3 m/s at 10 metres above ground level; or stability category F temperature inversion conditions and wind speeds greater than 2 m/s at 10 metres above ground level, or stability category G temperature inversion conditions;*
3. *Site-only $L_{A1,1minute}$ attributed to WCM;*
4. *Bold results in red indicate an exceedance of relevant criterion; and*
5. *NA in exceedance column means atmospheric conditions outside conditions specified in development consent, therefore criterion was not applicable, or there is no applicable criterion.*

4.12 December 2020

4.12.1 Total Measured Noise Levels

Overall noise levels measured at each location during attended measurement in December 2020 are provided in Table 4.36.

Table 4.36: MEASURED NOISE LEVELS – DECEMBER 2020[1]

Location	Start Date and Time	L_{Amax} dB	L_{A1} dB	L_{A10} dB	L_{Aeq} dB	L_{A50} dB	L_{A90} dB	L_{Amin} dB
N01	03/12/2020 22:39	50	47	45	43	43	41	37
N16	03/12/2020 23:19	50	48	46	43	42	38	33
N20A	03/12/2020 22:48	46	38	37	35	35	34	32
N21	03/12/2020 22:14	50	47	46	40	37	34	31
N26	03/12/2020 22:21	46	45	45	44	44	43	42

Notes:

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

4.12.2 Modifying Factors

Measured site-only levels were assessed for the applicability of modifying factors in accordance with the NPfI and methodology described in Section 3.4.

There were no modifying factors, as defined in the NPfI, applicable during the survey.

4.12.3 Attended Noise Monitoring

Table 4.37 to Table 4.38 detail noise levels from WCM in the absence of other noise sources. Noise criteria are applicable if weather conditions during the measurement were within parameters outlined in the WCM development consent.

Table 4.37: $L_{Aeq,15minute}$ GENERATED BY WCM AGAINST PROJECT APPROVAL METEOROLOGICAL CONDITIONS – DECEMBER 2020

Location	Start Date and Time	Wind Speed m/s	Stability Category[1]	Criterion $L_{Aeq,15min}$ dB	Criterion Applies?[2]	WCM $L_{Aeq,15min}$ dB [3,4]	Exceedance [4,5]
N01	03/12/2020 22:39	1.2	F	38	Yes	IA	Nil
N16	03/12/2020 23:19	0.6	F	35	Yes	IA	Nil
N20A	03/12/2020 22:48	0.6	F	35	Yes	IA	Nil
N21	03/12/2020 22:14	0.4	F	39	Yes	IA	Nil
N26	03/12/2020 22:21	0.4	F	35	Yes	IA	Nil

Notes:

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

Table 4.38: $L_{A1,1minute}$ GENERATED BY WCM AGAINST PROJECT APPROVAL METEOROLOGICAL CONDITIONS – DECEMBER 2020

Location	Start Date and Time	Wind Speed m/s	Stability Category[1]	Criterion $L_{A1,1min}$ dB	Criterion Applies?[2]	WCM $L_{A1,1min}$ dB [3,4]	Exceedance [4,5]
N01	03/12/2020 22:39	1.2	F	48	Yes	IA	Nil
N16	03/12/2020 23:19	0.6	F	45	Yes	IA	Nil
N20A	03/12/2020 22:48	0.6	F	45	Yes	IA	Nil
N21	03/12/2020 22:14	0.4	F	49	Yes	IA	Nil
N26	03/12/2020 22:21	0.4	F	45	Yes	IA	Nil

Notes:

1. *Stability Class calculated using sigma theta method provided by NPfI;*
2. *Noise emission limits identified in the above table apply under all meteorological conditions except wind speeds greater than 3 m/s at 10 metres above ground level; or stability category F temperature inversion conditions and wind speeds greater than 2 m/s at 10 metres above ground level, or stability category G temperature inversion conditions;*
3. *Site-only $L_{A1,1minute}$ attributed to WCM;*
4. *Bold results in red indicate an exceedance of relevant criterion; and*
5. *NA in exceedance column means atmospheric conditions outside conditions specified in development consent, therefore criterion was not applicable, or there is no applicable criterion.*

5 LONG TERM NOISE TRENDS

Site-only L_{Aeq} noise levels measured during monthly attended environmental noise monitoring over a 5-year period from January 2016 to December 2020 have been collated and graphed to summarise WCM long-term noise performance. Less than five years of data was available at three locations due to monitoring commencing at those locations during the 5-year period.

Due to the qualitative nature of some attended noise monitoring descriptors, calculation of site noise statistics such as mean, median, and standard deviation is not always possible. Subsequently, site-only L_{Aeq} noise levels for each monitoring event have been grouped into one of three categories:

1. WCM-only L_{Aeq} was either inaudible (IA), not measurable (NM), or less than 30 dB, which together are represented by green bars;
2. WCM-only L_{Aeq} was between 30 dB and 40 dB (inclusive) represented by blue bars; or
3. WCP-only L_{Aeq} was greater than 40 dB for that location, represented by red bars.

For each calendar year, the percentage of occurrence for each of these categories is shown, as well as annual trend lines over the entire five-year period. Figures show site-only L_{Aeq} noise levels, including adjustments due to modifying factors, as defined by the EPA NPfI.

Meteorological conditions and applicability of noise criteria have not been considered.

5.1 Noise Trend Graphs

Site-only L_{Aeq} noise levels measured during attended environmental noise monitoring over a 5-year period have been collated and graphed to summarise long-term noise trends. Figure 2 to Figure 6 provide percentage occurrence information for WCM noise levels at eight monitoring locations.

As meteorological conditions and applicability of noise criteria have not been considered in long-term trend analysis, potential exceedances indicated in the following graphs may not have been applicable depending on weather conditions at the time of monitoring.

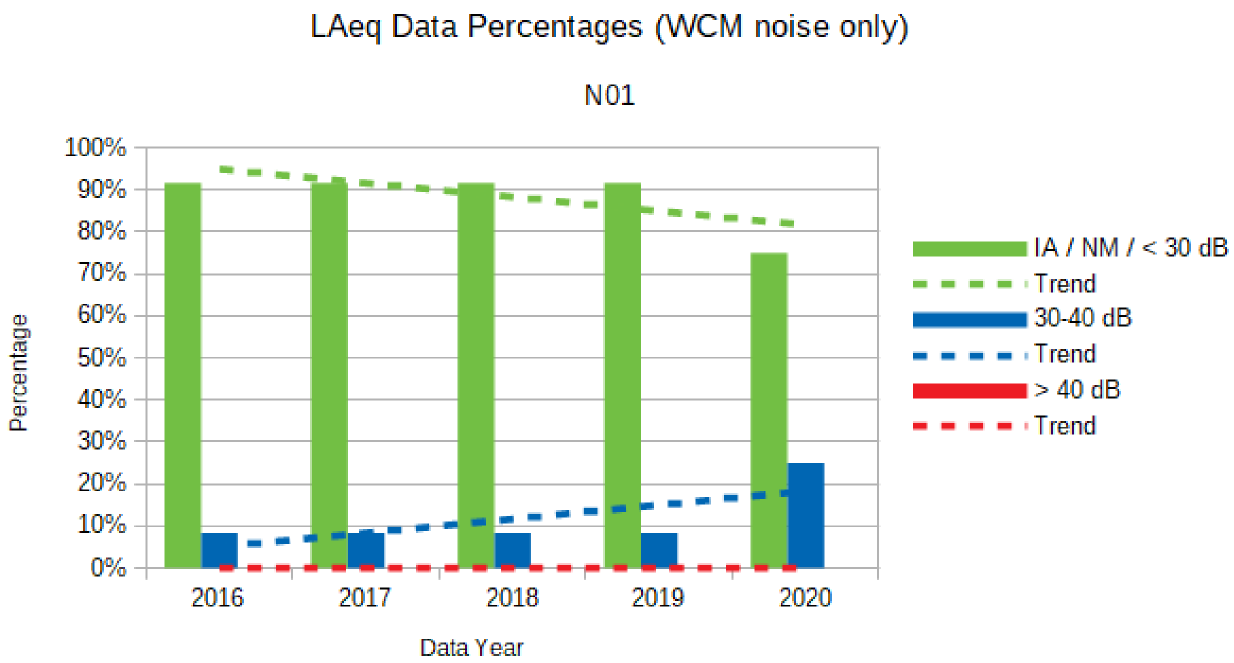

Figure 2: Attended noise monitoring data, N01

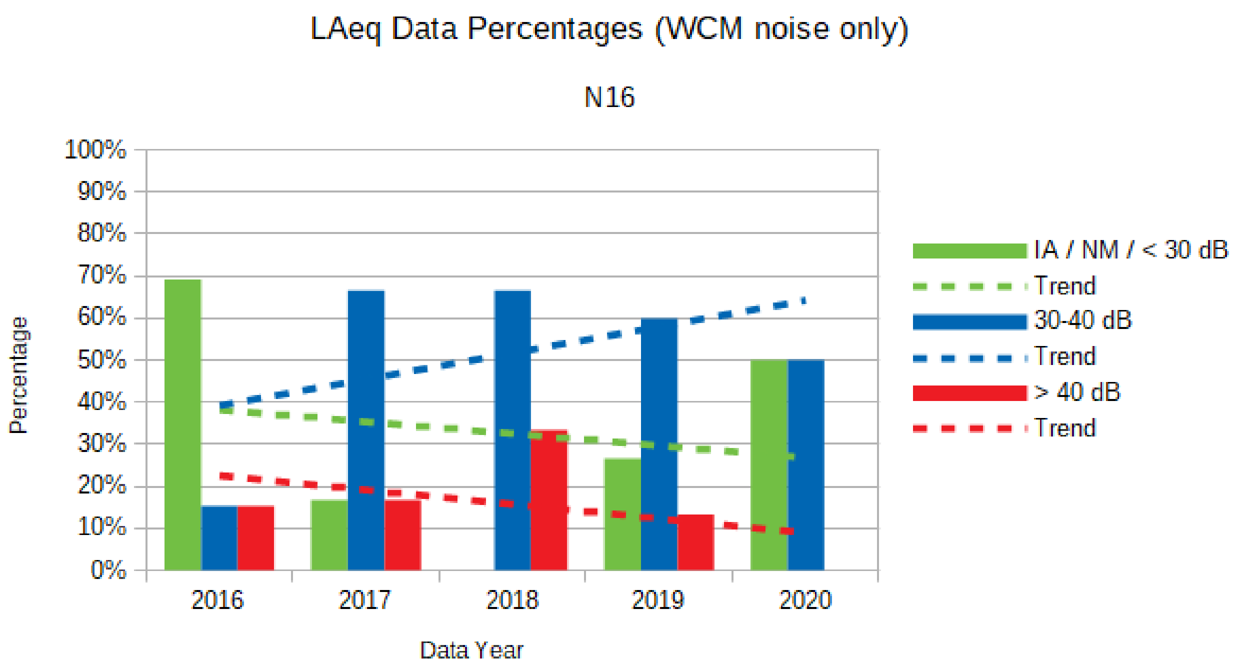

Figure 3: Attended noise monitoring data, N16

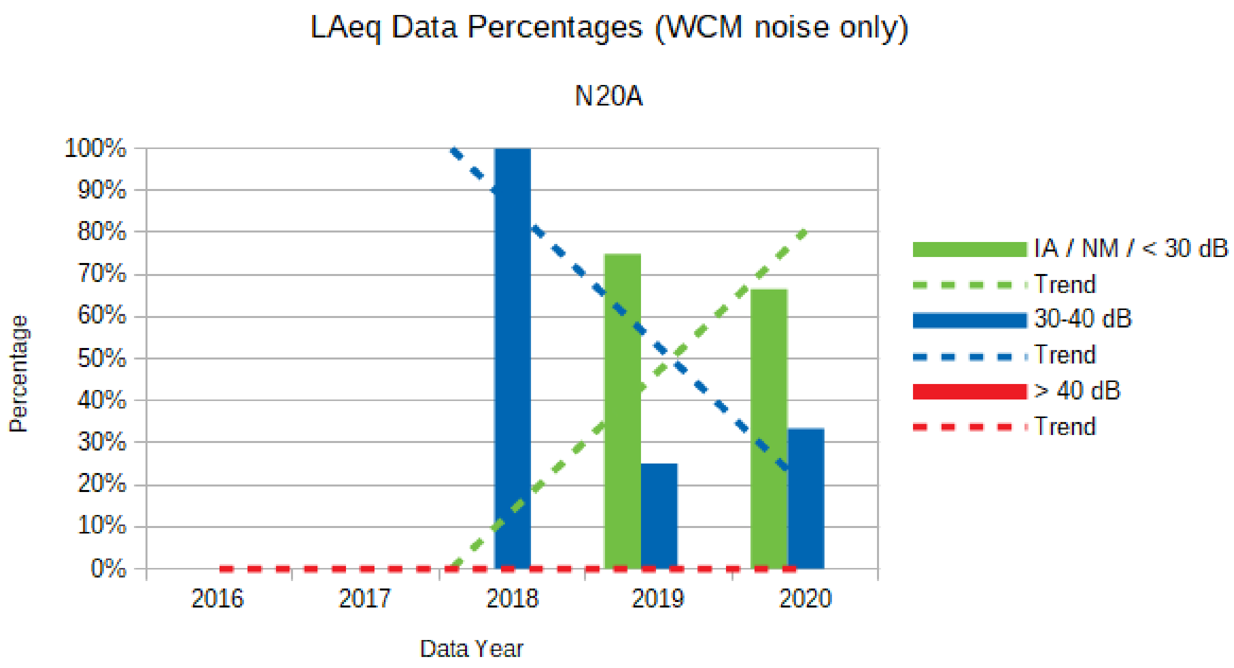

Figure 4: Attended noise monitoring data, N20A

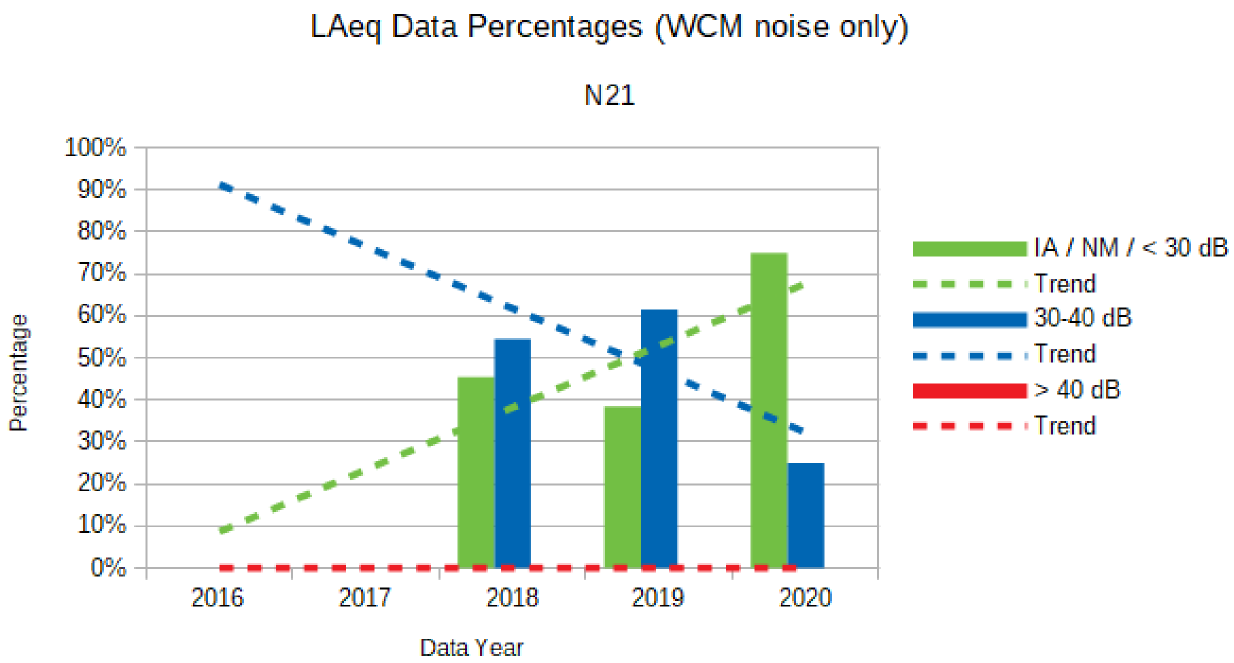

Figure 5: Attended noise monitoring data, N21

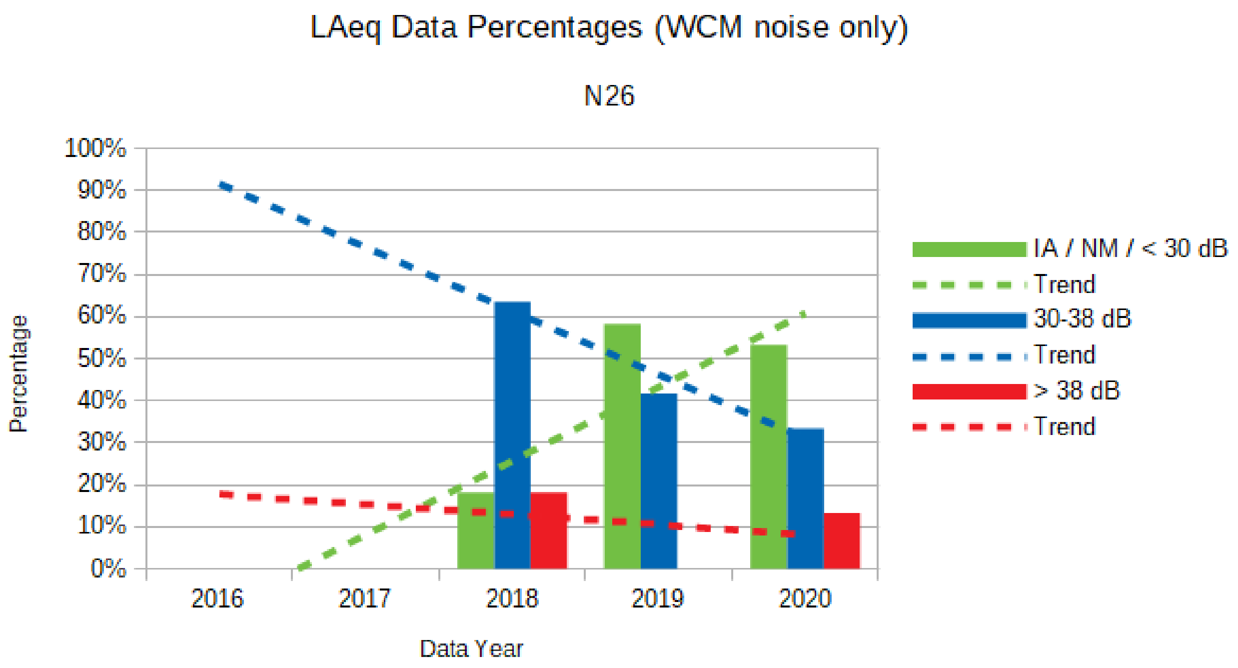

Figure 6: Attended noise monitoring data, N26

5.2 Discussion

During the 5-year period analysed, WCM noise levels at most monitoring locations increased from 2016 to 2018 as mining operations progressed to the northwest and were initially less shielded. From 2018 to 2020, site noise levels decreased at most monitoring locations, likely due to mining activity being deeper in pit and therefore more shielded from receptors.

Additional discussion of individual monitoring locations is provided below:

- At N01, site-only L_{Aeq} noise levels were low (either IA, NM, or less than 30 dB) for a large majority of measurements;
- At N16, site-only L_{Aeq} noise levels increased from 2016 to 2018, then decreased in 2019 and 2020; and
- At N20A, N21, and NA26, site-only L_{Aeq} noise levels decreased from 2018 to 2020

From 1 December 2020, open cut mining is no longer undertaken by WCM and noise emissions are expected to decrease significantly.

6 COMPARISON WITH EIS MODELLED PREDICTIONS

A NIA was prepared in July 2016 as part of the EIS to support application for the United Wambo project. As part of the modelling assessment, cumulative noise levels from WCM and United Wambo were predicted for representative operating scenarios, time periods and weather conditions.

Predicted noise levels for Year 2 have been used for comparison to measured noise levels, as it most closely aligned to the 2020 reporting year. Table 6.1 summarises predicted $L_{Aeq,1minute}$ noise levels for specific monitoring locations detailed in Table F.1 of the NIA. These have been compared to noise-enhancing meteorological condition defined in Section 3.5 of this report.

Table 6.1: WCM OPERATIONAL PREDICTIONS, YEAR 2 – dB

Monitoring Location ID	Location	Nearest Property ID	Night $L_{Aeq,15minute}$ Non-Winter	Night $L_{Aeq,15minute}$ Winter
N01	Wambo Road Residence	3	33	36
N16	Jerrys Plains Road	39	45	46
N20A	Redmanvale Road Central	343	36	37
N21	Wambo South	25	34	38
N26	Redmanvale Road South	345	36	33

Notes:

1. *This property is now mine owned. Comparisons to predicted levels have been provided for informational purposes only.*

Table 6.2 summarises sleep disturbance noise levels for specific monitoring locations detailed in Table F.4 of the NIA under certain meteorological condition defined in Section 3.5 of this report.

Table 6.2: WCM SLEEP DISTURBANCE PREDICTIONS, YEAR 2 – dB

Monitoring Location ID	Location	Nearest Property ID	Night $L_{A1,1minute}$ Calm	Night $L_{A1,1minute}$ SE Wind	Night $L_{A1,1minute}$ Inversion
N01	Wambo Road Residence	3	<30	<30	32
N16	Jerrys Plains Road	39	33	45	45
N20A	Redmanvale Road Central	33[2]	<30	44	43
N21	Wambo South	25	<30	<30	33
N26	Redmanvale Road South	346[3]	<30	37	46

Notes:

1. *This property is now mine owned. Comparisons to predicted levels have been provided for informational purposes only;*
2. *Sleep disturbance prediction for Property 343 was not provided. Property 33 was the nearest residence with predicted noise levels; and*
3. *Sleep disturbance prediction for Property 345 was not provided. Property 346 was the nearest residence with predicted noise levels.*

Table 6.3 to Table 6.7 of this report compare the measured operational levels to predicted noise levels in the NIA for Year 2. A positive difference indicates the measured level is greater than the predicted level and a negative difference indicates the measured levels are less than predicted in the NIA.

When meteorological conditions during the attended monitoring measurement do not correspond with those that are modelled, the meteorological conditions are considered “not applicable” (NA) and no further analysis is undertaken. When meteorological conditions during the measurement correspond with modelled conditions, but measured WCM noise levels were not directly quantifiable, measured and modelled noise levels are “not comparable” (NC) and no further analysis is required.

6.1.1 N01, Wambo Road Residence

Table 6.3: MEASURED WCM NOISE LEVELS COMPARED TO YEAR 2 PREDICTED NOISE LEVELS AT N01, dB(A)

Month	Applicable Meteorological Condition[1]	Measured WCM $L_{Aeq,15minute}$	Predicted WCM $L_{Aeq,15minute}$	Difference[2,3]	Applicable Meteorological Condition[1]	Measured WCM $L_{A1,1minute}$	Predicted WCM $L_{A1,1minute}$	Difference[2,3]
January	NA	25	-	NA	NA	27	-	NC
February	NA	IA	-	NA	NA	IA	-	NC
March	NA	IA	-	NA	NA	IA	-	NC
April	NA	IA	-	NA	NA	IA	-	NC
May	NA	28	-	NA	NA	32	-	NC
June	NA	24	-	NA	NA	29	-	NC
July	NA	31	-	NA	NA	37	-	NC
August	Inversion	<25	33	NC	NA	<25	-	NC
September	NA	30	-	NA	NA	40	-	NC
October	NA	IA	-	NA	NA	IA	-	NC
November	NA	31	-	NA	NA	37	-	NC
December	NA	IA	-	NA	NA	IA	-	NC

Notes:

1. *Refer to Table 3.1 and Table 3.2 for applicable meteorological conditions;*
2. *NA indicates meteorological conditions during the measurement did not correspond with any modelled meteorological conditions, and were not applicable for comparison; and*
3. *NC indicates measured WCM noise levels were IA, NM, or expressed as a "less than" quantity (e.g. less than 30 dB), therefore measured and predicted noise levels were not comparable.*

At N01, measured noise levels were typically not comparable to Year 2 predictions in the EIS, apart from one instance in which the measured site-only L_{Aeq} was lower than predicted.

6.1.2 N16, Jerrys Plains Road

Table 6.4: MEASURED WCM NOISE LEVELS COMPARED TO YEAR 2 PREDICTED NOISE LEVELS AT N16, dB(A)

Month	Applicable Meteorological Condition[1]	Measured WCM $L_{Aeq,15minute}$	Predicted WCM $L_{Aeq,15minute}$	Difference[2,3]	Applicable Meteorological Condition[1]	Measured WCM $L_{A1,1minute}$	Predicted WCM $L_{A1,1minute}$	Difference[2,3]
January	Inversion	<20	45	NC	NA	26	-	NA
February	NA	28	-	NA	NA	40	-	NA
March	Inversion	33	45	-12	NA	41	-	NA
April	NA	37	-	NA	NA	46	-	NA
May	NA	IA	-	NA	NA	IA	-	NA
June	NA	IA	-	NA	NA	IA	-	NA
July	NA	30	-	NA	NA	35	-	NA
August	NA	35	-	NA	NA	37	-	NA
September	NA	33	-	NA	NA	36	-	NA
October	NA	NM	-	NA	NA	NM	-	NA
November	NA	32	-	NA	NA	39	-	NA
December	Inversion	IA	45	NC	NA	IA	-	NA

Notes:

1. *Refer to Table 3.1 and Table 3.2 for applicable meteorological conditions;*
2. *NA indicates meteorological conditions during the measurement did not correspond with any modelled meteorological conditions, and were not applicable for comparison;*
3. *NC indicates measured WCM noise levels IA, NM, or expressed as a "less than" quantity (e.g. less than 30 dB), therefore measured and predicted noise levels were not comparable; and*
4. *Remeasure.*

When comparable to modelled noise levels, measured L_{Aeq} noise levels at N16 were lower than Year 2 predictions in the EIS. Measured $L_{A1,1minute}$ noise levels were not comparable with Year 2 predictions in the EIS.

6.1.3 N20A, Redmanvale Road Central

Table 6.5: MEASURED WCM NOISE LEVELS COMPARED TO YEAR 2 PREDICTED NOISE LEVELS AT N20A, dB(A)

Month	Applicable Meteorological Condition[1]	Measured WCM $L_{Aeq,15minute}$	Predicted WCM $L_{Aeq,15minute}$	Difference[2,3]	Applicable Meteorological Condition[1]	Measured WCM $L_{A1,1minute}$	Predicted WCM $L_{A1,1minute}$	Difference[2,3]
January	NA	<25	-	NA	NA	<25	-	NA
February	NA	IA	-	NA	NA	IA	-	NA
March	Wind Only	35	36	-1	SE Wind	40	44	-4
April	Inversion	35	36	-1	NA	44	-	NA
May	NA	IA	-	NA	NA	IA	-	NA
June	NA	<20	-	NA	NA	22	-	NA
July	NA	<25	-	NA	Inversion	<25	43	NC
August	NA	34	-	NA	NA	43	-	NA
September	NA	IA	-	NA	NA	IA	-	NA
October	NA	38	-	NA	NA	43	-	NA
November	Inversion	IA	36	NC	NA	IA	-	NA
December	Inversion	IA	36	NC	NA	IA	-	NA

Notes:

1. *Refer to Table 3.1 and Table 3.2 for applicable meteorological conditions;*
2. *NA indicates meteorological conditions during the measurement did not correspond with any modelled meteorological conditions, and were not applicable for comparison; and*
3. *NC indicates measured WCM noise levels were IA, NM, or expressed as a "less than" quantity (e.g. less than 30 dB), therefore measured and predicted noise levels were not comparable.*

When comparable to modelled noise levels, measured noise levels at N20A were lower than Year 2 predictions in the EIS.

6.1.4 N21, Wambo Road South

Table 6.6: MEASURED WCM NOISE LEVELS COMPARED TO YEAR 2 PREDICTED NOISE LEVELS AT N21, dB(A)

Month	Applicable Meteorological Condition[1]	Measured WCM $L_{Aeq,15minute}$	Predicted WCM $L_{Aeq,15minute}$	Difference[2,3]	Applicable Meteorological Condition[1]	Measured WCM $L_{A1,1minute}$	Predicted WCM $L_{A1,1minute}$	Difference[2,3]
January	NA	25	-	NA	NA	26	-	NA
February	NA	IA	-	NA	Inversion	IA	33	NC
March	NA	IA	-	NA	SE Wind	IA	<30	NC
April	Inversion	IA	34	NC	NA	IA	-	NA
May	NA	34	-	NA	NA	41	-	NA
June	NA	<25	-	NA	NA	34	-	NA
July	NA	36	-	NA	Calm	44	<30	+15
August	NA	25	-	NA	Inversion	34	33	+1
September	NA	34	-	NA	NA	38	-	NA
October	NA	IA	-	NA	NA	IA	-	NA
November	NA	28	-	NA	NA	31	-	NA
December	NA	IA	-	NA	Inversion	IA	33	NC

Notes:

1. *Refer to Table 3.1 and Table 3.2 for applicable meteorological conditions;*
2. *NA indicates meteorological conditions during the measurement did not correspond with any modelled meteorological conditions, and were not applicable for comparison; and*
3. *NC indicates measured WCM noise levels IA, NM, or expressed as a "less than" quantity (e.g. less than 30 dB), therefore measured and predicted noise levels were not comparable*

At N21, measured L_{Aeq} noise levels were typically not comparable with Year 2 predictions in the EIS, apart from one instance in which the measured site-only L_{Aeq} was lower than predicted. When comparable to modelled noise levels, measured $L_{A1,1minute}$ noise levels were higher than predicted in the EIS on two occasions and lower than predicted on three occasions.

6.1.5 N26, Redmanvale Road South

Table 6.7: MEASURED WCM NOISE LEVELS COMPARED TO YEAR 2 PREDICTED NOISE LEVELS AT N26, dB(A)

Month	Applicable Meteorological Condition[1]	Measured WCM $L_{Aeq,15minute}$	Predicted WCM $L_{Aeq,15minute}$	Difference[2,3]	Applicable Meteorological Condition[1]	Measured WCM $L_{A1,1minute}$	Predicted WCM $L_{A1,1minute}$	Difference[2,3]
January	NA	IA	-	NA	NA	IA	-	NA
February	NA	IA	-	NA	NA	IA	-	NA
March	Wind Only	35	36	-1	SE Wind	42	37	+5
April	Inversion	33	36	-1	NA	37	-	NA
May	NA	IA	-	NA	Inversion	IA	46	NC
June	NA	IA	-	NA	NA	IA	-	NA
July	NA	NM	-	NA	NA	NM	-	NA
August	NA	27	-	NA	NA	32	-	NA
September	NA	41	-	NA	NA	45	-	NA
September[4]	NA	27	-	NA	NA	29	-	NA
September[5]	NA	41	-	NA	NA	41	-	NA
September[6]	NA	38	-	NA	NA	40	-	NA
October	Inversion	38	36	+2	NA	41	-	NA
November	Wind Only	IA	36	NC	SE Wind	IA	37	NC
December	NA	IA	-	NA	Inversion	IA	46	NC

Notes:

1. *Refer to Table 3.1 and Table 3.2 for applicable meteorological conditions;*
2. *NA indicates meteorological conditions during the measurement did not correspond with any modelled meteorological conditions, and were not applicable for comparison;*
3. *NC indicates measured WCM noise levels were IA, NM, or expressed as a "less than" quantity (e.g. less than 30 dB), therefore measured and predicted noise levels were not comparable;*
4. *Remeasure;*
5. *Follow-up monitoring; and*
6. *Follow-up monitoring remeasure.*

At N26, measured L_{Aeq} noise levels were similar to Year 2 predictions in the EIS. When comparable to modelled noise levels, measured $L_{A1,1minute}$ noise levels were higher than predicted in the EIS on one occasion and lower than predicted on three occasions.

7 SUMMARY

Global Acoustics was engaged by WCM to provide an AEMR for 2020, in order to compare noise monitoring results against both relevant criteria and predictions in the most recently approved EIS for the United Wambo project.

This report summarises monthly attended noise monitoring surveys conducted around WCM during the reporting period 1 January to 31 December 2020. The purpose of the surveys was to quantify and describe the acoustic environment around the site and compare results with specified limits. The duration of each measurement was 15 minutes.

Attended noise monitoring described in this report was conducted on a monthly basis in accordance with DA 305-7-2003 (MOD 16), EPL No. 529, and the WCM NMP.

7.1 January to December 2020 Compliance

Noise levels from WCM complied with the relevant development consent and EPL criteria at all sites during 2020 attended monitoring, except on two occasions. The following exceedances of EPL criteria were measured during 2020 monitoring:

- On the night of 8/9 September 2020, WCM exceeded the L_{Aeq} criterion at N26 by 3 dB. A low-frequency modifying factor of +2 dB was applicable to the site-only L_{Aeq}. A re-measure was undertaken with resulting levels below the relevant limits; and
- During the follow-up measurement on the night of 10/11 September 2020, WCM exceeded the L_{Aeq} criterion at N26 by 3 dB. A low-frequency modifying factor of +2 dB was applicable to the site-only L_{Aeq}. A re-measure was undertaken with resulting levels below the relevant limits.

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

7.2 Long-Term Noise Trends

During the 5-year period analysed, WCM noise levels at most monitoring locations increased from 2016 to 2018 as mining operations progressed to the northwest and were initially less shielded. From 2018 to 2020, site noise levels decreased at most monitoring locations, likely due to mining activity being deeper in pit and therefore more shielded from receptors.

From 1 December 2020, open cut mining is no longer undertaken by WCM and noise emissions are expected to decrease significantly.

7.3 EIS Comparison

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

At N01, measured noise levels were typically not comparable to Year 2 predictions in the EIS, apart from one instance in which the measured site-only L_{Aeq} was lower than predicted.

At N16, measured L_{Aeq} noise levels were lower than Year 2 predictions in the EIS when comparable to modelled noise levels. Measured $L_{A1,1minute}$ noise levels were not comparable with Year 2 predictions in the EIS.

At NA20, measured noise levels were lower than Year 2 predictions in the EIS when comparable to modelled noise levels.

At N21, measured L_{Aeq} noise levels were typically not comparable with Year 2 predictions in the EIS, apart from one instance in which the measured site-only L_{Aeq} was lower than predicted. When comparable to modelled noise levels, measured $L_{A1,1minute}$ noise levels were higher than predicted in the EIS on two occasions and lower than predicted on three occasions.

At N26, measured L_{Aeq} noise levels were similar to Year 2 predictions in the EIS. When comparable to modelled noise levels, measured $L_{A1,1minute}$ noise levels were higher than predicted in the EIS on one occasion and lower than predicted on three occasions.

Global Acoustics Pty Ltd

APPENDIX D

ENVIRONMENTAL MONITORING DATA SUMMARIES

Blast ID	Date	BM01 - Homestead Peak Air Blast dBL	BM01 - Homestead Peak Resultant mm/s	BM02 - Kelly Peak Air Blast dBL	BM02 - Kelly Peak Resultant mm/s	BM03 - Harris Peak Air Blast dBL	BM03 - Harris Peak Resultant mm/s	BM05 - Muller Peak Air Blast dBL	BM05 - Muller Peak Resultant mm/s	BM07 - Thelander Peak Air Blast dBL	BM07 - Thelander Peak Resultant mm/s
M_27WTA_468	Fri/10/Jan/2020	91.8	0.03	82.6	0.03	72.4	0.03	111.4	0.57	101.9	0.73
M_27WMA_471	Fri/10/Jan/2020	89.2	0.04	80.2	0.08	81.1	0.02	103.4	0.48	97.7	0.48
M_27WRC_467	Fri/10/Jan/2020	90.3	0.12	78.6	0.12	84.2	0.08	98.9	0.49	96.2	0.29
M_27WMA_474	Tue/21/Jan/2020	99.5	0.13	83.3	**9.12**	90	0.05	104.9	0.46	101.9	0.32
M_27WTA_469	Tue/21/Jan/2020	102.6	0.01	92.1	0.04	89.1	0.01	100.6	0.19	103.9	0.17
M_27WMA_475	Tue/28/Jan/2020	97.4	0.15	88.2	0.22	80.4	0.07	101.4	0.47	96.7	0.4
M_27WMA_476	Tue/28/Jan/2020	99.3	0.05	92.8	0.06	78.4	0.02	100.7	0.25	99.7	0.14
M_27WMA_479	Mon/03/Feb/2020	104.5	0.12	98.3	0.06	92.5	0.04	102	0.6	90.5	0.35
HS_WRB_483	Fri/14/Feb/2020	107.6	0.48	101.3	0.52	96.1	0.07	87.2	0.02	78.2	0.03
M_27WMA_476b	Sat/15/Feb/2020	94.7	0.03	90.3	0.04	82.8	0.01	99.8	0.19	101.3	0.12
M_27WMA_477	Tue/18/Feb/2020	102	0.12	83.6	0.16	89.5	0.07	101.2	0.4	97.6	0.32
MW_WWA_484	Wed/26/Feb/2020	112.9	0.18	107.8	0.14	102.6	0.18	104.6	0.57	101.7	1.06
M_27WRC_481	Wed/26/Feb/2020	105	0.04	96	0.11	97.3	0.02	94.4	0.16	95.5	0.11
M_27WRC_485	Mon/02/Mar/2020	101.2	0.1	93.2	0.12	85.6	0.04	92.6	0.35	95.5	0.19
M_27WMA_488	Fri/06/Mar/2020	105.5	0.01	87.4	0.02	94.6	0.01	94.8	0.08	93.8	0.06
M_27WMA_489	Fri/06/Mar/2020	104.1	0.07	98.1	0.08	90	0.03	100.6	0.33	94.7	0.29
M_27WRC_494	Thu/19/Mar/2020	92	0.15	81.2	0.24	72.9	0.06	**115.8**	0.77	111.7	0.51
M_27WMA_490	Thu/19/Mar/2020	92	0.15	81.2	0.24	72.9	0.06	**115.8**	0.77	111.7	0.51
M_27WMA_489_2	Thu/19/Mar/2020	92	0.15	81.2	0.24	72.9	0.06	**115.8**	0.77	111.7	0.51
M_27WMA_487	Thu/19/Mar/2020	92.7	0.21	79.9	0.22	72.4	0.09	104.8	0.68	101.3	0.49
M_27WMA_491	Thu/26/Mar/2020	106.4	0.35	97.1	0.39	95.6	0.05	86.4	0.01	74.3	0.02
M_27WMA_487_2	Thu/02/Apr/2020	101.1	0.24	81.5	0.25	77.5	0.11	108.3	0.55	102.7	0.35
M_27WMA_490_2	Thu/02/Apr/2020	101.1	0.24	81.5	0.25	77.5	0.11	108.3	0.55	102.7	0.35

Blast ID	Date	BM01 - Homestead		BM02 - Kelly		BM03 - Harris		BM05 - Muller		BM07 - Thelander	
		Peak Air Blast	Peak Resultant	Peak Air Blast	Peak Resultant	Peak Air Blast	Peak Resultant	Peak Air Blast	Peak Resultant	Peak Air Blast	Peak Resultant
		dBL	mm/s	dBL	mm/s	dBL	mm/s	dBL	mm/s	dBL	mm/s
M_27WMA_497a	Sat/11/Apr/2020	106.8	0.02	99.8	0.04	104.2	0.03	99	0.12	101.7	0.09
M_27WWA_485	Fri/17/Apr/2020	103.1	0.07	86.6	0.06	95.8	0.08	100	0.37	96.7	0.38
M_27WRC_496	Fri/17/Apr/2020	104.4	0.15	105.3	0.11	92	0.07	101.3	0.31	92.9	0.17
M_27WMA_495	Fri/24/Apr/2020	104.4	0.09	94.7	0.17	92	0.04	104.1	0.58	99	0.34
WTA 500_1	Fri/01/May/2020	**119.1**	0.12	100.8	0.15	81.5	0.06	96.9	0.43	91.9	0.48
WMA 490_3	Fri/01/May/2020	**119.1**	0.12	100.8	0.15	81.5	0.06	96.9	0.43	91.9	0.48
WTA 501_1	Fri/08/May/2020	102.8	0.14	98.8	1.34	91.1	0.17	97.3	0.14	95.3	0.17
WMA 503	Fri/08/May/2020	98.5	0.19	92.7	0.23	91.9	0.07	95.4	0.45	90	0.34
WMA_502	Wed/20/May/2020	97	0.17	86.2	0.04	80	0.09	83	0.08	85.5	0.13
WTA 501_2	Wed/20/May/2020	93.6	0.04	94.8	0.22	79.7	0.03	94	0.19	94.9	0.23
RCA 504	Wed/20/May/2020	87.7	0.07	90.2	0.23	72.4	0.04	95.9	0.46	93.6	0.39
WMA 506_1	Thu/28/May/2020	92.1	0.15	75.4	0.07	72.4	0.06	99.4	0.27	95.8	0.24
WTA_500_2	Thu/28/May/2020	86.4	0.07	77.6	0.2	69.7	0.05	99	0.41	98.4	0.31
WRC_507	Fri/05/Jun/2020	92.4	0.08	94.1	0.1	87.2	0.03	103.3	0.21	94.4	0.16
WMA_509	Tue/16/Jun/2020	99.3	0.07	83.4	0.13	82.6	0.04	94.3	0.36	93.8	0.3
WTA_500_3	Wed/24/Jun/2020	109.2	0.16	84	0.2	80.4	0.09	98	0.55	95.8	0.36
WRA_511_1	Fri/03/Jul/2020	101.8	0.11	97.6	0.21	98	0.06	102.3	0.28	99.9	0.19
WTA_500_4B	Fri/10/Jul/2020	98.9	0.11	83.2	0.17	99.7	0.04	98.1	0.33	88.3	0.24
WRC_505_510	Fri/10/Jul/2020	96.2	0.18	96.3	0.18	74.4	0.1	102	0.19	89.2	0.12
WRC_512A	Thu/16/Jul/2020	95.4	0.2	89.2	0.12	74.8	0.05	**118.5**	0.21	107.3	0.18
WTA_500_4b2	Thu/23/Jul/2020	83.8	0.22	80.2	0.25	74.8	0.14	104.7	0.51	100.7	0.37
WTA_500_6	Thu/23/Jul/2020	83.8	0.22	80.2	0.25	74.8	0.14	104.7	0.51	100.7	0.37
WMA_506_2a2 part 1	Sat/01/Aug/2020	93.5	0.24	92.5	0.21	73.4	0.11	101.1	0.48	96.9	0.27

Blast ID	Date	BM01 - Homestead		BM02 - Kelly		BM03 - Harris		BM05 - Muller		BM07 - Thelander	
		Peak Air Blast	Peak Resultant	Peak Air Blast	Peak Resultant	Peak Air Blast	Peak Resultant	Peak Air Blast	Peak Resultant	Peak Air Blast	Peak Resultant
		dBL	mm/s	dBL	mm/s	dBL	mm/s	dBL	mm/s	dBL	mm/s
WRC_515	Sat/01/Aug/2020	93.5	0.24	92.5	0.21	73.4	0.11	101.1	0.48	96.9	0.27
WMA_506_2a2 part 2	Thu/06/Aug/2020	89.2	0.21	84.3	0.19	86.1	0.11	95.1	0.43	92.6	0.29
WTA_500_4c	Wed/12/Aug/2020	97	0.23	81.9	0.26	78.9	0.15	100.2	0.45	95.5	0.48
WMA_506_2a2 part 3&4	Thu/20/Aug/2020	101.8	0.32	96	0.26	97.5	0.2	91	0.39	87.7	0.4
WMA_513_123	Fri/28/Aug/2020	91.2	0.31	82.4	0.26	92.6	0.16	102.4	0.52	101.9	0.32
WMA_513_1_2_part2	Fri/04/Sep/2020	99	0.12	93.9	0.12	87.8	0.06	97.6	0.27	95	0.26
WRA_511_2a	Tue/08/Sep/2020	92.9	0.07	91	0.08	79.7	0.03	96.7	0.11	92.7	0.08
WTA_500_8_part1	Thu/17/Sep/2020	97.3	0.39	88.4	0.25	79.2	0.13	95.3	0.67	92.4	0.27
WRC_518	Thu/17/Sep/2020	97.3	0.39	88.4	0.25	79.2	0.13	95.3	0.67	92.4	0.27
WTA_501_3a	Fri/25/Sep/2020	110.7	0.05	107.7	0.07	92.1	0.03	103.7	0.12	100.6	0.07
WTA_500_8_part2	Thu/01/Oct/2020	99.7	0.35	91.5	0.26	81.7	0.13	98	0.43	97.6	0.41
WMA_506R	Fri/02/Oct/2020	83.4	0.01	83.2	0.07	83.6	0	93	0.01	84.5	0
WMA_524 (reshoot)	Fri/09/Oct/2020	103.3	0.04	86.2	0.05	97.8	0.02	94.1	0.13	91.2	0.08
WMA_520 (Ramp)	Sat/17/Oct/2020	94.4	0.3	91.4	0.27	75.7	0.12	100.2	0.37	94.7	0.34
WTA_500_7	Fri/23/Oct/2020	93.6	0.25	89.6	0.3	86.3	0.15	99.8	0.49	95.4	0.31
WTA_500_8_part3	Wed/04/Nov/2020	85.3	0.16	84.8	0.13	72.4	0.09	95.2	0.34	92.1	0.35
WMA_519	Fri/13/Nov/2020	98.9	0.34	94.8	0.28	80.8	0.18	99.8	0.4	93.1	0.36
WRC_523	Fri/20/Nov/2020	97.8	0.07	81.2	0.06	74.8	0.02	98.8	0.1	91.7	0.08

ND = no data available for this blast.

Date	D11 Ash Residue (g/m2/ month)	D11 Insoluble Solids (g/m2/ month)	D11 AR/IS Ratio	D19 Ash Residue (g/m2/ month)	D19 Insoluble Solids (g/m2/month)	D19 AR/IS Ratio	D21 Ash Residue (g/m2/ month)	D21 Insoluble Solids (g/m2/month)	D21 AR/IS Ratio	D22 Ash Residue (g/m2/ month)	D22 Insoluble Solids (g/m2/ month)	D22 AR/IS Ratio
Jan-20	2.7	-	-	4.7	-	-	2	-	-	4.3	-	-
Feb-20	2.6	3.3	0.8	3.6	5.1	0.7	2.2	2.9	0.8	3.6	5.1	0.7
Mar-20	2	2.4	0.8	5.4	7.4	0.7	1.7	2	0.9	3.3	3.9	0.8
Apr-20	1	1.3	0.8	2.5	3.9	0.6	1.5	2.1	0.7	-	-	-
May-20	1.7	2.2	0.8	1.5	2.4	0.6	1.2	1.4	0.9	2.9	3.5	0.8
Jun-20	1.1	1.5	0.7	0.7	1.1	0.6	0.6	1	0.6	1.9	2.6	0.7
Jul-20	1.3	1.8	0.7	2.1	3.1	0.7	0.7	0.9	0.8	2.4	2.8	0.9
Aug-20	-	-	-	-	-	-	-	-	-	-	-	-
Sep-20	1.6	2.4	0.7	2.3	3.3	0.7	1	1.5	0.7	3.3	4.2	0.8
Oct-20	-	-	-	-	-	-	-	-	-	-	-	-
Nov-20	-	-	-	-	-	-	-	-	-	-	-	-
Dec-20	-	-	-	-	-	-	-	-	-	-	-	-
Average	**1.8**	**2.1**	**0.8**	**2.9**	**3.8**	**0.7**	**1.4**	**1.7**	**0.7**	**3.1**	**3.7**	**0.8**

Date of Run	PM01 - Coralie (Sentinex 19) PM$_{10}$ 24 Hour Result (ug/m^3)	PM01 - Coralie (Sentinex 19) YTD Average	PM02 - Wambo Road (Caban) (Sentinex 20) PM$_{10}$ 24 Hour Result (ug/m^3)	PM02 - Wambo Road (Caban) (Sentinex 20) YTD Average	PM03 - Thelander (Sentinex 21) PM$_{10}$ 24 Hour Result (ug/m^3)	PM03 - Thelander (Sentinex 21) YTD Average	PM04 - Muller (Sentinex 22) PM$_{10}$ 24 Hour Result (ug/m^3)	PM04 - Muller (Sentinex 22) YTD Average
1/01/2020	75.10	75.10	99.20	99.20	115.10	115.10	107.60	107.60
2/01/2020	44.30	59.70	54.50	76.85	43.40	79.25	42.30	74.95
3/01/2020	45.50	54.97	57.40	70.37	47.10	68.53	50.00	66.63
4/01/2020	58.30	55.80	92.40	75.88	63.40	67.25	50.20	62.53
5/01/2020	106.10	65.86	132.50	87.20	137.80	81.36	131.40	76.30
6/01/2020	50.58	63.31	42.27	79.71	46.07	75.48	47.20	71.45
7/01/2020	41.20	60.15	50.70	75.57	33.20	69.44	36.73	66.49
8/01/2020	75.40	62.06	70.80	74.97	57.80	67.98	64.90	66.29
9/01/2020	49.90	60.71	44.10	71.54	42.40	65.14	46.10	64.05
10/01/2020	46.80	59.32	48.00	69.19	46.90	63.32	40.10	61.65
11/01/2020	80.80	61.27	78.40	70.02	84.70	65.26	87.70	64.02
12/01/2020	85.30	63.27	56.50	68.90	65.40	65.27	65.60	64.15
13/01/2020	44.70	61.84	34.00	66.21	38.70	63.23	46.30	62.78
14/01/2020	35.50	59.96	27.90	63.48	30.20	60.87	41.40	61.25
15/01/2020	33.60	58.21	31.80	61.36	26.10	58.55	40.60	59.88
16/01/2020	27.10	56.26	22.20	58.92	24.80	56.44	33.40	58.22
17/01/2020	25.80	54.47	25.50	56.95	25.70	54.63	32.50	56.71
18/01/2020	19.30	52.52	17.00	54.73	18.00	52.60	19.10	54.62
19/01/2020	17.70	50.68	12.70	52.52	15.60	50.65	20.20	52.81
20/01/2020	34.60	49.88	30.80	51.43	39.10	50.07	34.10	51.87
21/01/2020	43.20	49.56	42.30	51.00	43.90	49.78	46.20	51.60
22/01/2020	34.90	48.89	34.60	50.25	35.70	49.14	51.00	51.57
23/01/2020	61.50	49.44	68.90	51.06	28.30	48.23	51.80	51.58
24/01/2020	41.70	49.12	43.80	50.76	57.20	48.61	46.30	51.36
25/01/2020	53.90	49.31	44.00	50.49	52.90	48.78	44.50	51.09
26/01/2020	23.60	48.32	21.70	49.38	18.90	47.63	23.90	50.04
27/01/2020	42.60	48.11	41.10	49.08	46.40	47.58	43.20	49.79
28/01/2020	30.50	47.48	32.20	48.47	24.80	46.77	44.70	49.61
29/01/2020	33.80	47.01	31.70	47.90	41.40	46.59	33.40	49.05
30/01/2020	39.10	46.75	34.10	47.44	42.40	46.45	41.80	48.81
31/01/2020	34.90	46.36	35.20	47.04	34.40	46.06	44.00	48.65
1/02/2020	37.40	46.08	44.40	46.96	35.90	45.74	44.50	48.52
2/02/2020	40.40	45.91	56.90	47.26	44.90	45.71	51.00	48.60
3/02/2020	30.30	45.45	23.20	46.55	23.90	45.07	20.30	47.77
4/02/2020	69.10	46.13	47.20	46.57	59.60	45.49	48.10	47.78
5/02/2020	46.20	46.13	22.10	45.89	25.00	44.92	38.80	47.53
6/02/2020	21.70	45.47	11.40	44.96	11.30	44.01	16.60	46.69
7/02/2020	5.50	44.42	3.40	43.87	3.70	42.95	4.80	45.59

Date of Run	PM01 - Coralie (Sentinex 19) PM$_{10}$ 24 Hour Result (ug/m^3)	PM01 - Coralie (Sentinex 19) YTD Average	PM02 - Wambo Road (Caban) (Sentinex 20) PM$_{10}$ 24 Hour Result (ug/m^3)	PM02 - Wambo Road (Caban) (Sentinex 20) YTD Average	PM03 - Thelander (Sentinex 21) PM$_{10}$ 24 Hour Result (ug/m^3)	PM03 - Thelander (Sentinex 21) YTD Average	PM04 - Muller (Sentinex 22) PM$_{10}$ 24 Hour Result (ug/m^3)	PM04 - Muller (Sentinex 22) YTD Average
8/02/2020	12.10	43.59	8.40	42.96	7.40	42.04	7.60	44.61
9/02/2020	8.10	42.70	5.30	42.01	5.40	41.12	4.90	43.62
10/02/2020	16.20	42.06	12.50	41.29	11.00	40.39	12.80	42.87
11/02/2020	18.10	41.49	20.10	40.79	15.70	39.80	16.10	42.23
12/02/2020	18.20	40.94	14.90	40.19	18.20	39.30	15.30	41.61
13/02/2020	24.10	40.56	13.90	39.59	14.20	38.73	16.60	41.04
14/02/2020	17.50	40.05	18.60	39.12	21.50	38.34	20.10	40.57
15/02/2020	23.50	39.69	21.80	38.75	18.10	37.90	21.40	40.16
16/02/2020	22.50	39.32	15.10	38.24	18.90	37.50	17.20	39.67
17/02/2020	13.10	38.78	10.70	37.67	11.00	36.95	13.20	39.12
18/02/2020	21.30	38.42	22.80	37.37	17.50	36.55	15.80	38.64
19/02/2020	35.00	38.35	36.80	37.36	NaN	36.55	30.80	38.48
20/02/2020	28.30	38.15	25.10	37.12	23.10	36.28	24.00	38.20
21/02/2020	32.10	38.04	22.50	36.83	25.90	36.08	28.00	38.00
22/02/2020	24.70	37.79	16.30	36.45	22.80	35.82	24.30	37.74
23/02/2020	22.50	37.50	15.30	36.06	16.60	35.46	26.10	37.53
24/02/2020	16.40	37.12	9.90	35.58	14.10	35.06	21.50	37.24
25/02/2020	18.80	36.79	14.80	35.21	12.30	34.65	15.40	36.85
26/02/2020	12.80	36.37	14.70	34.85	10.70	34.22	11.40	36.40
27/02/2020	26.30	36.20	27.90	34.73	19.60	33.97	28.90	36.27
28/02/2020	26.50	36.03	27.20	34.60	26.60	33.84	27.70	36.13
29/02/2020	22.60	35.81	18.40	34.33	20.10	33.61	29.80	36.02
1/03/2020	22.00	35.58	19.80	34.09	15.60	33.31	20.80	35.77
2/03/2020	18.20	35.30	14.90	33.78	18.20	33.06	15.30	35.44
3/03/2020	23.40	35.11	23.70	33.62	21.60	32.87	29.90	35.35
4/03/2020	20.00	34.88	14.10	33.32	13.50	32.57	23.10	35.16
5/03/2020	12.70	34.54	9.80	32.96	9.60	32.21	14.40	34.84
6/03/2020	8.70	34.15	6.50	32.56	8.40	31.84	8.40	34.44
7/03/2020	17.40	33.90	12.90	32.26	15.70	31.60	15.20	34.15
8/03/2020	15.40	33.62	11.30	31.95	15.10	31.35	20.30	33.95
9/03/2020	20.30	33.43	12.10	31.67	11.40	31.06	20.40	33.75
10/03/2020	17.30	33.20	12.80	31.40	12.80	30.79	24.10	33.62
11/03/2020	23.50	33.06	18.40	31.21	16.20	30.58	21.10	33.44
12/03/2020	28.10	32.99	16.50	31.01	16.30	30.38	26.00	33.34
13/03/2020	18.00	32.79	17.40	30.82	16.50	30.19	24.80	33.22
14/03/2020	13.00	32.52	12.70	30.58	9.60	29.91	16.50	32.99
15/03/2020	14.00	32.27	11.80	30.33	12.10	29.67	22.40	32.85
16/03/2020	7.20	31.94	6.40	30.01	5.80	29.35	12.60	32.59

Date of Run	PM01 - Coralie (Sentinex 19) PM10 24 Hour Result (ug/m3)	PM01 - Coralie (Sentinex 19) YTD Average	PM02 - Wambo Road (Caban) (Sentinex 20) PM10 24 Hour Result (ug/m3)	PM02 - Wambo Road (Caban) (Sentinex 20) YTD Average	PM03 - Thelander (Sentinex 21) PM10 24 Hour Result (ug/m3)	PM03 - Thelander (Sentinex 21) YTD Average	PM04 - Muller (Sentinex 22) PM10 24 Hour Result (ug/m3)	PM04 - Muller (Sentinex 22) YTD Average
17/03/2020	12.70	31.69	9.10	29.74	9.80	29.09	17.00	32.38
18/03/2020	16.90	31.50	15.20	29.55	15.60	28.92	27.10	32.32
19/03/2020	19.80	31.36	23.80	29.48	20.70	28.81	24.90	32.22
20/03/2020	22.70	31.25	37.90	29.59	19.50	28.69	21.40	32.09
21/03/2020	35.40	31.30	32.30	29.62	35.90	28.78	40.60	32.19
22/03/2020	27.40	31.25	34.30	29.68	28.10	28.77	32.20	32.19
23/03/2020	29.30	31.23	23.50	29.60	21.30	28.68	28.70	32.15
24/03/2020	23.50	31.14	19.60	29.48	17.80	28.55	25.30	32.07
25/03/2020	16.70	30.97	15.60	29.32	11.50	28.35	16.60	31.89
26/03/2020	10.20	30.73	8.60	29.08	8.70	28.12	10.10	31.63
27/03/2020	20.60	30.61	13.10	28.90	15.00	27.97	16.00	31.45
28/03/2020	19.50	30.48	10.20	28.68	14.70	27.81	19.50	31.32
29/03/2020	15.80	30.32	16.90	28.55	13.30	27.65	20.60	31.20
30/03/2020	10.70	30.10	10.00	28.35	7.10	27.42	12.50	30.99
31/03/2020	14.00	29.92	13.20	28.18	11.00	27.24	12.30	30.78
1/04/2020	19.10	29.81	16.80	28.06	17.80	27.13	23.50	30.70
2/04/2020	16.70	29.66	16.30	27.93	12.10	26.97	16.00	30.55
3/04/2020	13.30	29.49	10.70	27.75	9.40	26.78	9.40	30.32
4/04/2020	15.20	29.34	16.60	27.63	12.70	26.63	12.40	30.13
5/04/2020	17.40	29.22	21.70	27.57	15.30	26.51	14.50	29.97
6/04/2020	16.80	29.09	18.30	27.47	15.20	26.39	16.30	29.83
7/04/2020	15.60	28.95	12.00	27.31	13.00	26.25	23.10	29.76
8/04/2020	12.40	28.78	13.20	27.17	8.70	26.08	24.80	29.71
9/04/2020	18.60	28.68	17.20	27.07	13.10	25.94	22.10	29.63
10/04/2020	9.00	28.49	9.10	26.89	6.00	25.74	8.40	29.42
11/04/2020	21.40	28.42	16.20	26.79	11.90	25.61	12.70	29.26
12/04/2020	21.70	28.35	16.60	26.69	14.50	25.50	23.60	29.21
13/04/2020	21.20	28.28	19.50	26.62	13.70	25.38	24.30	29.16
14/04/2020	20.80	28.21	24.10	26.60	18.00	25.31	26.90	29.14
15/04/2020	21.20	28.15	19.50	26.53	13.70	25.20	24.30	29.09
16/04/2020	24.90	28.11	29.00	26.55	15.90	25.11	15.60	28.96
17/04/2020	17.90	28.02	37.70	26.66	13.20	25.00	12.60	28.81
18/04/2020	20.60	27.95	26.60	26.65	14.70	24.91	25.00	28.78
19/04/2020	19.40	27.87	26.60	26.65	17.10	24.84	27.20	28.76
20/04/2020	20.60	27.81	30.30	26.69	12.80	24.73	11.80	28.61
21/04/2020	20.70	27.75	36.00	26.77	13.00	24.62	11.60	28.46
22/04/2020	19.00	27.67	36.30	26.85	13.70	24.52	12.80	28.32
23/04/2020	25.40	27.65	48.30	27.04	17.30	24.46	17.10	28.22

Date of Run	PM01 - Coralie (Sentinex 19) PM10 24 Hour Result (ug/m3)	PM01 - Coralie (Sentinex 19) YTD Average	PM02 - Wambo Road (Caban) (Sentinex 20) PM10 24 Hour Result (ug/m3)	PM02 - Wambo Road (Caban) (Sentinex 20) YTD Average	PM03 - Thelander (Sentinex 21) PM10 24 Hour Result (ug/m3)	PM03 - Thelander (Sentinex 21) YTD Average	PM04 - Muller (Sentinex 22) PM10 24 Hour Result (ug/m3)	PM04 - Muller (Sentinex 22) YTD Average
24/04/2020	32.20	27.69	65.00	27.37	21.50	24.43	25.80	28.20
25/04/2020	25.10	27.67	31.20	27.41	17.10	24.37	17.60	28.11
26/04/2020	30.40	27.69	34.00	27.46	21.10	24.34	20.40	28.04
27/04/2020	21.10	27.63	27.30	27.46	21.50	24.32	21.30	27.99
28/04/2020	20.20	27.57	23.10	27.42	17.70	24.26	23.60	27.95
29/04/2020	18.50	27.49	40.70	27.53	12.50	24.16	19.10	27.88
30/04/2020	10.10	27.35	8.00	27.37	10.10	24.05	17.20	27.79
1/05/2020	10.30	27.21	10.90	27.24	7.20	23.91	7.40	27.62
2/05/2020	13.60	27.10	10.80	27.10	6.74	23.77	8.30	27.46
3/05/2020	10.60	26.97	9.70	26.96	7.00	23.63	15.70	27.37
4/05/2020	19.80	26.91	15.00	26.87	13.50	23.55	21.20	27.32
5/05/2020	15.40	26.82	12.70	26.76	12.50	23.46	18.10	27.25
6/05/2020	12.30	26.70	10.50	26.63	6.00	23.32	6.40	27.08
7/05/2020	14.80	26.61	24.40	26.61	9.30	23.21	9.70	26.95
8/05/2020	17.70	26.54	24.10	26.59	10.10	23.11	10.70	26.82
9/05/2020	16.20	26.46	18.90	26.53	11.10	23.01	11.60	26.70
10/05/2020	9.20	26.33	6.90	26.38	5.80	22.88	5.20	26.54
11/05/2020	16.40	26.26	17.20	26.31	8.60	22.77	17.00	26.47
12/05/2020	NaN	26.26	19.30	26.26	10.20	22.68	13.70	26.37
13/05/2020	15.70	26.18	23.20	26.24	11.80	22.60	14.30	26.28
14/05/2020	23.10	26.15	22.10	26.21	11.20	22.51	18.20	26.22
15/05/2020	15.40	26.07	12.60	26.11	11.30	22.43	19.80	26.17
16/05/2020	14.70	25.99	8.60	25.98	11.80	22.35	21.00	26.14
17/05/2020	29.40	26.02	13.60	25.89	20.30	22.34	40.30	26.24
18/05/2020	24.80	26.01	16.40	25.82	13.90	22.27	25.60	26.23
19/05/2020	11.10	25.90	12.60	25.73	11.50	22.20	15.10	26.15
20/05/2020	21.80	25.87	20.70	25.69	8.40	22.10	10.20	26.04
21/05/2020	13.90	25.78	13.70	25.61	7.10	21.99	6.50	25.90
22/05/2020	11.00	25.68	8.70	25.49	5.10	21.87	5.50	25.76
23/05/2020	12.40	25.59	18.60	25.44	8.80	21.78	8.70	25.64
24/05/2020	6.50	25.46	9.20	25.33	7.60	21.68	5.50	25.50
25/05/2020	8.40	25.34	8.10	25.21	6.60	21.58	6.30	25.37
26/05/2020	8.60	25.22	9.20	25.10	9.00	21.49	10.50	25.27
27/05/2020	19.80	25.19	12.70	25.02	11.20	21.42	14.50	25.20
28/05/2020	12.60	25.10	15.30	24.95	10.90	21.35	14.82	25.13
29/05/2020	18.40	25.06	13.26	24.87	15.94	21.32	24.40	25.12
30/05/2020	11.70	24.97	8.80	24.77	9.30	21.23	17.40	25.07
31/05/2020	12.60	24.89	10.30	24.67	7.30	21.14	23.70	25.06

Date of Run	PM01 - Coralie (Sentinex 19) PM$_{10}$ 24 Hour Result (ug/m^3)	PM01 - Coralie (Sentinex 19) YTD Average	PM02 - Wambo Road (Caban) (Sentinex 20) PM$_{10}$ 24 Hour Result (ug/m^3)	PM02 - Wambo Road (Caban) (Sentinex 20) YTD Average	PM03 - Thelander (Sentinex 21) PM$_{10}$ 24 Hour Result (ug/m^3)	PM03 - Thelander (Sentinex 21) YTD Average	PM04 - Muller (Sentinex 22) PM$_{10}$ 24 Hour Result (ug/m^3)	PM04 - Muller (Sentinex 22) YTD Average
1/06/2020	24.50	24.88	21.90	24.65	11.20	21.08	12.70	24.98
2/06/2020	10.30	24.79	16.20	24.60	6.30	20.98	6.20	24.86
3/06/2020	12.00	24.70	13.70	24.53	8.90	20.90	27.60	24.88
4/06/2020	10.10	24.65	9.40	24.43	12.70	20.85	23.70	24.87
5/06/2020	8.00	24.57	21.60	24.41	6.10	20.75	6.80	24.76
6/06/2020	10.20	24.53	21.40	24.40	11.60	20.70	18.40	24.72
7/06/2020	22.80	24.51	25.20	24.40	17.90	20.68	22.90	24.70
8/06/2020	17.90	24.44	11.40	24.32	11.70	20.62	16.70	24.65
9/06/2020	7.90	24.34	5.50	24.20	7.80	20.54	8.90	24.56
10/06/2020	8.60	24.24	3.90	24.08	5.30	20.45	7.80	24.45
11/06/2020	11.30	24.16	6.50	23.97	8.80	20.38	15.40	24.40
12/06/2020	17.40	24.12	7.60	23.87	10.60	20.32	28.90	24.42
13/06/2020	17.10	24.08	12.40	23.80	19.60	20.31	33.20	24.48
14/06/2020	10.70	24.00	8.80	23.71	10.10	20.25	8.10	24.38
15/06/2020	11.00	23.92	10.80	23.63	8.10	20.18	7.40	24.28
16/06/2020	11.20	23.84	9.90	23.55	8.30	20.11	6.50	24.17
17/06/2020	15.00	23.79	9.40	23.47	NaN	20.11	14.00	24.11
18/06/2020	14.30	23.73	10.40	23.39	NaN	20.11	14.60	24.06
19/06/2020	12.20	23.66	11.10	23.32	11.70	20.06	10.60	23.98
20/06/2020	10.10	23.59	8.40	23.23	5.40	19.97	5.80	23.87
21/06/2020	11.60	23.52	9.10	23.15	7.90	19.90	7.30	23.78
22/06/2020	6.60	23.42	5.80	23.05	5.00	19.81	5.10	23.67
23/06/2020	5.60	23.32	8.80	22.97	3.90	19.72	4.00	23.56
24/06/2020	6.90	23.22	18.70	22.94	4.30	19.63	4.50	23.45
25/06/2020	9.60	23.14	11.00	22.88	4.80	19.54	4.70	23.34
26/06/2020	12.60	23.08	13.70	22.82	8.00	19.48	18.50	23.31
27/06/2020	21.90	23.08	12.60	22.77	12.80	19.44	24.90	23.32
28/06/2020	24.00	23.08	7.80	22.68	18.90	19.44	26.20	23.34
29/06/2020	19.20	23.06	13.20	22.63	14.00	19.41	23.70	23.34
30/06/2020	11.03	23.00	10.10	22.56	8.20	19.34	12.30	23.28
1/07/2020	16.10	22.96	18.40	22.54	NaN	19.34	7.80	23.20
2/07/2020	20.30	22.94	26.60	22.56	NaN	19.34	12.50	23.14
3/07/2020	14.60	22.90	13.60	22.51	5.00	19.26	8.00	23.06
4/07/2020	10.10	22.83	10.40	22.45	1.80	19.17	5.30	22.96
5/07/2020	8.00	22.75	12.00	22.39	4.00	19.08	4.80	22.86
6/07/2020	10.20	22.68	13.30	22.34	4.00	19.00	8.60	22.79
7/07/2020	22.80	22.68	15.10	22.31	8.00	18.94	15.00	22.75
8/07/2020	17.90	22.66	14.20	22.26	10.70	18.90	25.00	22.76

Date of Run	PM01 - Coralie (Sentinex 19) PM$_{10}$ 24 Hour Result (ug/m^3)	PM01 - Coralie (Sentinex 19) YTD Average	PM02 - Wambo Road (Caban) (Sentinex 20) PM$_{10}$ 24 Hour Result (ug/m^3)	PM02 - Wambo Road (Caban) (Sentinex 20) YTD Average	PM03 - Thelander (Sentinex 21) PM$_{10}$ 24 Hour Result (ug/m^3)	PM03 - Thelander (Sentinex 21) YTD Average	PM04 - Muller (Sentinex 22) PM$_{10}$ 24 Hour Result (ug/m^3)	PM04 - Muller (Sentinex 22) YTD Average
9/07/2020	18.00	22.63	22.20	22.26	9.40	18.85	16.00	22.72
10/07/2020	14.50	22.59	11.40	22.21	4.70	18.77	11.90	22.67
11/07/2020	9.30	22.52	8.70	22.14	4.70	18.70	8.00	22.59
12/07/2020	7.50	22.44	6.60	22.06	3.50	18.62	6.60	22.51
13/07/2020	6.70	22.36	7.10	21.98	1.80	18.53	3.70	22.41
14/07/2020	7.10	22.28	7.40	21.91	3.40	18.45	5.50	22.33
15/07/2020	5.90	22.20	4.40	21.82	2.40	18.36	4.00	22.23
16/07/2020	8.30	22.13	8.40	21.75	1.20	18.27	5.30	22.15
17/07/2020	9.50	22.07	6.30	21.67	3.70	18.20	13.30	22.10
18/07/2020	15.30	22.03	12.30	21.62	10.60	18.16	19.70	22.09
19/07/2020	12.00	21.98	11.80	21.58	6.60	18.10	6.80	22.01
20/07/2020	12.00	21.93	11.50	21.53	6.30	18.04	6.10	21.94
21/07/2020	15.90	21.90	14.60	21.49	7.70	17.99	19.80	21.92
22/07/2020	20.80	21.90	18.40	21.48	12.70	17.96	17.00	21.90
23/07/2020	17.30	21.87	18.10	21.46	12.60	17.94	22.40	21.90
24/07/2020	24.10	21.88	18.40	21.45	11.60	17.90	18.20	21.89
25/07/2020	20.60	21.88	12.70	21.40	7.00	17.85	16.50	21.86
26/07/2020	4.00	21.79	2.50	21.31	0.20	17.76	NaN	21.86
27/07/2020	4.20	21.71	4.40	21.23	2.90	17.69	NaN	21.86
28/07/2020	5.20	21.63	4.40	21.15	0.20	17.61	3.10	21.77
29/07/2020	7.90	21.56	6.20	21.08	3.60	17.54	NaN	21.77
30/07/2020	10.50	21.51	7.10	21.01	5.80	17.48	12.60	21.73
31/07/2020	15.60	21.48	9.70	20.96	12.30	17.46	22.50	21.73
1/08/2020	10.00	21.43	9.80	20.91	5.29	17.40	9.40	21.67
2/08/2020	12.20	21.39	13.90	20.88	6.97	17.35	14.20	21.64
3/08/2020	16.00	21.36	22.70	20.88	6.19	17.30	7.70	21.57
4/08/2020	15.60	21.33	13.80	20.85	5.86	17.24	8.00	21.51
5/08/2020	13.90	21.30	16.50	20.83	3.63	17.18	6.90	21.44
6/08/2020	14.60	21.27	15.60	20.81	8.72	17.14	17.80	21.42
7/08/2020	19.00	21.26	7.90	20.75	7.74	17.09	27.80	21.45
8/08/2020	6.10	21.19	6.50	20.69	1.19	17.02	5.00	21.38
9/08/2020	4.80	21.12	4.70	20.61	0.69	16.95	3.20	21.29
10/08/2020	12.00	21.07	9.40	20.56	4.36	16.89	10.10	21.24
11/08/2020	13.20	21.04	9.50	20.51	8.91	16.85	15.10	21.21
12/08/2020	14.60	21.01	15.90	20.49	10.62	16.82	14.10	21.18
13/08/2020	11.10	20.97	9.10	20.44	5.85	16.77	12.80	21.14
14/08/2020	15.00	20.94	13.30	20.41	5.10	16.72	7.90	21.09
15/08/2020	6.80	20.88	6.20	20.35	2.53	16.66	5.80	21.02

Date of Run	PM01 - Coralie (Sentinex 19) PM10 24 Hour Result (ug/m3)	PM01 - Coralie (Sentinex 19) YTD Average	PM02 - Wambo Road (Caban) (Sentinex 20) PM10 24 Hour Result (ug/m3)	PM02 - Wambo Road (Caban) (Sentinex 20) YTD Average	PM03 - Thelander (Sentinex 21) PM10 24 Hour Result (ug/m3)	PM03 - Thelander (Sentinex 21) YTD Average	PM04 - Muller (Sentinex 22) PM10 24 Hour Result (ug/m3)	PM04 - Muller (Sentinex 22) YTD Average
16/08/2020	6.80	20.82	10.50	20.31	1.48	16.59	4.70	20.94
17/08/2020	7.80	20.76	11.90	20.27	1.50	16.52	4.60	20.87
18/08/2020	10.60	20.71	14.80	20.25	2.55	16.46	5.50	20.81
19/08/2020	62.80	20.90	77.20	20.49	32.89	16.53	36.20	20.87
20/08/2020	22.70	20.90	20.30	20.49	11.05	16.51	18.40	20.86
21/08/2020	11.80	20.87	15.40	20.47	2.31	16.45	5.70	20.80
22/08/2020	8.60	20.81	5.60	20.41	1.90	16.38	4.60	20.73
23/08/2020	11.40	20.77	7.10	20.35	2.36	16.32	5.30	20.66
24/08/2020	10.50	20.73	16.60	20.33	2.48	16.26	5.70	20.60
25/08/2020	14.10	20.70	13.80	20.31	15.63	16.26	15.20	20.57
26/08/2020	19.90	20.70	23.20	20.32	11.10	16.24	14.60	20.55
27/08/2020	19.13	20.69	27.30	20.35	7.07	16.20	7.80	20.49
28/08/2020	15.90	20.67	20.20	20.35	8.08	16.16	17.80	20.48
29/08/2020	19.80	20.67	23.50	20.36	12.40	16.15	23.30	20.49
30/08/2020	24.70	20.68	31.80	20.41	14.79	16.14	17.80	20.48
31/08/2020	29.70	20.72	33.60	20.46	20.22	16.16	26.30	20.51
1/09/2020	21.60	20.73	19.70	20.46	18.10	16.17	38.10	20.58
2/09/2020	30.00	20.76	29.70	20.49	12.00	16.15	21.40	20.58
3/09/2020	42.50	20.85	41.00	20.58	14.80	16.15	20.00	20.58
4/09/2020	33.60	20.90	29.60	20.61	13.40	16.13	18.50	20.57
5/09/2020	11.10	20.86	7.30	20.56	8.20	16.10	13.30	20.54
6/09/2020	22.30	20.87	16.90	20.55	21.00	16.12	35.30	20.60
7/09/2020	18.00	20.86	12.70	20.51	12.70	16.11	24.40	20.62
8/09/2020	21.70	20.86	18.40	20.51	11.00	16.09	17.80	20.61
9/09/2020	15.50	20.84	10.50	20.47	8.60	16.06	16.30	20.59
10/09/2020	13.10	20.81	8.20	20.42	2.38	16.00	15.80	20.57
11/09/2020	14.80	20.79	7.70	20.37	1.90	15.95	17.50	20.56
12/09/2020	11.00	20.75	7.80	20.32	1.28	15.89	7.80	20.51
13/09/2020	27.00	20.77	14.20	20.30	2.87	15.84	8.50	20.46
14/09/2020	20.50	20.77	20.00	20.29	3.21	15.79	16.30	20.44
15/09/2020	20.90	20.77	18.50	20.29	5.96	15.75	30.20	20.48
16/09/2020	19.80	20.77	16.20	20.27	4.08	15.70	12.40	20.45
17/09/2020	12.29	20.74	19.00	20.27	5.30	15.66	NaN	20.45
18/09/2020	19.50	20.73	17.10	20.26	5.43	15.62	19.40	20.45
19/09/2020	28.20	20.76	16.50	20.24	7.98	15.59	29.70	20.48
20/09/2020	11.40	20.72	7.50	20.19	3.75	15.55	13.50	20.46
21/09/2020	10.20	20.68	3.02	20.13	3.47	15.50	7.10	20.40
22/09/2020	18.90	20.68	15.90	20.11	NaN	15.50	12.50	20.37

Date of Run	PM01 - Coralie (Sentinex 19) PM$_{10}$ 24 Hour Result (ug/m^3)	PM01 YTD Average	PM02 - Wambo Road (Caban) (Sentinex 20) PM$_{10}$ 24 Hour Result (ug/m^3)	PM02 YTD Average	PM03 - Thelander (Sentinex 21) PM$_{10}$ 24 Hour Result (ug/m^3)	PM03 YTD Average	PM04 - Muller (Sentinex 22) PM$_{10}$ 24 Hour Result (ug/m^3)	PM04 YTD Average
23/09/2020	20.40	20.68	15.00	20.09	1.86	15.45	12.70	20.35
24/09/2020	12.80	20.65	10.40	20.06	0.84	15.39	6.10	20.29
25/09/2020	21.90	20.65	13.25	20.03	0.88	15.34	9.30	20.25
26/09/2020	10.60	20.61	NaN	20.03	0.39	15.28	4.90	20.19
27/09/2020	15.10	20.59	NaN	20.03	3.05	15.23	13.50	20.17
28/09/2020	19.40	20.59	NaN	20.03	3.82	15.19	24.80	20.18
29/09/2020	20.40	20.59	24.30	20.05	4.12	15.15	20.80	20.19
30/09/2020	15.80	20.58	2.84	20.03	2.84	15.10	12.90	20.16
1/10/2020	17.20	20.57	10.60	20.00	7.40	15.07	13.50	20.14
2/10/2020	16.80	20.55	16.70	19.98	13.20	15.07	22.30	20.14
3/10/2020	33.50	20.60	24.50	20.00	15.90	15.07	23.30	20.15
4/10/2020	34.50	20.65	20.50	20.00	14.90	15.07	18.90	20.15
5/10/2020	26.90	20.67	23.40	20.02	16.60	15.08	16.70	20.14
6/10/2020	25.00	20.69	17.30	20.01	23.40	15.11	28.40	20.17
7/10/2020	31.10	20.72	17.80	20.00	21.10	15.13	29.30	20.20
8/10/2020	26.80	20.75	17.30	19.99	16.70	15.13	19.50	20.20
9/10/2020	22.30	20.75	20.60	19.99	4.50	15.09	6.80	20.15
10/10/2020	11.70	20.72	14.20	19.97	6.40	15.06	7.50	20.10
11/10/2020	22.10	20.72	20.60	19.97	11.10	15.05	20.10	20.10
12/10/2020	29.50	20.75	23.50	19.98	20.90	15.07	33.00	20.15
13/10/2020	32.10	20.79	25.50	20.00	NaN	15.07	31.30	20.19
14/10/2020	36.00	20.85	26.10	20.02	24.40	15.10	32.10	20.23
15/10/2020	37.40	20.90	24.20	20.04	14.02	15.10	19.00	20.23
16/10/2020	46.00	20.99	27.30	20.06	26.44	15.14	32.70	20.27
17/10/2020	30.00	21.02	35.20	20.12	29.61	15.19	24.90	20.29
18/10/2020	11.80	20.99	7.00	20.07	2.78	15.15	6.80	20.24
19/10/2020	17.30	20.98	15.50	20.06	9.89	15.13	17.60	20.23
20/10/2020	21.20	20.98	12.60	20.03	13.18	15.12	21.10	20.23
21/10/2020	31.90	21.02	19.60	20.03	14.00	15.12	36.70	20.29
22/10/2020	28.50	21.04	23.70	20.04	16.23	15.12	29.60	20.32
23/10/2020	28.00	21.07	25.90	20.06	17.29	15.13	26.60	20.34
24/10/2020	11.60	21.03	9.20	20.02	7.93	15.10	8.40	20.30
25/10/2020	6.00	20.98	3.60	19.97	0.70	15.06	5.00	20.25
26/10/2020	4.20	20.93	3.70	19.91	1.88	15.01	4.40	20.20
27/10/2020	7.40	20.88	5.60	19.87	2.46	14.97	8.40	20.16
28/10/2020	8.59	20.84	7.42	19.82	5.89	14.94	8.23	20.12
29/10/2020	8.90	20.80	5.70	19.78	6.24	14.91	9.60	20.08
30/10/2020	18.90	20.80	10.20	19.75	8.39	14.89	15.40	20.07

Date of Run	PM01 - Coralie (Sentinex 19) PM$_{10}$ 24 Hour Result (ug/m^3)	PM01 YTD Average	PM02 - Wambo Road (Caban) (Sentinex 20) PM$_{10}$ 24 Hour Result (ug/m^3)	PM02 YTD Average	PM03 - Thelander (Sentinex 21) PM$_{10}$ 24 Hour Result (ug/m^3)	PM03 YTD Average	PM04 - Muller (Sentinex 22) PM$_{10}$ 24 Hour Result (ug/m^3)	PM04 YTD Average
31/10/2020	21.10	20.80	9.70	19.71	7.40	14.86	11.00	20.04
1/11/2020	11.10	20.76	8.00	19.67	3.40	14.82	8.50	20.00
2/11/2020	20.40	20.76	13.70	19.65	10.10	14.81	16.40	19.99
3/11/2020	27.00	20.78	14.20	19.64	13.30	14.80	19.20	19.98
4/11/2020	20.50	20.78	16.70	19.63	7.60	14.78	10.00	19.95
5/11/2020	19.70	20.78	9.90	19.60	4.30	14.74	10.10	19.92
6/11/2020	13.70	20.76	12.10	19.57	10.10	14.73	14.70	19.90
7/11/2020	28.20	20.78	16.30	19.56	19.50	14.74	27.90	19.93
8/11/2020	22.90	20.79	13.10	19.54	16.80	14.75	21.80	19.93
9/11/2020	15.70	20.77	11.90	19.51	11.30	14.74	21.00	19.94
10/11/2020	13.90	20.75	12.60	19.49	11.60	14.73	19.90	19.94
11/11/2020	24.50	20.76	21.80	19.50	12.50	14.72	21.10	19.94
12/11/2020	30.10	20.79	28.90	19.53	19.10	14.74	27.30	19.97
13/11/2020	19.20	20.79	16.40	19.52	12.70	14.73	16.40	19.95
14/11/2020	17.10	20.77	10.70	19.49	9.80	14.71	14.20	19.94
17/11/2020	44.20	20.90	32.60	19.54	32.62	14.75	41.60	20.02
18/11/2020	34.10	20.94	25.30	19.56	24.02	14.78	35.70	20.07
19/11/2020	25.00	20.95	21.70	19.56	23.01	14.81	30.60	20.10
20/11/2020	36.20	21.00	30.00	19.60	22.61	14.83	36.30	20.15
21/11/2020	39.20	21.05	32.20	19.64	28.81	14.88	38.60	20.21
22/11/2020	31.40	21.09	27.70	19.66	23.37	14.90	29.00	20.23
23/11/2020	20.60	21.08	13.30	19.64	11.21	14.89	13.00	20.21
24/11/2020	22.70	21.09	14.30	19.62	11.06	14.88	15.50	20.20
25/11/2020	23.40	21.10	18.90	19.62	15.71	14.88	16.40	20.18
26/11/2020	29.90	21.12	21.00	19.63	14.21	14.88	20.20	20.18
27/11/2020	45.30	21.20	39.60	19.69	34.33	14.94	36.90	20.24
28/11/2020	46.90	21.27	26.40	19.71	15.61	14.94	22.00	20.24
29/11/2020	60.80	21.39	42.50	19.78	23.35	14.97	34.20	20.28
30/11/2020	43.60	21.46	26.20	19.80	21.58	14.99	27.30	20.30
1/12/2020	50.90	21.55	47.61	19.88	23.30	15.01	33.30	20.34
2/12/2020	NaN	21.55	20.18	19.88	NaN	15.01	21.60	20.35
3/12/2020	20.30	21.54	16.43	19.87	NaN	15.01	15.20	20.33
4/12/2020	27.10	21.56	16.50	19.86	NaN	15.01	17.10	20.32
5/12/2020	39.00	21.61	20.68	19.86	25.90	15.05	23.10	20.33
6/12/2020	24.30	21.62	14.58	19.85	16.70	15.05	13.50	20.31
7/12/2020	24.70	21.63	14.41	19.83	14.90	15.05	14.90	20.29
8/12/2020	16.20	21.61	11.26	19.81	9.00	15.03	11.00	20.27
9/12/2020	23.70	21.62	21.60	19.81	17.40	15.04	19.00	20.26

Date of Run	PM01 - Coralie (Sentinex 19) PM$_{10}$ 24 Hour Result (ug/m^3)	PM01 - Coralie (Sentinex 19) YTD Average	PM02 - Wambo Road (Caban) (Sentinex 20) PM$_{10}$ 24 Hour Result (ug/m^3)	PM02 - Wambo Road (Caban) (Sentinex 20) YTD Average	PM03 - Thelander (Sentinex 21) PM$_{10}$ 24 Hour Result (ug/m^3)	PM03 - Thelander (Sentinex 21) YTD Average	PM04 - Muller (Sentinex 22) PM$_{10}$ 24 Hour Result (ug/m^3)	PM04 - Muller (Sentinex 22) YTD Average
10/12/2020	49.70	21.70	20.60	19.81	19.10	15.05	27.20	20.28
11/12/2020	33.30	21.73	10.29	19.79	12.50	15.04	14.50	20.27
12/12/2020	38.00	21.78	10.47	19.76	16.90	15.05	22.70	20.27
13/12/2020	30.40	21.81	9.57	19.73	11.80	15.04	17.70	20.27
14/12/2020	27.30	21.82	12.57	19.71	14.10	15.04	14.10	20.25
15/12/2020	10.95	21.79	5.55	19.67	0.48	14.99	6.12	20.21
16/12/2020	16.85	21.78	9.42	19.64	7.05	14.97	9.41	20.18
17/12/2020	NaN	21.78	5.48	19.60	7.66	14.95	6.50	20.14
18/12/2020	13.60	21.75	10.98	19.57	8.26	14.93	10.66	20.11
19/12/2020	21.57	21.75	7.74	19.54	11.05	14.92	12.48	20.09
20/12/2020	14.44	21.73	8.32	19.51	8.38	14.90	12.45	20.07
21/12/2020	17.79	21.72	7.10	19.47	4.47	14.87	10.67	20.04
22/12/2020	9.92	21.69	2.00	19.42	3.61	14.84	3.94	19.99
23/12/2020	21.65	21.69	11.60	19.40	6.63	14.81	12.57	19.97
24/12/2020	20.12	21.68	15.90	19.39	8.63	14.80	15.98	19.96
25/12/2020	17.33	21.67	12.07	19.37	4.66	14.77	15.50	19.95
26/12/2020	15.70	21.65	10.65	19.35	NaN	14.77	12.22	19.93
27/12/2020	21.28	21.65	14.20	19.33	NaN	14.77	12.12	19.91
28/12/2020	19.06	21.64	11.94	19.31	NaN	14.77	12.09	19.88
29/12/2020	11.46	21.62	5.56	19.27	6.98	14.74	8.38	19.85
30/12/2020	9.16	21.58	5.00	19.23	3.63	14.71	8.21	19.82
31/12/2020	10.86	21.55	6.34	19.20	5.73	14.69	7.93	19.79

Site	Date	pH	EC (µS/cm)	TSS (mg/L)	Comments
SW01	29-Jan				No Flow
SW01	7-Feb				No Flow
SW01	6-Mar	6.9	755	22	-
SW01	26-Mar	7.1	847	12	-
SW01	6-Apr	6.6	358	7	-
SW01	29-May				No Access
SW01	29-Jun				No Safe Access
SW01	27-Jul				Access Blocked
SW01	11-Aug				No Access
SW01	20-Sep				No Access
SW01	27-Oct	7.2	755	<5	-
SW01	16-Nov	7.05	390	12	-
SW01	29-Dec	6.96	333	8	-
SW02	29-Jan				Dry
SW02	7-Feb				No Flow
SW02	10-Feb	7.4	619	98	-
SW02	6-Mar	6.9	677	<5	-
SW02	26-Mar	7.6	890	12	-
SW02	6-Apr	6.8	327	<5	-
SW02	29-May	7.2	795	<5	-
SW02	29-Jun	7.3	845	9	-
SW02	27-Jul	7.3	829	14	-
SW02	11-Aug	7.2	352	5	-
SW02	20-Sep	7.2	581	<5	-
SW02	26-Oct	7.2	660	<5	-
SW02	16-Nov	7.23	452	<5	-
SW02	29-Dec	7.09	347	6	-
SW03	29-Jan				Dry
SW03	7-Feb				Dry
SW03	10-Feb	6.4	261	34	-
SW03	6-Mar	6.9	661	<5	-
SW03	26-Mar	7.2	966	10	-
SW03	6-Apr	6.8	322	<5	-
SW03	29-May	7.1	925	<5	-
SW03	29-Jun	7.2	881	<5	-
SW03	27-Jul	7.3	820	<5	-
SW03	11-Aug	7	360	6	-
SW03	30-Sep	7.3	597	10	-
SW03	26-Oct	7.3	670	<5	-
SW03	16-Nov	7.19	457	<5	-
SW03	20-Dec	7.02	318	8	-
SW04	29-Jan				Dry
SW04	7-Feb				No Flow
SW04	10-Feb	7.1	295	18	-
SW04	6-Mar				Dry

Site	Date	pH	EC (µS/cm)	TSS (mg/L)	Comments
SW04	26-Mar				No Flow
SW04	6-Apr	7.3	366	<5	-
SW04	29-May				Dry
SW04	29-Jun				Dry
SW04	27-Jul				No Flow
SW04	11-Aug				No Flow
SW04	30-Sep				Dry
SW04	26-Oct				No Flow
SW04	16-Nov				Dry
SW04	29-Dec				No Flow
SW05	29-Jan				Dry
SW05	7-Feb				No Flow
SW05	10-Feb	6.8	286	66	-
SW05	6-Mar				No Flow
SW05	26-Mar				No Flow
SW05	6-Apr				Pool (No Flow)
SW05	29-May				No Flow
SW05	29-Jun				No Flow
SW05	27-Jul				No Flow
SW05	11-Aug				No Flow
SW05	30-Sep				Dry
SW05	26-Oct				No Flow
SW05	16-Nov				Dry
SW05	29-Dec				No Flow
SW06	29-Jan				Dry
SW06	7-Feb				Unsafe Access
SW06	10-Feb	6.7	278	34	-
SW06	6-Mar	6.6	450	<5	-
SW06	26-Mar	7.2	231	169	-
SW06	6-Apr	6.8	300	<5	-
SW06	29-May	6.8	515	<5	-
SW06	29-Jun	7	518	44	-
SW06	27-Jul	7	470	6	-
SW06	11-Aug	6.7	332	6	-
SW06	30-Sep	7	471	<5	-
SW06	26-Oct	7	460	276	-
SW06	16-Nov	6.97	511	13	-
SW06	29-Dec	6.91	360	<5	-
SW07	29-Jan				Dry
SW07	7-Feb				-
SW07	10-Feb	6.6	260	32	-
SW07	6-Mar				No Flow
SW07	26-Mar	7.4	766	8	-
SW07	6-Apr	6.9	322	<5	-
SW07	29-May				No Flow

Site	Date	pH	EC (µS/cm)	TSS (mg/L)	Comments
SW07	29-Jun				No Flow
SW07	27-Jul				No Flow
SW07	11-Aug	7	470	12	-
SW07	30-Sep				No Flow
SW07	26-Oct				No Flow
SW07	16-Nov				No Flow
SW07	29-Dec	7.03	294	20	-
SW08	29-Jan				Dry
SW08	7-Feb				Unsafe Access
SW08	10-Feb	6.8	287	12	-
SW08	6-Mar				Unsafe Access
SW08	26-Mar	7.6	263	61	-
SW08	6-Apr	6.8	323	<5	-
SW08	29-May	6.5	458	<5	-
SW08	29-Jun				Dry
SW08	27-Jul				No Access
SW08	11-Aug	6.7	553	<5	-
SW08	30-Sep	6.5	568	<5	-
SW08	26-Oct				No Access
SW08	16-Nov	6.69	581	<5	-
SW08	29-Dec				Inaccessible
SW12	23-Jan	8.7	6690	32	-
SW12	10-Feb	9.2	4170	33	-
SW12	18-Mar	8.8	5650	12	-
SW12	15-Apr	8.7	5820	10	-
SW12	26-May	8.8	6980	14	-
SW12	18-Jun	8.9	6990	13	-
SW12	21-Jul	8.9	4920	14	-
SW12	19-Aug	9.1	3810	31	-
SW12	16-Sep	8.8	5580	22	-
SW12	26-Oct	8.8	7120	12	-
SW12	18-Nov	7.2	6490	17	-
SW12	29-Dec				-
SW14	23-Jan	8.6	592	7	-
SW14	10-Feb	8.2	494	9	-
SW14	18-Mar	8	543	18	-
SW14	16-Apr	8.3	600	45	-
SW14	26-May	8.4	686	<5	-
SW14	18-Jun	8.4	720	17	-
SW14	21-Jul	8.4	737	<5	-
SW14	19-Aug	8.4	696	23	-
SW14	16-Sep	8.6	604	5	-
SW14	20-Oct	8.7	655	6	-
SW14	18-Nov	7.97	593	14	-
SW14	29-Dec				-

Site	Date	pH	EC (µS/cm)	TSS (mg/L)	Comments
SW15	23-Jan	8.8	9040	64	-
SW15	7-Feb	8.9	11060	56	-
SW15	6-Mar	8.6	3780	79	-
SW15	6-Apr	8.8	3520	44	-
SW15	16-Apr	8.3	5240	33	-
SW15	26-May	8.7	4820	20	-
SW15	18-Jun	8.8	4340	11	-
SW15	21-Jul	8.9	4110	<5	-
SW15	11-Aug	8.8	6080	114	-
SW15	16-Sep	8.6	6520	62	-
SW15	20-Oct	9	8000	26	-
SW15	18-Nov	8	6790	27	-
SW15	29-Dec				-
SW27	23-Jan				Dry
SW27	7-Feb	7.7	491	1140	-
SW27	10-Feb	7.2	275	80	-
SW27	6-Mar				No Flow
SW27	26-Mar	7.7	417	416	-
SW27	6-Apr	8.2	661	23	-
SW27	29-May				Dry
SW27	29-Jun				Dry
SW27	27-Jul	7.8	847	225	-
SW27	11-Aug				No Flow
SW27	30-Sep				Dry
SW27	26-Oct	7.9	785	107	-
SW27	16-Nov				No Flow
SW27	29-Dec	7.79	586	356	-
SW31	23-Jan	9.2	5730	157	-
SW31	10-Feb	9.4	2700	96	-
SW31	18-Mar	8.9	3690	64	-
SW31	15-Apr	9	2370	45	-
SW31	26-May	8.7	1144	38	-
SW31	18-Jun				No Safe Access
SW31	21-Jul				No Safe Access
SW31	19-Aug	9.1	5180	158	-
SW31	16-Sep	9	6170	22	-
SW31	20-Oct	9.3	9200	31	-
SW31	18-Nov	7.96	4950	170	-
SW31	29-Dec				-
SW32a	29-Jan				Dry
SW32a	7-Feb	7.6	499	900	-
SW32a	10-Feb	7.3	288	82	-
SW32a	6-Mar	7.7	504	330	-
SW32a	26-Mar	7.9	333	658	-
SW32a	6-Apr	7.8	537	21	-

Site	Date	pH	EC (µS/cm)	TSS (mg/L)	Comments
SW32a	29-May				Dry
SW32a	29-Jun				Dry
SW32a	27-Jul	7.9	624	409	-
SW32a	11-Aug	7.4	667	266	-
SW32a	30-Sep				Dry
SW32a	26-Oct	7.7	572	276	-
SW32a	16-Nov				No Flow
SW32a	29-Dec	7.65	431	139	-
SW38	23-Jan	9.1	8390	54	-
SW38	10-Feb	9.3	3140	242	-
SW38	18-Mar	8.8	5240	14	-
SW38	15-Apr	8.9	4560	<5	-
SW38	26-May	9.1	4690	21	-
SW38	18-Jun	8.3	6620	21	-
SW38	21-Jul	8.8	6670	11	-
SW38	19-Aug	9	6240	16	-
SW38	16-Sep	9	6530	7	-
SW38	20-Oct	9.1	8690	<5	-
SW38	16-Nov				-
SW38	29-Dec				-
SW39	29-Jan				Dry
SW39	7-Feb				Unsafe Access
SW39	10-Feb				No Flow
SW39	6-Mar				No Flow
SW39	26-Mar				No Flow
SW39	6-Apr				Pool (No Flow)
SW39	29-May				No Flow
SW39	29-Jun				No Flow
SW39	27-Jul				No Flow
SW39	11-Aug				No Flow
SW39	30-Sep				No Flow
SW39	26-Oct				No Flow
SW39	16-Nov				No Flow
SW39	29-Dec				No Flow
SW40	29-Jan				Dry
SW40	10-Feb				No Flow
SW40	6-Mar	6.8	650	<5	-
SW40	26-Mar	7	878	10	-
SW40	6-Apr	7	320	<5	-
SW40	29-May				No Flow
SW40	29-Jun				No Flow
SW40	27-Jul	7.3	816	<5	-
SW40	11-Aug	6.9	353	6	-
SW40	30-Sep	7.1	582	<5	-
SW40	26-Oct	7.3	679	<5	-

Site	Date	pH	EC (µS/cm)	TSS (mg/L)	Comments
SW40	16-Nov	7.2	454	<5	-
SW40	29-Dec	6.98	260	9	-
SW41	23-Jan				-
SW41	10-Feb				-
SW41	18-Mar				-
SW41	16-Apr				-
SW41	29-May				Dry
SW41	29-Jun				No Flow
SW41	27-Jul				No Flow
SW41	11-Aug	7.3	147	53	-
SW41	30-Sep				No Flow
SW41	26-Oct				No Flow
SW41	16-Nov				No Flow
SW41	29-Dec				No Flow
SW51	23-Jan				Insufficient Water
SW51	10-Feb	8.2	28-Oct	468	-
SW51	18-Mar	8.1	518	193	-
SW51	16-Apr	8	664	114	-
SW51	26-May				-
SW51	18-Jun				-
SW51	21-Jul				-
SW51	19-Aug				-
SW51	16-Sep				-
SW51	20-Oct				-
SW51	18-Nov				-
SW51	29-Dec				-
SW52	23-Jan	9.3	1594	663	-
SW52	10-Feb	8.7	507	182	-
SW52	18-Mar	8.7	669	33	-
SW52	15-Apr	8.4	574	40	-
SW52	26-May	9.1	3380	6	-
SW52	18-Jun	9.2	2740	7	-
SW52	21-Jul	9.1	3280	<5	-
SW52	19-Aug	9	3760	27	-
SW52	16-Sep	9	4020	7	-
SW52	20-Oct	9.1	4700	8	-
SW52	18-Nov	7.42	4360	<5	-
SW52	29-Dec				-

APPENDIX E

WAMBO MINE 2020 AIR QUALITY MONITORING REVIEW

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3 March 2021

Attention: Nicole Dobbins
Wambo Coal Pty Ltd
PMB 1, Singleton NSW 2330

Project Name: Wambo Coal
Project Number: IA230800

Dear Nicole

Wambo Mine 2020 Air Quality Monitoring Review

I have completed a review of Wambo Coal's air quality monitoring data for 2020. Please see attached for the outcomes of the analysis. In summary, it has been concluded that Wambo Coal was in compliance with its development consent in terms of PM_{10} and $PM_{2.5}$ based on data collected in 2020.

Yours sincerely

Shane Lakmaker
Principal (Air Quality)
0419 239 687
shane.lakmaker@jacobs.com

1. Background

The Wambo Mine is owned and operated by Wambo Coal Pty Limited (Wambo Coal), a subsidiary of Peabody Energy Australia Pty Limited (Peabody). Mining is carried out under Development Consent DA 305-7-2003. The latest modification to DA 305-7-2003 (Mod 16) permits underground mining, operation of Wambo Mine infrastructure and associated surface development; collectively referred to as Phase 2 under DA 305-7-2003.

Wambo Coal has a network of air quality and meteorological monitoring equipment around Wambo Mine which is designed to meet the relevant conditions of DA 305-7-2003.

Figure 1 shows the meteorological and air quality monitoring network. This network includes:

- One (1) meteorological station.
- Four (4) tapered element oscillating microbalances (TEOM) measuring PM_{10}. Compliance is determined at AQ01 (D3 Kelly), AQ02 (D2 Caban), AQ03 (D4 Thelander) and AQ04 (D1 Muller).
- Two (2) beta attenuation monitors (BAMs) measuring $PM_{2.5}$.

A review of the air quality monitoring data collected in 2020 has been carried out. The main purpose of the review was to determine whether Wambo Coal had complied with the PM_{10} and $PM_{2.5}$ criteria specified in the development consent (DA 305-7-2003). Table 1 shows the relevant development consent criteria.

Table 1 Development consent criteria from DA 305-7-2003 Modification 16

Substance	Averaging time	Impact assessment criteria (applicable from 29 Aug 2019)
Particulate matter (PM_{10})	Annual	[a, c] 25 µg/m^3
	24 hour	[b] 50 µg/m^3
Particulate matter ($PM_{2.5}$)	Annual	[a, c] 8 µg/m^3
	24 hour	[b] 25 µg/m^3

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

Jacobs
3 March 2021

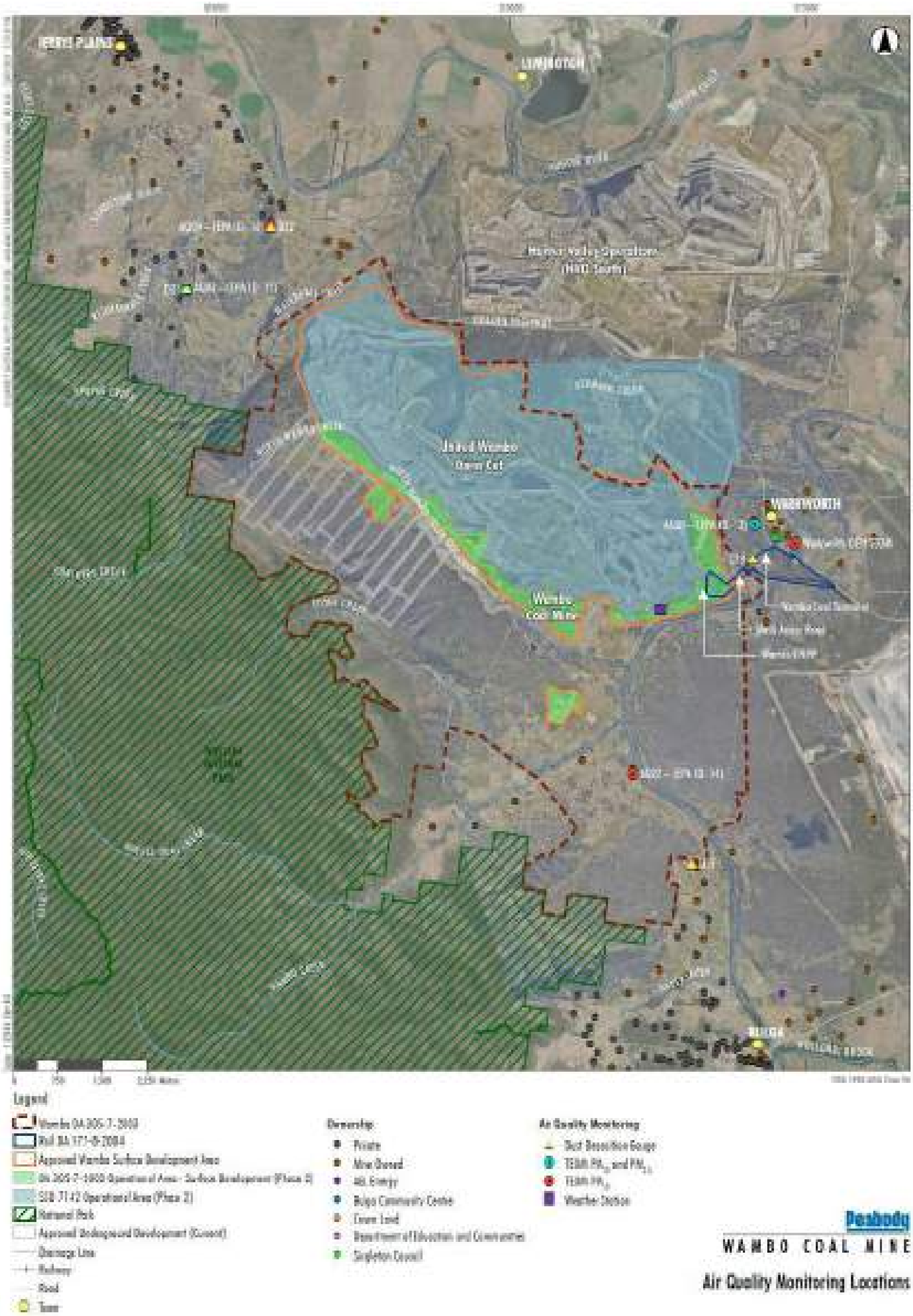

Figure 1 Location of monitoring stations around Wambo Mine

2. Approach to Review

2.1 Extraordinary Events

Late 2019 coincided with a period of unprecedented bushfires in Australia, predominantly across southeast Australia, but also affecting a reported 4 million hectares of land in NSW since early November 2019. The bushfires continued into January 2020 and adversely affected air quality across many parts of NSW. A total of 24 days in 2020 were subsequently declared as extraordinary events, based on advice from Wambo Coal who had been in consultation with the DPIE. Table 2 identifies the days that have been declared as extraordinary events.

Table 2 Days declared as extraordinary events in 2020

Month	Day(s)
Jan	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 15, 20, 21, 23, 24, 25
Feb	1, 2, 4, 19
Mar	-
Apr	-
May	-
Jun	-
Jul	-
Aug	19
Sep	-
Oct	-
Nov	29
Dec	-

The reporting of Wambo Coal's air quality monitoring data has excluded records from the days listed as extraordinary events in Table 2 above, where relevant to the provisions of the development consent.

Extraordinary events can be identified using Wambo Coal's monitoring data in combination with the data collected by the DPIE as part of the Upper Hunter Air Quality Monitoring Network (UHAQMN). For a particular day, this would involve:

- Checking if 24-hour average PM_{10} concentrations exceeded 50 µg/m^3 at more than one of Wambo Coal's monitoring stations. Specifically, at least one upwind and one downwind monitoring station.
- Checking if 24-hour average PM_{10} concentrations exceeded 50 µg/m^3 at either of the DPIE's Singleton or Muswellbrook compliance monitoring stations.

The checks above would show whether elevated PM_{10} concentrations were not unique to the monitors around Wambo mine, therefore indicating an extraordinary event. Wambo Coal should also seek confirmation from the DPIE on any days proposed to be declared as extraordinary events.

2.2 Particulate Matter (as PM_{10})

Evaluation of PM_{10} involved:

- Obtaining hourly average PM_{10} concentration data from all monitoring sites for 2020 and determining the 24-hour and annual averages.
- Obtaining hourly meteorological data from the Wambo Mine weather station for 2020 and calculating the contributions from the direction of Wambo Mine to each hourly PM_{10} concentration result.
- Summarising of all monitored PM_{10} concentration data and estimated contributions from the direction of Wambo Mine, and making comparisons to the consent criteria.

There is no standard prescribed methodology for determining contributions to air quality from mining operations. The methodology described below is based on the use of concurrent hourly meteorological and air quality monitoring data from suitably located monitoring stations around the mine site to estimate the potential contribution from the direction of the mine site. This method is referred to as an “upwind / downwind” calculation approach. In this context, “upwind” is a location that collects data representative of background conditions, not influenced by the source of interest, and does not necessarily need to be upwind of the source of interest.

The maximum contributions from the direction of Wambo Mine to each measured hourly average result was calculated by first determining the wind direction ranges which represented a wind from the direction of Wambo Mine towards the monitor. Table 3 shows the wind direction ranges that represented the direction to Wambo Mine from each monitor.

Table 3 Wind directions to Wambo Mine activities

Monitoring site	Directions to Wambo Mine
D1 Muller	Between 130 and 180 degrees from true north
D2 Caban	Between 320 and 10 degrees from true north
D3 Coralie / Kelly	Between 255 and 300 degrees from true north
D4 Thelander	Between 110 and 140 degrees from true north

The potential contribution from the direction of Wambo Mine to each monitor was calculated for every 1-hour average record for every day based on the concurrent wind direction and from a “monitor” concentration minus “background” concentration calculation. Table 4 shows the data representing “monitor” and “background” conditions for each monitoring site. The “monitor” concentration minus “background” concentration result was only calculated for hours with wind speeds greater than 0 m/s.

Table 4 Data for monitor and background calculations

Monitoring site	Data representing “background” conditions
D1 Muller	D2 Caban
D2 Caban	D1 Muller
D3 Coralie / Kelly	D4 Thelander
D4 Thelander	D3 Coralie / Kelly

The potential contribution to each monitor was then calculated as 24-hour and annual averages (not including negative values) from the 8,784 hourly records.

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.

2.3 Particulate Matter (as $PM_{2.5}$)

Evaluation of $PM_{2.5}$ involved:

- Obtaining hourly average $PM_{2.5}$ concentration data from all monitoring sites for 2020 and determining the 24-hour and annual averages.
- Summarising of all monitored $PM_{2.5}$ concentration data and making comparisons to the consent criteria, taking into consideration any declared extraordinary events where relevant.

3. Monitored Results

3.1 Meteorology

Meteorological conditions are important for determining the transport of emissions, and the potential influences on air quality. Rainfall can influence air quality conditions, particularly dust. Figure 2 shows the rainfall data collected by Wambo Coal in the past six years. Rainfall was well below the long-term average (which is 680 mm) in 2017, 2018 and 2019, coinciding with the drought, but exceeded the long term average in 2020.

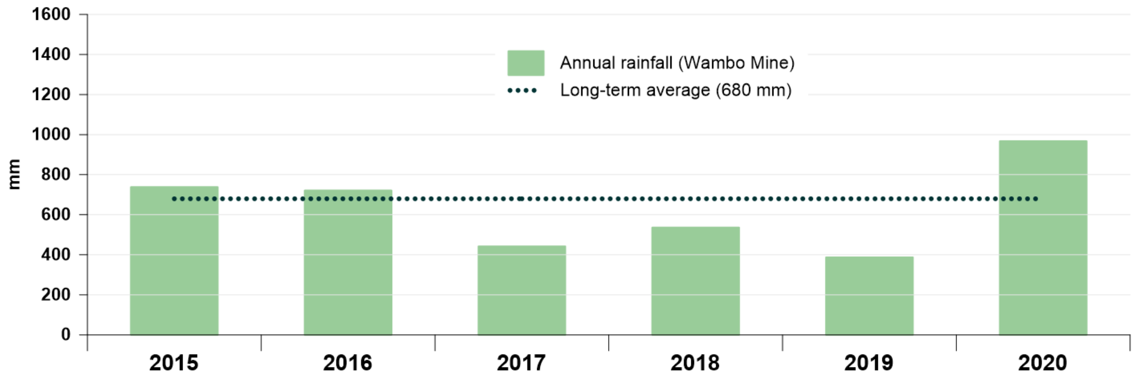

Figure 2 Annual rainfall from the Wambo Mine meteorological station

Wind-roses have been prepared to summarise the wind data that were collected in 2020. The wind-roses (Figure 3) show the frequency of wind speeds and wind directions based on hourly records for each location. The circular format of the wind rose shows the direction from which the wind blew and the length of each "spoke" around the circle shows how often the wind blew from that direction. The different colours of each spoke provide details on the speed of the wind from each direction.

It can be seen from Figure 3 that the winds in 2020 were predominantly from the southeast and northwest. This pattern of winds is common for many parts of the Hunter Valley and reflects the northwest-southeast alignment of the valley.

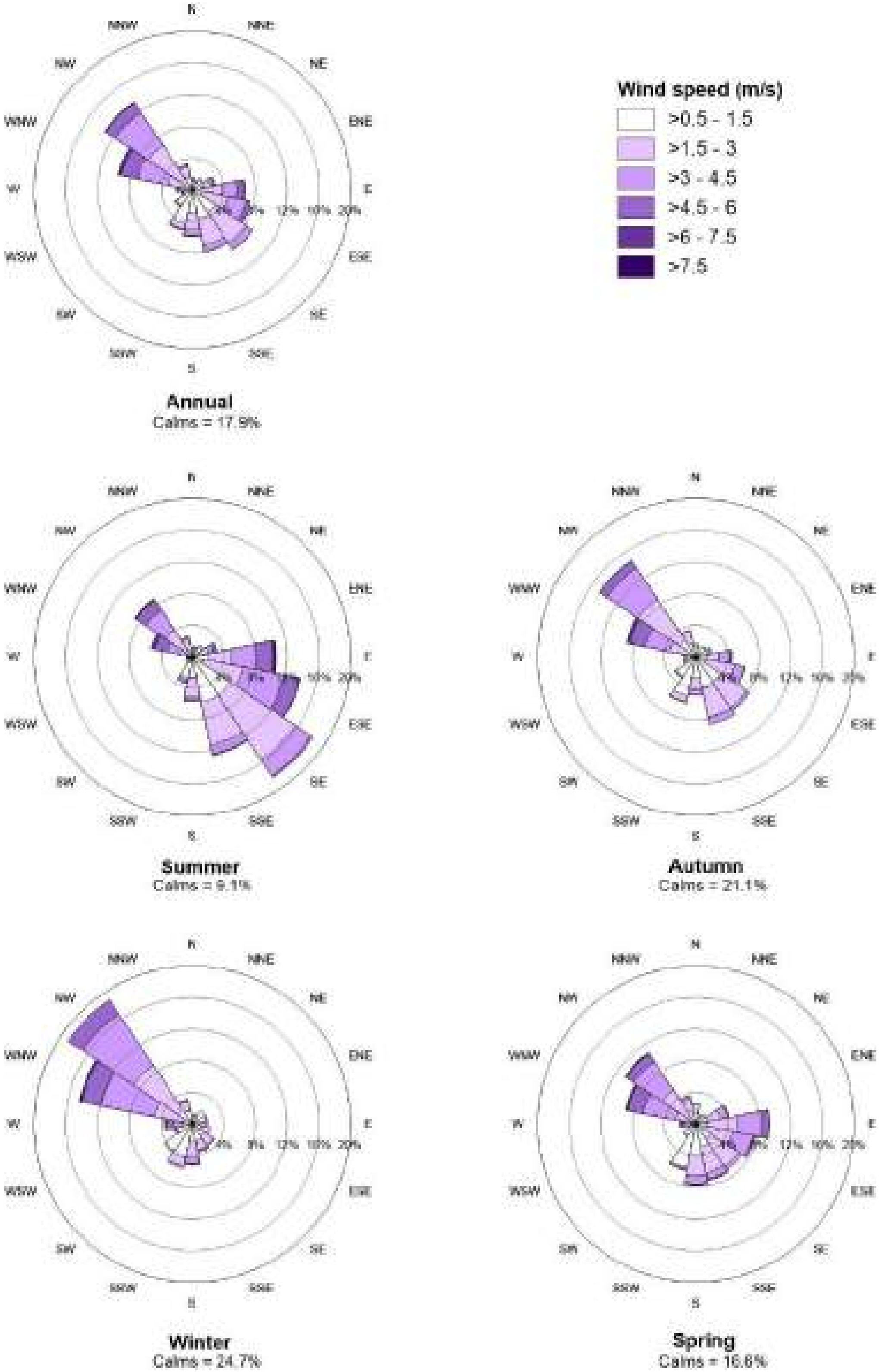

Figure 3 Annual and seasonal wind-roses from data collected at Wambo Mine in 2020

3.2 Particulate Matter (as PM_{10})

The PM_{10} data capture rates are shown in Table 5. Generally, a data capture rate of 90% or more is considered acceptable for air quality monitoring networks as this takes into account downtime from servicing, maintenance, calibrations and reasonable periods to deal with breakdowns. All sites achieved greater than 90% data capture.

Table 5 Data capture rates for PM_{10}

Year	D1 Muller	D2 Caban	D3 Coralie / Kelly	D4 Thelander
2020	98.9%	98.9%	98.9%	96.2%

Figure 4 shows the measured 24-hour average PM_{10} concentrations in 2020 from data collected at each compliance monitoring site. Extraordinary events have also been identified.

Table 6 summarises the measured PM_{10} concentrations. As noted in DA 305-7-2003, and reproduced in Table 1, determination of compliance against the impact assessment criteria is to exclude “extraordinary events such as bushfires, prescribed burning, dust storms, fire incidents or any other activity agreed by the Planning Secretary”. Therefore the results have been calculated without extraordinary events.

The data in Table 6 show that, without extraordinary events, the PM_{10} concentrations at all four monitors were below the 24-hour criterion (50 µg/m^3 as a development increment) and annual average criterion (25 µg/m^3 as a total). Consequently the monitoring demonstrates compliance with DA 305-7-2003 in terms of particulate matter as PM_{10}.

Table 6 Summary of PM_{10} concentrations from Wambo Coal monitors in 2020

Statistic	All data				All data except extraordinary events (with maximum contribution from direction of Wambo in parentheses)			
	D1 Muller	D2 Caban	D3 Coralie / Kelly	D4 Thelander	D1 Muller	D2 Caban	D3 Coralie / Kelly	D4 Thelander
1 Jan to 31 Dec (365 days)								
Maximum 24-hour average (µg/m^3)	131	133	106	138	51 (17)	65 (13)	51 (10)	46 (5)
Number of days above 50 µg/m^3	8	13	13	9	1	1	1	0
Average (µg/m^3)	20	19	22	15	17 (1.9)	16 (0.7)	19 (0.9)	12 (0.2)
Days of data available	362	362	362	352	342	342	342	342

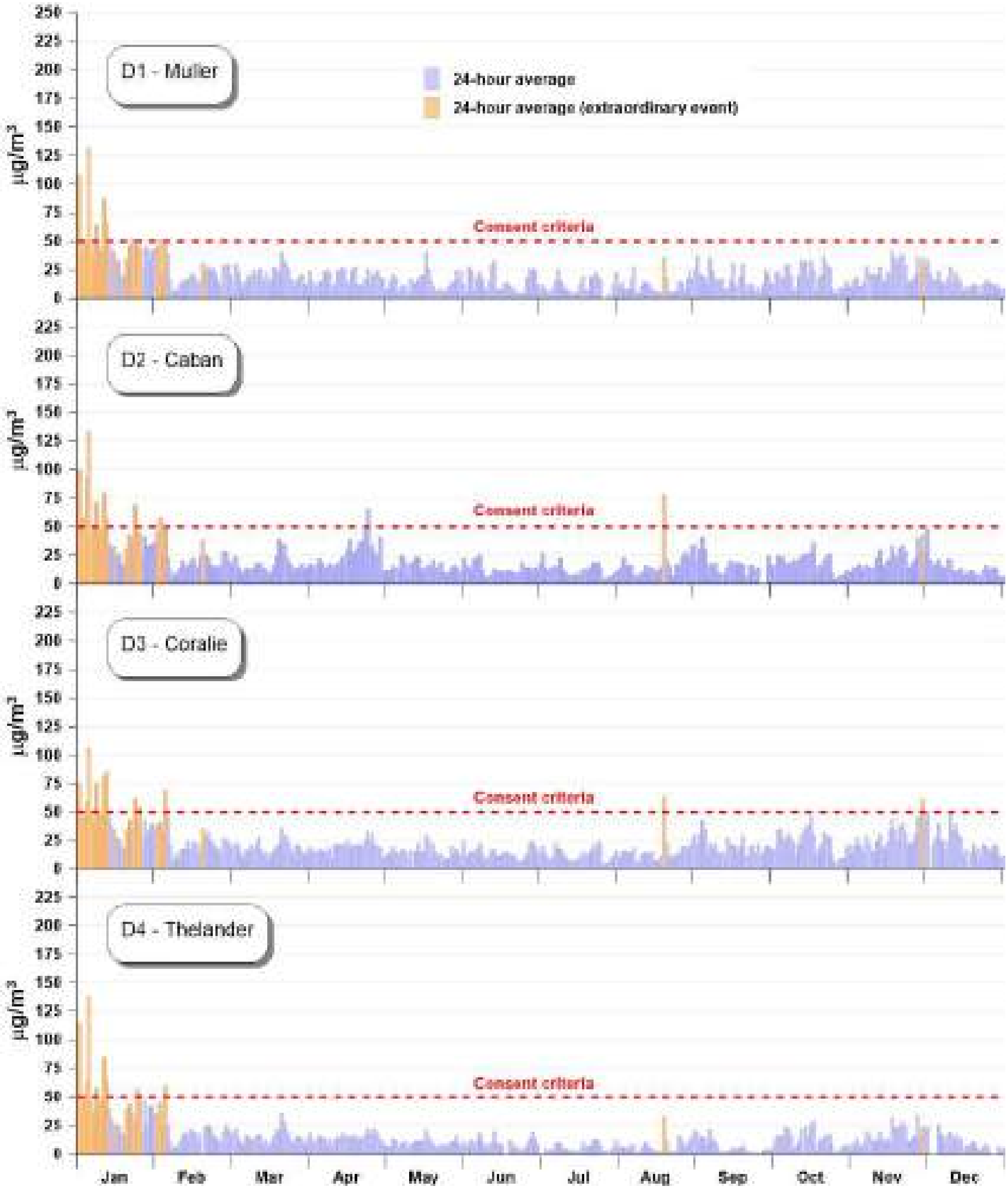

Figure 4 Measured 24-hour average PM_{10} concentrations in 2020

3.3 Particulate Matter (as $PM_{2.5}$)

The $PM_{2.5}$ data were available from late June 2020 onwards, following installation of the monitors. Data capture rates, based on the period with which the monitors were in place, are shown in Table 7. All sites achieved greater than 90% data capture for the July to December period.

Table 7 Data capture rates for $PM_{2.5}$

Year	D5 Coralie / Kelly	D4 Thelander
2020	100.0%	96.7%

Figure 5 shows the measured 24-hour average $PM_{2.5}$ concentrations in 2020 from data collected at the two Wambo coal monitors, as well as at Singleton. Extraordinary events have been identified.

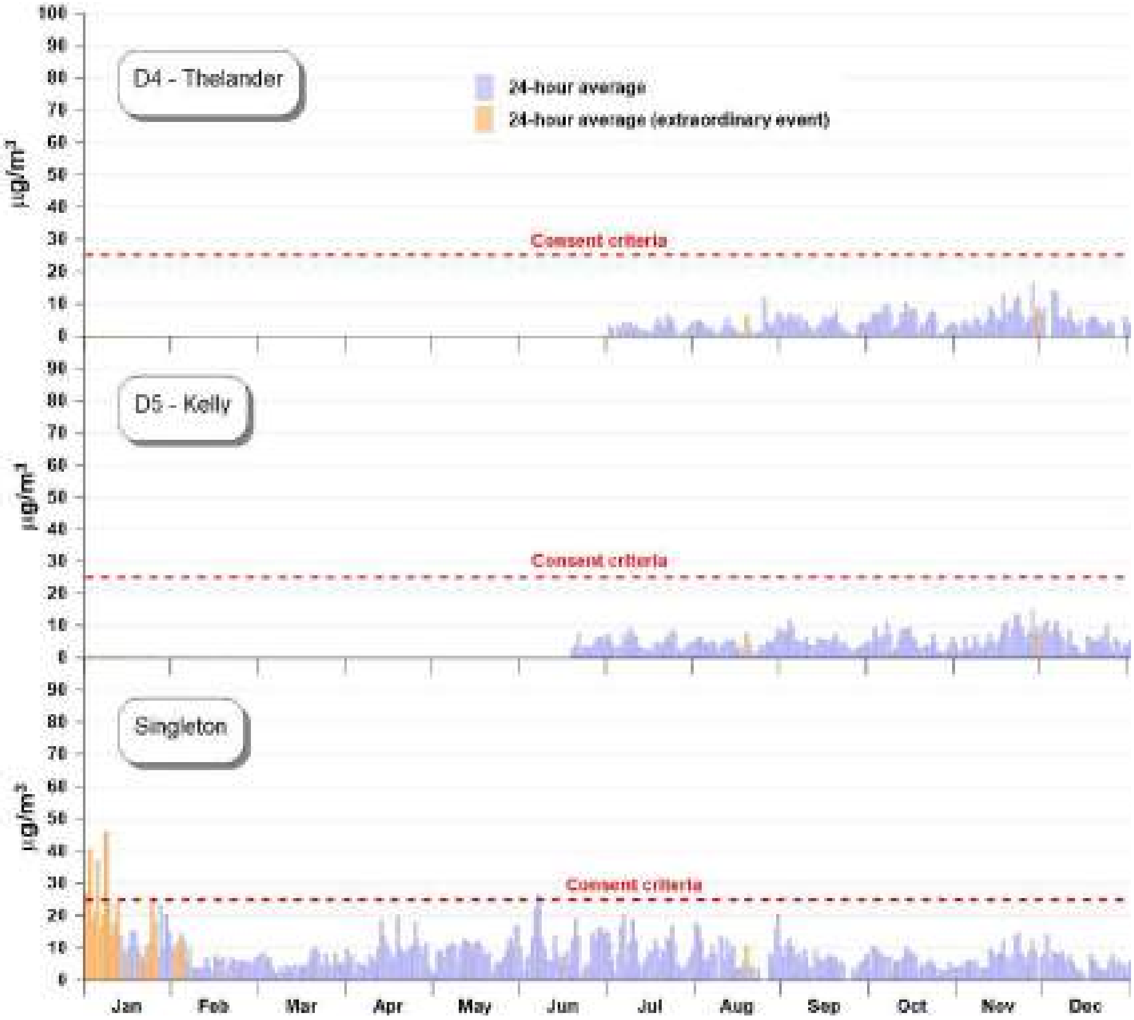

Figure 5 Measured 24-hour average $PM_{2.5}$ concentrations in 2020

Table 8 summarises the measured $PM_{2.5}$ concentrations from the Wambo Coal monitors. As noted in DA 305-7-2003, and reproduced in Table 1, determination of compliance against the impact assessment criteria is to exclude ""extraordinary events such as bushfires, prescribed burning, dust storms, fire incidents or any other activity agreed by the Planning Secretary". Therefore the results have been calculated without extraordinary events. The data in Table 8 show that, without extraordinary events, the $PM_{2.5}$ concentrations were below the 24-hour criterion (25 µg/m^3 as a development increment) and annual average criterion (8 µg/m^3 as a total).

Figure 5 shows that there was one day (7 June 2020) when the 24-hour average $PM_{2.5}$ concentration exceeded 25 µg/m^3. A measurement of 26.5 µg/m^3 was recorded. For this day, the PM_{10} calculations indicated that the maximum contribution from the direction of Wambo Mine to D1 to D4 was no more than 0.9 µg/m^3. Assuming that all PM_{10} was $PM_{2.5}$, this result demonstrates compliance with the incremental criterion of 25 µg/m^3 for maximum 24-hour average $PM_{2.5}$.

The monitoring data therefore demonstrates compliance with DA 305-7-2003 in terms of particulate matter as $PM_{2.5}$.

Table 8 Summary of $PM_{2.5}$ concentrations from Wambo Coal monitors in 2020

Statistic	All data		All data except extraordinary events	
	D5 Kelly	D4 Thelander	D5 Kelly	D4 Thelander
1 Jan to 31 Dec (365 days)				
Maximum 24-hour average (µg/m^3)	15	17	15	17
Number of days above 25 µg/m^3	0	0	0	0
Average (µg/m^3)	5.2	4.2	5.2	4.2
Days of data available	195	177	193	175

4. Conclusions

Based on the analysis and it has been concluded that Wambo Coal was in compliance with its development consent (DA 305-7-2003) in terms of PM_{10} and $PM_{2.5}$ impacts at all reportable monitoring sites for data collected in 2020.

APPENDIX F

ANNUAL FLORA AND FAUNA MONITORING REPORT 2020

Wambo Coal Mine Annual Flora and Fauna Monitoring Report 2020 – Volume 1

Wambo Coal Pty Ltd






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DOCUMENT TRACKING

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ACKNOWLEDGEMENTS

This document has been prepared by Eco Logical Australia Pty Ltd with support from Wambo Coal Pty Ltd.

Template 2.8.1

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Abbreviations

Abbreviation	Description
AEMR	Annual Environmental Management Report
BC Act	NSW Biodiversity Conservation Act 2016
BS	Bare soil cover
BOA	Biodiversity Offset Area
BMP	Biodiversity Management Plan
BVT	Biometric Vegetation Type
CEEC	Critically Endangered Ecological Community
DBH	Diameter at Breast Height
DPI	NSW Department of Primary Industries
EEC	Endangered Ecological Community
ELA	Eco Logical Australia Pty Ltd
EPBC Act	Federal Environment Protection and Biodiversity Conservation Act 1999
EPC	Exotic Plant Cover
FL	The length of Fallen Logs >10 cm diameter
GDE	Groundwater Dependent Ecosystem
HBT	Hollow-bearing Tree
INFI	Infiltration Index
LFA	Landscape Function Analysis
LI	Leaf litter cover
LOI	Landscape Organisation Index
NGCG	Native Ground Cover - Grasses
NGCO	Native Ground Cover - Other
NGCS	Native Ground Cover - Shrubs
NI	Nutrient Index
NMS	Native Mid-storey Cover – the projected native foliage cover of mid-storey (%)
NOS	Native Overstorey – the projected native foliage cover of canopy (%)
NPS	The number of Native Plant Species
OEH	NSW Office of Environment and Heritage
OR	Overstorey Regeneration
PCT	Plant Community Type
RWEA	Remnant Woodland Enhancement Area

Abbreviation	Description
RWEP	Remnant Woodland Enhancement Program
SI	Stability Index
SSA	Soil Surface Assessment
TEC	Threatened Ecological Community
VCA	Voluntary Conservation Area
WCPL	Wambo Coal Pty Ltd
WONS	Weed of National Significance

Executive summary

The Wambo Coal Mine annual flora and fauna monitoring program was undertaken by Eco Logical Australia (ELA) in 2020. Several different components make up this monitoring program. Floristic surveys, bird surveys, Landscape Function Analysis and riparian condition surveys were conducted during Spring across both remnant woodland and post-mining rehabilitation areas. New floristic and bird survey sites were established in the South Bates Extension underground mine area. Groundwater dependent ecosystem (GDE) monitoring sites were monitored for the first time following establishment in 2019. The first inspection of nest boxes that were installed in 2018 was completed.

Remnant woodland sites within Remnant Woodland Enhancement Area (RWEA) areas are generally performing well. High diversity of native flora species and an increase in native ground cover was recorded, likely in response to the above average rainfall. Fauna habitat features such as fallen logs and hollow bearing trees remain present.

The Rough-barked Apple - Narrow-leaved Ironbark - Blakely's Red Gum - Bull Oak - Coast Banksia woodland on sands of the Warkworth area community in RWEA A and RWEA Rail Loop failed to meet some performance criteria, despite acceptable diversity and high native grassy cover. Future surveys should continue to monitor for high exotic cover and low ground cover scores (shrubs and other) and increased weed management is recommended in this area.

An increase in cover of exotic species was also recorded within some Plant Community Types (PCTs) although this was generally driven by annual species responding to the wetter conditions. Exotic plant cover exceeding performance criteria and voluntary conservation area (VCA) targets was recorded in RWEA A and RWEA Rail Loop, particularly in riparian woodland where historic disturbance has been greatest. Increased weed management in is recommended to control exotic cover and allow native diversity and cover to increase in these areas. Plantings of canopy species could be considered in the open grassland areas of on the Wollombi Brook floodplain in RWEA A, where natural regeneration is unlikely to occur in a reasonable timeframe. Plantings may also assist weed control through establishment of a shading canopy.

Bird survey results from remnant woodland sites reflected the good condition of these woodland areas with RWEA areas continuing to support a large diversity of birds including several threatened species. Bird diversity and communities were largely consistent with the data available from previous monitoring years. Successful breeding of the threatened Dusky Woodswallow was recorded in RWEA D.

The North Wambo Creek Diversion (NWCD) has not yet met completion criteria for landscape function and this area will require continued active management actions to ensure that all completion criteria and other commitments are met in the near future. Gully erosion and areas of bare soil exceeding completion criteria were recorded. Major remediation works are currently underway in the NWCD to improve drainage, erosion and establishment of native plant communities.

Woodland rehabilitation areas generally met landscape function completion criteria, having a high cover of resource trapping leaf litter but fell below biometric completion criteria, with monitoring sites having relatively few native species and almost no groundcover or mid-storey. Recommendations to improve woodland rehabilitation areas have been presented by ELA in previous monitoring reports and include

focussing on the correct application of subsoil and topsoil and consideration of species diversity, structural diversity, local provenance as well as species performance in new areas of woodland rehabilitation.

Pasture rehabilitation areas are generally meeting landscape function performance targets for all attributes with the exception of landscape organisation, which remains high and close to the target. Some patches of bare soil within pasture rehabilitation areas exceed completion criteria and require active management to aid the establishment of vegetation and reduce erosion.

The use of LFA for future monitoring of rehabilitation areas is currently under review following recommendations made by the Biodiversity Conservation Division (BCD) of the NSW Department of Planning, Industry, and Environment (DPIE) on the Wambo Coal Mine Phase 2 Rehabilitation Management Plan (RMP). Any changes to the proposed monitoring methodology for rehabilitation at the Wambo mine will be incorporated into an updated Biodiversity Management Plan (BMP) for approval prior to implementation.

Riparian condition scores for North Wambo Creek, Wambo Creek and Stony Creek increased in 2020 following the drought and in response to the reduction/exclusion of grazing. Understorey vegetation cover has increased following higher rainfall in 2020, although a high proportion of ground cover contribution is from exotic species, owing to the agricultural disturbance history within these systems. Cattle should continue to be excluded from riparian areas, or fencing of the lower reaches of Stony Creek should be considered. Planting native trees in over-cleared areas, such as sections of the middle and lower reaches of Stony Creek, to facilitate more rapid regeneration is also recommended.

Floristic and bird monitoring sites were established in the South Bates Extension underground mine area, including reference sites outside of the mining area. Vegetation and bird communities were recorded in good condition and no significant impacts to floristic attributes or bird communities were recorded at sites within areas impacted by undermining to date.

The *Melaleuca decora* low forest GDE community was recorded to be in good condition with scores for most attributes increasing from 2019. This community was undermined during 2019 and 2020. The River Oak riparian tall woodland GDE recorded strong growth and monitored trees appeared in improved condition, likely in response to the higher rainfall in 2020. Ongoing monitoring of these areas is required to assess whether any impacts to GDEs occur from underground mining activities.

Subsidence was observed in several locations across the site including RWEA C and RWEA D and the NWCD, however no significant effects on flora and fauna or performance criteria exceedances were recorded. Repairs to tracks and subsidence cracks are required in RWEA C. Monitoring should continue to document and assess subsidence impacts across the site.

The Wambo United open cut mining project commenced in 2020 adjacent to the Wambo Mine and will result in changes to the site boundary of the area monitored under this program – generally resulting in the removal of the majority of the rehabilitation areas from the Wambo Mine site. Revision of the monitoring program will be required to address these changes and ensure the program is targeted at the appropriate 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 2020. 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 Review

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
- undertake the first inspection of 50 nest boxes that were installed within RWEAs in 2018
- establish new floristic and bird monitoring sites in South Bates Underground Extension area
- monitor Groundwater Dependent Ecosystems above the in South Bates Underground Extension area
- report on any mine subsidence observations
- document results and compare to performance criteria or past results (where relevant) and identify what and where management actions may be required.
- provide a summary of management actions.

1.1 Report structure

This report has been set out in the following manner:

- **Executive summary –** 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. Also reports on results of nest box monitoring within RWEAs
- **Rehabilitation areas –** provides methods, results and interpretation of data from LFA and biometric flora survey plots 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
- **South Bates Underground Extension area –** provides methods, results and interpretation of data from monitoring of Groundwater Dependent Ecosystems, flora and birds in the area above the South Bates Underground Extension. Flora and bird monitoring was undertaken in these areas for the first time in 2020
- **Mine subsidence observations and other management issues –** provides observations of mine subsidence and other management issues on land owned by WCPL
- **Summary of management actions –** provides a summary of required and recommended actions.

Raw data and photographs from monitoring sites are included in **Volume 2**.

2. Remnant Woodland Enhancement Areas (RWEAs)

2.1 Floristic monitoring

2.1.1 Introduction

The aim of floristic and fauna habitat monitoring is to measure the current condition of vegetation within the RWEA's in terms of floristics and habitat complexity. The results aim to provide direction to management of these areas and for the monitoring program in the future.

2.1.2 Methods

Data was collected by ELA ecologists Lily Gorrell and Liam Scanlan from 19-23 October 2020. 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).

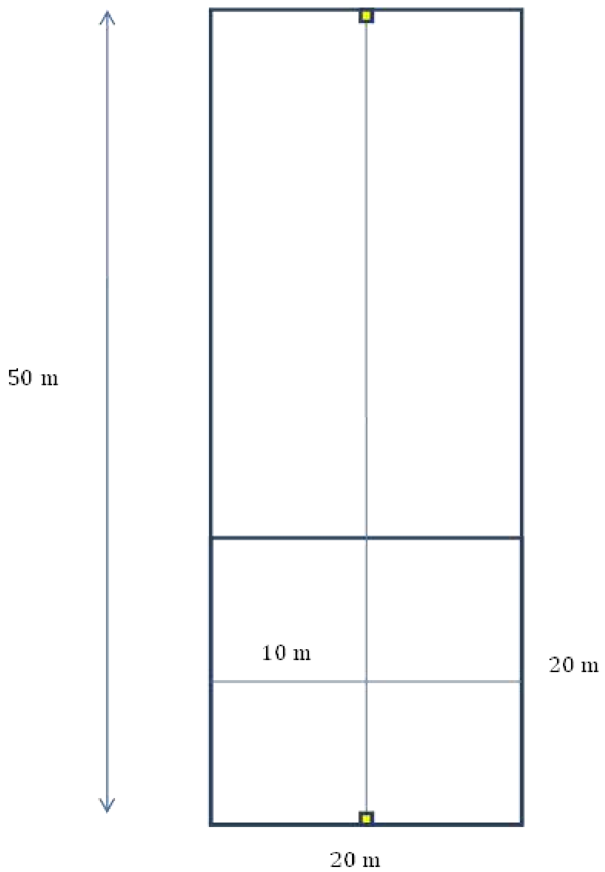

Figure 1: Biometric vegetation plot dimensions

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 Threatened Ecological Communities (TECs) under different nomenclature. **Table 1** clarifies the conversion of vegetation communities.

Data was collected from the 34 locations previously surveyed as part of the RWEP monitoring program. 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 2.3.** During 2019 and 2020, several additional floristic monitoring plots were added outside of RWEAs in the North Wambo Creek Diversion and South Bates Extension Underground Mine area as part of the broader Wambo Coal Mine biodiversity monitoring program. These sites are monitored using the same methods described here, with results presented in the relevant sections later in this report. All floristic plot locations are shown in **Figure 2**.

Table 1: Original vegetation classification, plant community type classification and TEC status for each monitoring plot in remnant vegetation

<table>
<tr><th>Vegetation Community (Orchid Research 2003)</th><th>Plant Community Type (PCT)</th><th>TEC</th><th>Plot name</th></tr>
<tr><td rowspan="5">River Oak / Rough-barked Apple Forest</td><td rowspan="9">PCT 42: River Red Gum / River Oak riparian woodland wetland in the Hunter Valley</td><td rowspan="9">Listed NSW Biodiversity Conservation Act 2016 (BC Act), E: Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions</td><td>V1-A1</td></tr>
<tr><td>V1-A2</td></tr>
<tr><td>V1-B1</td></tr>
<tr><td>V1-B2</td></tr>
<tr><td>V1-B3</td></tr>
<tr><td rowspan="3">River Red Gum Woodland</td><td>V2-A1</td></tr>
<tr><td>V2-B1</td></tr>
<tr><td>V2-B2</td></tr>
<tr><td>Yellow Box / Blakely's Red Gum / Rough-barked Apple Forest</td><td>V3-B1</td></tr>
<tr><td rowspan="4">Coast Banksia / Rough-barked Apple / Blakely's Red Gum Forest</td><td rowspan="4">PCT 1653: Rough-barked Apple - Narrow-leaved Ironbark - Blakely's Red Gum - Bull Oak - Coast Banksia woodland on sands of the Warkworth area</td><td rowspan="4">Listed BC Act, E: Warkworth Sands Woodland in the Sydney Basin Bioregion, also listed as CE under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) as Warkworth Sands Woodland of the Hunter Valley</td><td>V5-B1</td></tr>
<tr><td>V5-B2</td></tr>
<tr><td>V5-B3</td></tr>
<tr><td>V5-B4</td></tr>
<tr><td rowspan="8">Narrow-leaf Ironbark/Grey Box/Bulloak/Honeymyrtle Forest</td><td rowspan="10">PCT 1603: Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter</td><td rowspan="10">Listed BC Act, E: Central Hunter Grey Box-Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions, may also be listed as CE under the EPBC Act as Central Hunter Valley eucalypt forest and woodland, dependant on condition and landscape position</td><td>V6-A1c</td></tr>
<tr><td>V6-A3</td></tr>
<tr><td>V6-B1</td></tr>
<tr><td>V6-B1c</td></tr>
<tr><td>V6-B2</td></tr>
<tr><td>V6-B2c</td></tr>
<tr><td>V6-B3</td></tr>
<tr><td>V6-B4</td></tr>
<tr><td rowspan="2">Grey Gum/Narrow-leaf/ Ironbark/Bulloak/Honeymyrtle Forest</td><td>V11-B1</td></tr>
<tr><td>V11-B2</td></tr>
<tr><td rowspan="2">Spotted Gum/Narrow-leaf Ironbark/Bulloak/Paperbark Forest</td><td rowspan="2">PCT 1604: Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter</td><td rowspan="2">Listed BC Act, E: Central Hunter Ironbark - Spotted Gum - Grey Box Forest in the New South Wales North Coast and Sydney Basin Bioregions, may also be listed as CE under the EPBC Act as Central</td><td>V9-A1</td></tr>
<tr><td>V9-B1</td></tr>
</table>

Vegetation Community (Orchid Research 2003)	Plant Community Type (PCT)	TEC	Plot name
		Hunter Valley eucalypt forest and woodland, dependant on condition and landscape position	V9-B2
			V10-B1
Slaty Gum/Narrow-leaf Ironbark/Bulloak/Paperbark Forest	PCT 1176: Slaty Box - Grey Gum shrubby woodland on footslopes of the upper Hunter Valley, Sydney Basin Bioregion	Listed BC Act, V: Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion, may also be listed as CE under the EPBC Act as Central Hunter Valley eucalypt forest and woodland, dependant on condition and landscape position	V10-A1
			V10-A2
			V10-B3
White Mahogany/Rough-barked Apple Forest	PCT 1584: White Mahogany - Spotted Gum - Grey Myrtle semi-mesic shrubby open forest of the central and lower Hunter Valley	-	V13-B1
Brush Wilga/Native Olive Shrubland	PCT 1603: Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter	Listed BC Act, E: Central Hunter Grey Box-Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions	V14-A1
			V14-B1
			V14-B2

*CE – Critically Endangered, E – Endangered, V- Vulnerable

Cover/abundance scores for each species within each plot in the RWEAs was provided by WCPL from 2010 onwards, with the exception of woodland rehabilitation sites, which were only sampled for the first time by ELA during monitoring undertaken in 2015. Biometric plot data using the current method was collected for the first time during monitoring undertaken in 2014.

Data was examined for changes in native species richness within each sampled plant community over ten monitoring periods from 2010 to 2020 and cover of exotic species over the last five monitoring periods (2016 to 2020). Monitoring point photographs were also compared where possible to determine if major structural elements of each community had changed since the earliest photos available were taken (generally in 2013). Data from each vegetation community was compared to established performance criteria, biometric benchmarks and compared with reference sites outside of the RWEA areas where possible.

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

A green, yellow, amber and red colour system has been developed to rank each measured attribute according to performance and management actions required (**Table 2**). The structure of this table has been derived from (DECC 2008b). The number of hollow-bearing trees and length of fallen logs have been presented as a measure of fauna habitat attributes. However, no performance criteria have been set for these attributes in remnant vegetation, as in situations where historical logging or clearing has been intensive, it may take many years for a suitable density of hollows and logs to form naturally.

Table 2: Colour ranking system for floristic attributes and performance targets

Attribute	Red (needs greater improvement)	Orange (in need of improvement)	Yellow (not meeting target but values still acceptable)	Green (excellent – within target range)
Native species richness	0–10%	>10 – <50% of target range	50 – <100% of target range	≥ target range
Native overstorey cover % (*pfc)	0 – 10% or >200% of target range	> 10 – <50% or >150 – 200% of target range	50 – <100% or >100 – 150% of target range	within target range
Native mid-storey cover %(*pfc)	0 – 10% or >200% of target range	>10 – <50% or >150 – 200% of target range	50 – <100% or >100 – 150% of target range	within target range
Native ground cover – grasses %	0 – 10% or >200% of target range	>10 – <50% or >150 – 200% of target range	50 – <100% or >100 – 150% of target range	within target range
Native ground cover – shrubs %	0 – 10% or >200% of target range	>10 – <50% or >150 – 200% of target range	50 – <100% or >100 – 150% of target range	within target range
Native ground cover – other %	0 – 10% or >200% of target range	>10 – <50% or >150 – 200% of target range	50 – <100% or >100 – 150% of target range	within target range
Proportion of native overstorey species regenerating	0	0-0.5	0.5-1	1
Exotic cover	>66%	33-66	5-33	0-5%

Several abbreviations for measured attributes are used in tables throughout the following section. An explanation of these is provided below.

- NPS– the number of native plant species
- NOS (%) - projected native foliage cover of canopy
- NMS (%) – projected native mid-storey cover
- NGCG (%) – native groundcover of grasses
- NGCS (%) – native groundcover of shrubs
- NGCO (%) – native groundcover of other plant types (sedges, herbs etc.)

- EPC (%) – exotic plant cover
- OR – proportion of overstorey species regenerating over the whole vegetation zone
- HBT – number of hollow-bearing trees present in the 20 x 50 m vegetation plot
- FL – length of fallen logs >10 cm diameter.

In addition to those performance criteria listed above, Annexure C of the VCAs for the RWEA areas requires that WCPL aim for an exotic plant cover within the Conservation Areas that does not exceed the percentages detailed in **Table 3**. Photo-monitoring points established as part of the VCAs in 2013 were compared to photos at the same location during the current vegetation monitoring.

Table 3: Exotic plant cover criteria for VCA areas

RWEA	Aim	Timing
Coal Terminal	Exotic plant cover within the Conservation Area must not be permitted to exceed: - 5% of the foliage cover at monitoring site CT1* - 15% of the foliage cover at monitoring site CT2*.	In Year 1 and at the end of Year 5
RWEAs A, B, C and D	Exotic plant cover within the Conservation Area must not be permitted to exceed: - 70% of the foliage cover at monitoring site A1 within Area A - 20% of the foliage cover at monitoring site A2 within Area A - 30% of the foliage cover at monitoring site A3 within Area A - 10% of the foliage cover at monitoring site A4 within Area A - 5% of the foliage cover at monitoring site B1 within Area B - 5% of the foliage cover at monitoring site B2 within Area B - 5% of the foliage cover at monitoring site C1 within Area C - 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 - 5% of the foliage cover at monitoring site D1 within Area D.	Years 2-5

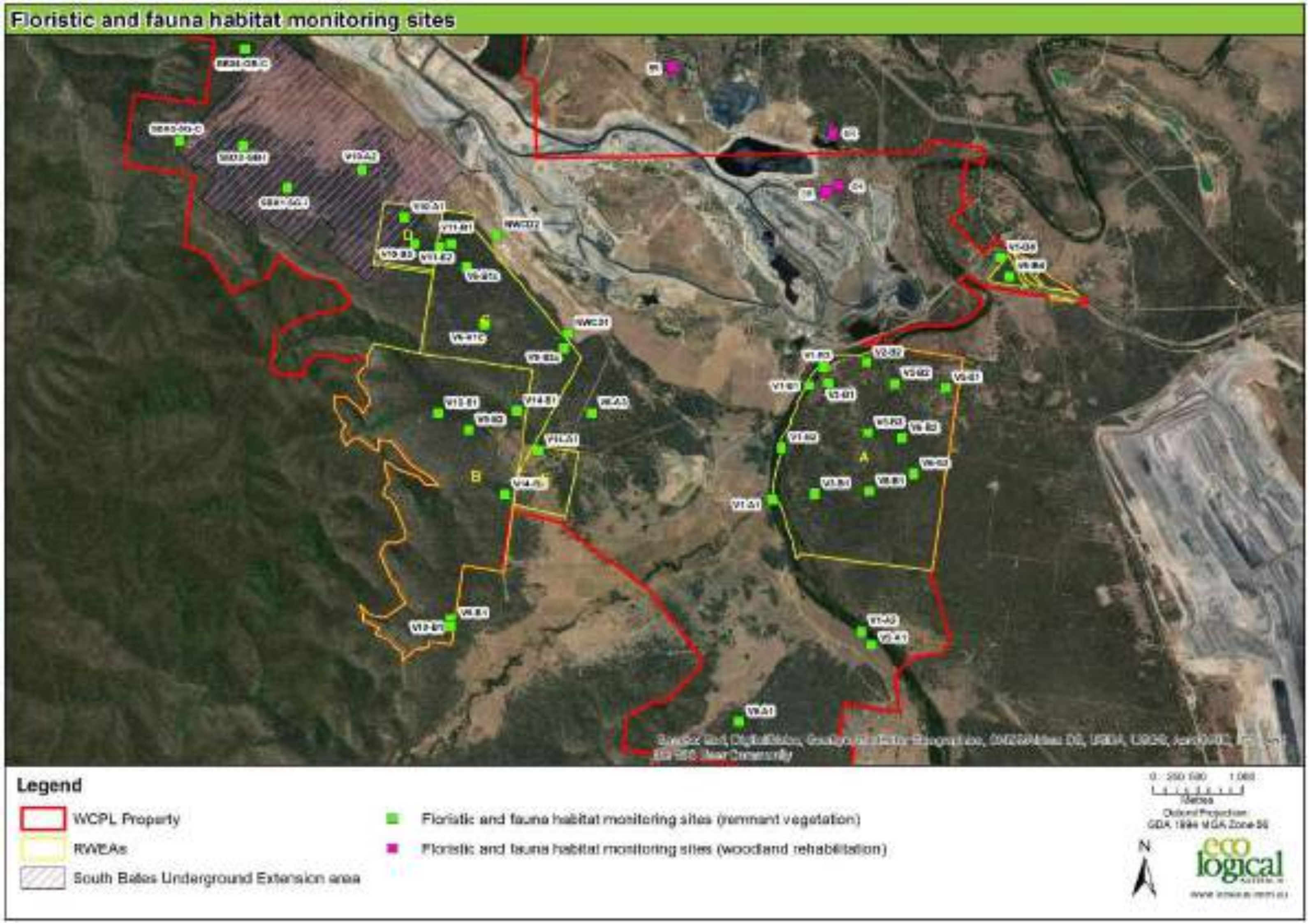

Figure 2: Floristic and habitat monitoring sites and RWEAs

2.1.3 Results

The floristic and biometric data collected during floristic and fauna habitat monitoring is summarised below, with the full floristic plot data and other data including plot photographs provided in **Volume 2**.

2.1.4 River Red Gum / River Oak riparian woodland wetland in the Hunter Valley

This community is one of the most disturbed vegetation communities on WCPL land, as it occurs on more fertile soils on the banks and floodplains of Wollombi Brook, is naturally disturbed by flood events and has been historically used more intensively for agricultural purposes.

River Red Gum / River Oak riparian woodland is distinguished by an overstorey of *Eucalyptus camaldulensis* (River Red Gum), *Casuarina cunninghamiana* subsp. *cunninghamiana* (River Oak), *Angophora floribunda* (Rough-barked Apple) and *Eucalyptus melliodora* (Yellow Box) on floodplains and riparian areas. This PCT conforms to the BC Act listed Endangered Ecological Community (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 (Photograph 1).

Photograph 1: River Red Gum / River Oak riparian woodland wetland on North Wambo Creek in 2020 (Site V1-A1 within the Wollombi Brook channel)

Nine monitoring plots are located within this PCT. V1 monitoring sites are located within *Casuarina cunninghamiana* dominated forest along the banks of Wollombi Brook. V2 monitoring sites are located on the partially cleared red gum dominated floodplains of Wollombi Brook and the V3 monitoring site is located in a slightly wetter site on the boundary of the floodplain and sand dunes supporting Warkworth Sands type vegetation.

Three sites (V1-A1, V1-A2 and V2-A1) appear to have been originally intended as reference sites at the commencement of the monitoring program, as they are located outside of the RWEP areas. However, cattle have been fenced out of the immediate riparian zone on Wollombi Brook (including sites V1-A1, V1-A2) and thus treatments for both reference sites and management sites are similar.

Floristic results for this vegetation zone in relation to performance criteria are presented in Table 5.

NMS and NGCG did not meet targets. Targets were met or acceptable for the other performance criteria.

The average number of NPS recorded per monitoring plot in River Red Gum / River Oak riparian woodland within RWEAs increased from 2019 and was above the average over the past ten years (Figure 3). The average number of NPS at the three reference sites also increased from the previous year and is the highest recorded for those sites. Although the RWEA sites scores are still higher than for the reference sites, they had been significantly above the reference sites during 2016-2018.

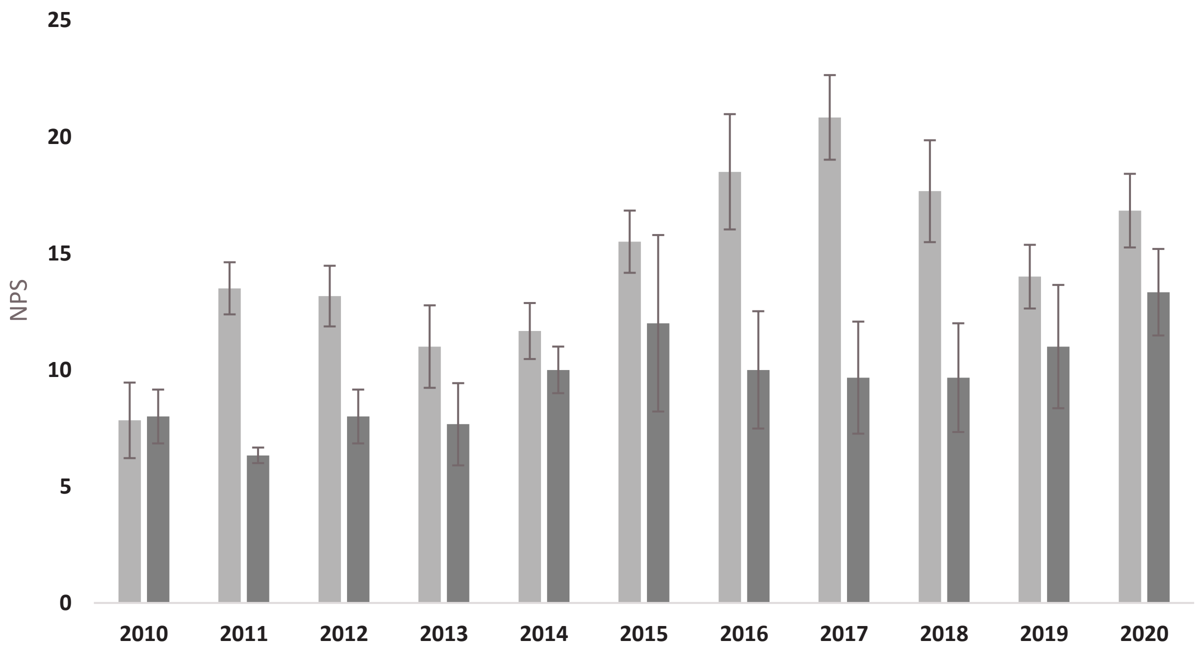

Figure 3: Average number of NPS per plot in monitoring sites within riparian woodland in RWEA A (light grey) and from three reference sites outside the boundary of RWEA's (dark grey). Error bars represent standard error

Total EPC has been recorded since 2014 and results are quite variable over time (Figure 4), even within each site. Total EPC in 2020 was the highest recorded to date, and significantly higher than all other years except 2016, which was notably also a year with higher than average rainfall. The trends suggest EPC is strongly correlated to rainfall. Floristic plot data suggests total exotic plant cover is a result of a combination of both annual and perennial species.

Several priority weeds are present within this PCT, these are listed in **Table 4** below, along with their biosecurity duty according to NSW Department of Primary Industries (DPI 2017). Priority weed distribution and abundance was generally similar to previous years, although the annual *Senecio madagascariensis* (Fireweed) was recorded at all sites and has likely responded to the wetter conditions. 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.

Photo monitoring points in this PCT, show no obvious changes within this PCT between years 2015 and 2020 (Photograph 2 **and** Photograph 3), and 2013 and 2020 monitoring (Photograph 4 **and** Photograph 5), although evidence of recent wetter seasonal conditions is evident in the understorey of some 2020 photos.

Overall, the performance of this PCT is acceptable, although continued weed management should be undertaken.

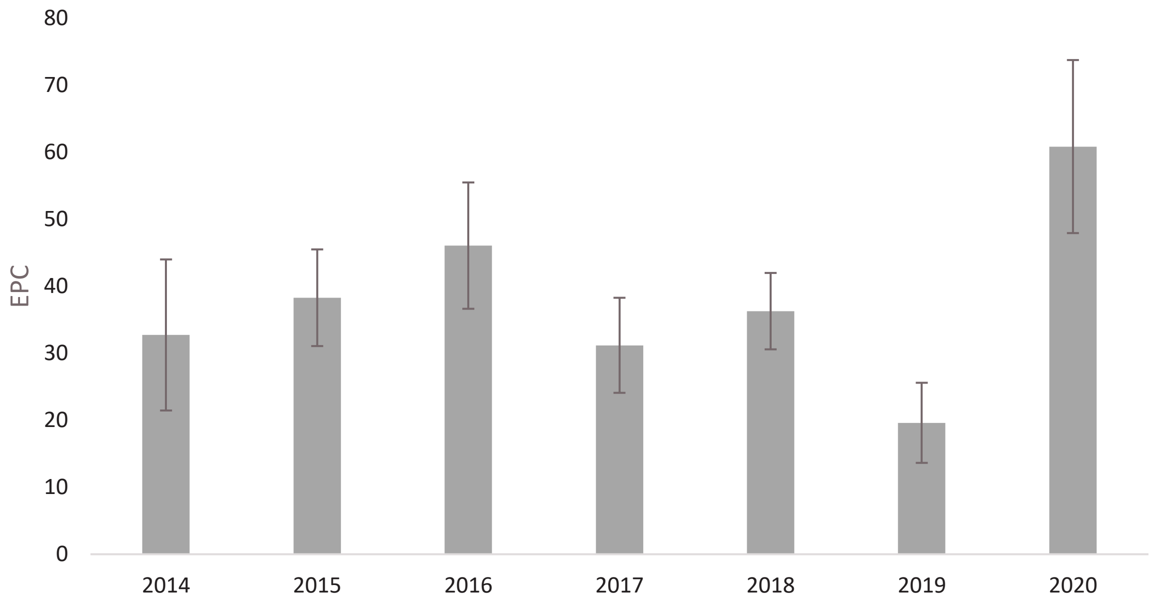

Figure 4: Average EPC (%) within all riparian woodland monitoring sites per year

Table 4: Declared weeds observed within the River Red Gum / River Oak riparian woodland PCT plots in 2020

Scientific Name	Common Name	Site	Biosecurity duty (NSW Biosecurity Act 2015)
Asparagus asparagoides	Bridal Creeper	V2-B1, V2-B2	**Prohibition on dealings** - Must not be imported into the State or sold
Echium plantagineum	Patterson's Curse	V1-A2, V1-B3	**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, V2-B2	**Prohibition on dealings** - Must not be imported into the State or sold
Olea europaea subsp. *cuspidata*	African Olive	V1-B3	**Regional Recommended Measure** - Land Area 1: Singleton and Maitland. Land Area 2: outbreaks in Hunter region except Singleton and Maitland. Land Area 1: Land managers should mitigate the risk of new weeds being introduced to their land. Land managers should mitigate spread from their land. Land Area 2: Land managers should mitigate spread from their land. Land managers should mitigate the risk of new weeds being introduced to their land. Plant should not be bought, sold, grown, carried or released into the environment.
Opuntia aurantiaca	Tiger Pear	V1-A2, 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-B2, V1-B3, V2-B1, V2-B2	**Prohibition on dealings** - Must not be imported into the State or sold
Salix species	Willows	V1-A1, V1-B1	**Prohibition on dealings** - Must not be imported into the State or sold
Senecio madagascariensis	Fireweed	All sites	**Prohibition on dealings** - Must not be imported into the State or sold

Photograph 2: Flora monitoring site V3-B1 during 2015

Photograph 3: Flora monitoring site V3-B1 during 2020

Photograph 4: Monitoring site A3 during 2013

Photograph 5: Monitoring site A3 during 2020

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	12	18	0	0	0	0	84	1	0	120
		Outside of RWEP	V1-A2	11	10.5	2.5	0	0	6	105.5		0	30
		A	V1-B1	20	12	0	4	0	62	2		0	10
		A	V1-B2	15	23	2	10	2	30	94		0	10
		A	V1-B3	13	11	2.7	0	6	0	98		0	10
River Red Gum Woodland		Outside of RWEP	V2-A1	17	6.2	25	50	0	6	22		2	7.5
		A	V2-B1	14	18.5	1	6	2	16	64		0	5
		A	V2-B2	16	13.5	9.5	40	2	2	62		2	15
Yellow Box / Blakely's Red Gum / Rough-barked Apple Forest		A	V3-B1	23	20.6	2	16	4	18	16		4	33
Average values for RWEA monitoring sites				16.8	16.4	2.9	12.7	2.7	21.3	25	1	0.2	18.0
Performance criteria				>20	10-50	10-50	20-60	1-5	5-30	<10	1	-	-

2.1.5 Rough-barked Apple - Narrow-leaved Ironbark - Blakely's Red Gum - Bull Oak - Coast Banksia woodland on sands of the Warkworth area

Within WCPL owned land, this community is mostly restricted to the eastern side of Wollombi Brook, primarily within the RWEP area A (Photograph 6). This PCT corresponds to the EPBC Act listed Critically Endangered Ecological Community (CEEC) *Warkworth Sands Woodland of the Sydney Basin Bioregion* and is also listed under the BC Act. This PCT occurs on aeolian sand deposits and is restricted to the Warkworth area.

Photograph 6: Warkworth Sands Woodland within RWEA A in 2020 (Site V5-B2)

The average number of NPS met the performance criteria in 2020 (Table 6) and has been relatively consistent over the past three years after lower diversity was recorded in 2017 (**Figure 5**).

Results for other performance criteria were mixed (Table 6). NOS and OR met the performance indicating a healthy canopy. NGCG was above the target, however this is not considered to be a major concern, with the higher grassy cover likely to be caused by strong growth as a result of higher rainfall in 2020. EPC was higher than the target, driven by sites V5-B1 with and V5-B4. At V5-B1, *Richardia humistrata* and *Tagetes minuta* (Stinking Roger) were the dominant exotics, and at V5-B4, *Melinis repens* (Red Natal Grass) contributed strongly to the high EPC. Ground cover of shrubs and other species were both below the target, although diversity and cover of species from these groups were recorded in the floristic data and are visible in plot photographs.

As reported in recent years, the environmental weed *Bryophyllum* sp. (Mother of Millions) was observed to be abundant in certain locations within this vegetation community, both within RWEA A and inside the Rail Loop area. *Bryophyllum* sp. is listed as a priority weed in the Hunter under the *Biosecurity Act 2015*. It is understood that this species is currently the focus of a weed management program.

Photo-monitoring point A2 within this PCT shows a minor change in vegetation between the 2013 and 2020 monitoring periods, with a reduction in cover of *Pteridium esculentum* (Bracken) apparent (Photograph 7 **and** Photograph 8). Canopy dieback of *A. floribunda* in some areas of this community was observed during the 2016 monitoring program. These trees displayed abundant epicormic growth in 2017 and have since mostly recovered (Photograph 9 **and** Photograph 10). NOS and NMS collected by ELA from the 2015 to 2020 monitoring periods have remained generally similar between years.

Banksia integrifolia (Coast Banksia) has been observed to suffer die-off over the past few years and was not recorded as live in any plots in 2020. Live individuals were observed more broadly within this PCT during 2020. Monitoring should continue to note the health of this species within the PCT.

Overall this community is performing acceptably, although surveys should continue to monitor the high EPC and low ground cover scores (NGCS and NGCO).

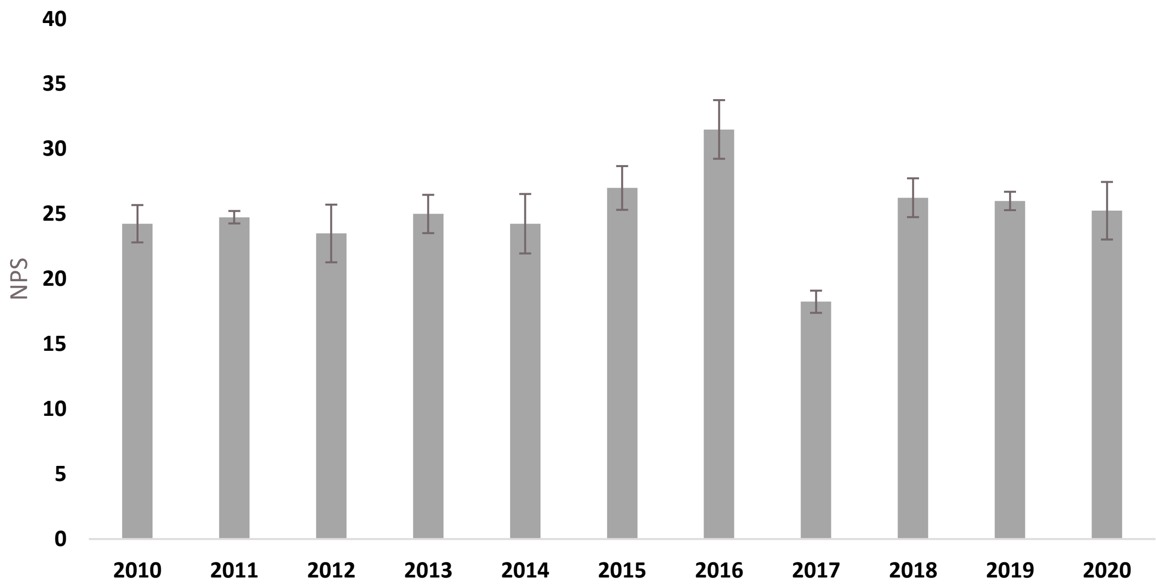

Figure 5: The average number of NPS recorded within Warkworth Sands Woodland monitoring plots over time.

Photograph 7: Photo monitoring point A2 during 2013

Photograph 8: Photo monitoring point A2 during 2020

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

Photograph 10: Continued recovery of *Angophora floribunda* canopy dieback observed in 2020

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	28	18	1	56	0	4	25	1	0	10
		A	V5-B2	22	14.6	8.5	76	0	2	2		3	3
		A	V5-B3	30	7	18.3	64	0	2	4		2	12
		Rail Loop	V5-B4	21	17.6	0	26	0	0	26		0	12
Average values for RWEP and Rail Loop monitoring sites				25.3	14.3	6.95	55.5	0	2	14.25	1	1.25	9.25
Performance criteria				>20	10-40	10-50	4-20	5-30	5-35	<10	1	-	-

2.1.6 Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter

This community on land owned by WCPL is generally dominated by the canopy species *Eucalyptus crebra* (Narrow-leaved Ironbark) and occasionally *Eucalyptus moluccana* (Grey Box) (Photograph 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 some areas.

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 listed under the EPBC Act.

This community appears to be performing well with generally very low cover of exotic species and high diversity of native species present at each monitoring plot. The number of native species recorded in 2020 was the highest on record (Figure 6) and achieved the performance target (**Table 7**). Performance criterion were met for all other attributes. A notable increase in ground cover (other) was recorded at several sites which mirrors and the increase in diversity and suggests many forbs have responded to the higher rainfall in 2020. Photo monitoring point A4 (Photograph 12 **and** Photograph 13) samples this community, and no major changes are visible between the 2013 and 2020 monitoring periods.

Subsidence cracking is present at four of the eight monitoring plots within this PCT. However, no significant vegetation damage has been observed. Very large cracks are present at site V11-B1 in RWEA C and this plot may not be safe to survey in the future. ELA recommends WCPL inspect this area and investigate remediation of large subsidence cracks. Potential for works to damage surrounding vegetation should also be taken into account when considering remediation.

Photograph 11: Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest at WCPL (site V6-A3 in 2020)

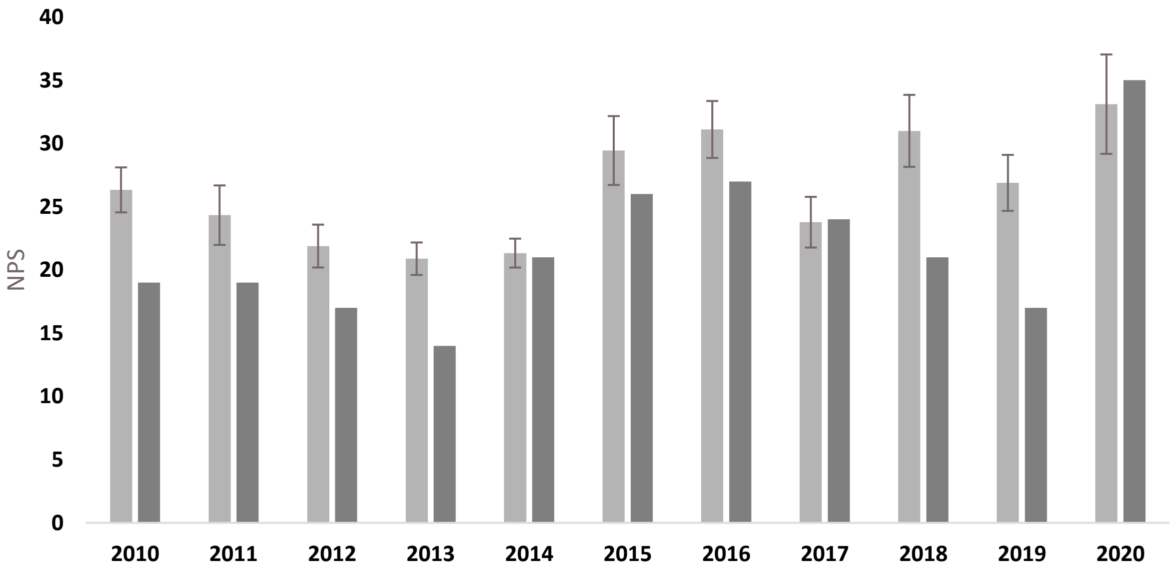

Figure 6: Average number of NPS recorded in Narrow-leaved Ironbark - Bull Oak - Grey Box open forest within RWEAs (light grey) compared to reference site V6-A3 (dark grey). Error bars represent the standard error of the mean

Photograph 12: Photo-monitoring point A4 during 2013

Photograph 13: Photo-monitoring point A4 during 2020

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	45	15	12	70	8	30	0	1	2	26
		Outside of RWEP	V6-A3	35	20	5	40	4	34	2		0	9
		A	V6-B1	27	19.6	12	34	2	0	4		2	32
		C	V6-B1c	33	9.7	8.1	54	4	6	2		1	25
		A	V6-B2	31	12.3	13.2	34	14	20	0		1	51
		C	V6-B2c	42	9	5	52	8	12	0		0	22
		A	V6-B3	29	13.3	9.5	30	10	12	2		3	31
		Rail Loop	V6-B4	9	14.8	0	8	2	0	0		0	5
Grey Gum / Narrow-leaf Ironbark / Bulloak / Honeymyrtle Forest		C	V11-B1	33	10.2	6	50	10	0	0		0	58
		C	V11-B2	49	12.3	3.8	80	4	40	6		0	23
Average values for RWEP and Rail loop monitoring sites				33.1	12.9	7.78	45.8	6.9	13.36	1.6	1	1	30.3
Performance criteria				>25	10-40	5-10	15-50	5-10	5-40	<5	1	-	-

2.1.7 Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter

Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter at WCPL is characterised by an overstorey of *Eucalyptus crebra*, *Corymbia maculata* (Spotted Gum) and *E. moluccana*. *E. punctata* and *E. dawsonii* (Slaty Gum) are also occasionally present. The mid-storey or shrub layer often includes Melaleuca decora, Bursaria spinosa subsp. spinosa, *Allocasuarina luehmannii* and *Olearia elliptica* (Sticky Daisy Bush). This community corresponds to the EEC *Central Hunter Ironbark -Spotted Gum – Grey Box Forest* listed under the 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 EPBC Act.

This PCT is performing well meeting all performance criteria in 2020, except ground cover (shrubs) which was slightly above the target (**Table 8**). The average number of native species in both RWEA and reference sites was the highest recorded to date (**Figure 7**). Generally, few weed species are present within this PCT, with the exception of small infrequent occurrences of *Opuntia* spp. (Prickly Pear, Creeping Pear or Tiger Pear). Exotic plant species only contributed to plant cover at one site (V10-B1) in the biometric transects. Ground cover (grasses) significantly increased from 2019 and is likely a result of increased growth in response to higher rainfall in 2020.

Photo-monitoring points in this community show little change in vegetation structure between the 2013 and 2020 monitoring periods (Photograph 14 **and** Photograph 15). Overall, this PCT is performing well and no additional management actions are required at this stage.

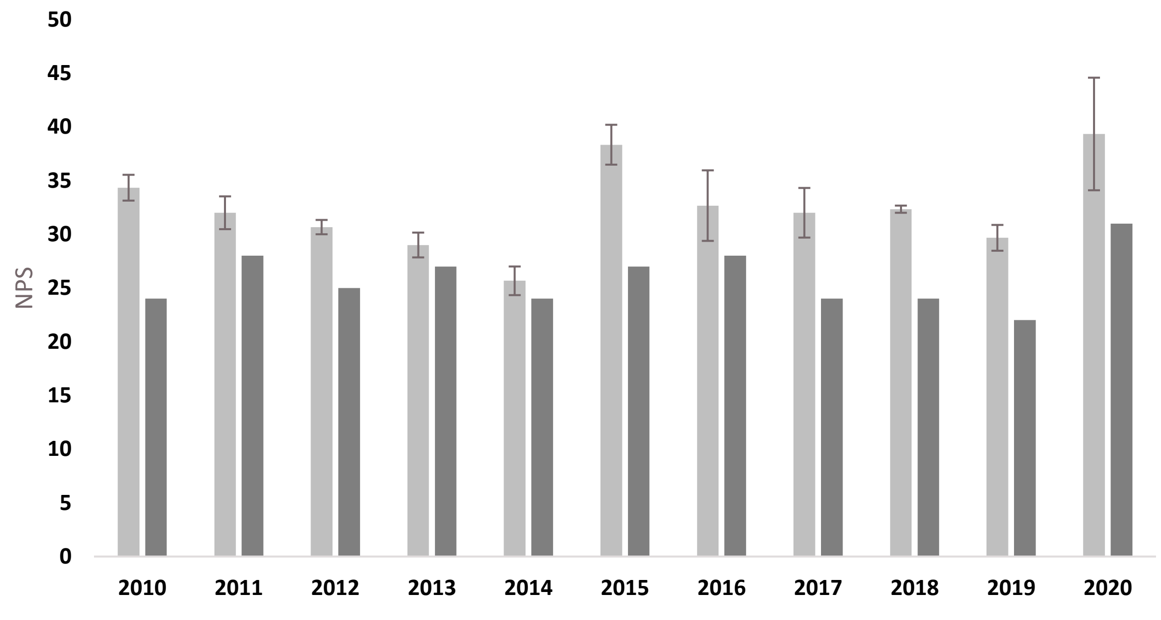

Figure 7: The average number of NPS in Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland within RWEAs (light grey) compared to the recorded number at reference site V9-A1 (dark grey). Error bars represent the standard error of the mean

Photograph 14: Photo-monitoring point B2 during 2013

Photograph 15: Photo-monitoring point B2 during 2020

Table 8: Floristic results, performance criteria for Narrow-leaved Ironbark - Grey Box - Spotted Gum woodland at Wambo

Vegetation Community (Orchid Research 2003)	Plant Community Type (PCT)	RWEP Area	Plot Name	NPS	NOS (%)	NMS (%)	NGCG	NGCS	NGCO	EPC	OR	HBT	FL
Spotted Gum / Narrow-leaf Ironbark/ Bulloak / Paperbark Forest	PCT1604: Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass of the central and lower Hunter	Outside of RWEP	V9-A1	31	23	11	32	0	0	4	1	1	17
		B	V9-B1	43	15.2	6.5	50	14	20	0		1	26
		B	V9-B2	29	15.8	7	40	18	10	0		1	19
		B	V10-B1	46	22.5	8.7	58	24	14	4		3	35
Average values for RWEP monitoring sites				39.3	17.8	7.4	49.3	18.7	14.7	1.3	1	1.7	26.7
Performance criteria				>35	15-40	5-20	30-50	5-15	5-40	< 5	1	-	-

2.1.8 Slaty Box - Grey Gum shrubby woodland on footslopes of the upper Hunter Valley, Sydney Basin Bioregion

The canopy of Slaty Box - Grey Gum shrubby woodland is typically dominated by *Eucalyptus dawsonii* and several other species including *E. punctata*, *E. moluccana* and *E. crebra.* *Acacia salicina* (Cooba) and *Allocasuarina luehmannii* may form a small tree layer or be part of the upper-most canopy. The shrub layer includes species such as *Olearia elliptica*, *Acacia cultriformis* (Knife-leaved Wattle), *Canthium odoratum* (Shiny-leaved Canthium), *Notelaea microcarpa var. microcarpa* and *Dodonaea viscosa* subsp. *cuneata* (Wedge-leaf Hopbush). The groundcover is generally sparse to very sparse and is can be species poor during drier years (Photograph 16). 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 EPBC Act.

At WCPL, this PCT primarily occurs on the smaller ridge tops and slopes and is patchily distributed at lower elevations. *E. 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 2020, except for NGCG which was above the target range (Table 9), and this not considered a management concern. The average NPS recorded in 2020 was the highest to date (**Figure 8**), suggesting a number of species have responded to the wetter conditions.

Overall, this PCT is considered to be performing well and no additional management actions are required at this stage.

Photograph 16: A typical example of Slaty Box woodland at WCPL during 2020 (Site V10-B3)

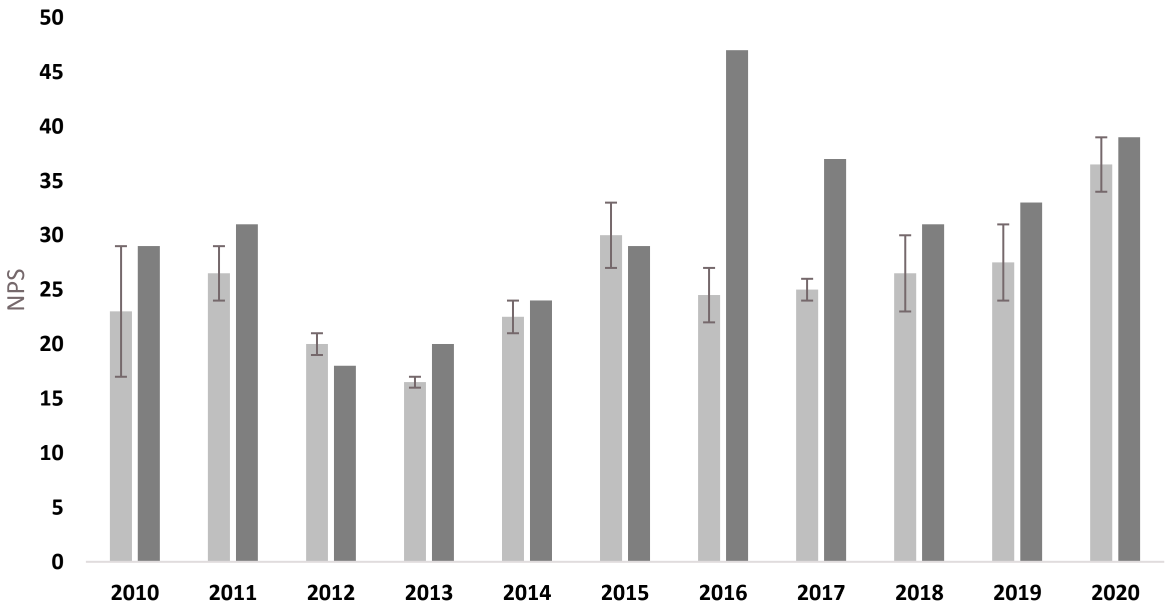

Figure 8: The average number of NPS recorded in Slaty Box shrubby woodland within RWEAs (light grey) compared to reference site V10-A2 (dark grey). Error bars represent the standard error of the mean

Table 9: Floristic results, performance criteria for Slaty Box - Grey Gum shrubby woodland

<table>
<tr><th>Vegetation Community (Orchid Research 2003)</th><th>Plant Community Type (PCT)</th><th>RWEP Area</th><th>Plot Name</th><th>NPS</th><th>NOS (%)</th><th>NMS (%)</th><th>NGCG</th><th>NGCS</th><th>NGCO</th><th>EPC</th><th>OR</th><th>HBT</th><th>FL</th></tr>
<tr><td rowspan="3">Slaty Gum / Narrow-leaf Ironbark / Bulloak / Paperbark Forest</td><td rowspan="3">1176: Slaty Box - Grey Gum shrubby woodland on footslopes of the upper Hunter Valley, Sydney Basin Bioregion</td><td>D</td><td>V10-A1</td><td>39</td><td>13.2</td><td>5.5</td><td>56</td><td>4</td><td>6</td><td>2</td><td rowspan="3">1</td><td>0</td><td>23</td></tr>
<tr><td>Outside of RWEP</td><td>V10-A2</td><td>39</td><td>6.5</td><td>6.5</td><td>14</td><td>12</td><td>6</td><td>2</td><td>0</td><td>12</td></tr>
<tr><td>D</td><td>V10-B3</td><td>34</td><td>19</td><td>10</td><td>14</td><td>0</td><td>8</td><td>0</td><td>2</td><td>42</td></tr>
<tr><td colspan="4">Average values for RWEP monitoring sites</td><td>36.5</td><td>16.1</td><td>7.75</td><td>35</td><td>2</td><td>7</td><td>1</td><td>1</td><td>1</td><td>32.5</td></tr>
<tr><td colspan="4">Performance criteria</td><td>21</td><td>15-40</td><td>5-30</td><td>5-30</td><td>0-25</td><td>2-10</td><td><5</td><td>1</td><td>-</td><td>-</td></tr>
</table>

2.1.9 White Mahogany - Spotted Gum - Grey Myrtle semi-mesic shrubby open forest of the central and lower Hunter Valley

At WCPL, this community occurs along Stony Creek and is sheltered by steep sandstone escarpments to the south and a large ridgeline to the north. This PCT is in good condition with many native species and occasional large remnant trees with hollows. One monitoring plot (V13-B1) samples this PCT (Photograph 17).

This monitoring site met all performance targets, except NGCG which was slightly above the target range (Table 10), and not considered a management concern. Grass cover was previously low with zero recorded for the transect in 2019, as such the high result in 2020 is considered to reflect the upper range of natural fluctuation in relation to environmental conditions. NPS was the second highest recorded, showing recovery from the recent dry conditions when the equal lowest NPS was recorded in 2019 (Figure 9). EPC is very low with only four species recorded in the floristic plots and no EPC recorded along the biometric transect.

Overall, this PCT is considered to be performing well and no additional management actions are required at this stage.

Photograph 17: White Mahogany - Spotted Gum - Grey Myrtle forest at V13-B1 in 2020

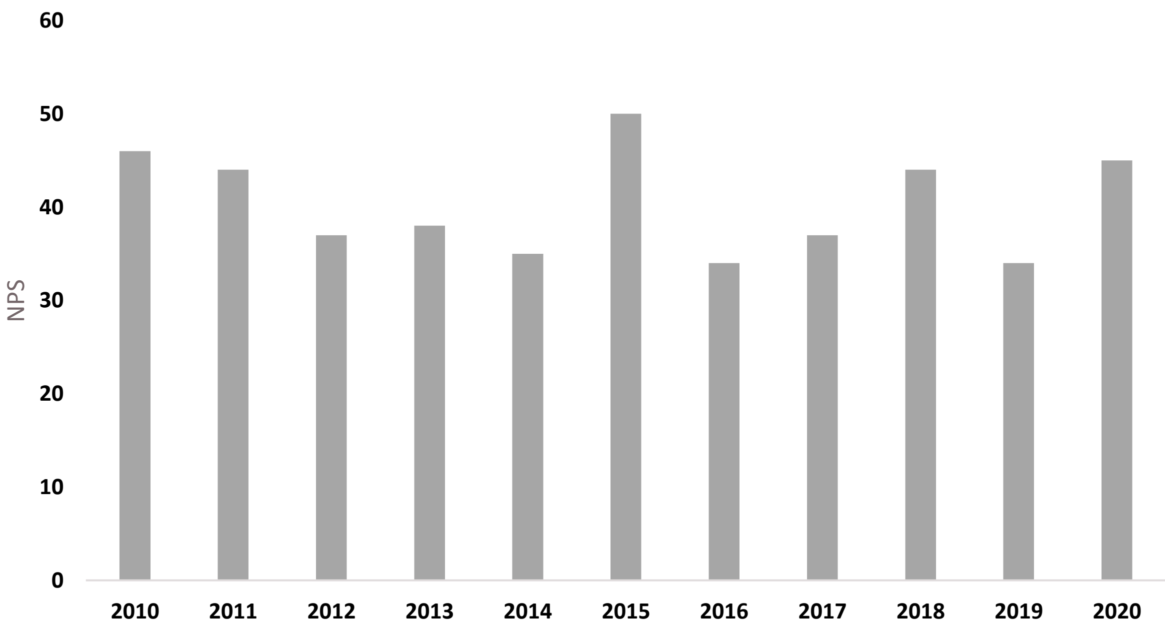

Figure 9: The number of NPS recorded in White Mahogany - Spotted Gum - Grey Myrtle forest at V13-B1 each year

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	45	27.3	27.5	42	18	30	0	1	1	31
Performance criteria				>45	15-45	5-40	5-40	10-20	5-20	0	1	-	-

2.1.10 Brush Wilga/Native Olive Shrubland

The monitoring plots within this PCT are dominated by the shrubs *Notelaea microcarpa var. microcarpa*, *Geijera salicifolia* (Brush Wilga), *Olearia elliptica* and the small tree *Brachychiton populneus* (Kurrajong) (Photograph 18). Occasional *Eucalyptus crebra* or *E. moluccana* are present as canopy species. The PCT sampled by floristic monitoring may be partially a derived community, resulting from the historic removal of overstorey species in Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest combined with a south facing aspect. These areas are in good condition, with a large number of native species and few exotic species. EPC has remained consistently very low over time at these monitoring plots.

This monitoring site met all performance targets, except native ground cover (grasses) which was slightly above the target range (**Table 11)**. High grass cover is not considered a management concern, likely the high score reflects the upper range of natural fluctuation in relation to environmental conditions such a rainfall. The average number of native species recorded within this PCT was above the performance criteria for the first time (**Figure 10**). Overall, this PCT is considered to be performing well and no additional management actions are required at this stage.

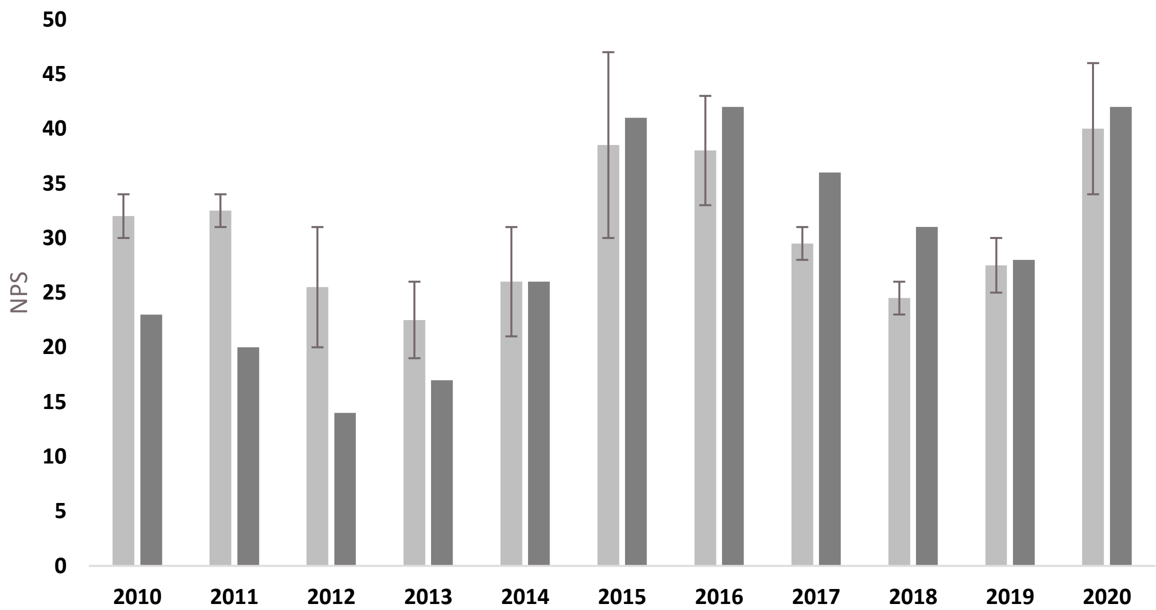

Figure 10: The average number of NPS recorded in Brush Wilga/Native Olive shrubland within RWEAs (light grey) compared to reference site V14-A1 (dark grey)

Photograph 18: Brush Wilga/Native Olive Shrubland at V14-B2 in 2020

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 *	Reference site/ now within RWEA E	V14-A1	42	11.5	35.5	30	4	28	8	1	0	8
		B	V14-B1	34	3.4	31	46	2	6	0		0	25
		B	V14-B2	46	17	18.5	78	10	44	0		0	5
Average values for RWEP monitoring sites				40	10.2	24.8	62	6	25	0	0.5	0	15
Performance criteria				>30	5-40	5-40	30-50	5-10	10-40	<5	1	-	-

*considered a variant of this PCT

2.1.11 Conservation agreement requirements and photo monitoring points

Annexure C of the VCAs requires that WCPL aim for an exotic plant cover within the Conservation Areas that does not exceed the exotic cover percentages detailed in **Table 3**. Target limits for Years 2-5 are used for the ongoing targets as no further limits are presented.

Four of the ten monitoring plots exceeded the exotic cover limits for the 2-5 year targets (Table 12). The sites exceeding limits are located within RWEA A and RWEA Rail Loop.

At Site A3, within the riparian zone of Wollombi Brook in RWEA A, very high exotic cover (94%) was recorded. *Ehrharta erecta* (Panic Veldtgrass), *Bidens subalternans* (Greater Beggar's Ticks) and *Heliotropium amplexicaule* (Blue Heliotrope) are dominant, with fifteen other common exotic flora species also recorded. Exotic cover at this site has fluctuated over time, previously being as high as 66% in 2016. The high cover in 2020 is a result of strong growth of ground cover vegetation in response to rainfall and surface water flows in the Wollombi Brook channel.

At Site CT2 within the Rail Loop, major fluctuations in exotic cover over time has also occurred. High exotic cover (26%) was recorded in 2020, no exotic cover was recorded from 2017-2019, and very high exotic cover (52%) was recorded in 2016. The exotic cover at this site is dominated by *Melinis repens* (Red Natal Grass). It is suspected that the variation in cover of *Melinis repens* is driven by rainfall, with 2016 and 2020 both being higher than average rainfall years, and 2017-2019 being relatively dry years. The data from floristic plot V5-B4 is used as a reference for CT2 results. Plot V5-B4 is technically outside of the RWEA Loop Area although the area receives the same management treatment. Photo monitoring from CT2 indicates actual exotic cover at the site is lower than at V5-B4, nevertheless weed management is required in this general area.

At Site A1, a high exotic cover limit is set (60%), reflecting the disturbed condition of the site. The limit was exceeded in 2020 with exotic cover of 64% recorded. This site has previously had exotic cover as high as 95% in 2014. Exotic cover at this site is dominated by *Heliotropium amplexicaule*, *Bidens subalternans* and *Galenia pubescens* (Galenia). Tree planting is recommended in this area with the strategy to shade out the exotic ground covers over time and improve fauna habitat.

Site A2 recorded total exotic cover of 25% with dominant exotic species of *Heliotropium amplexicaule* and *Bidens pilosa* (Cobbler's Pegs). Total exotic cover at this site has varied over time, however the result in 2020 represents the highest exotic cover recorded to date (since 2014), with the previous maximum of 18% in 2016 and 2018.

Exotic cover is very low or zero at the remaining sites and all these fell below the exotic cover limits.

Comparison of photo-monitoring sites between 2013 and 2020 monitoring show no major changes in vegetation over this time period. Wetter conditions during the 2020 are apparent in some photographs, with more green vegetative growth visible in the understorey, but in general, no major changes in species composition or structure are apparent. Dry conditions were observed and reported in the previous three years (2017-2019). These observations correspond to the floristic data collected within biometric plots with higher ground cover scores recorded across most PCTs this year.

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 2020
Coal Terminal (Rail Loop)	CT1	V6-B4	5	5	0
Coal Terminal (Rail Loop)	CT2	V5-B4	15	15	26
A	A1	V2-B1	70	60	64
A	A2	V5-B1	20	15	25
A	A3	V1-B2	30	20	94
A	A4	V6-B1	10	5	4
B	B1	V13-B1	5	5	0
B	B2	V9-B1	5	5	0
C	C1	V11-B1	5	5	0
D	D1	V10 -B3	5	5	4

2.1.12 Discussion and recommendations

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

The number of native species generally increased from the previous year and was the highest to date in several PCTs. The 2020 results appear to confirm that some lower scores for native species diversity recorded in recent years were a result of the dry conditions, with the increase this year in response to higher rainfall.

Several weed species listed under the *Biosecurity Act 2015* were observed in these areas that have potential to become problematic in the wider region e.g. *Olea europaea* subsp. *cuspidata* (African Olive). It is recommended to give priority to species such as this in the mine's weed control program. As discussed in previous monitoring reports, planting of canopy species should be considered in RWEA 'A', where natural regeneration is unlikely to occur in a reasonable timeframe (i.e. the open grassland areas of on the Wollombi Brook floodplain). Once established, these plantings may also reduce issues with exotic flora species in these areas.

Climatic conditions are considered to be a major factor in the fluctuation of results observed over time. Monthly rainfall data from 2020 from Bulga (Down Town) (BOM 2020) reveals that above average rainfall was recorded in the months of February, March, July, August, September and October, and the annual average rainfall total was reached by the end of October 2020. This follows below average rainfall for 2017, 2018 and 2019. This data corresponds to the generally higher diversity and cover of native flora species observed in 2020, and the lower scores reported in the previous few dry years. Similar increased in native diversity and exotic cover were reported in 2016 which was also a year of above average rainfall.

The Rough-barked Apple - Narrow-leaved Ironbark - Blakely's Red Gum - Bull Oak - Coast Banksia woodland (in RWEA A) appears to be suffering from *Banksia integrifolia* die-off in the mid-storey, first observed in 2019 and continuing this year. This was the only community to record a decrease in the average number of native species in 2020 and higher exotic covers were also recorded at some locations. This community occurs on sandy soils, and it is possible the soils suffered more significant drying during the recent dry years than other areas and the rainfall to date has not been sufficient to recharge the soil. This community is listed as a CEEC under the EPBC Act, future monitoring should continue to record the condition of this community; increased weed control is also recommended.

2.2 Bird monitoring within RWEA's

2.2.1 Introduction

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".

Additional avifauna surveys are undertaken in winter (alternate years) to specifically target Swift Parrot (*Lathamus discolor*) and Regent Honeyeater (*Anthochaera phrygia*). These surveys were undertaken in 2020.

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) 2015-2019. Wambo Coal Mine Flora and Fauna Monitoring Reports Prepared for Wambo Coal Pty Ltd.

2.2.2 Methods

2.2.2.1 Bird monitoring surveys

Bird monitoring during spring 2020 was consistent with the four previous monitoring events in methods and general timing of surveys. During the survey, two observers spent 10 minutes recording birds seen and heard within 50 m radius (0.8 ha) of a central point, followed by an additional 10 minutes searching the balance of a 2 ha plot, and recording the total numbers of birds detected (seen and heard). One morning and one afternoon survey was conducted per site.

The twenty-six (26) sites (**Figure 13**) were surveyed by ELA ecologists Tom Schmidt and Dee Ryder between 19-23 October and on 17 November 2020.

The total number of bird species recorded each year 2007-20, 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.

2.2.2.2 Targeted winter bird survey

Winter bird survey targeting Swift Parrot and Regent Honeyeater was undertaken in Winter 2020. No fixed survey sites are used; however, the survey targeted areas of high-quality habitat, including any flowering Eucalypts, and sought to cover as much of the site as possible. A rapid call-playback method was used where the calls of the target species were broadcast over a loudspeaker for 2-5 minutes followed by 5-10 minutes of searching the vicinity of the playback site. All bird species observed or heard during the survey were recorded.

The winter bird survey was conducted by ELA ecologists Daniel McKenzie and Dee Ryder on 22 August 2020.

2.2.3 Results

2.2.3.1 Bird monitoring surveys

The 2020 monitoring recorded a total of 86 bird species from 26 monitoring sites during formal bird surveys of RWEAs. This number is higher than the median from all 26 sites in previous monitoring periods (2007-2019 - 81 species), and is within the range of previous years, which have varied from a low of 64 species in 2012 to a high of 96 species in 2013 (**Figure 11)**.

One hundred and twenty-one bird species have been recorded during timed bird surveys over the last five years, with 86 (69%) of these recorded during 2020, including three species not previously recorded during bird monitoring surveys.

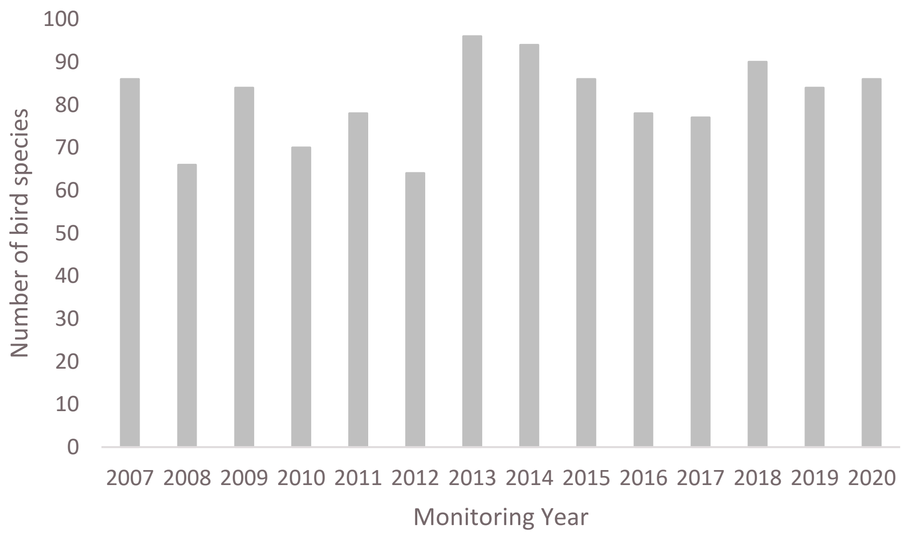

Figure 11: Number of bird species recorded at monitoring plots 2007 - 2019

The average number of bird species per 20-minute bird survey in 2020 was 14.5. This is the second highest number recorded, only last year (2019) was higher 15.3.

In 2020, the number of species detected at each site varied between 12 (at site BP19) and 30 (at BP11), with an average of 22.5 species recorded per monitoring site. This is the second highest average species diversity per site recorded from the years with available data, with the highest being 23 in 2019 **(Figure 12)**.

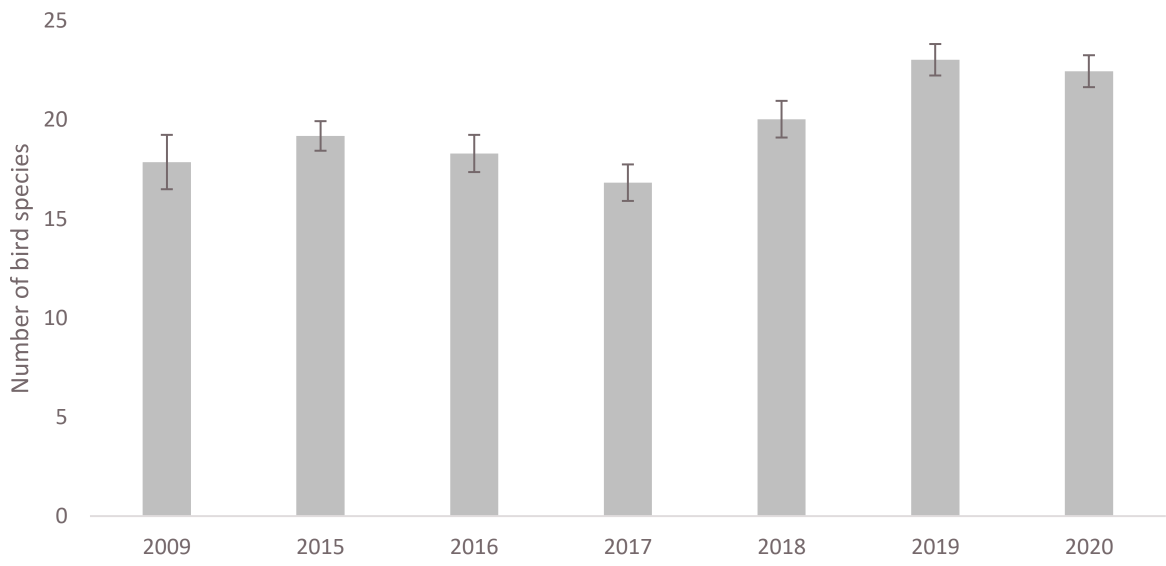

Figure 12: Average number of bird species recorded per monitoring site during 2009 and 2015-2019

The average number of birds recorded per survey was 22.7 birds recorded per survey during 2020 translating to a bird density of 11.4 birds/ha/20 mins. This is the lowest result recorded to date, with previous records ranging between 25.6 (2018) and 30.8 (2014) birds per survey. Numbers of birds were not presented in RPS (2009) and it is assumed only bird species were recorded.

The most species-diverse site during 2020 was BP11 (30 species). Other species-diverse sites included BP8 and BP26 (29 species), and BP9 and BP25 (27 species). BP11 has regularly been among the most diverse sites. BP19 had the lowest species diversity in 2020, with 12 species recorded.

Bird assemblages over time were not compared statistically, however, assemblages appear broadly similar to the previous five years and also to data from 2009 monitoring. When comparing the 20 most widely recorded species from each year, the results from 2020 contain an average of 11 of the same species recorded in the top 20 for previous years. The most widely recorded species in 2020 were Rufous Whistler (*Pachycephala rufiventris*), Australian Raven (*Corvus coronoides*), and Grey Butcherbird (*Cracticus torquatus*) all of which were also regularly recorded in previous years. Three species were recorded in the top 20 widely recorded species for the first time; Eastern Koel (*Eudynamys orientalis*), Pied Butcherbird (*Cracticus nigrogularis*) and Fan-tailed Cuckoo (*Cacomantis flabelliformis*).

Five threatened species listed under the BC Act were recorded during 2020 surveys; Dusky Woodswallow (*Artamus cyanopterus*), Grey-crowned Babbler (*Pomatostomus temporalis temporalis*), Varied Sittella (*Daphoenositta chrysoptera*), Speckled Warbler (*Chthonicola sagittata*) and Brown Treecreeper (eastern subspecies) (*Climacteris picumnus victoriae*). These threatened species are part of a group that are regularly recorded during the monitoring surveys, with between five and eight threatened bird species annually recorded between 2014 to 2019.

Comparison of numbers of individuals of threatened species during the 2015-2020 monitoring periods and the number of sites they were recorded at during the 2009 and 2014 to 2019 monitoring periods was undertaken. Grey-Crowned Babbler was recorded from the most sites ever (6), although higher numbers of individuals have been recorded previously. Speckled Warbler was recorded from seven sites with a total of 11 individuals, which are the equal lowest scores for this species. Varied Sittella was recorded from only one site with three individuals which are also the lowest scores for this species. Results for Dusky Woodswallow and Brown Treecreeper are within the range of previously recorded values.

2.2.3.2 Targeted winter bird survey

No Swift Parrot or Regent Honeyeater were recorded. A total of 52 species were recorded, including three threatened species (Brown Treecreeper, Speckled Warbler and Varied Sittella). Survey effort is shown on Figure 14. Species recorded are included in **Volume 2**.

2.2.4 Discussion

RWEA and other remnant woodland sites at WCPL continue to support a large diversity of bird species and no introduced bird species were detected within RWEA areas.

Although the abundance of birds per survey was lower in 2020, the recorded value was not significantly lower than previously recorded and bird species diversity remains high. Surveys were undertaken slightly later in spring than in previous years which may have contributed to lower detectability due to less advertising calls following breeding. Future surveys should continue to monitor abundance to ensure the lower abundance recorded in 2020 is not the beginning of a decline.

As vegetation and habitat attributes in RWEA areas have remained relatively stable over time (see previous section), variability in diversity and abundance between years is likely explained by a combination of factors such as varying numbers of nomadic and migratory bird species, weather and climate, sampling methods, differences in the skill of observers, the timing of surveys and surveys coinciding with the flowering of trees and also broader landscape scale and seasonal changes across the Hunter Valley. The total number of bird species detected each year has varied over time and the 86 species recorded during 2020 is within the range of previous years.

There was no clear trend for threatened species overall, with Grey-crowned Babbler recorded at the most sites since recording, while other species were recorded at fewer sites (e.g. Varied Sittella) or absent (Little Lorikeet (*Glossopsitta pusilla*)). In 2019 Grey-crowned Babbler was recorded as having low abundance and to continue monitoring to ensure a population decline was not occurring. The 2020 results indicate no significant decline has occurred.

Although Varied Sittella was only recorded at one site during RWEA monitoring at fixed sites, the species was also recorded twice during the winter bird survey and once during surveys in the South Bates Underground Extension area indicating the species remains present across the site.

Little Lorikeet which had been present in the previous five years was not recorded in 2020. The paucity of eucalypt blossom across the site is likely to have been a factor in the absence of this nomadic, highly mobile nectar feeding species.

Following a high number of Dusky Woodswallow recorded in 2019, the result in 2020 is more in line with the usual number recorded. Evidence of successful breeding was recorded for Dusky Woodswallow at site BP25, with three chicks observed in nest and then several days later observed as fledglings in a tree nearby to the nest (Photograph 19).

Photograph 19 :Dusky Woodswallow fledglings at site BP25. Evidence of successful breeding of a threatened species within the RWEA D.

Figure 13: Bird monitoring locations and remnant woodland enhancement areas

Figure 14: Winter Bird Survey effort 2020

2.3 Nest box monitoring

2.3.1 Introduction

In 2018, a total of 50 nest boxes were installed in five clusters within RWEAs B, C and D (Figure 15). The nest boxes were installed in response to recommendations made in the 2015 Independent Environmental Audit, however no recommendations regarding monitoring were made.

In 2019, ELA recommended the establishment of a nest box monitoring program to document the use and effectiveness of the nest boxes and ensure they are maintained in usable condition. The BMP now details that nest boxes are to be inspected every two years. The 2020 nest box inspection represents the first survey of the next boxes since their installation, with the next inspection scheduled for 2022.

2.3.2 Methods

Nest boxes were inspected using a GoPro Hero7 camera attached to an extendable fibreglass pole. The camera was connected and controlled via Bluetooth where the surveyor could take photographs and video.

Due to their open bottom design, microbat boxes were inspected visually from the ground using binoculars, with the inside of the box illuminated by torchlight.

Details of species presence, indications of usage, and any maintenance issues/requirements were recorded.

Nest boxes were inspected by ELA ecologists Tom Schmidt and Dee Ryder on 4 and 17 November 2020.

2.3.3 Results

Five (10%) of the 50 nest boxes were occupied when inspected, each containing a single Common Brushtail Possum (*Trichosurus vulpecula*). An additional 18 (36%) nest boxes showed signs of use. Twenty-seven (54%) of the 50 next boxes showed no evidence of usage. Three nest boxes had fallen to the ground and should be re-erected/replaced.

Nest box monitoring results are presented in Table 13, with inspection photographs in Volume 2.

Table 13: Nest box inspection results 2020

Box ID	RWE A	Target Species	Tree Species	Height (m)	Aspect	Northing	Easting	Fauna species	Notes
1	D	Glider	Slaty Gum	3.5	NW	6394218	307696		Evidence of usage, chewing at entrance
2	D	Small Parrot	Slaty Gum	3.5	W	6394231	307730		Evidence of usage, leaves in nest box
3	D	Small Parrot	Slaty Gum	3.5	SE	6394292	307785		Evidence of usage, leaves in nest box
4	D	Glider	Ironbark	4	NW	6394328	307746		Evidence of usage, chewing at entrance
5	D	Microchiropteran Bat	Slaty Gum	4.5	S	6394277	307747		No evidence of usage
6	D	Microchiropteran Bat	Slaty Gum	5	N	6394217	307720		No evidence of usage
7	D	Galah	Slaty Gum	5	W	6394189	307726	Common Brushtail Possum	Occupied
8	D	Galah	Slaty Gum	4	NW	6394298	307752	Common Brushtail Possum	Occupied
9	D	Pygmy Possum	Ironbark	3	S	6394312	307822		No evidence of usage
10	D	Pygmy Possum	Slaty Gum	3	SW	6394195	307769		Evidence of usage, leaves in nest box
11	C	Small Parrot	Grey Box	3.5	NW	6393256	308564		Evidence of usage, chewing at entrance, woodchips arranged in nest
12	C	Small Parrot	Ironbark	3.5	W	6393198	308596		No evidence of usage
13	C	Glider	Grey Box	3	E	6393262	308624		Evidence of usage, chewing at entrance
14	C	Microchiropteran Bat	Ironbark	5	S	6393229	308601		No evidence of usage
15	C	Microchiropteran Bat	Ironbark	5.5	W	6393278	308664		No evidence of usage
16	C	Pygmy Possum	Grey Box	3	S	6393244	308689		No evidence of usage
17	C	Galah	Ironbark	5	W	6393205	308574	Common Brushtail Possum	Occupied
18	C	Pygmy Possum	Ironbark	3	W	6393204	308625		No evidence of usage

Box ID	RWEA	Target Species	Tree Species	Height (m)	Aspect	Northing	Easting	Fauna species	Notes
19	C	Galah	Ironbark	5.5	W	6393218	308640		Evidence of usage, woodchips arranged in nest
20	C	Glider	Grey Box	3	E	6393279	308587		Evidence of usage, chewing at entrance
21	B	Pygmy Possum	Ironbark	3	SW	6392720	308929		No evidence of usage
22	B	Pygmy Possum	Ironbark	3	SW	6392678	308927		Evidence of usage, chewing at entrance
23	B	Microchiropteran Bat	Ironbark	5	NW	6392628	308900		No evidence of usage
24	B	Small Parrot	Ironbark	4.5	W	6392604	308870	Common Brushtail Possum	Evidence of usage, chewing at entrance
25	B	Microchiropteran Bat	Ironbark	4.5	W	6392641	308928		No evidence of usage
26	B	Glider	Ironbark	3.5	N	6392612	308852		No evidence of usage
27	B	Glider	Ironbark	3.5	W	6392656	308831		No evidence of usage
28	B	Galah	Ironbark	5.5	W	6392691	308840		Evidence of usage, woodchips arranged in nest
29	B	Galah	Ironbark	5	SW	6392728	308933		Evidence of usage, Common Brushtail Possum spray
30	B	Small Parrot	Ironbark	5	S	6392717	308894	Common Brushtail Possum	Evidence of usage, chewing at entrance
31	B	Galah	Ironbark	5	NW	6392064	308729		No evidence of usage
32	B	Galah	Ironbark	5	W	6392098	30867		Evidence of usage, woodchips arranged in nest
33	B	Pygmy Possum	Ironbark	3	W	6392077	308686		No evidence of usage
34	B	Pygmy Possum	Grey Box	3	E	6392126	308664		No evidence of usage
35	B	Small Parrot	Grey Box	4	SW	6392042	308632		No evidence of usage
36	B	Small Parrot	Ironbark	4.5	E	6392021	308735		No evidence of usage
37	B	Microchiropteran Bat	Ironbark	5.5	W	6392018	308653		No evidence of usage
38	B	Microchiropteran Bat	Ironbark	3	W	6392060	308702		No evidence of usage

Box ID	RWE A	Target Species	Tree Species	Height (m)	Aspect	Northing	Easting	Fauna species	Notes
39	B	Glider	Spotted Gum	4	SW	6392025	308629		Nest box fallen, termites in nest box.Box requires replacement.
40	B	Glider	Spotted Gum	4	NW	6392067	308629		No evidence of usage
41	B	Microchiropteran Bat	Spotted Gum	5	E	6390496	308641		No evidence of usage
42	B	Microchiropteran Bat	Spotted Gum	5	SW	6390494	308587		No evidence of usage
43	B	Galah	Spotted Gum	4	W	6390459	308571		Nest box fallen, Common Brushtail Possum scat. Nest box re-useable.
44	B	Galah	Spotted Gum	5	W	6390504	308602		Nest box fallen. Nest box re-useable.
45	B	Pygmy Possum	Spotted Gum	3	W	6390438	308629		No evidence of usage
46	B	Pygmy Possum	Grey Box	3	SW	6390499	308685		No evidence of usage
47	B	Glider	Ironbark	3	SW	6390525	308617		Evidence of usage, leaves in nest box
48	B	Glider	Spotted Gum	4.5	SW	6390493	308658		Evidence of usage, leaves in nest box
49	B	Small Parrot	Ironbark	4	W	6390441	308609		No evidence of usage
50	B	Small Parrot	Spotted Gum	5	W	6390478	308734		Evidence of usage, leaves in nest box, chewing at entrance

2.3.4 Discussion

This report represents the first inspection of nest boxes within the RWEAs since their installation in 2018. Nest boxes were generally in good condition, with some occupied, others with signs of use and three of the 50 requiring re-installation/replacement after falling.

All five of the occupied nest boxes contained the same species, Common Brushtail Possum, which is a common species and not a target of the nest box program. Future monitoring should continue to investigate potential use by other species, in particular the target species and threatened species.

Evidence of usage was recorded in a higher number of boxes than those that were occupied. Inspection earlier in spring may increase the likelihood of detecting other species using nest boxes for breeding.

The three nest boxes that have fallen should be re-installed/replaced with the same type of nest box as soon as possible. It is recommended that the nest boxes are installed with the wire loop going around the tree is positioned above a branch so that they will not slip down the trunk to the ground.

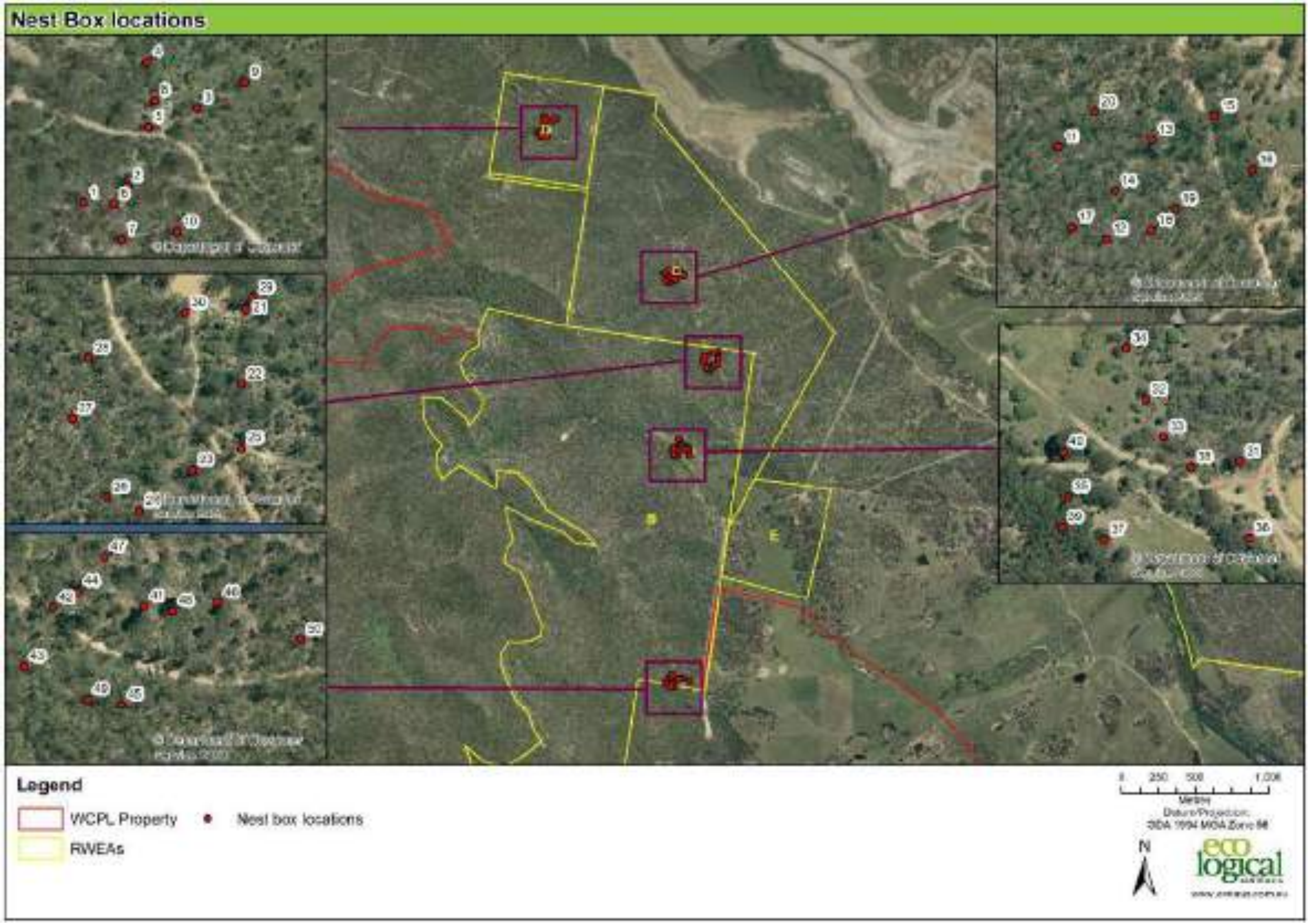

Figure 15: Nest box locations

3. Rehabilitation areas

3.1 Introduction

Rehabilitation areas are monitored using a combination of LFA and biometric plots (woodland rehabilitation areas and North Wambo Creek Diversion).

LFA is currently used to monitor the progress of the North Wambo Creek diversion, woodland rehabilitation and pasture rehabilitation towards achieving a suitable condition for their intended land use post-mining. The rehabilitation objectives for the North Wambo Creek Diversion (WCPL 2015) include:

- To establish pasture species consistent with revegetation strategy
- Tree species established along creek lines consistent with the riparian zone
- Creek diversion stable and will not present a greater safety hazard than surrounding land
- Creek diversion able to shed water safely without causing excessive erosion, jeopardising landform integrity or increasing pollution of downstream watercourses
- All watercourses subject to subsidence impacts shall be hydraulically and geomorphologically stable, with riparian vegetation established that is the same or better than prior to commencement of mining.

Completion criteria for the North Wambo Creek diversion, mixed woodland/pasture areas and woodland corridors for LFA have been developed using previous monitoring results from relatively undisturbed and natural landscapes surrounding the mine. These are listed in each results table below.

Additional completion criteria for these rehabilitation areas are listed in the Mining Operations Plan (WCPL, 2015) and include ensuring that:

- Minimum 70% of area has a vegetative cover
- No single bare area >20m^2
- Biometric monitoring confirms exotic cover <33%
- No tunnel or gully erosion is to be present
- Rill erosion is to be limited to <200 mm deep and/or <200 mm wide.

Woodland rehabilitation monitoring sites currently occur within plantings of *Eucalyptus cladocalyx* (Sugar Gum) that do not match up with the species composition of natural vegetation communities surrounding the mine and completion criteria based for biometric monitoring has also been developed for these areas. As existing woodland rehabilitation areas have been designed and implemented applying old techniques that do not reflect the current best practice of utilising species of local provenance, performance criteria for these older rehabilitation areas have been developed by modifying condition benchmarks for *Grey Box –Slaty Box shrub – grass woodland*, which is expected to have a similar vegetation structure, albeit different species composition, to the mature rehabilitated woodland community.

LFA monitoring at WCPL focusses on scores for Landscape Organisation, Stability, Infiltration/Runoff and Nutrient Cycling. **Landscape organisation** relates to the proportion of the transect occupied by patches - patches being landscape elements that are relatively permanent and provide stable, resource accumulating structures, such as grassy tussocks and other ground cover, leaf litter and logs. Therefore, a larger Landscape Organisation Index (LOI) number implies a more stable transect that traps water and nutrients and is less prone to soil erosion.

A Soil Surface Assessment (SSA) is completed for each patch type on each LFA transect. Five 'query zones' are selected for each patch type where possible. Scores are recorded for rain splash protection, vegetation cover, plant litter cover, cryptogam cover (cover of algae, mosses and liverworts, lichen and fungi), crust brokenness, erosion type and severity, deposited materials, surface roughness, surface nature and the stability and texture of the soil. These soil surface indicators are then used to give Stability, Infiltration/Runoff and Nutrient Cycling scores for each transect.

Stability is defined as the ability of the soil to withstand erosive forces, and to reform after disturbance. The stability index is derived from data collected during the SSA's, such as crust broken-ness, surface resistance, slake tests, erosion type and severity, deposited materials, cryptogam cover, rain splash protection and leaf litter cover.

Infiltration concerns the way water interacts with soil to become soil water (and becomes available for plants) or runoff water where water is lost from the system or transports materials (such as soil, nutrients and seed) away. Scores for vegetation cover, surface roughness, slake tests, litter cover, origin and decomposition, surface resistance to disturbance and soil texture contribute to the infiltration index.

Nutrient cycling is defined as how efficiently organic matter is cycled back into the soil. Scores for vegetation cover, litter cover, origin and decomposition, cryptogam cover and surface roughness contribute to nutrient cycling values.

3.2 Methods

3.2.1 Landscape Function Analysis

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 16**). LFA methods followed the method for Landscape organisation and SSA, as provided in Tongway and Hindley (2004). LFA data was collected between 14-18 September 2020 by ELA ecologists Tom Schmidt and Dee Ryder.

One site (6R Woodland) was adjusted in 2020. This site was moved to similar age and condition woodland rehabilitation approximately 35 m from the original location due to the existing monitoring site being removed as part of the construction of the adjacent Wambo United Mine project. Refer to previous reports (ELA 2017, 2018, 2019) for past site adjustments.

Raw numerical values from previous years were available for Landscape organisation, Stability, Infiltration and Nutrient cycling indices. Data for pasture and woodland sites was available for the 13 monitoring periods from 2006 – 2018, while creek diversion sites were first sampled at the completion of the creek diversion construction and subsequent seeding in 2008. Trends in these values over time along with general field observations were used to inform management recommendations.

Performance criteria have previously been developed from a range of scores from previous monitoring years from nearby sites with relatively undisturbed riparian habitat. The following colour system is used to highlight the performance of each LFA site as shown below in **Table 14.**

Table 14: Colour system devised to highlight the performance of each LFA site

Green	Yellow	Orange	Red
Area generally meets or exceeds target values and values do not show trend of decline over time – where monitoring sites are meeting targets and values are relatively consistent, reduce monitoring to infrequent LFA when changes in landscape or management practices occur i.e. fire or grazing)	Area generally falls below target values but within 75% of targets or appears to be on a trajectory of improvement without the need for management intervention – further monitoring required	Area generally falls between 75% and 50% of target values or shows little sign of improvement over several monitoring events – further monitoring and possibly management actions required	Area falls below 50% of target and is unlikely to improve without management actions or shows trend of decline which is unlikely to improve without management actions

3.2.1.1 Future use of Landscape Function Analysis

The use of LFA for future monitoring of rehabilitation areas is currently under review following recommendations made by the Biodiversity Conservation Division (BCD) of the NSW Department of Planning, Industry, and Environment (DPIE) on the Wambo Coal Mine Phase 2 Rehabilitation Management Plan (RMP). BCD suggested the use of LFA should be reconsidered as recent peer reviewed articles have indicated LFA may not be appropriate for monitoring post mining landscapes (Erskine et al. 2013).

Any changes to the proposed monitoring methodology for rehabilitation at the Wambo mine will be incorporated into an updated Biodiversity Management Plan (BMP) for approval prior to implementation.

3.2.2 Floristic monitoring

Floristic monitoring is undertaken using the BioMetric plots as described in **Section 2.1.2**. Four sites are sampled within woodland rehabilitation areas and two new sites were established within the North Wambo Creek Diversion (NWCD) in 2020 (Figure 2).

Woodland rehabilitation areas were sampled as per the previous monitoring design, with four LFA monitoring locations at sites 3R, 4R, 6R and 8R. Site 6R was moved approximately 30m west to a new site (6R new) as the old site had been mostly cleared as part of the Wambo United mine project.

Floristic monitoring targets for the NWCD have been derived from the NWCD Revegetation Management Plan (Cumberland Plains Seeds 2019). are based on combination of Benchmark Values for River Red Gum/ River Oak riparian woodland wetland in the Hunter Valley and Narrow-leaved Ironbark–Grey Box – spotted gum shrub grass open forest of the central and lower hunter. The exotic plant cover target has been modified to match the performance criteria for the NWCD from the Wambo Mining Operation Plan (WCPL, 2015).

Refinement of floristic monitoring locations and target values within the NWCD may be appropriate following additional remediation and revegetation works planned during 2020-2025 under the NWCD Management Plan (WCPL, 2020). The original intention of the NWCD was to establish riparian vegetation, however analysis of soils and water flows has indicated that a combination of woodland and riparian vegetation is more appropriate (WCPL, 2020). Additional monitoring may also assist in identifying success or issues with early stage revegetation. Utilising several 1x1m quadrats to count density of native species as an extra step at each BioMetric plot is recommended as a method to monitor early stage revegetation in the NWCD Revegetation Management Plan (Cumberland Plains Seeds, 2019).

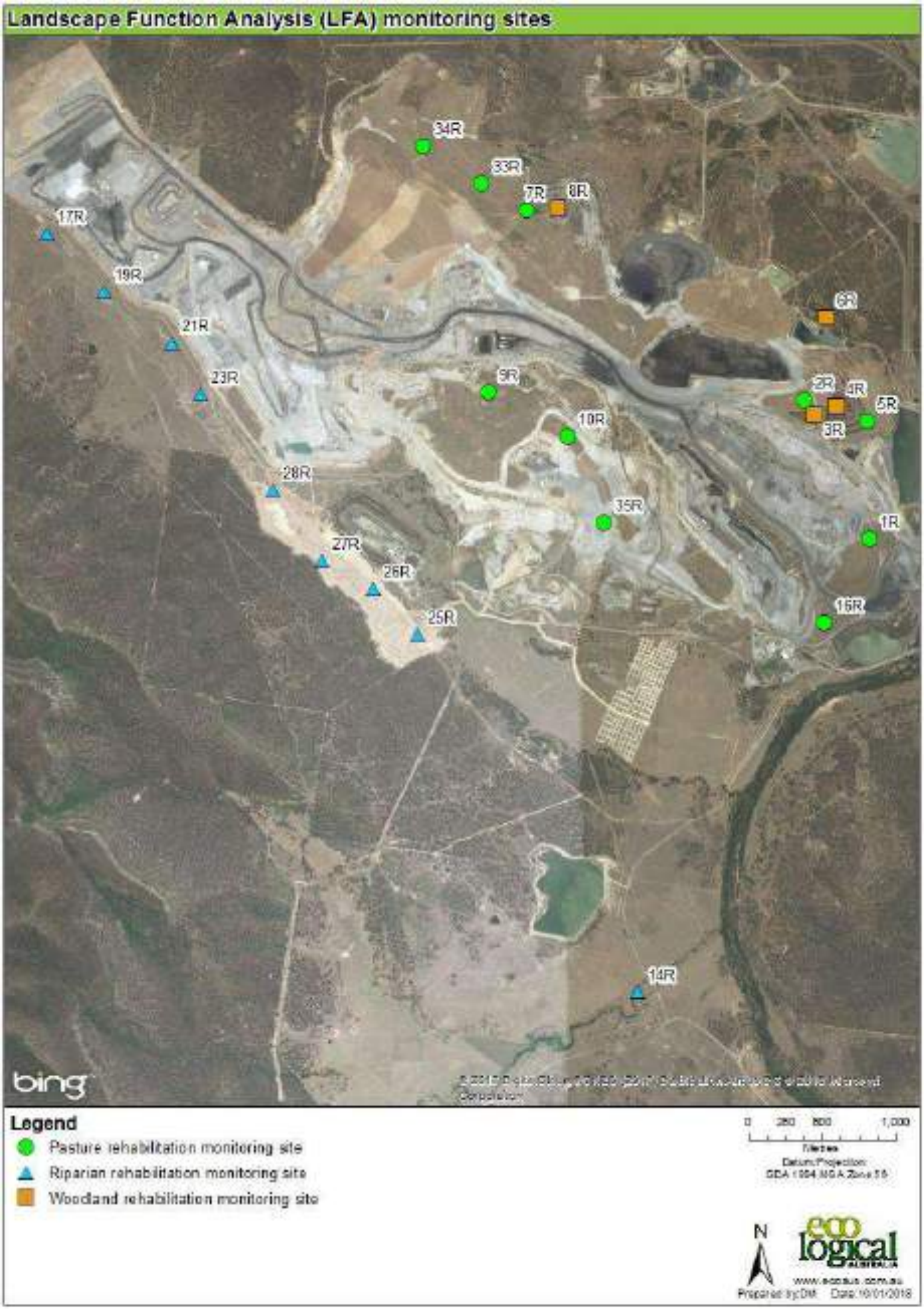

Figure 16: LFA monitoring sites

3.3 Results

3.3.1 North Wambo Creek Diversion

3.3.1.1 Landscape Function Analysis

Monitoring sites within the NWCD area are variable in condition (Table 15), with monitoring sites described in **Table 16**. All monitoring sites are open pasture areas and generally have few native plant species and consist of predominantly low grass, primarily *Cynodon dactylon* (Common Couch), with tussocks of *Chloris gayana* (Rhodes Grass) and *Setaria* sp. Native *Acacia* sp. and *Eucalyptus* sp. seedlings and shrubs observed in the south of the diversion area as a result of direct seeding works are continuing to grow and develop in some areas (Photograph 20). Natural establishment of *Casuarina cunninghamiana* and *Eucalyptus* sp. in the creek bed, particularly in the north of the creek diversion, also continues. Erosion was observed in some areas of the creek channel, including gully erosion (Photograph 21).

It is important to note that significant soil remediation works have been undertaken at the NWCD during 2020 by the NSW Soil Conservation Service (Photograph 22). No remediation works had been undertaken at LFA transects prior to the surveys.

Photograph 20: North Wambo Creek Diversion during 2020 at site 25R showing grasses with native shrubs and some bare soil

Photograph 21: Gully erosion within the North Wambo Creek Diversion (near site 23R) in 2020

Photograph 22: Example of active soil remediation work in the North Wambo Creek Diversion area in 2020

Table 15: North Wambo Creek Diversion LFA results in 2019 (Plots are organised by location - upstream to downstream)

Monitoring Plot	LOI	ST	INFI	NI
17R	0.86	57.0	28.6	25.0
19R	0.82	62.2	26.5	24.3
21R	0.89	58.8	35.4	30.6
23R	0.43	46.6	33.1	19.4
28R	0.87	60.0	32.7	29.5
27R	0.60	50.0	29.5	23.0
26R	0.84	59.5	33.8	31.9
25R	0.83	52.0	31.8	22.3
Average score	0.77	55.76	31.43	25.75
Target score	>0.84	>62	>41	>37
14R (reference site)	1	71.5	56.2	47.7

The average **LOI** score did not meet the performance target, although the scores continue on a trajectory of improvement.

Site 23R continues to have the lowest LOI score, resulting from a bare slope in the middle of the transect, which is a lower slope of the broader creek diversion channel. Site 23R and adjacent areas have issues with erosion (also noted in previous reports), with rills, scalds and eroding creek banks recorded close by. Several rills are likely to exceed the depth specified in the completion criteria in regard to erosion control (WCPL 2015). In 2020, soil remediation works were being undertaken in the vicinity of these areas.

Site 27R recorded a large reduction in LOI score following an increase the previous year. The fluctuation at this site is due to the presence of patches of bare soil which were previously scored as litter. Small woodchips which were present have now decomposed and/or washed away. Monitoring sites 27R and 28R have previously been ripped and reshaped in an effort to control weeds, establish cover and prevent erosion. Low grass remains present on the ripped slope at Site 27R.

The reference site 14R recorded a significant increase in score from 0.39 in 2019 to 1 in 2020 (indicating no bare soil). Of note is that this site also had a score of 1 in 2018 suggesting regular fluctuations of ground cover vegetation at this site. In 2020 the ground cover was predominantly exotic annual species which have flourished in response to the higher rainfall in 2020.

LOI scores generally increased or were similar to recent years at most monitoring sites and the average scores show a trend towards achieving the performance criteria. The general increase in ground cover vegetation was driven by annuals at many sites, although underlying perennial grasses were regularly present. The addition of four sites in the more recently constructed southern portion of the diversion during 2015 is observable in the data via a drop in LOI scores and the very low scores reported from the first monitoring year in 2008 may reflect the bare soil of the newly created diversion followed by the establishment of a cover crop in the following years (**Figure 17**).

The average **stability** index at creek diversion sites in 2020 did not meet the performance target, however the score is very close to the target and has remained similar over time (Figure 18). The overall average stability index decreased very slightly, but this not considered to represent any significant change in conditions at the sites. The lowest stability scores were recorded at the sites 23R, 27R and 25R. Site 25R recorded the largest reduction in stability score, from 66% in 2019 to 52% in 2020. This reduction is contributed by minor increase in erosion at the site likely following the high rainfall in 2020. The average stability index (56%) is lower than the score recorded at the analogue site 14R (72%) which also recorded the highest score.

The average **infiltration** index was 31% and fell below the performance target of 41%. This is a slight drop from the previous year (**Figure 19**). Sites 21R and 28R recorded slight increases in infiltration index, and all other sites recorded decreases. The overall decrease in infiltration score suggests a minor increase in propensity for water to run-off from the site rather than enter the system as soil-water. This result may be caused by higher rainfalls in 2020 increasing run-off and affecting the infiltration indicators such as litter cover which had built up over drier times, and surface roughness. Analogue site 14R achieved the target score.

The average **nutrient** index was 26% and fell below the performance target of 37%. This result is slight drop from the previous year (**Figure 20**). Sites 21R and 28R recorded slight increases in infiltration index, and all other sites recorded decreases. The overall decrease in nutrient index suggests the system is less efficient at cycling organic matter back into the soil. This result may be caused by higher rainfalls in 2020 increasing run-off and affecting the nutrient indicators such as litter and cryptogam cover, perennial basal cover and surface roughness. Analogue site 14R achieved the target score.

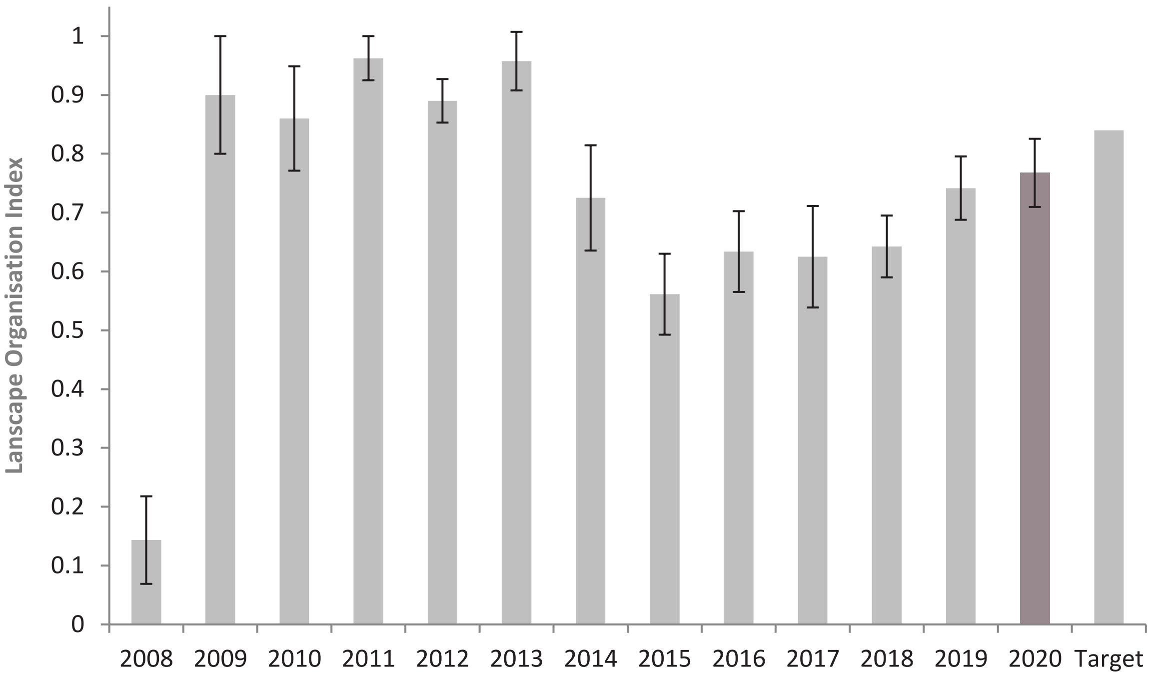

Figure 17: Average landscape organisation scores from the creek diversion sites. Average scores onwards from 2015 incorporate four additional sites (25r, 26R, 27R and 28R). Error bars represent standard error of the mean. Only 3 sites 19R, 21R and 23R were sampled in 2008. The target bar represents completion criteria for the Landscape Organisation Index.

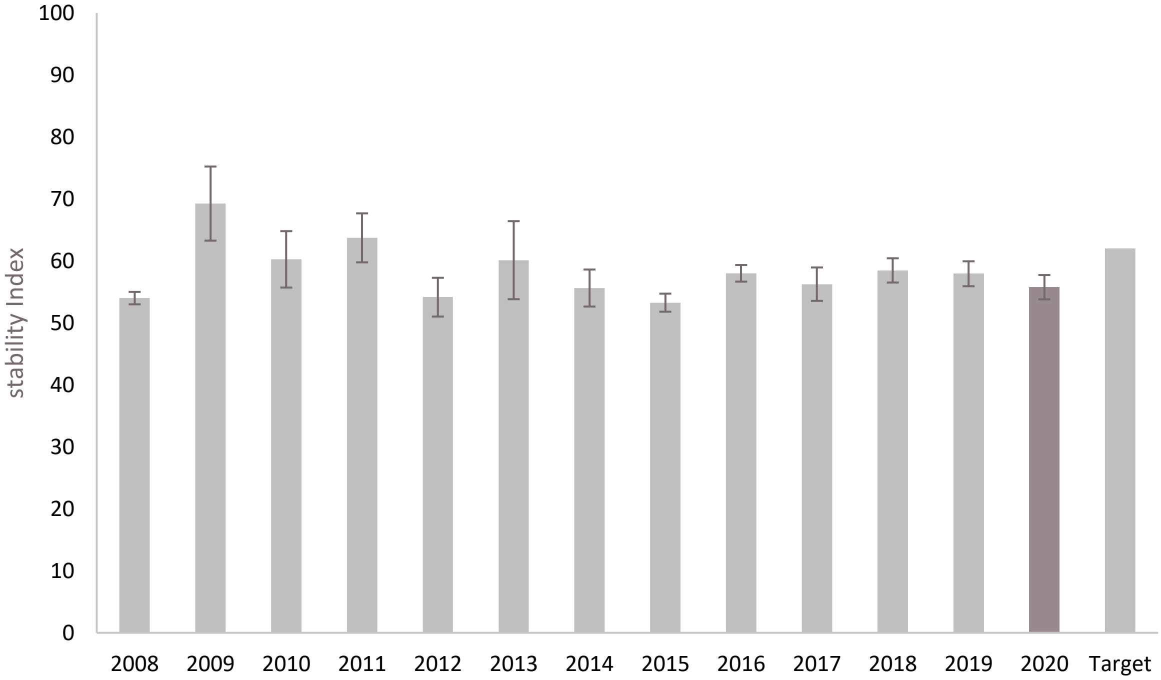

Figure 18: Average stability index values from the creek diversion sites. Values are derived from sites 17r, 19r, 21r and 23r each year since 2009-2014. Average scores from 2015 onwards incorporate four additional sites (25r-28r). Error bars represent standard error of the mean. Only sites 19R, 21R and 23R were sampled in 2008. The target bar represents completion criteria for the Stability Index.

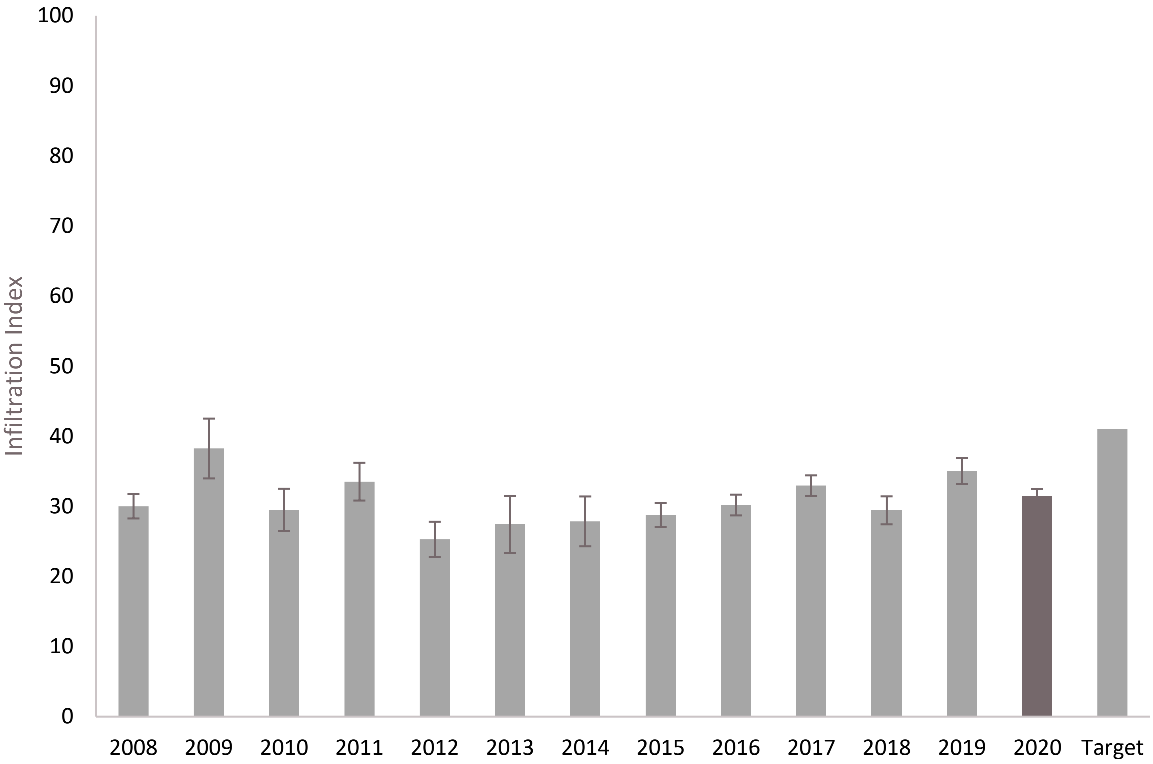

Figure 19 : Mean infiltration index values from the creek diversion sites. Values are derived from sites 17r, 19r, 21r and 23r each year between 2009 -2014. Average scores from 2015 onwards incorporate four additional sites (25r-28r). Error bars represent standard error of the mean. Only sites 19R, 21R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

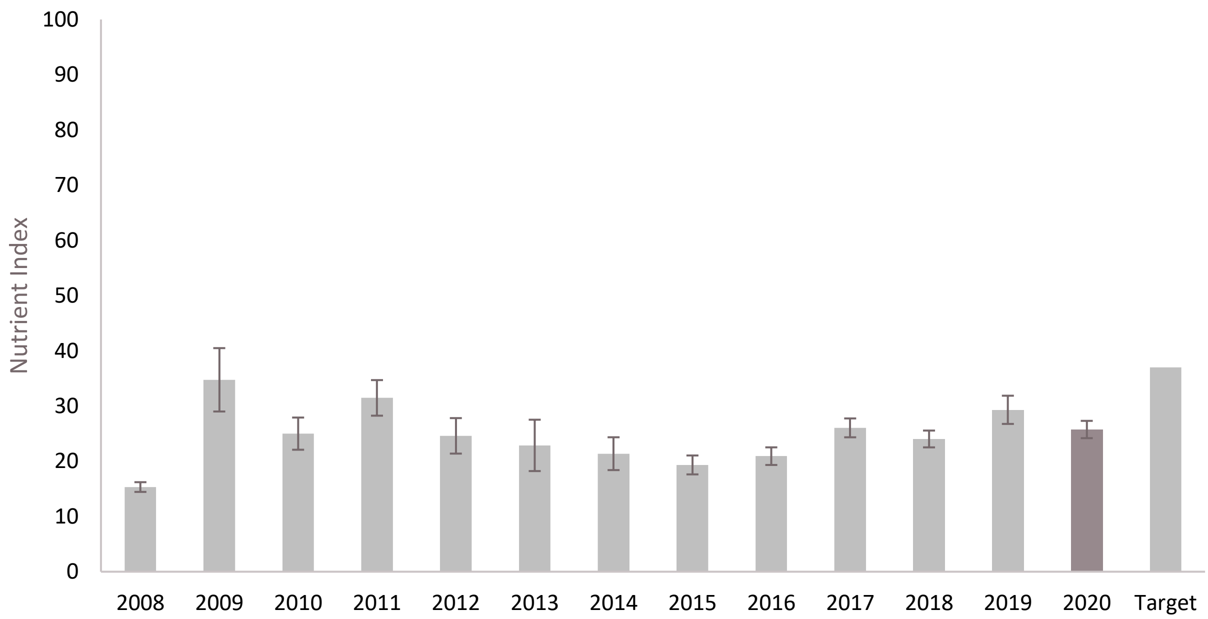

Figure 20: Mean nutrient index values from the creek diversion sites. Values are derived from sites 17r, 19r, 21r and 23r each year between 2009 -2014. Average scores from 2015 onwards incorporate four additional sites (25r-28r). Error bars represent standard error of the mean. Only sites 19R, 21R and 23R were sampled in 2008. The target bar represents completion criteria for the Nutrient Index.

Table 16: Site description of each creek diversion transect

Transect	Notes	Photograph
17R	This transect consists of relatively flat ground covered in pasture. Low grass (primarily *Cynodon dactylon*) and grass tussocks (primarily exotic *Chloris* gayana), together with high cover of annual ground covers make up 86% of the transect. An increase in annual ground cover was recorded following the wet year.	
19R	Transect relatively flat and comprised primarily of low grass (78%) and Galenia (4%), dispersed with patches of bare soil (18%). The appearance and scores are similar to the previous year. Young *Eucalyptus* and *Acacia* species are growing on creek banks downstream. Evidence of ripping activity from 2018 is visible near this transect, and the soil has been disturbed by vehicle tracks.	
21R	Transect relatively flat grassland dominated by annuals, low grass and Galenia (89%) with bare soil (11%). An increase in annual cover and decrease in bare ground was recorded from the previous year.	

Transect	Notes	Photograph
23R	Low grass occurs over 40% of the transect, similar to 2019. Large bare patches of stony soil occur towards the middle and end of transect where there is a slope. Bare soil patches cover 57% of the area. Some areas of active erosion including some 30cm deep rills occur in the surrounding area. The creek bank is in this area has been undercut and there is slumping on western bank. Regenerating *Casuarina cunninghamiana* (up to 8m) and some Eucalypts and *Acacia* sp. are present in and near the channel.	
28R	Transect primarily samples the relatively steep eastern creek bank. The majority of this transect was ripped to control *Galenia pubescens* and erosion prior to the 2017 monitoring. The dominant components were low grass 87 % and bare soil (13%), an increase in grass cover from the previous year. This transect was subject to soil remediation works by the Soil Conservation Service following the survey in 2020.	
27R	Transect samples the relatively steep western bank of the cutting. The majority of this transect was ripped to control *Galenia pubescens* and erosion prior to the 2017 monitoring. Low sparse grasses and logs dominate the flat area adjacent to the creek channel. The transect is dominated by low grass (47%) and tussocks (10%). Bare soil (40%) has increased from 2019, which corresponds to a loss of litter. Litter at this transect previously comprised small woodchips which have now decomposed and washed away. The low grass *Cynodon dactylon* is moderately established at the site.	

Transcect	Notes	Photograph
26R	Transect samples the relatively steep eastern bank to the edge of the creek channel. Low grass (56%) and tussocks (17%) dominated this transect in 2020. Bare soil areas (17%) and logs (8%) make up the remainder. The transect remained essentially unchanged from 2019. A*cacia* sp. shrubs are continuing to establish on some sections of the bank near this transect.	
25R	This slope is relatively steep with low grass dominating 74% of transect and having the highest contribution to soil stability. Bare soil is most prevalent at the top of transect where some minor erosion is occurring and makes up 17% of the transect. Large tussock grasses (*Chloris gayana*) and logs are present at the bottom of the transect near the creek channel. Overall scores were very similar to 2019. *Acacia* sp. shrubs are continuing to develop on the bank near this transect.	

3.3.1.2 Floristic monitoring

Two floristic monitoring sites were established within the NWCD area in 2020 (**Figure 2;** Photograph 23 **and** Photograph 24). Results of the floristic monitoring are presented in Table 17.

Results in relation to the performance criteria were mixed. NGCG met the target and OR was recorded at both sites which is a positive result. A moderate diversity of native species was recorded, although the target was not reached. EPC exceeded the target. Interrogation of floristic plot data suggests a significant proportion of the EPC is attributable to annual species such as *Centaurium tenuiflorum* and *Lysimachia arvensis*, which is of lower concern than weed cover from perennials. NOS and NMS targets were not met however these are likely to take longer to reach for rehabilitation.

These results represent the first floristic monitoring undertaken within the NWCD. Ongoing monitoring will provide further insights into the vegetation condition and trajectory. Inclusion of additional monitoring sites and methods is likely to assist assessment of the vegetation condition and performance.

Table 17: Biometric scores for NWCD moniotring sites and performance criteria

Plant Community Type (PCT)	Plot Name	NPS	NOS (%)	NMS (%)	NGCG	NGCS	NGCO	EPC	OR	HBT	FL
Target: PCT 42: River Red Gum / River Oak riparian woodland wetland in the Hunter Valley	NWCD1	13	0	0	10	0	0	76	1	0	67
	NWCD2	16	0	0	42	0	6	24	1	0	3
Average value		14.5	0	0	26	0	3	50	1	0	35
Performance criteria		>20	10-50	10-50	20-60	1-5	5-30	<33	1	-	-

Photograph 23: NWCD Biometric Plot 1 in 2020

Photograph 24: NWCD Biometric Plot 2 in 2020

3.3.2 Woodland rehabilitation

3.3.2.1 Landscape Function Analysis

LFA scores fell within the range of the recorded scores from three reference sites sampled over 5 years starting in 2010 and ending in 2014. Results are presented in **Table 18,** with site descriptions in Table 19.

Sites 6R (new) was the highest performing site and met all performance targets, with the entire transect containing leaf litter and no areas of bare soil leading to a maximum LOI score of 1. LOI at sites 3R and 8R did not meet the performance targets, with these sites having large areas of exposed bare soil, although the values were within the range previously recorded at reference sites. Leaf litter was the main patch type at all woodland rehabilitation sites and the main contributor to stability of soil, water infiltration/runoff and nutrient cycling.

Both photos taken at the sites and collected data, show that these sites have remained quite stable over the last six years notwithstanding the dieback of *Acacia saligna* and growth of trees (Photograph 25 **and** Photograph 26).

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.

The average score across woodland monitoring sites were analysed. LOI was lower than the target score with a very slight improvement on scores from previous years and a continued trajectory toward the target (Figure 21). The stability score was slightly higher than the previous year and was just below the target (Figure 22). Woodland monitoring plot score averages recorded in 2020 achieved target scores for both infiltration and nutrient indices (Figure 23 **and** Figure 24).

Table 18: LFA scores and performance criteria for woodland rehabilitation areas

Monitoring Plot	LOI	SI	INFI	NI
3R	0.68	46.1	42.5	37.2
4R	0.95	55.9	38.6	36.9
6R (new)	1	72.2	65.3	64.9
8R	0.74	57.9	45.1	41.2
Average score	0.84	58	47.9	45.1
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

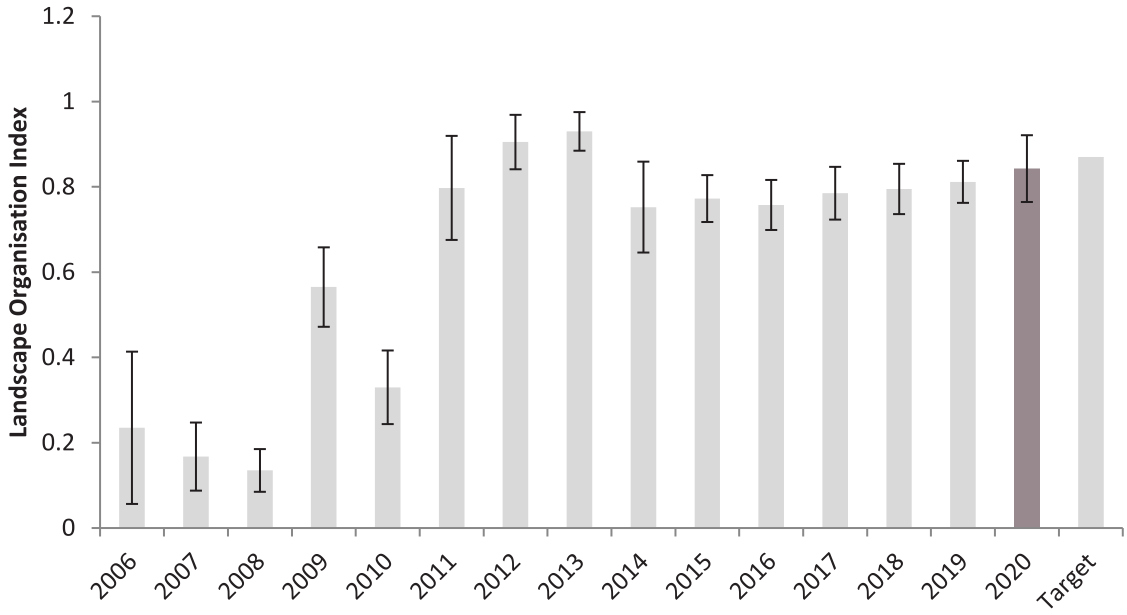

Figure 21: Average landscape organisation scores across the four woodland rehabilitation sites since 2006

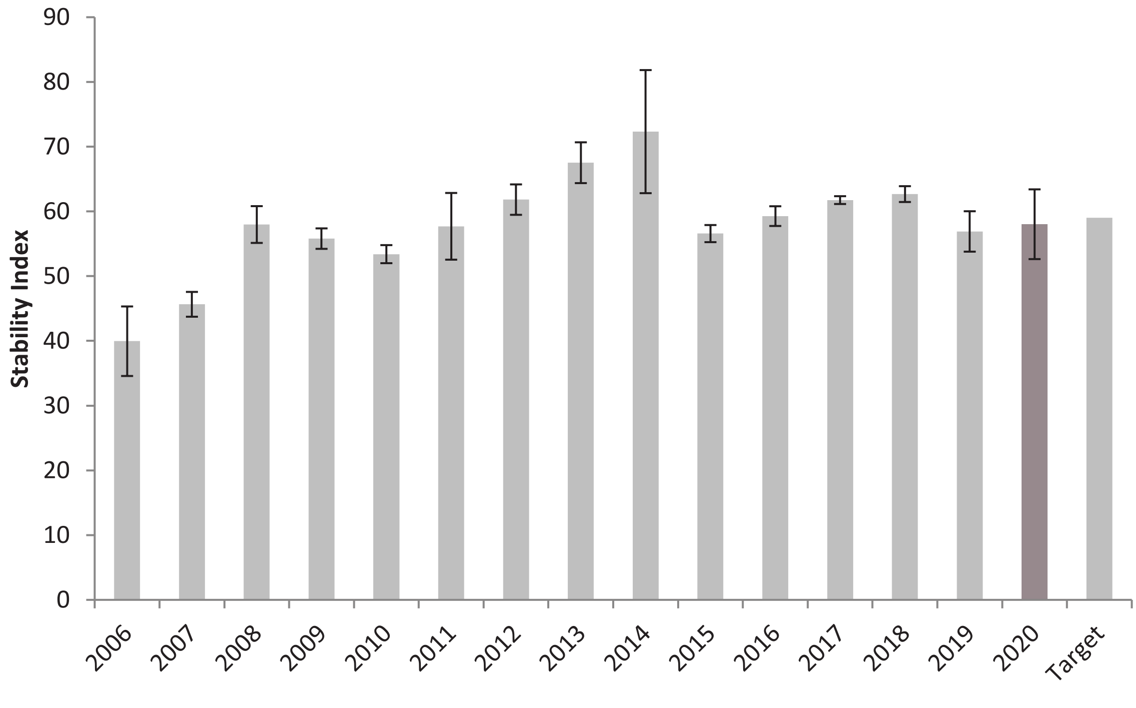

Figure 22: Average stability scores across the four woodland rehabilitation sites 2006-2020

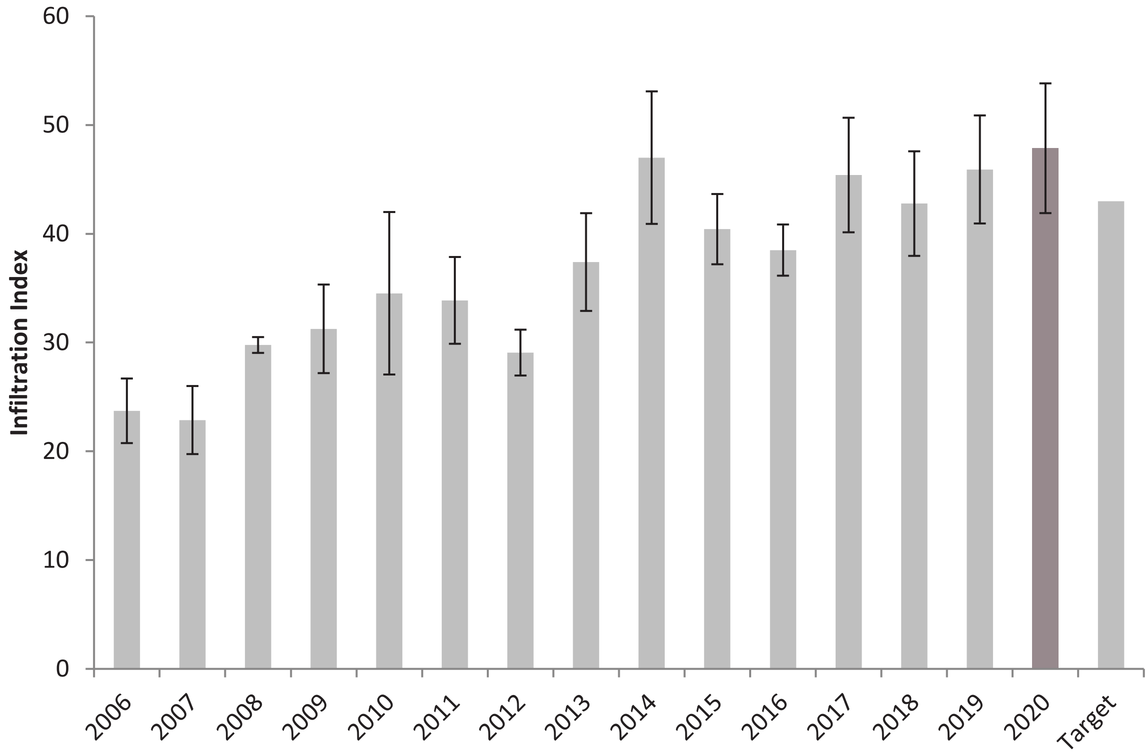

Figure 23: Average infiltration scores across the four woodland rehabilitation sites 2006-2020

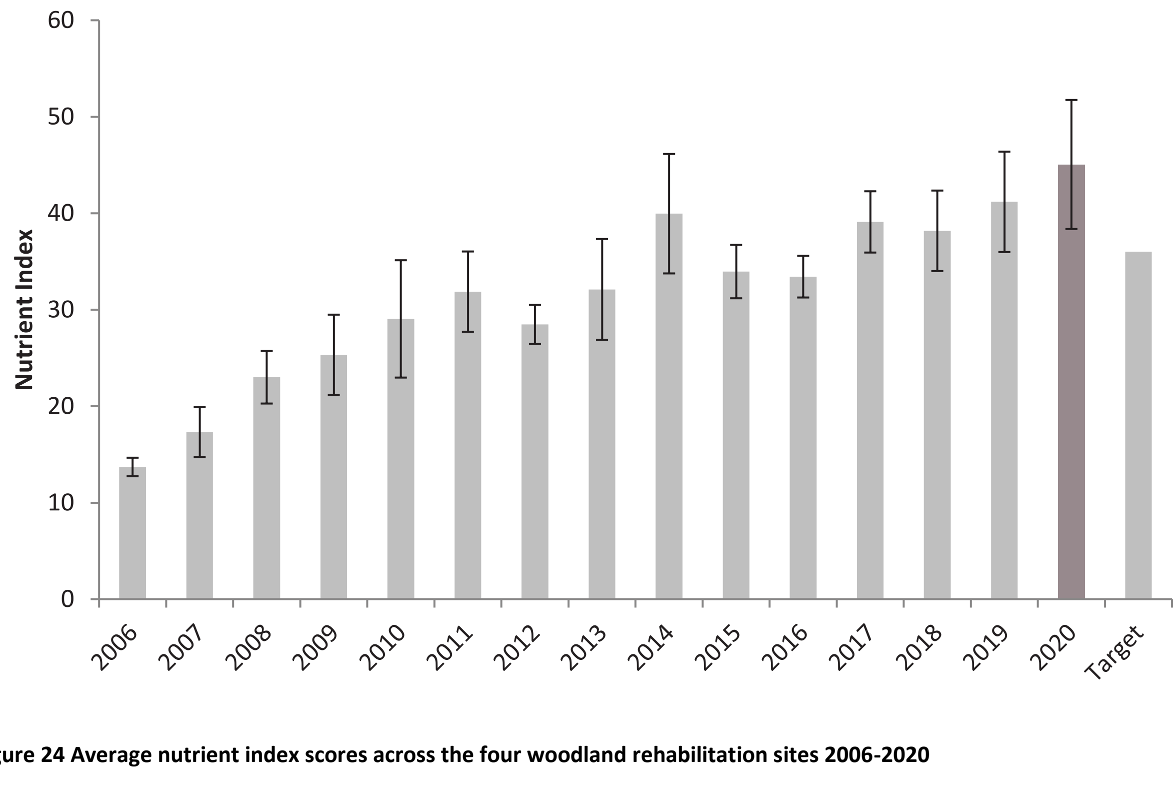

Figure 24 Average nutrient index scores across the four woodland rehabilitation sites 2006-2020

Photograph 25: Site 3R during 2014

Photograph 26: Site 3R during 2020

Table 19: Site description of each woodland rehabilitation transect

Transect	Notes	Photograph (2020)
3R	A relatively flat transect through a planting of *Eucalyptus cladocalyx*. Scattered and sparse *Corymbia maculata* are also present. Eight native groundcover species were recorded in the 20 x 20 m plot, although the cover of these species remains very sparse, such as <5 individuals. Leaf litter is the major patch type making up 66% of the LFA transect with bare rocky soil areas covering 31%. The weed *Opuntia sp.* (Prickly pear) is scattered around the site and makes up 3%.	
4R	This transect travels along a small ridge and slopes slightly towards the end. The transect is surrounded by plantings of *Eucalyptus cladocalyx* and *Corymbia maculata*. Ground cover vegetation is very sparse to absent across the plot. Leaf litter is the major patch type on the LFA transect, covering 79% of the transect. Patches of bare soil make up 5%, with logs making up the remainder.	
6R (new)	This site is new in 2020, and is located 35m west of the previous site 6R. The site was moved as the previous site was cleared. This site has a canopy of *Eucalyptus cladocalyx, E. fibrosa* with a ground cover dominated by leaf litter (100%). Nine native ground cover species were recorded in the 20x20m plot and the weed *Galenia pubescens* also occurs in small patches.	

Transect	Notes	Photograph (2020)
8R	This transect is located on a lightly sloping site with plantings of *Eucalyptus cladocalyx* and *Corymbia maculata*. Epicormic growth was observed in 2020. Fourteen native ground cover species were recorded in 2020, these are very sparse and generally present as < 5 individuals within the 20x20m plot. Leaf litter covers 74% of the transect length, with the remainder 26% bare soil. The site has remained similar over time.	

3.3.2.2 Floristic monitoring

Vegetation in woodland rehabilitation areas consists primarily of *Eucalyptus cladocalyx* and occasionally *Corymbia maculata* (Photograph 27). *Acacia saligna* (Golden Wreath Wattle) was a dominant mid-storey species at site 4R and is also present at 8R, however, this species has mostly died-off within the woodland rehabilitation areas. *E. cladocalyx* is native to South Australia and *Acacia saligna* is native to the south of Western Australia, but both have been planted widely in eastern Australia.

The substrate in these areas consists of fine grey sediment intermixed with rocks and forms a sandy clay, it appears topsoil was not used in the establishment of these woodland rehabilitation areas. As a result, the understorey in these areas remains very sparse with occasional native species present at low densities including *Enchylaena tomentosa* (Ruby Saltbush), *Calotis* spp. (Burr-Daisy) and several native grasses including *Cymbopogon refractus* (Barbed Wire Grass).

No significant issues with exotic weeds were identified in these areas, however patches of *Galenia pubescens* were common in monitoring plots 4R and 6R (new) and *Opuntia* sp. (Prickly pear) is scattered around the transect site in monitoring plot 3R. Biometric results from woodland rehabilitation sites are presented in Table 20. Scores have remained similar since their first floristic sampling in 2015. The number of native species is generally very low when compared to natural woodland sites nearby, although site 8R recorded sixteen species which is much higher than previously recorded at that site. The mid-storey and groundcover that is present remains very sparse, with groundcover vegetation scoring zero along biometric transects at all four monitoring sites in 2020.

As these areas were established using outdated rehabilitation techniques, performance criteria have been developed for these older rehabilitation areas. However, a generally small number of native species and very low native groundcover mean that these sites generally fall below the performance criteria.

Photograph 27: Woodland rehabilitation area dominated by *E. cladocalyx* at site 8R in 2020

Table 20: 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	10	15	0	0	0	0	0	0	0	0
	4R	9	25	0	0	0	0	0	0	0	0
	6R (new)	10	55	0	0	0	0	0	0	0	0
	8R	16	16.5	0	0	0	0	0	0	0	0
Average values		11.25	27.88	0	0	0	0	0	0	0	0
Performance criteria for older woodland rehabilitation areas		> 15	15-40	5-40	5-15	5-10	5-15	<20	1	-	5

3.3.3 Pasture rehabilitation

Pasture rehabilitation is currently meeting performance targets for all attributes with the exception of LOI. The LOI average score remains relatively high and close to the target, with resource accumulating patches covering an average of 87% of transect length with a target of 93% (**Table 21**). A description of each site is provided in Table 22, with a typical site shown in Photograph 28.

Change in LOI scores across the ten pasture rehabilitation sites were mixed during 2020. Scores increased or stayed constant at six sites (2R, 7R, 10R, 33R, 34R, 35R) and decreased at four sites (1R, 5R, 9R, 16R) resulting in an overall change in the LOI average -1%. The average LOI (Figure 25) was reduced by the influence of sites 5R and 16R. Site 5R had a 13% increase in the area of bare soil up to a total of 33%, and site 16R increased 17% up to a total of 23%.

From the 2010 to 2012 monitoring periods and again in the 2014 monitoring period, most sites (all sites in 2012) recorded a LOI score of 1 or very close to 1, indicating that there were no bare soil patches present in the transects at all. While no raw data sheets prior to the 2015 monitoring are available to investigate these results, examination of site photos suggest some of these previous high LOI scores may be erroneous.

Average indices for stability, infiltration and nutrient cycling all met performance criteria and increased slightly from the previous year. These indices are all on a consistent trend of improvement (**Figure 26, Figure 27** and **Figure 28**).

Comparison with site photos from 2014 monitoring indicate vegetation at pasture sites generally remains very similar, with the major change being the growth and spread of the native small tree *Acacia salicina* at sites 1R, 2R, 5R, 7R and 34R.

Photograph 28: Pasture rehabilitation area showing high grass cover at site 33R in 2020

Table 21: LFA scores and performance criteria for pasture rehabilitation areas 2020

Monitoring Plot	LOI	ST	INFI	NI
1R	0.88	70.0	43.7	43.5
2R	0.87	68.9	36.1	37.8
5R	0.67	70.6	42.9	42.6
7R	0.96	63.8	44.4	35.7
9R	0.81	63.8	38.4	33.4
10R	0.98	69.6	41.8	38.5
16R	0.77	67.2	38.1	35.2
33R	0.98	69.7	49.8	43.4
34R	0.88	64.2	34.5	30.4
35R	0.91	68.2	34.9	30.8
Average score	0.87	67.6	40.7	37.3
Target score	0.93	61	29	25

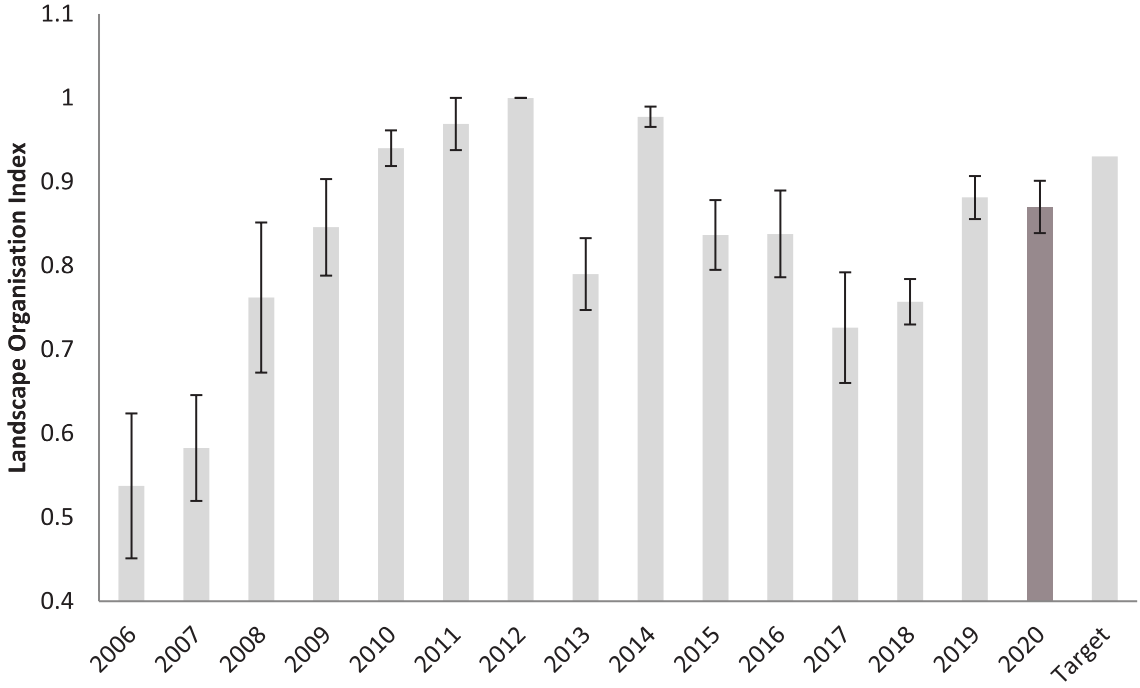

Figure 25: Average Landscape Organisation Index scores from pasture rehabilitation sites 2006-2019. Error bars represent standard error and the target bar represents performance criteria. Only four sites were sampled in 2006 and 2007, increasing to nine sites in 2010.

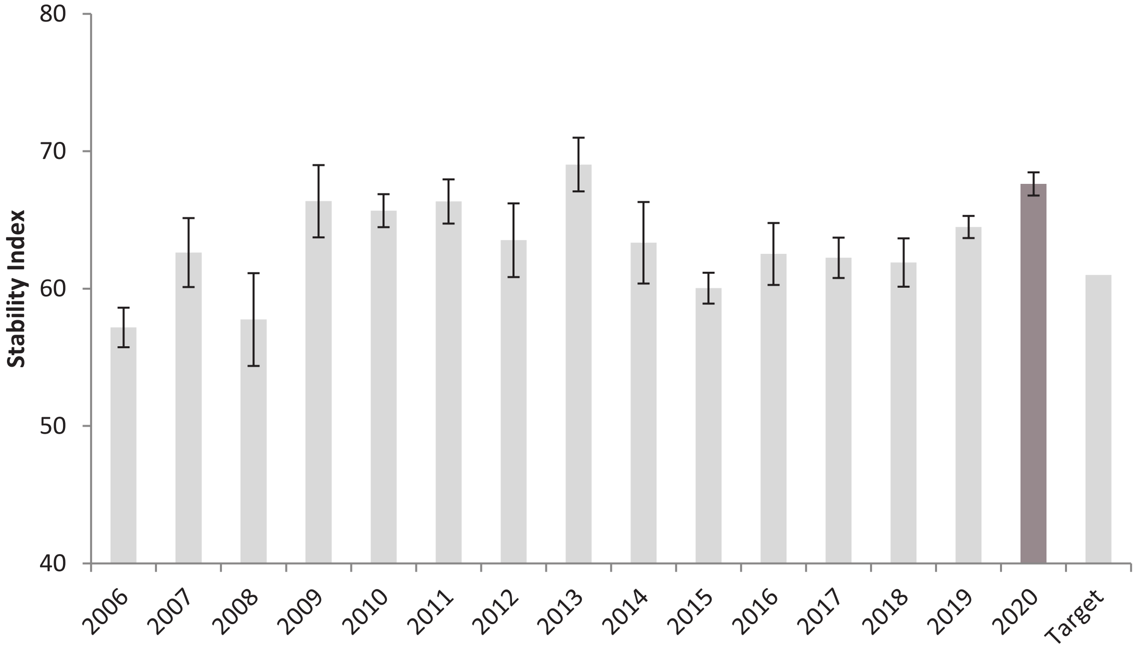

Figure 26: Average Stability Index scores from pasture rehabilitation sites 2006-2019. Error bars represent standard error and the target bar represents performance criteria.

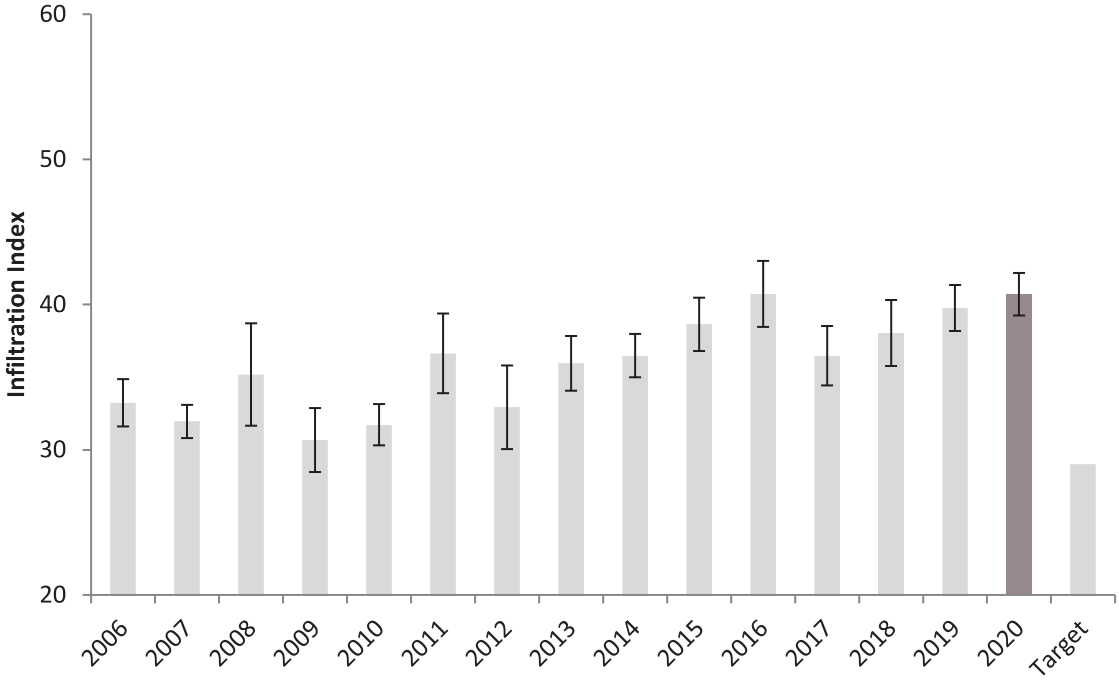

Figure 27: Average Infiltration Index scores from pasture rehabilitation sites 2006-2019. Error bars represent standard error and target bar represents performance criteria.

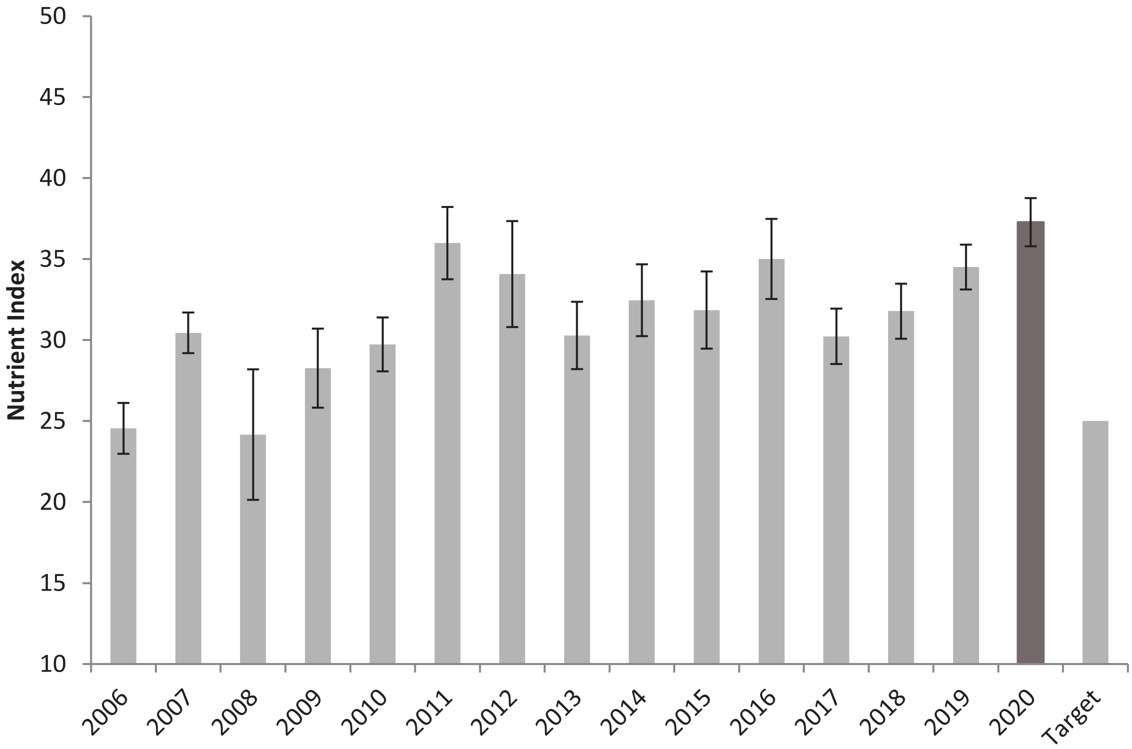

Figure 28: Average Nutrient Index scores from pasture rehabilitation sites 2006-2019. Error bars represent standard error and target bar represents performance criteria.

Table 22: Site description of each pasture rehabilitation transect

Transect	Notes	Photograph (2020)
1R	Low grassy patches (74%) and tussocks of the exotic *Chloris gayana* (13%) dominate the transect and are the main stabilising features of this rehabilitation area near the coal preparation plant. These features also contribute toward infiltration and nutrient cycling. Bare soil has reduced to 10% in 2020, with a corresponding increase in grassy cover.	
2R	This transect runs down a very slight slope and was dominated by grassy patches (76%), bare soil (13%) and tussocks (10%). When compared to 2019 results, grass cover has increased, and bare soil has reduced. This site is meeting the target scores for stability, infiltration and nitrogen cycling, however the LOI target has not been met, although the LOI score has improved significantly since 2018 when it was 0.48, suggesting strong growth of grassy cover over bare soil in that time.	
5R	This site is dominated by grassy patches (48%), exotic tussock grasses (*Setaria* sp.) (19%) and bare soil (33%). Scattered large *A. salicina* are present surrounding the transect area. This site recorded an increase in grassy cover and bare soil, and a decrease in litter and tussock cover, resulting in an overall decrease to the LOI score from the previous year. This site is meeting the target scores for stability, infiltration and nitrogen cycling.	

Transect	Notes	Photograph (2020)
7R	Transect was dominated by short grass (43%) and the exotic *Galenia pubescens* (36%). Litter (14%), bare soil (4.5%).and exotic C*hloris gayana* tussocks (2%) contributed the remainder. Increases in Galenia and grass correspond to reductions in litter, suggesting ground cover vegetation has responded well to recent rainfall in areas with litter cover. The locally native *Acacia salicina* continues to colonise the rehabilitation in this area. This site is meeting all performance criteria including the LOI target, however the high cover of Galenia should be monitored.	
9R	A large rocky soil scald dominates the start of this transect, however grassy patches and litter result scores for all indices except LOI above the performance criteria. Grassy patches (60%) and litter (18%) dominate the transect, the soil scald and other bare patches cover 18% of the transect. An increase in litter corresponds to a reduction in tussocks as many tussocks were dead. The LOI score continues to fall short of the did not meet the performance criteria target, indicating grassy cover is not expanding over bare soil.	
10R	Dense tussocks of *Chloris gayana* (45%), leaf litter fallen from the dense tussocks and dry dead exotic perennial vegetation (29 %) and grassy patches (24%) made up the majority of this transect. Bare soil patches were minimal making up just 2% of the transect length. These results are similar to the previous year. This scores for this site meet all performance criteria. This site has the highest LOI score recorded in the 2019 surveys, indicating this transect has the least bare soil.	

Transect	Notes	Photograph (2020)
16R	Transect primarily composed of grassy patches (40%) and tussocks of *Chloris gayana* (30%) with litter (6%) and bare soil (23%). This site is exceeding all performance criteria except the LOI target. A increase in bare soil associated with excavator tracks from pipe installation for the Wambo United mine has contributed to the lower LOI score.	
33R	Transect primarily composed of low grass (62%), litter (18%), Galenia (13%) and tussocks (5%). Bare soil patches made up less than 2% of the transect. The progression of this site over the past three years has seen tussocks from 2018 break down into litter in 2019 and an increase in low grass in 2020. This site is meeting all performance criteria including the LOI target.	
34R	Transect is composed of low spreading grassy patches (69%), dense tussocks of *C. gayana* (27%) with fallen dead grass (leaf litter - 23%) and bare soil patches (12%). Grassy patches were the primary contributor to the site stability, nutrient and infiltration scores which exceed the targets. The LOI score has not been met for this transect due to the amount of bare soil (interpatch).	

Transect	Notes	Photograph (2020)
35R	Low grass (83.5%) dominated this newer area of rehabilitation, tussocks cover 7.5% with bare soil (9%) making up most the remaining transect. The LOI score has not been met for this transect due to the amount of bare soil (interpatch). Performance targets are met for the other indices.	

3.4 Conclusion and recommendations

3.4.1 North Wambo Creek Diversion

The NWCD did not meet the completion targets for any LFA index based on average scores across all sites. However, the scores were above 75% of the target values for all indices except infiltration which was 70% of the target. Generally, areas of bare soil associated with the steeper slopes of the creek diversion are contributing to the lower scores.

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, particularly in the downstream reaches of the NWCD, as a whole the creek diversion remains primarily open pasture which is dominated by exotic species. 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) is yet to be achieved.

Some areas of erosion that exceed completion criteria targets are present, with some gully erosion, deeper rills and large areas of bare soil observed. Significant soil remediation works have been undertaken within the North Wambo Creek Diversion in 2020 by the Soil Conservation Service and works continue. The works include several new rock chutes manage drainage and erosion and ripping to stabilise soil and are likely to lead to significant improvement to the condition of the NWCD over time.

Monitoring should continue and site locations may requirement refinement following completion of remediation works. Additional monitoring sites are likely to be required to fully characterise the vegetation performance along the NWCD. Floristic monitoring sites should be established across the full range of revegetation areas, i.e. if the final revegetation plan includes multiple target communities such as woodland and riparian areas. In areas of newly established revegetation additional monitoring methods may also assist in assessing success and provide data to guide future works, if required. The inclusion of several 1x1m quadrats along the BioMetric transect to count the number of native plants/metre squared was recommended for the first 2-3 years post sowing by Cumberland Plain Seeds (2019).

In light of the currently active management works, no further management actions are currently recommended, however ongoing active management including soil stabilisation, planting native species and weed control will be required following completion of the current works.

3.4.2 Woodland rehabilitation

Woodland rehabilitation monitoring sites met LFA performance targets for infiltration and nutrient index and were just below the target scores for LOI and stability.

The high scores are largely due to the presence of leaf litter layers which provide protection from soil erosion and reduce the area of bare soil. All sites appear visually similar to the previous years of monitoring and this similarity was also observed in the recorded data, with similar landscape organisation and biometric scores recorded as previous years. A slight increase in number of native species was recorded at site 8R, likely a result of the higher rainfall in 2020 allowing germination. Epicormic growth was observed in trees within woodland rehabilitation areas, this suggests trees were under stress during recent drier years but are now recovering.

Comparison of the earliest available photos from 2014, appear to show a dieback in the non-local native *Acacia saligna,* which previously occurred as a mid-storey species at most woodland rehabilitation sites but is now mostly absent. Other than this and an apparent slight growth of trees, rehabilitated woodland monitoring sites in 2020 all appear very similar to photos taken in 2014.

Issues with the woodland rehabilitation monitoring sites have been addressed in previous monitoring reports and include:

- a lack of groundcover and mid-storey at most sites
- poor native species diversity when compared to remnant woodland sites
- the dominant Eucalypt species at these sites is not locally endemic to the Hunter Valley and originates in South Australia
- two large and deep holes, possibly related to mine subsidence, were observed near site 4R in areas of woodland rehabilitation.

Most of these issues likely relate to either a lack of, or no topsoil being used in these areas prior to tree planting. This is clearly visible where pasture rehabilitation areas with red-brown topsoil adjoin woodland rehabilitation areas with pale grey soil and rock.

Previous recommendations to improve LFA results include increasing the complexity of ground cover or woody debris to improve LOI scores and over time improve stability, infiltration and nutrient indices. However due to the large effort and cost involved in trying to enhance older rehabilitation areas, WCPL could instead focus on ensuring new areas of woodland rehabilitation are planned and implemented using best practice techniques.

3.4.3 Pasture rehabilitation

Average LFA scores for pasture rehabilitation generally met completion criteria, with the exception of LOI, which was still high and close to the target.

Site 16R had an increased proportion of bare soil along the transect due to disturbance from an excavator constructing a pipeline for the adjacent Wambo United Mine project. Tussocks of *Chloris gayana* were previously more dominant at some sites, for example 33R and 34R, and have gradually died off and been replaced by low grass cover. Tussock grasses generally contribute strongly to overall scores, although they now contribute to litter and are likely to improve nutrients loads in the soil. Die off of tussock grasses may be temporary and a result of drought conditions in previous years.

A significant increase in the cover of *Galenia pubescens* was recorded at some transects such as 7R and 33R. This exotic species has the potential to smother other vegetation and decrease the quality of pasture rehabilitation. It is important to consider the final intended land-use and that LFA completion targets for pasture rehabilitation have been based on scores from areas of pasture surrounding the mine and do not directly reflect the suitability of the land to support grazing.

Some large patches of bare soil which exceed the completion criteria were observed more broadly within pasture rehabilitation areas (e.g. near 33R). Actions to improve pasture rehabilitation areas could involve the slashing of large grass tussocks and subsequent mulching of bare areas to improve the soil profile and encourage establishment of vegetation in bare areas. Large areas of bare soil can be readily identified in pasture rehabilitation areas by reviewing recent, high-quality aerial imagery.

4. Riparian condition assessment

4.1 Introduction

The riparian EFA monitoring program is a requirement of the 2004 Development Consent conditions. The objective of the monitoring program is to evaluate how the riparian environment is responding to management initiatives (such as cattle exclusion) and document any impacts arising from mine subsidence.

North Wambo Creek drains the mid and eastern sections of the North Wambo Underground Mine development area and flows south-east into Wollombi Brook, approximately 600 m south of the Mine. North Wambo Creek has been highly disturbed both by historic and present grazing activities and by the North Wambo Creek Diversion. The diversion channels the creek around the open-cut mining operation.

Stony Creek drains from Mount Wambo in a north-east direction and meanders across the western boundary of coal lease (CL) 397 near the south-western boundary of the North Wambo Underground Mine and passes in a south-easterly direction through the existing underground development area of WCPL to join Wambo Creek. Wambo Creek then runs east to join Wollombi Brook. Much of the riparian zone along Wambo Creek has been disturbed by historic agricultural activities.

4.2 Methods

Field sampling for the riparian monitoring was undertaken between 19 and 22 October 2020. The *Rapid Appraisal of Riparian Condition* method, developed by Jansen et. al. (2005) and used during the 2016 to 2019 monitoring, was utilised during the 2020 survey period. Using this method, an overall score is obtained at each monitoring site by examining the width of riparian vegetation, proximity to large patches of native vegetation, vegetation cover, debris (leaf litter, standing dead trees and fallen logs) and other features (native canopy and understory regeneration, tussock grasses and reeds on creek banks). Areas monitored were:

- North Wambo Creek
- (South) Wambo Creek
- Stony Creek.

Methods followed Jansen et. al. (2005) with four 40 m long cross-section transects sampled at each monitoring site (an approximate 500 m length of riparian zone). Three monitoring sites were measured along each creek. The location of monitoring sites and transects is illustrated in **Figure 29** with photographs presented in **Volume 2**.

The three creeks and sample sites were compared in regard to the following sub-indices:

- *Habitat* - longitudinal continuity of canopy vegetation (> 5 m wide); width of riparian canopy vegetation; and proximity to nearest patch of native vegetation > 10 ha
- *Cover* - vegetation cover and structural complexity
- *Native* - dominance of native species versus exotic species
- *Debris* - leaf litter; standing dead trees; hollow-bearing trees; and fallen logs

- *Features* - other indicative features such as regeneration, presence of large native tussock grasses (e.g. *Austrostipa* spp.) and reeds.

The five sub-indices were assessed across the three separate reaches of each creek and were combined to create a *Total Score.* Site photos and scores from previous monitoring reports (ELA (2016 to 2019) were compared. Although not directly comparable due to differing site locations and methodologies, data and photos from Niche (2014d) and RPS (2009)) were also reviewed.

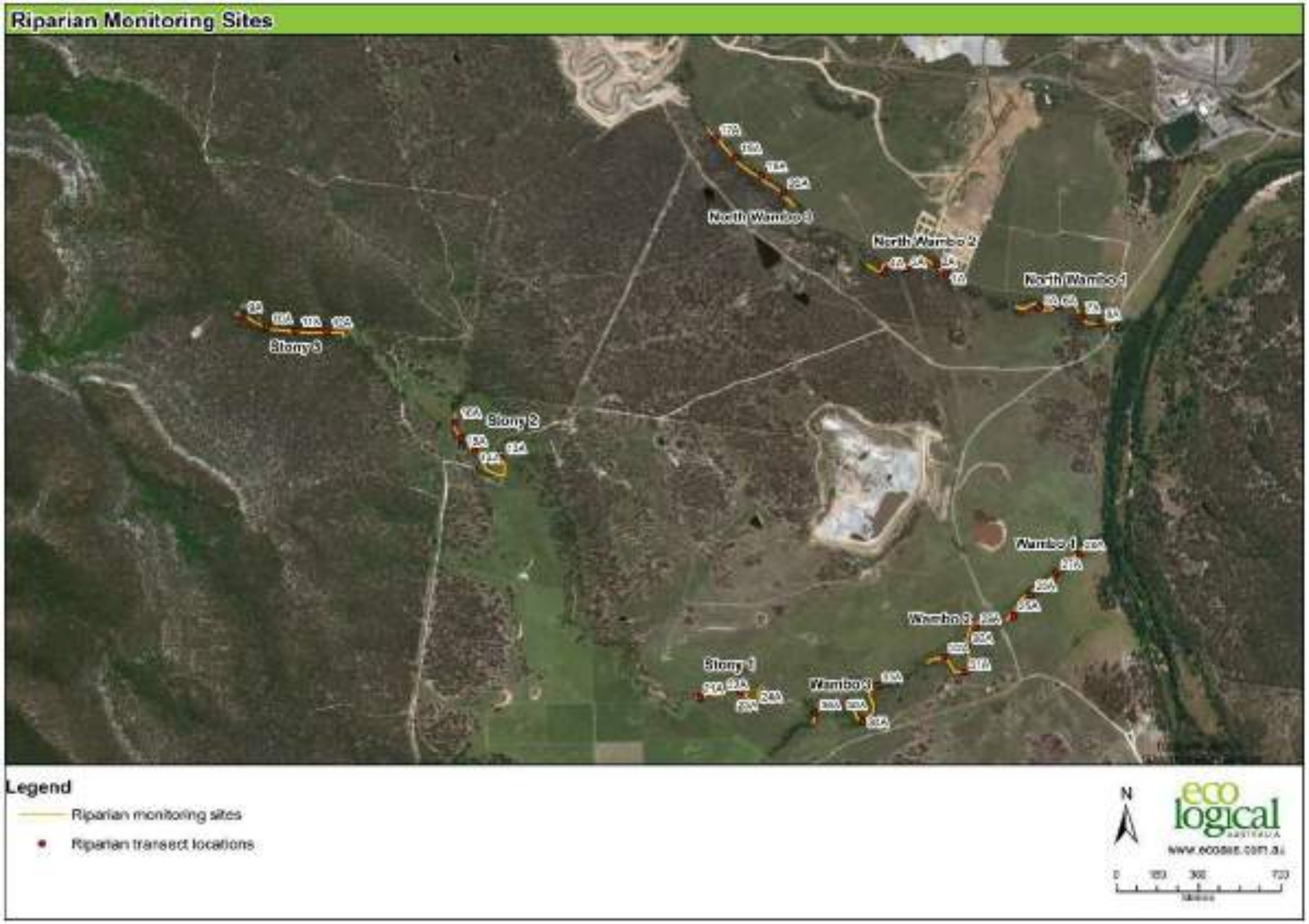

Figure 29: Location of riparian monitoring cross-sections and transects

4.3 Results

The results of the riparian condition monitoring are presented below, with raw data included in **Volume 2**.

The average total score for all three creeks increased in 2020. South Wambo Creek recorded its highest average score and North Wambo Creek and Stony Creek recorded their highest average scores since 2017 (**Figure 30**).

South Wambo Creek remains the lowest scoring creek system based on the sub-indices measured.

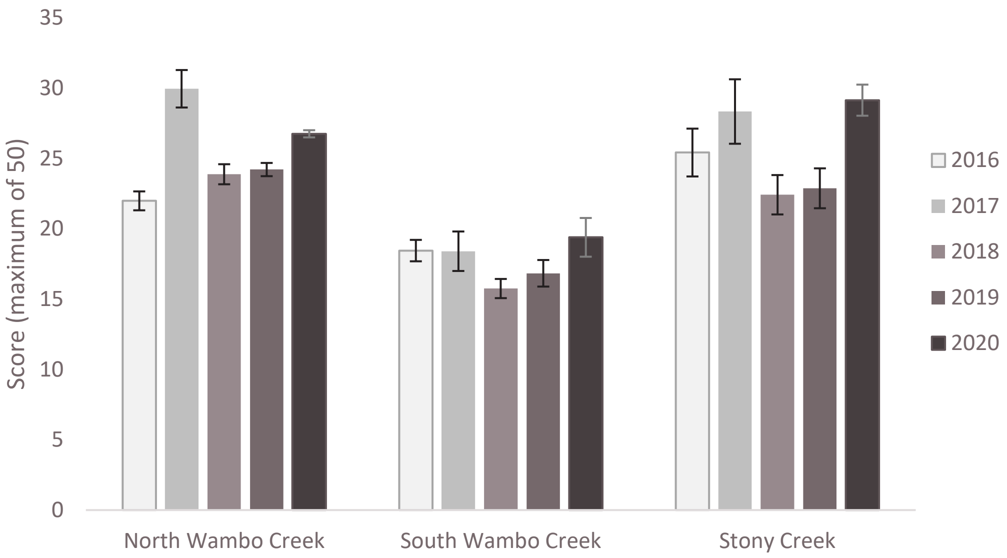

Figure 30: Average "Total Score" for North Wambo Creek, South Wambo Creek, and Stony Creek, from surveys in 2016 - 2020

4.3.1 North Wambo Creek

North Wambo Creek recorded a slight increase in score for all sub-indices from 2019. These results reflect the gradual regeneration of riparian vegetation and an increase in ground cover vegetation following the wetter year in 2020.

Evidence of significant recent stream flow was observed within the channel, with debris lodged in trees and shrubs along the banks. High cover of exotic annual ground cover weeds was observed in some areas (Photograph 29), with their growth a response to the higher rainfall in 2020.

Photograph 29 :North Wambo Creek at transect 8A showing the creek channel dominated by annual thistles

4.3.2 South Wambo Creek

South Wambo Creek recorded increases for *cover*, *debris*, *natives* and *features*; *habitat* score remained steady. The *habitat* score is controlled by features which change over longer periods of time such as canopy connectivity and proximity to large patches of native vegetation.

South Wambo Creek has consistently recorded low scores for *features.* The features score is derived from regeneration of canopy and shrub species, and the presence of large native tussock grasses and reeds. Review of aerial imagery from South Wambo Creek, in the area of the South Wambo 1 and South Wambo 2 sites, shows significant riparian regeneration over time (**Photograph 30** and **Photograph 31**). There was an increase in the features score in 2020, mostly a result of the presence of tussock grasses and reeds at South Wambo 3. The monitoring methodology only scores regeneration under 50cm tall, therefore only very recent/young regeneration contributes to the scores, despite older regeneration being present in many areas.

No evidence of recent cattle grazing was recorded in this area. Grazing pressure reduces the ground cover and destabilises the soils leaving these areas more prone to erosion. In previous years cattle grazing had impacted riparian condition scores along South Wambo Creek.

Photograph 30: Aerial image of South Wambo Creek from May 2020 (NearMap) showing riparian cover and cattle exclusion fencing

Photograph 31: Aerial image of South Wambo Creek from December 2002 (GoogleEarth) showing limited riparian vegetation

4.3.3 Stony Creek

Stony Creek recorded increases for *cover*, *debris*, *natives* and *features*. These results reflect the gradual regeneration of riparian vegetation in the lower reaches and an increase in ground cover vegetation following the wetter year in 2020.

The *habitat* score remained the same as in 2019. The *habitat* score is controlled by features which change over longer periods of time such as canopy connectivity and proximity to large patches of native vegetation and has always remained at the maximum score at Stony Creek 3 where the site is within high condition native vegetation.

There remains large variability in the *habitat* sub-index between longitudinal transects at Stony Creek which reflects the differences in vegetation and habitat features between the cleared lower reaches (Stony Creek 1) and the heavily forested upper reaches (Stony Creek 3).

It is unclear whether cattle have been excluded from the lower reaches of Stony Creek at Stony Creek 1. No evidence of recent cattle grazing was recorded, however there was no fencing that would prevent cattle accessing the riparian area. In previous years cattle grazing had impacted riparian condition scores along lower reaches of Stony Creek.

4.3.4 General observations

Overall increases in scores at all creeks were observed, particularly due to an increase in ground cover following drought in the previous two years. The change in ground cover from 2019 to 2020 can be seen in Photograph 32 and Photograph 33.

No evidence of recent subsidence impacts was observed at North Wambo Creek, South Wambo Creek, or Stony Creek during the 2020 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 South Wambo creek being in moderate condition. General comparison of riparian area photos from 2020 with those from 2014 show that the riparian vegetation generally remains similar.

Photograph 32: Transect 14 at stony Creek 2 in 2020 showing high ground cover following high recent rainfall

Photograph 33: Transect 14 at stony Creek 2 in 2019 showing drought impacted ground cover

4.4 Conclusions and recommendations

The increase in average scores for all creeks reflects the wetter conditions following previous drought and the reduction/exclusion of grazing. Understorey vegetation cover has increased following higher rainfall in 2020, although a high proportion of ground cover contribution is from exotic species.

Sub-indices relating to more permanent features such as habitat connectivity, tree canopy and logs and hollows remained similar.

Exclusion of cattle from riparian areas has been recommended in previous monitoring reports and no evidence of cattle grazing was recorded in 2020. Cattle should continue to be excluded from riparian areas 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 riparian area and the surrounding environment.

5. South Bates Extension Underground Mine area

5.1 Floristic Monitoring

5.1.1 Introduction

Floristic monitoring of the South Bates Extension underground mine area is a new component to the annual biodiversity monitoring program in 2020. The purpose of this monitoring is to measure the current condition of vegetation in terms of floristics and habitat complexity and identify whether any adverse impacts from undermining are occurring. The results aim to provide direction to management of these areas and for the monitoring program in the future.

5.1.2 Methods

Floristic monitoring is undertaken using the BioMetric plots as described in **Section 2.1.2**. The monitoring was undertaken on by ELA ecologists Lily Gorrell and Dee Ryder on 19 November 2020.

Four new sites were established in 2020 to sample the two dominant PCTs in the South Bates Extension area. Data from two existing monitoring plots that are also within the South Bates Extension area were also used for analysis. Of the new sites, two were established outside of the approved mining area and are intended as reference sites. A summary of the monitoring sites is presented in Table 23 and site locations are shown on Figure 2.

Table 23: Floristic monitoring sites for the South Bates Extension Underground Mine

Plant Community Type (PCT)	TEC	Plot name	Type	Site age
PCT 1603: Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter	Listed BC Act, E: Central Hunter Grey Box-Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions, may also be listed as CE under the EPBC Act as Central Hunter Valley eucalypt forest and woodland, dependant on condition and landscape position	SBX2-GB-I	Impact	New
		SBX4-GB-C	Reference	New
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	Impact	Existing
		V10-A2	Impact	Existing
		SBX1-SG-I	Impact	New
		SBX3-SG-C	Reference	New

Performance targets for the same communities within the RWEP areas have been adopted as an indication of good condition vegetation for reference. Reference sites outside of the approved mining area are used as a comparison for assessing seasonal variation factors.

5.1.3 Results

Floristic data from new and existing monitoring sites within the South Bates Extension Underground Mine area indicate the vegetation and habitat features are in good condition with most attributes meeting the performance criteria (Table 24).

Both sites within Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest have not been undermined to date and therefore data collected in 2020 is considered to be baseline data. NMS was slightly below target at both sites, with NGCS also lower than target at the reference site. These results are likely to represent natural variation within the community.

Of the four sites within the Slaty Box - Grey Gum shrubby woodland, two (V10-A1 and V10-A2) have been undermined and two (SBX1-SG-I and SBX3-SG-C) are acting as current reference sites. NOS was slightly below target at both impact sites and grass cover was high at V10-A1. NOS has fluctuated over time with most sites across the monitoring program scoring higher in 2020 than the previous year. Site V10-A2 scored lower for canopy cover, however review of plot photographs (Photograph 34) shows canopy in good condition, with all trees healthy and no observable impacts to the canopy from undermining. The two current reference sites within this community met the performance criteria for most attributes. At one site, SBX1-SG-I, NMS and NGCG were slightly below target although this is considered likely to representing natural variation within the community.

Photograph 34: Site V10-A2 in 2020 with canopy in good condition

5.1.4 Conclusions and recommendations

Floristic monitoring results for vegetation communities within the South Bates Extension underground reveal vegetation is in good condition, generally meeting performance targets. No evidence of mine subsidence impacting native vegetation condition were detected.

It is recommended monitoring continue in this area, including the use of reference sites to allow comparison including impacts of seasonal variation.

Table 24: BioMetric scores from South Bates Extension floristic monitoring sites in 2020

Plant Community Type (PCT)	Plot Name	Site type	Mining status	NPS	NOS (%)	NMS (%)	NGCG	NGCS	NGCO	EPC	OR	HBT	FL
PCT 1603: Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter	SBX2-GB-I	Impact	Not yet mined	33	34	4	22	6	10	0	1	0	10
	SBX4-GB-C	Reference	Outside mining area	32	18.5	1	26	4	18	2	1	1	52
Performance criteria				>25	10-40	5-10	15-50	5-10	5-40	<5	1	-	-
1176: Slaty Box - Grey Gum shrubby woodland on footslopes of the upper Hunter Valley, Sydney Basin Bioregion	V10-A1	Impact	Undermining has occurred	39	13.2	5.5	56	4	6	2	1	0	23
	V10-A2	Impact	Undermining has occurred	39	6.5	6.5	14	12	6	2	1	0	12
	SBX1-SG-I	Impact	Not yet mined	27	28.5	1.5	4	0	4	1	1	0	45
	SBX3-SG-C	Reference	Outside mining area	30	22	9	14	6	4	0	1	0	21
Performance criteria				21	15-40	5-30	5-30	0-25	2-10	<5	1	-	-

5.2 Bird monitoring

5.2.1 Introduction

Bird monitoring of the South Bates Extension underground mine area is a new component to the annual biodiversity monitoring program in 2020. The purpose of this monitoring is to use bird diversity and abundance as an indicator of health of the local fauna populations and identify whether any adverse impacts from undermining are occurring. The results aim to provide direction to management of these areas and for the monitoring program in the future.

5.2.2 Methods

Bird monitoring survey methods are the same as described in **Section 2.2.2.** Surveys were undertaken by ELA ecologists Tom Schmidt and Dee Ryder on 19 and 22 October and 4 and 17 November 2020.

Four new bird monitoring sites (BP17-BP30) in the South Bates Extension Underground Mine area were established in 2020, and one existing bird survey site (BP26) is within the South Bates Extension Underground Mine area. Of the new sites, two were established outside of the approved mining area and are intended as reference sites. Bird survey site locations are shown on Figure 13. The current progress of mining in the South Bates Extension area means that of the five sites only BP26 is currently in an area that has been undermined (Table 25). As such, current data from all four new sites can be considered baseline data for comparison after mining occurs.

Table 25: Bird monitoring sites within the South Bate Extension underground mine area

Site	Mining status	PCT
BP26	Undermining has occurred	1176: Slaty Box - Grey Gum shrubby woodland
BP27	Reference site (outside mining area)	1176: Slaty Box - Grey Gum shrubby woodland
BP28	Reference site (outside of mining area)	1603: Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest
BP29	Not yet undermined	1176: Slaty Box - Grey Gum shrubby woodland
BP30	Not yet undermined	1603: Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest

5.2.3 Results

The highest diversity and abundance of birds was recorded at BP26 (Figure 31), which is currently the only impact site. This site was surveyed in October with the new sites surveyed in November, which may have contributed to the results. Three threatened bird species were recorded at the monitoring sites, with two species recorded at sites BP26 and BP28 and one species recorded at the other sites (Table 26).

Table 26: Threatened bird species recorded at South Bates Extension underground mine bird survey sites

Species	BP26	BP27	BP28	BP29	BP30
Dusky Woodswallow	2				
Grey-crowned Babbler	2		1	2	
Speckled Warbler		1	1		2

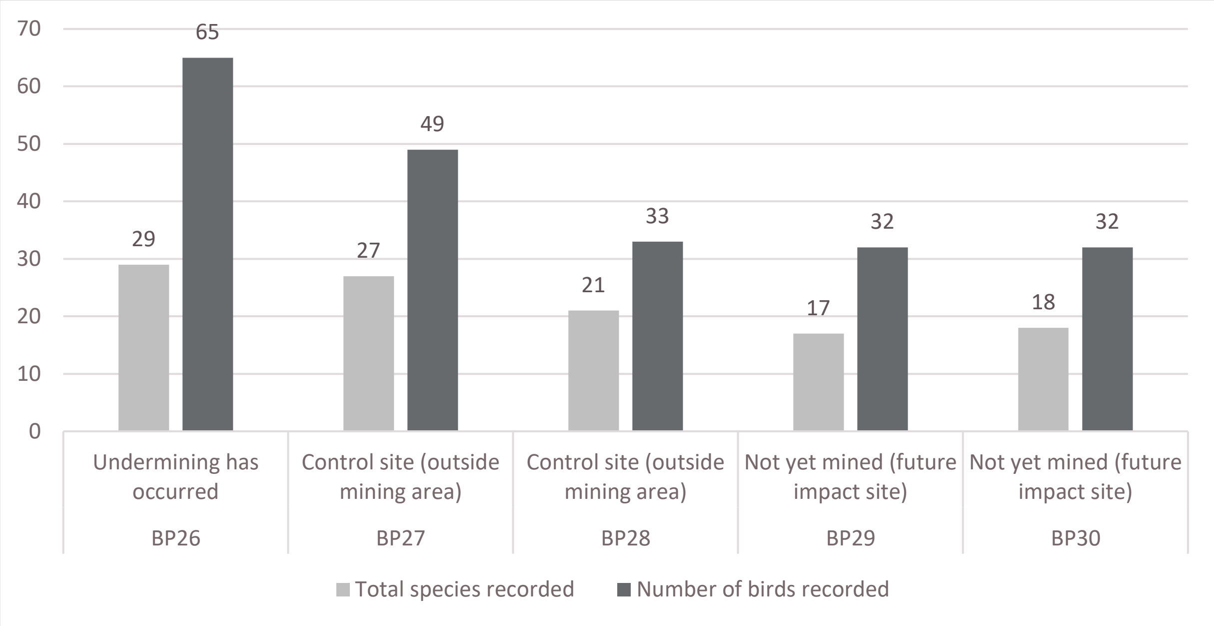

Figure 31: Bird monitoring results for sites in the South Bates Extension underground mine area

5.2.4 Conclusions and recommendations

Bird surveys recorded data at four new sites and one existing site associated with the South Bates Extension underground mine area. One of the five sites was located above an area which had been undermined to date in 2020. This site recorded the highest diversity and abundance of bird species and also had the equal highest number of threatened bird species recorded. As such, there is no indication that the undermining is having a detectable impact on bird species within this area.

There was up to approximately one month between surveys at different sites which may have influenced the results. Future monitoring should be undertaken across all sites within the shortest time period practical to reduce the influence of temporal variation.

Continued monitoring is recommended in this area, including the use of reference sites to allow comparison including impacts of seasonal variation. Progress of underground mining activities should be corelated to site locations annually to ensure results are appropriately analysed as baseline, or impact once undermining progresses.

5.3 Groundwater Dependent Ecosystem monitoring

5.3.1 Introduction

Monitoring of Groundwater Dependent Ecosystems (GDEs) is a new component to the annual biodiversity monitoring program initiated in 2019. The GDE Vegetative Assessment Report (Hunter Eco, 2019) identified two likely GDEs in the area above the South Bates Underground Extension:

- River Oak riparian tall woodland
- M*elaleuca decora* low forest.

The South Bates Underground Extension has the potential to impact groundwater in the vicinity of the two GDEs. Hunter Eco (2019) recommended the establishment of a GDE monitoring program including:

- Vegetation condition and extent assessed by aerial imagery and on-ground inspection over time
- Document tree height and diameter at breast height (DBH) of selected River Oak saplings and mature trees.

5.3.2 Methods

GDE monitoring was undertaken on by ELA ecologists Lily Gorrell, Liam Scanlan and Dee Ryder on 22 October and 20 November 2020. Several methods were used to monitor GDEs, as described below.

5.3.2.1 Vegetation survey plots

Two vegetation monitoring plots (standard biometric plot 50 x 20 m - refer to (**Section 2.1.2**)), established in 2019, were surveyed in each GDE (Figure 35). Vegetation structure and function data compliant with the Biodiversity Assessment Method (BAM) plot method (current standard method for ecological impact assessment) was also collected.

5.3.2.2 Photo monitoring points

At each photo monitoring plot, images were captured at 0, 90, 180, and 270 degrees, as well as one at the ground. A total of eight photo monitoring points were surveyed (Figure 35).

5.3.2.3 Tree measurements

Thirty *Casuarina cunninghamiana* trees (15 mature trees and 15 saplings) were selected for monitoring across the River Oak riparian tall forest GDE area along North Wambo Creek in 2019 (Figure 37). Each tree was permanently marked with a numbered metal tree tag and the DBH was measured. The point of DBH measurement (1.3m above the ground) was sprayed with paint so that the measurement location can be replicated during subsequent monitoring. In 2020 the DBH for each tree was re-measured.

Crown extent was assessed for each of the 30 tagged trees. Crown extent was assessed as the percentage of the assessable crown (all live and dead branches on the tree) in which there are live leaves. Two observers each recorded a crown extent estimate from opposite sides of the tree to the nearest 5%, and the average of the two scores was recorded.

5.3.2.4 Mapping of vegetation extent

Mapping the extent of the River Oak riparian tall woodland community along the upper reach of North Wambo Creek was completed in a GIS at 1:1000 scale using georeferenced aerial imagery (3 May 2020, NearMap). Polygons were drawn with reference to Rapid Data Points (RDPs) and photos collected during the monitoring survey and using comparison to aerial imagery from 2019 (NearMap) when the community extent was first mapped in detail.

5.3.3 Results

The results of the GDE monitoring are presented below, with raw data and all photographs included in **Volume 2**.

5.3.3.1 Vegetation survey plots

Two monitoring plots were surveyed in each GDE (Figure 35). BioMetric data from each plot is presented in Table 27.

The BioMeteric results from the *Melaleuca decora* low forest GDE indicated the community is in good condition, with the majority of scores increasing from 2019, likely as a result of the increased rainfall in 2020. The average number of native species recorded increased by 12 (Figure 32), and NGCG increased by over 50%. NMS and NGCO each increased by around 10%. EPC was zero along the BioMetric transect in both plots.

The River Oak riparian tall woodland GDE also recorded increased scores for most categories. NPS increased by 17.5 from 2019 (Figure 32), NGCG and NGCO increased by 26% and 20% respectively. EPC increased by 18%, mostly driven by exotic annuals which had proliferated after the higher rainfall year, and the presence of *Galenia pubescens* at site GDE3.

Table 27. BioMetric data for GDE monitoring plots in 2020

GDE	Plot Name	NPS	NOS (%)	NMS (%)	NG CG	NGC S	NGC O	EPC	OR	HBT	FL	LI	BS
***Melaleuca decora* low forest**	GDE1	38	10.1	14	58	6	14	0	1	0	32	84	2
	GDE2	32	6	16	70	22	12	0	1	0	22	84	4
	Average	35	8.05	15	64	14	13	0	1	0	27	84	3
River Oak riparian tall woodland	GDE3	23	17	0	16	0	10	58	1	1	32	8	10
	GDE4	43	23	1.5	24	6	46	14	1	0	15	2	10
	Average	33	20	0.75	20	3	28	36	1	0.5	23.5	5	10

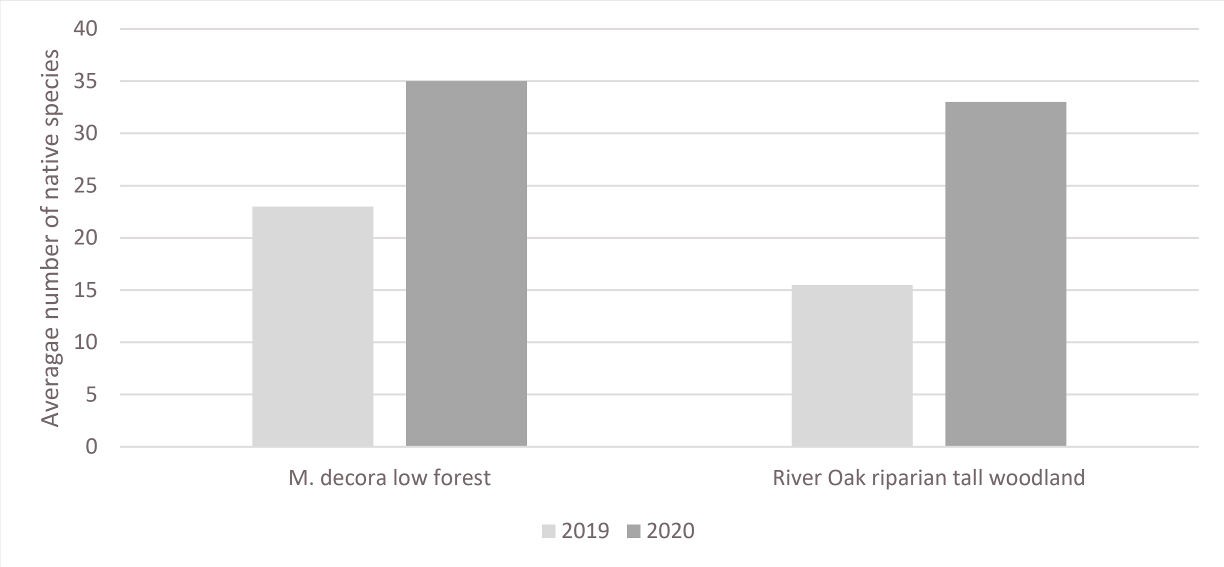

Figure 32: Average number of native species within each GDE over time from 2019-2020

5.3.3.2 Photo monitoring points

Review of images from photo monitoring points show GDE vegetation in good condition in 2020. A noticeable increase in ground cover vegetation is visible in both *Melaleuca decora low forest* and *River Oak riparian tall woodland* GDE communities (Photograph 35 **to** Photograph 38).

Photograph 35: GDE Photo monitoring point M2 (facing south) in *Melaleuca decora* low forest in 2019

Photograph 36: GDE Photo monitoring point M2 (facing south) in *Melaleuca decora* low forest in 2020

Photograph 37: GDE Photo monitoring point M7 (facing south) in River Oak riparian tall woodland in 2019

Photograph 38: GDE Photo monitoring point M7 (facing south) in River Oak riparian tall woodland in 2020

5.3.3.3 Tree measurements

Individual tree measurements from 2020 are presented in Table 28. The average DBH increased for both saplings (4 cm) and mature (3 cm) River Oak trees (Figure 33). This indicates tree growth and suggests the trees have received good access to water over the past year. Sapling growth is expected to be greater than mature trees. Two individual adult trees (Trees 1 and 19) recorded smaller DBH in 2020 than the previous year, this was a result of a portion of bark falling away; in both cases trees appear healthy.

The average canopy extent increased by 16% for both saplings and mature River Oak trees (Figure 34). This result indicates that tree health has improved from the previous year when drought conditions were present.

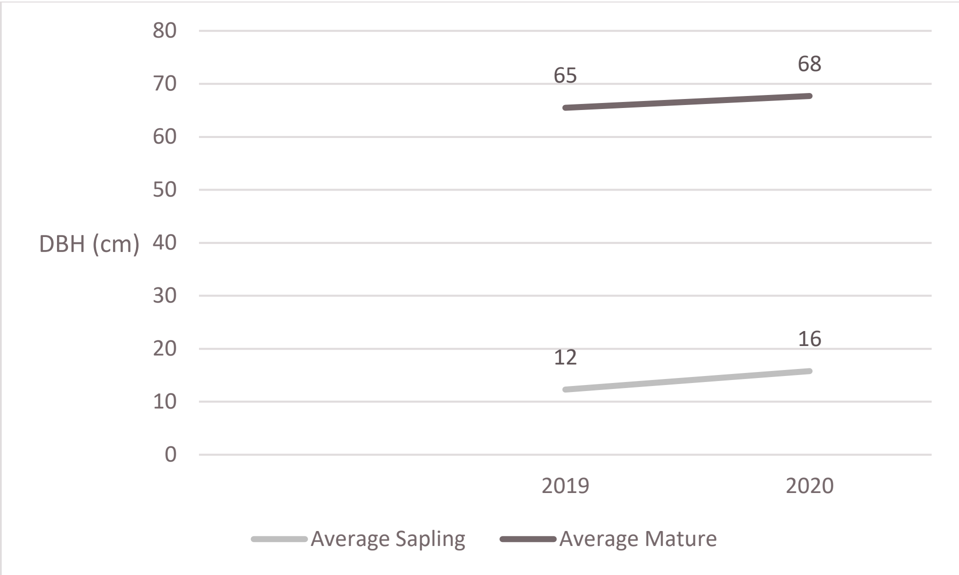

Figure 33: Change in DBH over time of measured trees within the GDE River Oak riparian tall woodland GDE

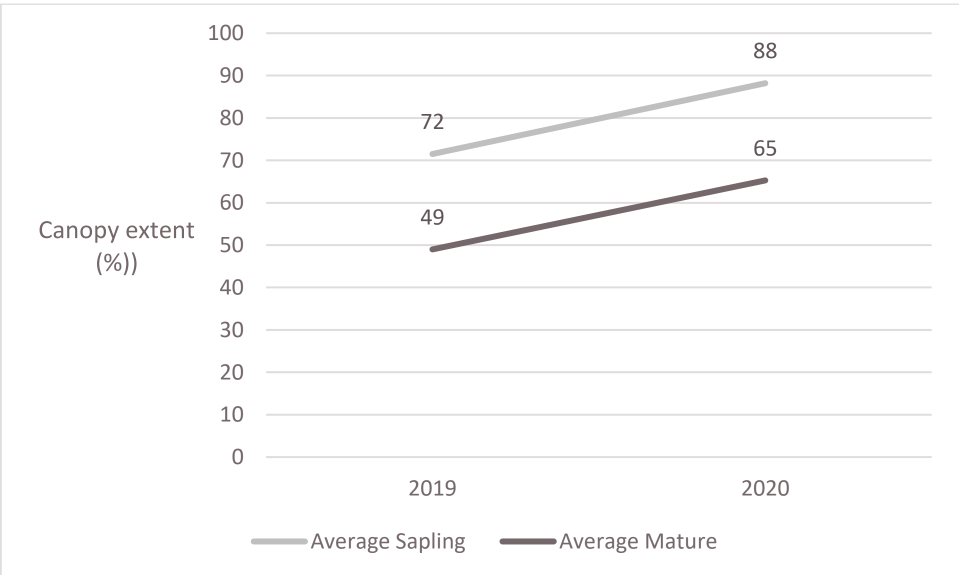

Figure 34: Change in canopy extent over time of measured trees within the GDE River Oak riparian tall woodland GDE

Table 28. River Oak tree monitoring results in 2020

Tree Tag No.	Age class	DBH (cm)	Canopy Extent (%)	Easting	Northing
1	Mature	73	63	306275	6395900
2	Mature	37.6	68	306164	6395894
3	Sapling	26.5	97	306090	6395881
4	Mature	82.2	83	306050	6395868
5	Mature	32.15	18	305952	6395693
6	Mature	99	78	305964	6395705
7	Sapling	23	85	305811	6395612
8	Sapling	13.5	88	305753	6395618
9	Mature	60.5	75	305785	6395619
10	Sapling	14.5	95	305529	6395440
11	Sapling	24	95	305470	6395438
12	Mature	64.8	75	305442	6395439
13	Sapling	6.5	93	305380	6395409
14	Mature	58	50	305379	6395410
15	Sapling	6.8	88	305573	6395454
16	Sapling	11.5	90	305587	6395457
17	Sapling	13.3	78	305593	6395493
18	Mature	111.5	65	305566	6395521
19	Mature	77	68	305571	6395591
20	Sapling	17.5	85	305607	6395612
21	Mature	111	78	305338	6395325
22	Mature	59.5	80	305307	6395248
23	Sapling	19.6	83	305264	6395213
24	Mature	52.3	38	305218	6395224
25	Sapling	21.2	83	305202	6395237
26	Mature	49	65	305171	6395235
27	Sapling	19.2	90	305038	6395194
28	Mature	48	75	305035	6395190
29	Sapling	10.6	95	305021	6395183
30	Sapling	9	78	305004	6395173

5.3.3.4 Mapping of River Oak riparian tall woodland vegetation extent

No change in extent of River Oak riparian tall woodland was observed in the field or observable in the aerial imagery. The total area of the GDE remains 5.07 ha (**Figure 36**).

5.3.4 Conclusions and recommendations

GDE monitoring sites were resurveyed for the first time following initial establishment of sites and baseline data collection in 2019. Ongoing monitoring of these sites is required to assess whether any impacts to GDEs occurs as a result from planned mining activities in this area.

Floristic monitoring recorded generally increased scores for both GDEs surveyed. High rainfall in 2020 is likely to be the major factor in these results and photo monitoring clearly shows increased vegetation cover, particularly in the understorey of both areas.

For the *Melaleuca decora* low forest GDE, it may be appropriate to use data collected during 2019 and 2020 as the baseline conditions for the community. This area was undermined during 2019 and 2020 and no obvious impacts have occurred, and any adverse effects to vegetation are unlikely to have been detectable yet. As such future monitoring surveys may be considered as post impact surveys and compared to the 2019 and 2020 results.

GDE tree monitoring within River Oak riparian tall woodland recorded tree growth and increased canopy extent, suggesting improved health of the trees following the increased rainfall in 2020.

The River Oak riparian tall woodland remains approximately 1km from the closest mined portion of the South Bates Underground Extension mining area. As such, there may be no current impacts from undermining and the current data will serve as a baseline for reference once mining activities occur in the vicinity of the community. Variation in results between the dry year in 2019 and wetter year in 2020 is likely to be useful to understand the natural changes which occur in the community when attempting to determine whether any future changes observed are the result of mining impacts or natural variation.

No discernible change in the extent of the River Oak riparian tall woodland GDE was recorded. Changes to the extent of the community are likely to take place over the course of several years. The wetter year in 2020 may have provided suitable conditions for the spread and germination of canopy and mid storey species which in the coming years may result in an increase in the extent of the community.

Monitoring should continue to determine whether any impacts to the *Melaleuca decora* low forest GDE GDEs are occurring and to continue collecting baseline and future impact data for the River Oak riparian tall woodland GDE. Several groundwater monitoring wells have been established in the vicinity of the GDE along North Wambo Creek and the data from these is also likely to assist with determining whether any impacts to GDEs are likely to occur.

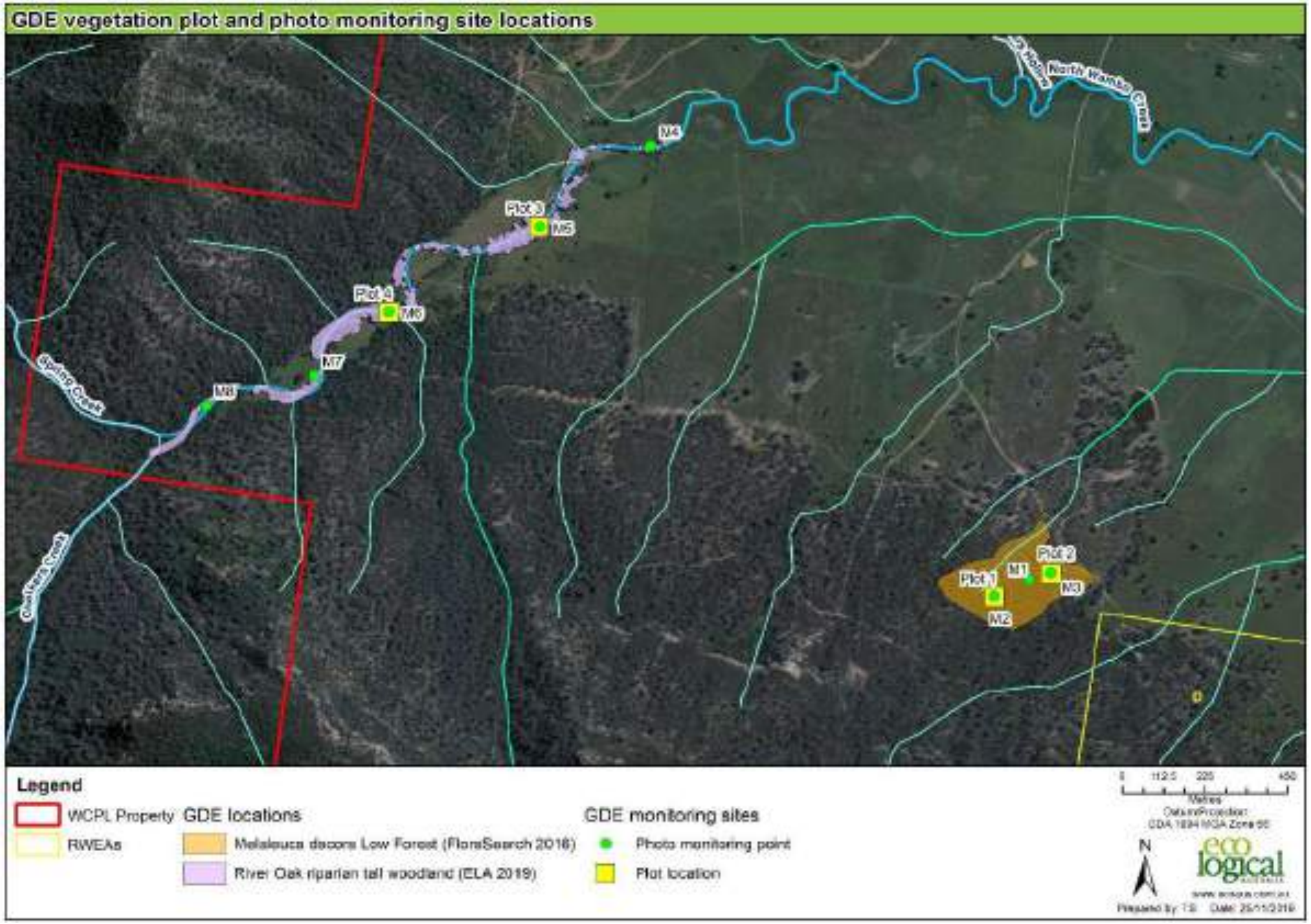

Figure 35. GDE monitoring site locations

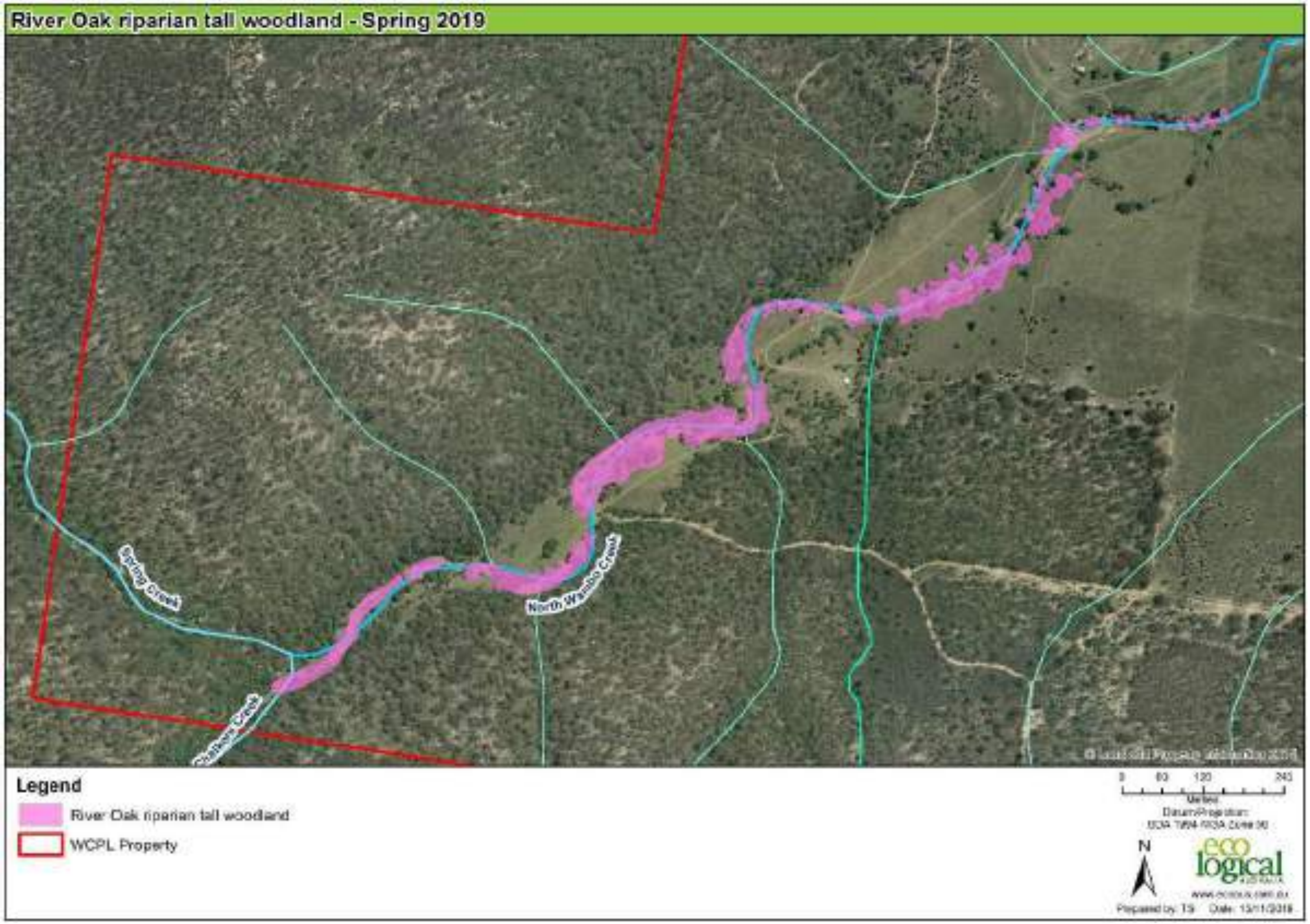

Figure 36. Extent of River Oak riparian tall woodland mapped in spring 2020, unchanged from spring 2019

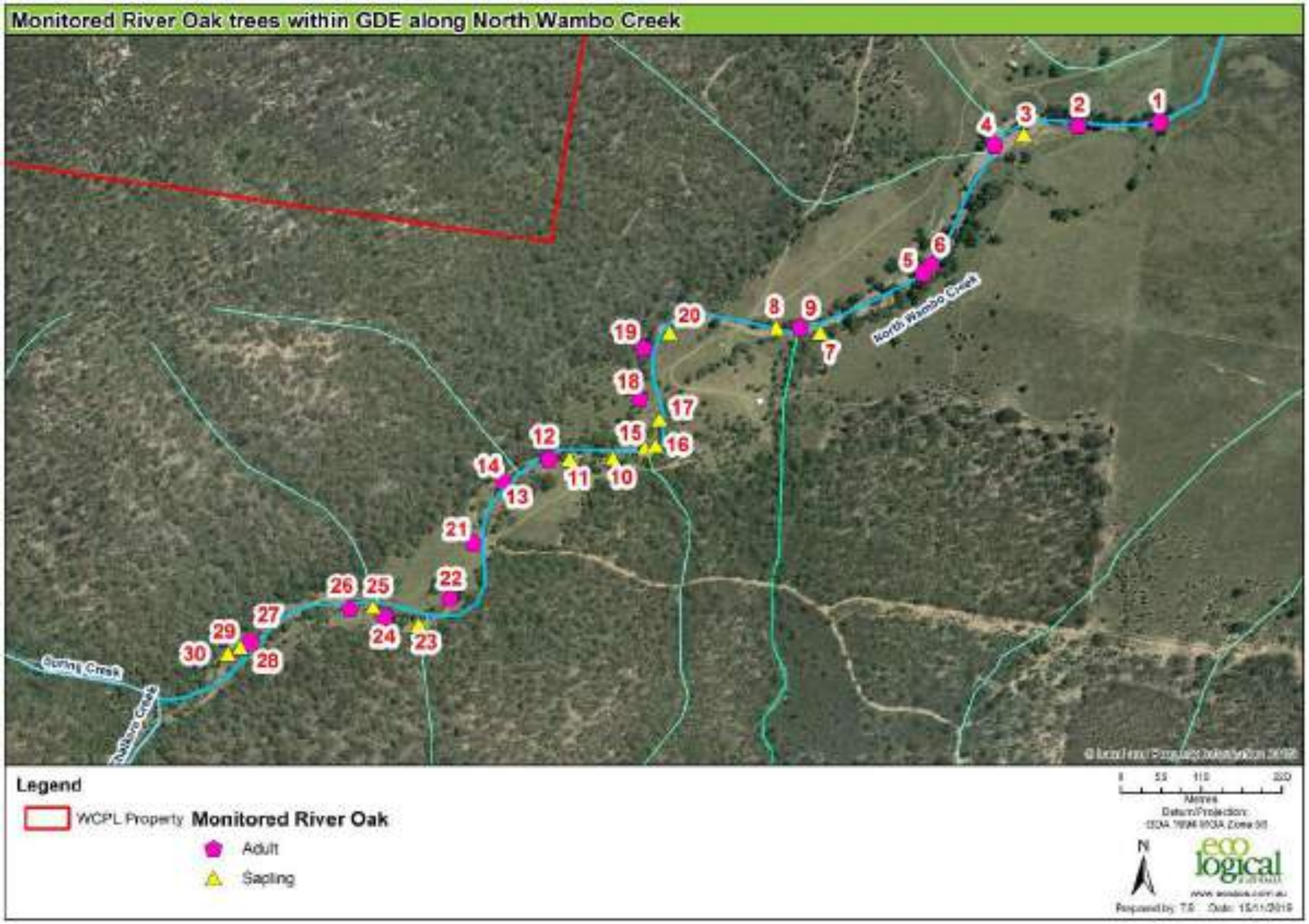

Figure 37. Monitored River Oak trees along North Wambo Creek

6. Mine subsidence observations and other management considerations

Mine subsidence and land management issues observed during the 2020 monitoring surveys across the RWEAs and rehabilitated landforms are summarised in Table 29 and mapped on Figure 38.

Table 29. Mine subsidence and other land management observations recorded during 2020 Spring monitoring (# corresponds to the labels on Figure 38)

#	Type	Location	Notes
1	Erosion	NWCD	Erosion in creek diversion
2	Subsidence cracking	NWCD	30m x 20cm, large crack in creek diversion area
3	Subsidence cracking	NWCD	30m x 30cm, large crack in creek diversion area
4	Erosion	NWCD	Rilling in creek bank
5	Subsidence cracking	RWEA C	8m x 20cm
6	Subsidence cracking	RWEA C	2m x 1m, slump hole in side of track
7	Erosion	NWCD	rill erosion, 5m x 50cm
8	Erosion	Rehabilitation area	Open bare soil
9	Subsidence cracking	RWEA D	1m x 1m hole in track near gate
10	Subsidence cracking	RWEA C	8m x 0.5m crack beside track
11	Subsidence cracking	RWEA C	Large cracks very deep 5m+ at edges of road and 1x1m hole in middle of road
12	Subsidence cracking	RWEA C	Large crack 5m+ deep at edge of track
13	Subsidence cracking	General surface area	20m x 1m crack
14	Subsidence cracking	General surface area	4 m x 1m crack
15	Subsidence cracking	General surface area	>30m x 10cm crack across track
16	Pest species	RWEA C	evidence of pigs

Figure 38. Subsidence and other land management observations from Spring 2020 biodiversity monitoring surveys

6.1 Remnant woodland enhancement areas

6.1.1 Subsidence observations

Subsidence cracks were noted during flora field work within RWEA C and RWEA D, within the Narrow-leaved Ironbark and Slaty Gum communities. The largest subsidence cracks were noted near flora site V11-B1, as per recent years (**Photograph 39 and Photograph 40** from 2019). These cracks appeared larger in 2020, however the cracking was not having any observable significant impacts on vegetation at the current time, with the adjacent trees and shrubs surviving.

Photograph 39: Large subsidence cracks near flora monitoring site V11-B1 (in 2019)

Photograph 40: Large subsidence cracks near flora monitoring site V11-B1 (in 2019)

6.1.2 Other management observations

A low intensity fire was reported in RWEA D in 2019 near bird monitoring site BP25. The fire had burnt the understorey and parts of the mid-storey, with limited impact to the canopy. In 2020, this area was observed to be in good condition (Photograph 41).

A new infestation of the weed *Galenia pubescens* was observed within high condition native vegetation in RWEA C. The weed appears to have been transported into the area during road maintenance works undertaken a few years ago (Photograph 42). This infestation should be treated as a high priority while it is localised, before it spreads. Further weed observations will be undertaken as part of the Annual Weed Treatment Plan update in early 2021.

Active track repair works were underway in RWEA D to repair a subsidence hole at the gate between RWEA C and D.

Photograph 41: Recent low intensity fire has burnt within RWEA D near BP 25.

Photograph 42: Infestation of *Galenia pubescens* in RWEA C, likely transported into area during road works

6.1.3 Performance criteria and results

Performance criteria and findings during the 2020 monitoring for subsidence impacts are presented in Table 30, which is based on **Table 20** in the *Wambo Coal Biodiversity Management Plan* (WCPL 2017). These performance criteria exclude any impacts and consequences of mining that occurred prior to February 2011 in accordance with Condition 22, Schedule 4, of Development Consent DA 305-7-2003.

Table 30: Subsidence performance measures, indicators and 2019 findings

Biodiversity feature	Performance measure	Performance indicator (WCPL 2017)	2020 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 2020.
Other species, populations or communities listed under the Biodiversity Conservation Act 2016 or Environmental Protection and Biodiversity Conservation Act 1999	Minor cracking and ponding of the land surface or other impact. Negligible environmental consequences.	The performance indicator will be considered to have been exceeded if annual monitoring at flora monitoring sites V6-B1c and V11-B1 or bird monitoring sites (BP14, BP16, BP20, BP21) above Longwalls 11 to 16 indicate a statistically significant downward trend or change between monitoring periods not observed at analogue/reference sites.	Bird monitoring sites showed no downward trend or indication that bird populations have declined (**Figure 39**). Subsidence cracks were recorded at both sites V6-B1c and V11-B1. No significant vegetation damage was observed at these sites. Flora monitoring sites V6-B1c and V11-B1 showed an increase in the number of native species recorded, with a similar increase recorded at the reference site (**Figure 40**), indicating no significant effect of undermining was recorded. The same trend was also recorded across the majority of flora sites in 2020. Vegetation at these sites and in the wider area remains in relatively good condition at the time of survey considering the dry conditions.
Warkworth Sands Woodland Community		The Warkworth Sands Woodland Community is absent from the South Bates Underground Mine area. Monitoring and performance indicators relevant to mine subsidence in the Warkworth Sands Woodland Community	Area not currently undermined – no subsidence observations.

Biodiversity feature	Performance measure	Performance indicator (WCPL 2017)	2020 findings
		will be addressed in future revisions of the BMP prior to any extraction under the Warkworth Sands Woodland Community	
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.

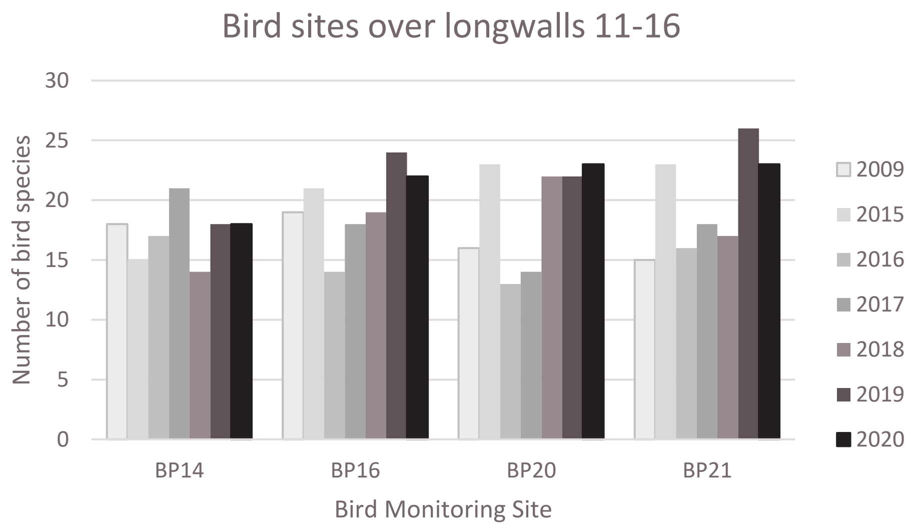

Figure 39: Total number of bird species recorded at sites located over longwalls 11 to 16 in 2009 and 2015-20

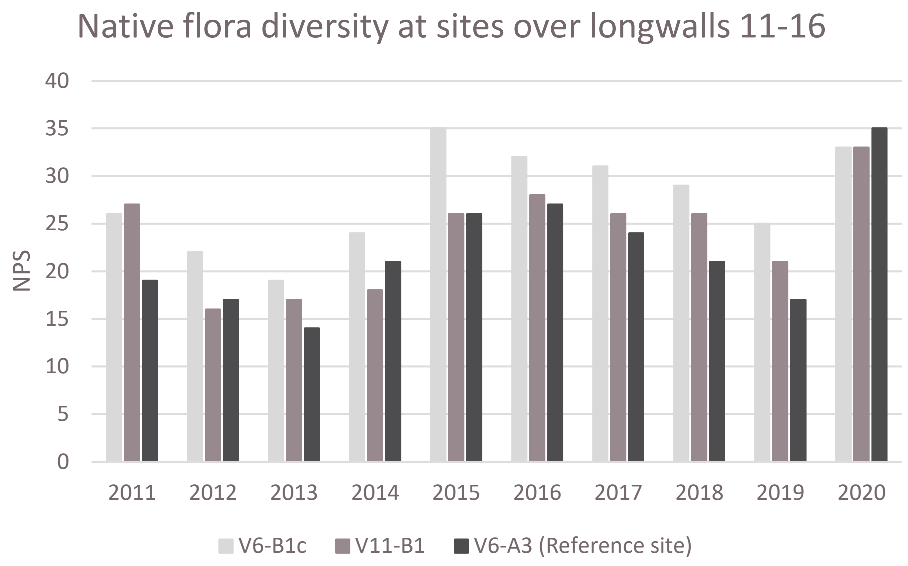

Figure 40. Average number of native flora species recorded at sites located over longwalls 11-16 and reference site 2010-2020

6.1.4 Conclusion and recommendations

Subsidence was observed in the RWEA C above Longwalls 11 to 16. Monitoring data does not indicate any exceedance of the performance criteria or any significant effects on flora and fauna at this stage, however future monitoring should continue to document and assess subsidence impacts across the site.

Targeted weed treatment is recommended for the newly identified *Galenia pubescens* infestation in high quality vegetation within RWEA C. Detailed actions will be presented within the Annual Weed Treatment Plan.

6.2 Rehabilitation areas and other land

The condition of rehabilitated land has been discussed in **Section 3**, however, some relevant opportunistic observations relating to land management and biodiversity were made while traversing the mine site (Figure 38).

Along the North Wambo Creek Diversion erosion and subsidence issues were recorded (**Photograph 43**). These issues/areas are under current active management efforts from by the NSW Soil Conservation Service. Erosion and subsidence/slumping of land were recorded within pasture and woodland rehabilitation areas (**Photograph 44**). Several areas of erosion and bare soil observed exceed the completion criteria for rehabilitated areas listed in the Mining Operations Plan (WCPL 2015).

Photograph 43: Erosion issues along the North Wambo Creek Diversion near site 23R

Photograph 44: Large area of erosion/bare soil at failed pasture rehabilitation near site 33R (exceeding completion criteria)

6.3 Weed issues

Environmental weeds have largely been discussed in previous sections. Exotic annual species have increased in abundance in 2020 following higher than average rainfall. Management of weeds across WCPL land should continue, particularly for priority weeds and Weeds of National Significance (WONS), to prevent their spread.

A targeted weed survey and update to Annual Weed Treatment Plan is scheduled for early 2021, which will record weed issues, incorporating the results of this monitoring program, and outline proposed strategy for weed treatment in 2021 in detail.

7. Summary of management actions required

A summary of the management actions required and recommended to be undertaken by WCPL based on the results of the 2020 annual biodiversity monitoring program is provided in Table 31.

Table 31: Summary of management actions required

Area/Feature	Performance criteria	Result	Action required
RWEA A and Rail Loop	VCA Target: Exotic plant cover limits within RWEA A and Rail Loop **Targets** Rail Loop CT2: 15% RWEA A A1: 60% RWEA A A2: 15% RWEA A A3: 20%	Exotic plant cover at CT2 (Rail Loop), and A1, A2, and A3 (RWEA A) exceeded targets **Results** Rail Loop CT2: 26% RWEA A A1: 64% RWEA A A2: 25% RWEA A A3: 94%	Conduct annual weed survey and review of weed management activities success. Update Annual Weed Treatment Plan. Continue weed management in RWEA A and Rail Loop in accordance with Updated Weed Treatment Plan – increased management effort may be required Consider planting native trees in over-cleared riparian areas and other priority areas (see Figure 41).
RWEA A and Rail Loop PCT1658	Performance target: Various mid-storey and ground cover attributes	Native ground cover scores within several sites/PCTs were below targets	Continue monitoring and increase weed management in RWEA A and Rail Loop 2021 monitoring to record additional details of mid-storey, shrub and ground cover others
North Wambo Creek Diversion	Mining Operations Plan: No tunnel or gully erosion is to be present	Gully erosion observed in creek diversion near 23R	Current active management in progress by NSW Soil Conservation Service. Continue active management of creek diversion to encourage establishment of native species and address erosion issues
North Wambo Creek Diversion	Mining Operations Plan: No single bare area >20m²	Several areas of bare soil larger than 20m² observed along creek diversion	
Pasture rehabilitation	Mining Operations Plan: No single bare area >20m²	Several areas of bare soil larger than 20m² observed within pasture rehabilitation areas	Undertake active management of bare soil patches to control erosion and encourage establishment of vegetation
Woodland rehabilitation	Performance targets: NPS, NMS, NGCG, NGCS, NGCO, OR	Scores below targets for several attributes at most sites	Ensure new areas of woodland rehabilitation are planned and implemented using best practice techniques
Riparian areas	N/A	Riparian areas of lower reaches of Stony Creek may be open to cattle grazing	Exclude cattle from riparian areas to improve vegetation condition and increase resilience to drought.

Area/Feature	Performance criteria	Result	Action required
			Consider planting native trees in over-cleared riparian areas
RWEAs	N/A	Nest box monitoring identified three fallen nest boxes	Re-install the three fallen/damaged nest boxes

Figure 41: Potential revegetation areas

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Wambo Coal Mine

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Wambo Coal Pty Ltd

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Contents

List of Tables

1. Introduction

This document provides raw data and photographs collected during spring 2020 monitoring at the Wambo Coal Mine.

2. Flora monitoring

2.1 Monitoring data

Data collected during the 2019 floristic surveys are presented below in **Table 1.**

Several abbreviations for measured attributes are used in tables throughout the following section. An explanation of these is provided below:

- NPS – the number of native plant species within 20 x 20 plot
- NOS (%) - projected native foliage cover of canopy
- NMS (%) – projected native midstorey cover
- NGCG – native groundcover of grasses
- NGCS – native groundcover of shrubs
- NGCO – native groundcover of other plant types (sedges, herbs etc.)
- EPC – exotic plant cover
- OR – proportion of overstorey species regenerating over the whole vegetation zone
- HBT – number of hollow-bearing trees present in the 20 x 50 m vegetation plot
- FL – length of fallen logs >10 cm diameter
- LI (%) – leaf litter cover
- BS (%) – bare soil cover

Table 1: Biometric plot data for remnant woodland areas

Plot Name	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	LI	BS
V1-A1	12	18	0	0	0	0	84	0	1	120	22	6
V1-A2	11	10.5	2.5	0	0	6	105.5	0	1	30	32	0
V1-B1	20	12	0	4	0	62	2	0	0	10	18	38
V1-B2	15	23	2	10	2	30	94	0	0	10	0	0
V1-B3	13	11	2.7	0	6	0	98	0	0	10	2	0
V2-A1	17	6.2	25	50	0	6	22	2	1	7.5	82	4
V2-B1	14	18.5	1	6	2	16	64	0	1	5	28	8
V2-B2	16	13.5	9.5	40	2	2	62	2	1	15	52	2
V3-B1	23	20.6	2	16	4	18	16	4	1	33	88	4
V5-B1	28	18	1	56	0	4	25	0	1	10	94	0
V5-B2	22	14.6	8.5	76	0	2	2	3	0	3	90	4
V5-B3	30	7	18.3	64	0	2	4	2	1	12	70	2
V5-B4	21	17.6	0	26	0	0	26	0	1	12	80	0
V6-A1c	45	15	12	70	8	30	0	2	1	26	80	0
V6-A3	35	20	5	40	4	34	2	0	1	9	98	0
V6-B1	27	19.6	12	34	2	0	4	2	1	32	96	0
V6-B1c	33	9.7	8.1	54	4	6	2	1	1	25	92	0
V6-B2	31	12.3	13.2	34	14	20	0	1	0	51	96	0
V6-B2c	42	9	5	52	8	12	0	0	1	22	88	2
V6-B3	29	13.3	9.5	30	10	12	2	3	1	31	100	0
V6-B4	9	14.8	0	8	2	0	0	0	1	5	90	8
V11-B1	31	23	11	32	0	0	4	1	1	17	88	16
V11-B2	43											
V9-A1	29	15.8	7	40	18	10	0	1	1	19	98	8
V9-B1	39	13.2	5.5	56	4	6	2	0	1	23	96	0
V9-B2	39	6.5	6.5	14	12	6	2	0	1	12	82	14
V10-A1	46	22.5	8.7	58	24	14	4	3	1	35	100	0
V10-A2	34	19	10	14	0	8	0	2	1	42	78	30
V10-B1	33	10.2	6	50	10	0	0	0	1	58	84	8
V10-B3	49	12.3	3.8	80	4	40	6	0	1	23	32	0
V13-B1	45	27.3	27.5	42	18	30	0	1	1	31	98	0
V14-A1	42	11.5	35.5	30	4	28	8	0	1	8	84	14
V14-B1	34	3.4	31	46	2	6	0	0	1	25	76	6
V14-B2	46	17	18.5	78	10	44	0	0	0	5	74	4

Table 2: Biometric plot data for woodland rehabilitation monitoring plots

Plot Name	NPS	OS	MS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	LI	BS
3R	10	15	0	0	0	0	0	0	0	0	88	12
4R	9	25	0	0	0	0	0	0	0	0	94	8
6R (new)	10	55	0	0	0	0	0	0	0	0	100	0
8R	16	16.5	0	0	0	0	0	0	0	0	64	36

Table 3: Biometric plot data for GDE, South Bates Extension and North Wambo Creek Diversion Plots

	NPS	OS	MS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	LI	BS
GDE-P1	38	10	14	58	6	14	0	0	1	32	84	2
GDE-P2	32	6	16	70	22	12	0	0	1	22	84	4
GDE-P3	23	17	0	16	0	10	58	1	1	32	8	10
GDE-P4	43	23	1.5	24	6	46	14	0	1	15	2	10
SBX1-SG_I	27	28.5	1.5	4	0	4	0	0	1	45	80	12
SBX2-GB-I	33	34	4	22	6	10	0	0	1	10	56	6
SBX3-SG-C	30	22	9	14	6	4	0	0	1	21	78	0
SBX4-GB-C	32	18.5	1	26	4	18	2	1	1	52	48	2
NWCD1	13	0	0	10	0	0	76	0	1	67	0	14
NWCD2	16	0	0	42	0	6	24	0	1	3	2	26

Table 4: Flora species lists from RWEA monitoring plots

Scientific Name	Common Name	Native/Exotic	V1A1	V1A2	V1B1	V1B2	V1B3	V2A1	V2B1	V2B2	V3B1	V5B1	V5B2	V5B3	V5B4	V6A1	V6A3	V6B1	V6B1c	V6B2	V6B2c	V6B3	V6B4	V9A1	V9B1	V9B2	V10A1	V10A2	V10-B1	V10-B3	V11-B1	V11-B2	V13-B1	V14A1	V14-B1	V14-B2
Abutilon oxycarpum	Lantern Bush	N																	1													1	2		2	3
Acacia amblygona	Fan Wattle	N														2	1	2	1		3			2		2				2	3	1				
Acacia binervia	Coast Myall	N																	2										3	2		3				
Acacia decora	Western Silver Wattle	N																												3						
Acacia decurrens	Black Wattle, Green Wattle	N		2									1	2	2																					
Acacia filicifolia	Fern-leaved Wattle	N				1		1		3																										
Acacia implexa	Hickory Wattle	N																			1															
Acacia longifolia		N																			1							2								
Acacia longissima		N																	1																	
Acacia parramattensis	Parramatta Wattle	N							2																											
Acacia salicina	Cooba	N														1														2					1	
Acacia sp.		N	1														1							3				2						2		1
Acetosella vulgaris	Sorrel, Sheep Sorrel	E						2																												
Adiantum aethiopicum	Common Maidenhair	N																															2			
Aira cupaniana	Silvery Hairgrass	E					3	1																												
Alisma plantago aquatica		N			1																															
Allocasuarina luehmannii	Bulloak	N												3	2	2	4	3	3	1	4	2	4	3	1	3	2	3			2	3				
Alternanthera denticulata		N			2																															
Alternanthera sp.		N																									1									
Amyema gaudichaudii	Paperbark Mistletoe	N																									1									
Angophora floribunda	Rough-barked Apple	N									2	3	4	2	4																					
Aristida ramosa	Purple Wiregrass	N						1				2		3	2	2	2	2	1	2	2	2	3	3	1		2	3	1	3		2			2	2
Aristida vagans	Threeawn Speargrass	N										2		2	2	3	4	2	3	1	2	2			3	3	3	2	3		3	3			3	2
Arthropodium milleflorum	Vanilla Lily	N																						1	2											
Asparagus asparagoides	Bridal Creeper	E							1	1																										
Asparagus officinalis		E							2	1			2																							
Aster spp.		E					2																													
Austrostipa ramosissima	Stout Bamboo Grass	N		1		2			1							2				1													4			4
Austrostipa scabra subsp. scabra		N														3																			2	2
Austrostipa sp.(tussock)		N																	3	1										2						
Austrostipa verticillata	Slender Bamboo Grass	N																																1		
Axonopus ficilifolius		E						2																												
Backhousia myrtifolia	Grey Myrtle	N			1																															
Bidens pilosa	Cobbler's Pegs	E	2	1						2	3	3	3					2		2		2			2				2							

Scientific Name	Common Name	Native/Exotic	V1A1	V1A2	V1B1	V1B2	V1B3	V2A1	V2B1	V2B2	V3B1	V5B1	V5B2	V5B3	V5B4	V6A1	V6A3	V6B1	V6B1c	V6B2	V6B2c	V6B3	V6B4	V9A1	V9B1	V9B2	V10A1	V10A2	V10-B1	V10-B3	V11-B1	V11-B2	V13-B1	V14A1	V14-B1	V14-B2
Bidens subalternans	Greater Beggar's Ticks	E				4	3		5	1			1																					1		
Brachychiton populneus subsp. populneus	Kurrajong	N							2			2				1				2	1					1	1						1	4	1	
Breynia oblongifolia	Coffee Bush	N								2		3	4	2	2	2						1		2	1	2	1		1	1	2	3	2		1	1
Bromus catharticus	Prairie Grass	E	2						2	1																										
Brunoniella australis	Blue Trumpet	N														2	3			2	3	2				2				3				2	2	2
Bryophyllum delagoense	Mother of Millions	E											3																							
Bursaria spinosa	Native Blackthorn	N													1	1			2						4	3	2	3	4	2	3	3	3			2
Caesia parviflora	Pale Grass-lily	N															1		3	1	1	1									1	2				
Callistemon rigida		N			1																															
Calotis cuneifolia	Purple Burr-Daisy	N									2						2					2														
Calotis lappulacea	Yellow Burr-daisy	N															2	1				1										2		2		
Calystegia marginata		N	1						2																											
Cardiospermum grandiflorum	Balloon Vine	E		3	2	2	2																													
Carex inversa	Knob Sedge	N									2																									
Cassinia arcuata	Sifton Bush	N																													1					
Cassinia cunninghamii		N																										3								
Casuarina cunninghamiana	River Oak	N	5	3	4	3	4																													
Cayratia clematidea	Slender Grape	N					2																										2			2
Centaurium sp	small, yellow flower	E									3																									
Centaurium tenuiflorum		E	1								3																	2								
Centella asiatica	Pennywort	N	2		3						3																									
Centipeda minima	Spreading Sneezeweed	N			3						5																									
Cheilanthes distans	Bristly Cloak Fern	N										1				4		1	2	3	2			2			2		1		2				4	2
Cheilanthes sieberi subsp. sieberi		N						2		1	2			2	2		2	3			2			1	3		2	3	2	2	1	2		3		2
Chloris divaricata var. divaricata		N														2																				
Chloris gayana	Rhodes Grass	E	1																																	
Chloris sp.		N																		2	1	2					1			2				1		
Chloris truncate	Windmill Grass	N						1										2							1											
Chloris ventricosa	Tall Chloris	N														2		2																	1	
Choretrum candollei	White Sour Bush	N						2					2						1						2			2				2				
Chrysocephalum apiculatum	Common Everlasting, Yellow Buttons	N	1					3			2	2			2																					
Cirsium vulgare	Spear Thistle	E	3				1				3											1						1				2				
Clematicissus opaca		N																																	2	

Scientific Name	Common Name	Native/Exotic	V1A1	V1A2	V1B1	V1B2	V1B3	V2A1	V2B1	V2B2	V3B1	V5B1	V5B2	V5B3	V5B4	V6A1	V6A3	V6B1	V6B1c	V6B2	V6B2c	V6B3	V6B4	V9A1	V9B1	V9B2	V10A1	V10A2	V10-B1	V10-B3	V11-B1	V11-B2	V13-B1	V14A1	V14-B1	V14-B2
Clematis aristata	Old Man's Beard	N					1					1	1																1				1			
Commelina cyanea	Scurvey Weed	N										1													1				1			2				3
Conyza bonariensis	Flaxleaf Fleabane	E	3	1		3							1	1	1													1	1		1	2		2		
Conyza sumatrensis	Tall fleabane	E			1		3				2																									
Corymbia maculata	Spotted Gum	N																						3	3	3			3				3			
Cotoneaster pannosus		E										2																								
Crassula sieberiana		N					1							2			3		3		2			2			3	3			1			2	2	
Cyanthilium cinereum		E																				1		1												
Cyclospermum		E	2																									1								
Cymbopogon refractus	Barbed Wire Grass	N						3	2	1	2	2	2	2	2	2	2	3	3	3	3	2		3	3	2	3	2	2	2	2	2	1		2	1
Cynodon dactylon	Common Couch	N	2					4	2	1	2	1	1	2				2						2				1	2							
Cynoglossum australe	4 seed velcro heads	E				1			2				2		1							1														
Cyperus gracilis	Slender Flat-sedge	N														1	2					2		1			3		2					2		2
Cyperus polystachyos		N																						1												
Cyperus spp.		N														3					2	2			2									2		2
Datura stramonium	Common Thornapple	E									3																									
Daucus carrota		E					1	1														1														1
Daviesia genistifolia	Broom Bitter Pea	N																								1										
Desmodium brachypodum	Large Tick-trefoil	N														1			2		2	3												2		3
Desmodium rhytidophyllum		N																								2										
Desmodium varians	Slender Tick-trefoil	N														2	2	1	1	1	2			1	1	1		1	2	1			2	2	2	3
Dianella caerulea var. caerula		N														2		1	2						2	1			2	2	1	3				
Dianella longifolia		N															2																			
Dianella longifolia var. longifolia		N																			3			2				2	1							
Dianella revoluta var. revoluta		N											3	1	2				1				2		1					1		2				
Dichelachne sp.		N																									2	1							3	
Dichondra repens	Kidney Weed	N														2				2		2			2		2	2	2				1	2	1	2
Dichopogon	Chocolate Lily	N															1												1							
Digitaria spp.		N																											1		1	3				
Dodonaea viscosa subsp. cuneata		N															1		1					1		2			1		4	1			1	
Dysphania sp.		N														1														2						
Echinopogon caespitosus	Bushy Hedgehog-grass	N												1																						
Echium plantagineum	Patterson's Curse	E		4			2																													
Ehrharta erecta	Panic Veldtgrass	E	3	3	2	4	5		3	3		1	3					1																		
Einadia hastata	Berry Saltbush	N												3							2								1					3		1

Scientific Name	Common Name	Native/Exotic	V1A1	V1A2	V1B1	V1B2	V1B3	V2A1	V2B1	V2B2	V3B1	V5B1	V5B2	V5B3	V5B4	V6A1	V6A3	V6B1	V6B1c	V6B2	V6B2c	V6B3	V6B4	V9A1	V9B1	V9B2	V10A1	V10A2	V10-B1	V10-B3	V11-B1	V11-B2	V13-B1	V14A1	V14-B1	V14-B2
Einadia nutans		N															2							2										1		2
Einadia polygonoides		N										1	2			2					1	1					2							3	2	
Einadia trigonos subsp. trigonos		N		3					3	2		2	2			2		1	1	1				2			2	2	1	1						3
Enchylaena tomentosa		N														2	1		1	2	1	2									1			1		
Entolasia marginata	Bordered Panic	N			1																															
Entolasia sp		N														2														1		3	3			
Entolasia stricta	Wiry Panic	N																						3		2		2		1	2	3			3	
Eragrostis benthamii		N																	1												1					
Eragrostis brownii	Brown's Lovegrass	N														1							2	2	2			2	2							
Eragrostis curvula	African Lovegrass	E	4		2		2	1							2																					
Eragrostis leptostachya	Paddock Lovegrass	N																			2															
Eragrostis parviflora		N														2																				
Eremophila debilis	Amulla	N														2	2	2		3	4	3					2		1			2		2		3
Eucalyptus blakelyi	Blakely's Red Gum	N									4			1																						
Eucalyptus camaldulensis	River Red Gum	N						3	4	4																										
Eucalyptus crebra	Narrow-leaved Ironbark	N									1					4	4	1	3		4	1	1	4	3	3	3	4	3		3	3	3			2
Eucalyptus dawsonii	Slaty Gum	N										1															3			3						
Eucalyptus moluccana	Grey Box	N														2		3		3	3	3											3		3	
Eucalyptus punctata	Grey Gum	N																							1				2		3	2				
Euchiton involucratus	Star Cudweed	N		2							2									2					1		2	2	1			2	2	1		1
Euchiton sp.		N			2	2			2		3	1		2	2																1					
Exocarpus strictus	Cherry Ballart	N							1	3				2											2											
Facelis retusa	Annual Trampweed	E		3			3	3						1	1						1				1						2	1				1
Fimbristylis dichotoma		N																							1											
Gahnia aspera	Rough Saw-sedge	N																								1	1	2		1		2	2	1	2	1
Galenia pubescens	Galenia	E		4				2	4																											
Galium propinquum	Maori Bedstraw	N																															3	1		3
Geijera salicifolia var. salicifolia		N														1	1				1														3	2
Geitonoplesium cymosum	Scrambling Lily	N																												1			2			2
Geranium sp.		N																															1			
Glycine clandestina		N								1			1	1	1			1	1						2			1			1	1	1		1	
Glycine microphylla		N						1				2	2				2				2	1			1	1	1	1	1					2		1
Glycine tabacina	Variable Glycine	N										2	1		1	1				2				2	1		1	1	2				1	1		2
Gomphocarpus fruticosus	Narrow-leaved Cotton Bush	E																				1										2				
Goodenia hederacea	Ivy Goodenia	N															2				1							2								

Scientific Name	Common Name	Native/Exotic	V1A1	V1A2	V1B1	V1B2	V1B3	V2A1	V2B1	V2B2	V3B1	V5B1	V5B2	V5B3	V5B4	V6A1	V6A3	V6B1	V6B1c	V6B2	V6B2c	V6B3	V6B4	V9A1	V9B1	V9B2	V10A1	V10A2	V10-B1	V10-B3	V11-B1	V11-B2	V13-B1	V14A1	V14-B1	V14-B2
Goodenia rotundifolia		N															1		2		1			2	3	2			3		2	4				
Grevillea montana		N																								3		2								
Grevillea robusta	Silky Oak	N			2																															
Grevillea sp		N												2																						
Hardenburgia violaceae		N																							1											
Heliotropium amplexicaule	Heliotrope	E		4	2	4	3	4	5	3		3	2					3																		
Hibbertia diffusa		N										2																								
Hibbertia sp.		N											1	1	1													1				3				
Hibiscus heterophyllus subsp. heterophyllus	Native Rosella	N																															3			
Hirschfeldia incana		E	3																																	
Hovea sp.		N												1																		2				
Hydrocotyle bonariensis		E			2																															
Hydrocotyle verticillata	Sheild Pennywort	N	2		2																															
Hypochoeris radicata	Catsear	E	2			1	2	3	1				2																							
Imperata cylindrica		N											3																							
Isopogon dawsonii	Nepean Conebush	N												3																						
Jacksonia scoparia		N										2													1											
Jasminum volubile		N																																1		
Juncus polyanthemus		N									2				1																					
Juncus usitatus		N																						1												
Kennedia rubicunda		N																											1							
Lachnagrostis filiformis		N			3	1					5																									
Lamiaceae	purple flower	N														1																		2		
Laxmannia gracilis	Slender Wire Lily	N																			2		1	3												
Lepidosperma laterale		N																														3	1			
Leptospermum petersonii	Lemon-scented Teatree	N				2																														
Leptospermum polyanthum		N		2				1																												
Leptospermum sp.		N					4			1																										
Leucopogon muticus	Blunt Beard-heath	N													1																	2				
Lobelia purpurascens	Whiteroot	N																							1											
Lolium sp.	Rye grass	E	3					1	1																											
Lomandra confertifolia subsp. pallida		N																				1														
Lomandra filiformis	Wattle Matt-rush	N																			1							2								
Lomandra filiformis subsp. coriacea		N								1						1		2		2				1	2				2			2			1	
Lomandra filiformis subsp. filiformis		N						2																						1						

Scientific Name	Common Name	Native/Exotic	V1A1	V1A2	V1B1	V1B2	V1B3	V2A1	V2B1	V2B2	V3B1	V5B1	V5B2	V5B3	V5B4	V6A1	V6A3	V6B1	V6B1c	V6B2	V6B2c	V6B3	V6B4	V9A1	V9B1	V9B2	V10A1	V10A2	V10-B1	V10-B3	V11-B1	V11-B2	V13-B1	V14A1	V14-B1	V14-B2
Lomandra longifolia	Spiny-headed Mat-rush	N			3	1						4	3	4																		2	2			
Lomandra multiflora	Many-flowered Mat-rush	N										2																2	1							
Lomandra multiflora subsp. multiflora	Many-flowered Mat-rush	N									2		2	2	2	2	2	3	1	3	3	2	2			2	2			2	2	2		1	2	
Lomandra sp.		N													2		2						1		1		2	2						2		1
Lycium ferocissimum	African Boxthorn	E		2		1				1														1												
Lysmachia minima	Scarlet/Blue Pimpernel	E	4		2	2	3	2	3	2	2	2									1							3						3	2	
Macroxamia sp.		N																										2								
Macrozamia flexuosa		N																	1						1								1			
Macrozamia reducta		N																								2			1							
Maireana microphylla	Small-leaf Bluebush	N																1												1				1	2	
Maytenus silvestrus		N														1													1							1
Melaleuca decora		N																3	3	3	2	3	1	3	4		4		3		3	2				
Melaleuca nodosa		N																										3								
Melaleuca thymifolia		N									3																									
Melia azedarach	White Cedar	N			1		2		1	1		1																					2	1		
Melinis repens	Red natal grass	E					1					1	2	1	5																					
Microlaena stipoides var. stipoides	Weeping Grass	N		4		3	2		2	2		1	2	3														2	1				2	3		3
Microtis sp.		N						1																												
Modiola caroliniana		E	2																																	
Myoporum platycarpum	Rutaceae, white flower, toothed leaf	N																												3						
Notelaea longifolia	Large Mock-olive	N																			1												3			
Notelaea microcarpa var. microcarpa		N				1			2	2	1	2	2	3	2	4	1	1	2	3	1	1			1	2	3		2	3	2	3	4	4	4	5
Oenothera stricta subsp. stricta	Common Evening Primrose	E	3	1				1																												
Olea europaea subsp. cuspidata		E					2					2	1																							
Olearia elliptica	Sticky Daisy Bush	N														3	2		4	3	2				3	4			2	2		3	1	1	2	3
Opercularia sp.		N																						1	1	2										2
Oplismenus aemulus		N	1		2		3																										4			3
oplismenus imbicilus		N																											3							
Opuntia aurantiaca	Tiger Pear	E		1					1			1	1					1		1				2												
Opuntia humifusa	Creeping pear	E												2																						
Opuntia stricta	Prickly Pear	E				1	1		2	1		1	1		2	1	2	2		2	1	2	3	2	1					2	1	2				
Oxalis corniculata	Creeping Oxalis	E		2		1			2				1	1																						

Scientific Name	Common Name	Native/Exotic	V1A1	V1A2	V1B1	V1B2	V1B3	V2A1	V2B1	V2B2	V3B1	V5B1	V5B2	V5B3	V5B4	V6A1	V6A3	V6B1	V6B1c	V6B2	V6B2c	V6B3	V6B4	V9A1	V9B1	V9B2	V10A1	V10A2	V10-B1	V10-B3	V11-B1	V11-B2	V13-B1	V14A1	V14-B1	V14-B2
Oxalis perennans		N						2		1	1	2	2														1					2	2	2		1
Oxalis spp.		N					1																										2			
Oxylobium cordifolium		N																								1										
Pandorea pandorana	Wonga Wonga Vine	N																															2			
Panicum effusum		N																		2																
Panicum simile	Two-colour Panic	N																													2					
Panicum sp.		N						1					1				2	2	2								2									
Paspalidium distans		N																											2			4				
Pavonia hastata		E				2	2	2	3	5	?			3																						
Pennisetum clandestinum	Kikuyu Grass	E	1																																	
Persicaria sp.		N			1																															
Persoonia linearis	Narrow-leaved Geebung	N												1											1				1			2				
Petrorhagia nanteuilii		E					2	3	2																											
Phalaris aquatica		E							1																											
Phragmites australis	Common Reed	N	4	3	3	2	2																													
Phyllanthus virgatus		N			2	1	2																													
Pimelea linifolia	Slender rice flower	N												1																						
Plantago debilis		N									2					2				2												2		2	2	
Plantago lanceolata	Lamb's Tongues	E	3					2																				1								
Plantago varia		N																									2	3				3				
Plectranthus sp.		N																																		2
Poa spp.		N																																1		
Polycarpon tetraphyllum		E							2			1															2									
Pomax umbellatum		N																							1			1			2	4				
Psydrax oderatum		N																									2			1						
Pteridium esculentum		N										3	3	1																						
Richardia humistrata		E						3			1	2	3								1															
Rumex brownii	Swamp Dock	N	1	1																																
Rytidosperma (Austrodanthonia) spp.	Wallaby grass	N														1	2		2		2				1	2	2	2		2	2	2				
Salix spp.	Willow	E	2		1																															
Schoenus brevifolius		N			5																															
Sedge sp.		N									3																									
Senecio madagascariensis	Fireweed	E	3	2	2	2	2	3	2	1	2				1	2	2		2		3			2		1	2	2	1	2	2	3	2	1	2	1
Senecio sp.		N												1								1														
Senna sophera		N														2											2					2	2			2

Scientific Name	Common Name	Native/Exotic	V1A1	V1A2	V1B1	V1B2	V1B3	V2A1	V2B1	V2B2	V3B1	V5B1	V5B2	V5B3	V5B4	V6A1	V6A3	V6B1	V6B1c	V6B2	V6B2c	V6B3	V6B4	V9A1	V9B1	V9B2	V10A1	V10A2	V10-B1	V10-B3	V11-B1	V11-B2	V13-B1	V14A1	V14-B1	V14-B2
Setaria sp.		E									1																	1								
Sida corrugata		N															1				1								1	2		1		2		
Sida rhombifolia	Paddy's Lucerne	E	3	1		2																											1	1		
Sida sp.		N									2											2											1		2	
Sigesbeckia orientalis		N				2	1												2											1			3	1	3	1
Silene gallica var. gallica	French Catchfly	E	2			1		2																												
Sisyrichium iridifolium	Iris	E	2		2				2		3																									
Solanum brownii		N														2											2	2			1			1		2
Solanum chenopodoides		E	3			2	3		2	1																						2				
Solanum nigrum	Black-berry Nightshade	E				1	2										1		1		1							3			1	2		2		2
Solanum prinophyllum	Forest Nightshade	N												1			1			2	1	2			1				1		2	2	1	1		
Solanum sp.		E																													2	2	2			
Solanum sp.	Non hairy, very spikey	N																		2		2														
Solanum spp.		N		2																																
Solivia sessilis	Bindii	E									4																									
Sonchus oleraceus	Common Sowthistle	E	3	1		1	1			1	2									1											1	1	1			1
Spartothamnella juncea	Bead-bush	N														2		2		2						2							1	3	3	3
Sporobolus creber	Western Rat's Tail Grass	N																1			1						1				2					
Sporobolus elongatus		N						1									2																			
Stephania japonica		N	2		2	3																											1			
Swainsona galegifolia	Smooth Darling Pea	N																						2	1								1			
Tagetes minuta	Stinky Roger	E							2			2	2																							
Tetragonia tetragonioides	New Zealand Spinach	N		2		1	2																													
Tricoryne elatior		N						2				1																								
Trifolium campestre	Hop Clover	E						1																												
Verbascum virgatum	Twiggy Mullein	E	2					2	1																											
Verbena bonariensis	Purpletop	E	3	1				1			1														1			1			1					
Verbena rigida	Veined Verbena	E						3		1																										
Veronica plebeia	Trailing Speedwell	N							2																								2			
Vittadinia cuneata		N																		2		2														
Vittadinia sulcata		N														1	1	2			1						3			2				2	3	1
Vulpia bromoides	Squirrel Tail Fescue	E					2																													
Wahlenbergia communis	Tufted Bluebell	N				2						2			2						2				2			3	1		2	3		2	3	2
Wahlenbergia gracilis		N	2							2	2									2				2		2	2		1	2			1			
Xanthium spinosum	Bathurst burr	E									1																									

Table 5: Woodland rehabilitation species list and cover scores

Scientific Name	Common Name	Native/Exotic	4R	8R	3R	6R new
Acacia saligna		NLN		1		
Acacia sp.1		N		2	1	
Acacia sp.2		N				1
Allocasuarina sp.		N			1	
Aristida ramosa	Purple Wiregrass	N		1		1
Bidens pilosa		E		1	1	1
Bothriochloa macra	Red Grass	N	1	1	1	2
Calotis cuneifolia	Purple Burr-Daisy	N	2		1	2
Calotis lappulacea	Yellow Burr-daisy	N	1	1		
Chloris divaricata		N		1	1	
Chloris gayana	Rhodes Grass	E		1		
Chloris sp.		N	1			
Chloris ventricosa	Tall Chloris	N				2
Conyza sp.		E		1	1	1
Corymbia maculata	Spotted Gum	N	2	2	1	
Cymbopogon refractus	Barbed Wire Grass	N	1	2	2	
Echium sp.		E				1
Enchylaena tomentosa	Ruby Saltbush	N	2	2	2	2
Eremophila debilis		N		1		1
Eucalyptus cladocalyx		NLN	3	3	4	4
Eucalyptus crebra	Narrow-leaved Ironbark	N		1		
Eucalyptus fibrosa	Red Ironbark	N				2
Euchiton sp		N	1			
Galenia pubescens	Galenia	E	1			2
Gomphocarpus fruticosus		E	1		1	
Hardenbergia violoacea		N				1
Lysimachia arvensis		E	1	1	1	
Mentha saturoides		N		1		
Oxalis sp.		N		1		
Panicum sp.		N		1		
Plantago debilis		N		1		
Senecio madagascariensis	Fireweed	E	1	1		
Solanum sp.1		E	1	1	1	
Solanum sp.2		N		1	1	
Sonchus oleraceus		E	1	1	1	1
Sporobolus creber		N				1
Vittadinia sp.		N	1	1	1	

NLN = non-local Australian native species

2.2 Floristic monitoring plot photographs

A photograph has been taken at the start and end of the 50 m central transect of each biometric monitoring plot.

2.2.1 River Red Gum / River Oak riparian woodland wetland in the Hunter Valley

Plate 1: V1-A1 – start

Plate 2: V1-A1 – end

Plate 3: V1-A2 – start

Plate 4: V1-A2 – end

Plate 5: V1-B1 – start

Plate 6: V1-B1 – end

Plate 7: V1-B2 – start

Plate 8: V1-B2 – end

Plate 9: V1-B3 – start

Plate 10: V1-B3 – end

Plate 11: V2-A1 – start

Plate 12: V2-A1 – end

Plate 13: V2-B1 – start

Plate 14: V2-B1 end

Plate 15: V2-B2 – start

Plate 16: V2-B2 – end

Plate 17: V3-B1 – start

Plate 18: V3-B1 – end

2.2.2 Rough-barked Apple - Narrow-leaved Ironbark - Blakely's Red Gum - Bull Oak - Coast Banksia woodland on sands of the Warkworth area

Plate 19: V5-B1 – start

Plate 20: V5-B1 – end

Plate 21: V5-B2 – start

Plate 22: V5-B2 – end

Plate 23: V5-B3 – start

Plate 24: V5-B3 – end

Plate 25: V5-B4 – start

Plate 26: V5-B4 – end

2.2.3 Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter

Plate 27: V6-A1c – start

Plate 28: V6-A1c – end

Plate 29: V6-A3 – start

Plate 30: V6-A3 – end

Plate 31: V6-B1 – start

Plate 32: V6-B1 – end

Plate 33: V6-B1c – start

Plate 34: V6-B1c – end

Plate 35: V6-B2 – start

Plate 36: V6-B2 – end

Plate 37: V6-B2c – start

Plate 38: V6-B2c – end

Plate 39: V6-B3 – start

Plate 40: V6-B3 – end

Plate 41: V6-B4 – start

Plate 42: V6-B4 – end

Plate 43: V11–B1 – start

Plate 44: V11-B1 – end

Plate 45: V11-B2 – start

Plate 46: V11-B2 – end

2.2.4 Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter

Plate 47: V9-A1 – start

Plate 48: V9-A1 – end

Plate 49: V9-B1 – start

Plate 50: V9-B1 – end

Plate 51: V9-B2 – start

Plate 52: V9-B2 – end

Plate 53: V10-B1 – start

Plate 54: V10-B1 – end

2.2.5 Slaty Box - Grey Gum shrubby woodland on footslopes of the upper Hunter Valley, Sydney Basin Bioregion

Plate 55: V10-A1 – start

Plate 56: V10-A1 – end

Plate 57: V10-A2 – start

Plate 58: V10-A2 – end

Plate 59: V10-B3 – start

Plate 60: V10-B3 – end

2.2.6 White Mahogany - Spotted Gum - Grey Myrtle semi-mesic shrubby open forest of the central and lower Hunter Valley

Plate 61: V13-B1 – start

Plate 62: V13-B1 – end

2.2.7 Brush Wilga/Native Olive Shrubland

Plate 63: V14-A1 – start

Plate 64: V14-A1 – end

Plate 65: V14-B1 – start

Plate 66: V14-B1 – end

Plate 67: V14-B2 – start

Plate 68: V14-B2 – end

2.2.8 Groundwater Dependent Ecosystems

Plate 69: GDE P1 – start

Plate 70: GDE P1 – end

Plate 71: GDE P2 – start

Plate 72: GDE P2 – end

Plate 73: GDE P3 – start

Plate 74: GDE P3 – end

Plate 75: GDE P4 – start

Plate 76: GDE P4 - end

2.3 Floristic monitoring point photographs

2.3.1 RWEA Photo monitoring points

Plate 77: A1 – 2013

Plate 78: A1 – 2020

Plate 79: A2 – 2013

Plate 80: A2 – 2020

Plate 81: A3 – 2013

Plate 82: A3 – 2020

Plate 83: A4 – 2013

Plate 84: A4 – 2020

Plate 85: B1 – 2013

Plate 86: B1 – 2020

Plate 87: B2 – 2013

Plate 88: B2 – 2020

Plate 89:C1 – 2013

Plate 90: C1 – 2020

Plate 91: C2 – 2013

Plate 92: C2 – 2020

Plate 93: CT1 – 2013

Plate 94: CT1 – 2020

Plate 95: CT2 – 2013

Plate 96: CT2 – 2020

Plate 97: D1 – 2013

Plate 98: D1 – 2020

2.3.2 South Bates Extension plot photos

Plate 99: SBX1-SG-I – 2020

Plate 100: SBX2-GB-I – 2020

Plate 101: SBX3-SG-C - 2020

Plate 102: SBX4-GB-C – 2020

2.3.3 Groundwater Dependent Ecosystems

Plate 103: GDE M1 – 2020

Plate 104: GDE M2 – 2020

Plate 105: GDE M3 - 2020

Plate 106: GDE M4 – 2020

Plate 107: GDE M5 – 2020

Plate 108: GDE M6 – 2020

Plate 109: GDE M7 - 2020

Plate 110: GDE M8 – 2020

2.3.4 North Wambo Creek Diversion plot photos

Plate 111: NWCD1 – 2020

Plate 112: NWCD2 – 2020

3. Groundwater Dependent Ecosystem Tree Monitoring

3.1 GDE Trees photographs

Plate 113: GDE Tree 1 - 2020

Plate 114: GDE Tree 2 - 2020

Plate 115: GDE Tree 3 - 2020

Plate 116: GDE Tree 4 - 2020

Plate 117: GDE Tree 5 - 2020

Plate 118: GDE Tree 6 - 2020

Plate 119: GDE Tree 7 - 2020

Plate 120: GDE Tree 8 - 2020

Plate 121: GDE Tree 9 - 2020

Plate 122: GDE Tree 10 - 2020

Plate 123: GDE Tree 11 - 2020

Plate 124: GDE Tree 12 – 2020

Plate 125: GDE Tree 13 - 2020

Plate 126: GDE Tree 14 - 2020

Plate 127: GDE Tree 15 - 2020

Plate 128: GDE Tree 16 - 2020

Plate 129: GDE Tree 17 – 2020

Plate 130: GDE Tree 18 - 2020

Plate 131: GDE Tree 19 - 2020

Plate 132: GDE Tree 20 - 2020

Plate 133: GDE Tree 21 – 2020

Plate 134: GDE Tree 22 – 2020

Plate 135: GDE Tree 23 - 2020

Plate 136: GDE Tree 24 – 2020

Plate 137: GDE Tree 25 – 2020

Plate 138: GDE Tree 26 – 2020

Plate 139: GDE Tree 27 - 2020

Plate 140: GDE Tree 28 – 2020

Plate 141: GDE Tree 29 – 2020

Plate 142: GDE Tree 30 - 2020

4. Landscape function analysis

4.1 Landscape function analysis monitoring photographs

4.1.1 North Wambo Creek diversion and riparian areas

Plate 143: 17R (2020)

Plate 144: 19R (2020)

Plate 145: 21R (2020)

Plate 146: 23R (2020)

Plate 147: 25R (2020)

Plate 148: 26R (2020)

Plate 149: 27R (2020)

Plate 150: 28R (2020)

4.1.2 Woodland rehabilitation areas

Plate 151: 3R (2020)

Plate 152: 4R (2020)

Plate 153: 6R (2020)

Plate 154: 8R (2020)

4.1.3 Pasture rehabilitation areas

Plate 155: 1R (2020)

Plate 156: 2R (2020)

Plate 157: 5R (2020)

Plate 158: 7R (2020)

Plate 159: 9R (2020)

Plate 160: 10R (2020)

Plate 161: 16R (2020)

Plate 162: 33R (2020)

Plate 163: 34R (2020)

Plate 164: 35R (2020)

5. Riparian condition assessment

5.1 Riparian condition data

Table 6: 2020 Riparian condition scores

Site	Habitat	Cover	Natives	Debris	Features	Total
Maximum Score	**11**	**12**	**9**	**10**	**8**	**50**
North Wambo 1	2.25	7.50	5.00	5.25	2.25	22.25
North Wambo 2	3.75	7.00	2.75	4.50	4.25	22.25
North Wambo 3	3.75	7.25	3.75	4.75	4.25	23.75
Wambo 1	2.25	6.00	2.00	3.25	1.00	14.50
Wambo 2	2.00	6.50	2.50	3.75	1.75	16.50
Wambo 3	9.25	6.50	2.00	3.00	0.50	21.25
Stony Creek 1	2.00	7.67	4.00	6.75	2.25	22.67
Stony Creek 2	3.00	8.00	4.00	5.75	3.50	24.25
Stony Creek 3	3.25	7.42	2.75	4.75	2.00	20.17

5.2 Riparian condition assessment photographs

5.2.1 North Wambo Creek

Plate 165: North Wambo Creek 1 - 8a (2020)

Plate 166: North Wambo Creek 1 - 7a (2020)

Plate 167: North Wambo Creek 1 - 6a (2020)

Plate 168: North Wambo Creek 1 - 5a (2020)

Plate 169: North Wambo Creek 2 – 1a (2020)

Plate 170: North Wambo Creek 2 - 2a (2020)

Plate 171: North Wambo Creek 2 - 3a (2020)

Plate 172: North Wambo Creek 2 - 4a (2020)

Plate 173: North Wambo Creek 3 – 20a (2020)

Plate 174: North Wambo Creek 3 - 19a (2020)

Plate 175: North Wambo Creek 3 - 18a (2020)

Plate 176: North Wambo Creek 3 - 17a (2020)

5.2.2 Wambo Creek Riparian condition assessment

Plate 177: Wambo Creek 1 – 28a

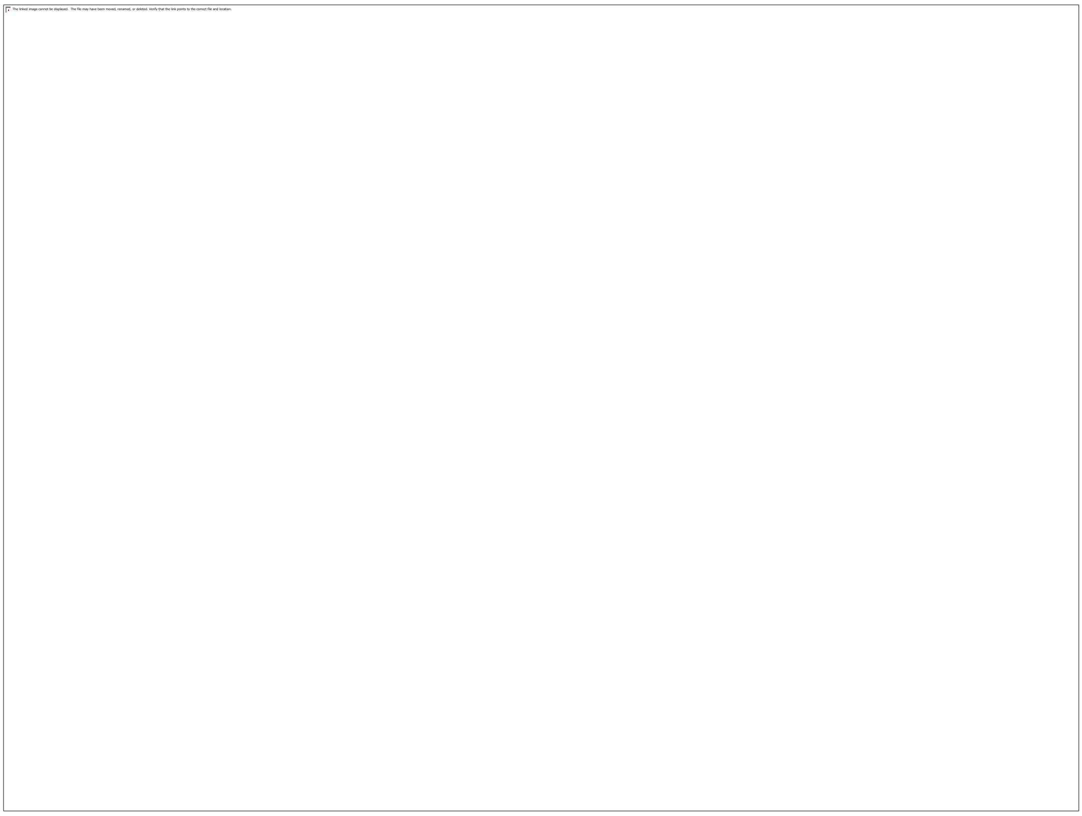

Plate 178: Wambo Creek 1 - 27a

Plate 179: Wambo Creek 1 – 26a

Plate 180: Wambo Creek 1 - 25a

Plate 181: Wambo Creek 2 – 29a

Plate 182: Wambo Creek 2 - 30a

Plate 183: Wambo Creek 2 - 31a

Plate 184: Wambo Creek 2 - 32a

Plate 185: Wambo Creek 3 - 33a

Plate 186: Wambo Creek 3 – 34a

Plate 187: Wambo Creek 3 - 35a

Plate 188: Wambco Creek 3 - 36a

5.2.3 Stony Creek Riparian condition assessment

Plate 189: Stony Creek 1 – 24a

Plate 190: Stony Creek 1 - 23a

Plate 191: Stony Creek 1 - 22a

Plate 192: Stony Creek 1 - 21a

Plate 193: Stony Creek 2 – 13a

Plate 194: Stony Creek 2 - 14a

Plate 195: Stony Creek 2 - 15a

Plate 196: Stony Creek 2 - 16a

Plate 197: Stony Creek 3 – 12a

Plate 198: Stony Creek 3 - 11a

Plate 199: Stony Creek 3 - 10a

Plate 200: Stony Creek 3 - 9a

6. Bird monitoring

6.1 Bird monitoring data

Table 7: Species and maximum count of birds, heard and observed over two site visits; morning and afternoon during spring 2020 surveys

Scientific name	Common Name	Monitoring site and maximum count from the two bird surveys																											
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	Total	No. sites
Alisterus scapularis	Australian King-Parrot	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	0	1	1
Cracticus tibicen	Australian Magpie	1	1	0	1	2	1	0	0	0	0	1	2	1	1	0	1	1	1	1	2	2	0	2	1	1	1	24	19
Aegotheles cristatus	Australian Owlet-nightjar	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2
Corvus coronoides	Australian Raven	1	0	1	1	2	2	1	0	0	3	1	0	0	1	3	1	0	1	1	1	1	2	1	2	1	1	28	20
Acrocephalus australis	Australian Reed-Warbler	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3	0	0	0	0	0	0	0	0	5	2
Chenonetta jubata	Australian Wood Duck	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1
Geopelia humeralis	Bar-shouldered Dove	1	1	1	0	2	1	0	1	1	0	2	0	0	0	0	0	0	1	1	0	0	0	0	0	1	2	15	12
Manorina melanophrys	Bell Miner	0	0	0	0	0	0	0	10	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	2
Coracina novaehollandiae	Black-faced Cuckoo-shrike	0	1	1	2	2	2	1	1	1	0	1	0	1	0	1	1	0	0	1	1	1	0	0	0	2	4	24	17
Falco berigora	Brown Falcon	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	2	2
Acanthiza pusilla	Brown Thornbill	4	0	0	0	0	0	0	0	0	0	0	1	0	0	0	3	0	0	0	0	1	1	0	0	0	0	10	5
Climacteris picumnus	**Brown Treecreeper**	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1
Melithreptus brevirostris	Brown-headed Honeyeater	0	0	0	0	2	0	1	1	2	0	0	0	5	1	0	1	0	0	0	0	0	0	0	0	0	0	13	7
Cacomantis variolosus	Brush Cuckoo	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	1	0	0	1	1	0	0	0	0	0	6	6
Acanthiza reguloides	Buff-rumped Thornbill	0	0	0	0	1	1	0	0	0	0	0	0	2	0	3	0	0	0	0	0	0	0	1	0	0	0	8	5
Scythrops novaehollandiae	Channel-billed Cuckoo	2	0	0	2	0	0	2	0	0	1	0	0	0	2	0	0	0	0	0	0	1	0	1	3	1	0	15	9
Coracina tenuirostris	Cicadabird	0	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	4	4
Phaps chalcoptera	Common Bronzewing	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	2	2
Eurystomus orientalis	Dollarbird	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	5	3
Taeniopygia bichenovii	Double-barred Finch	0	0	0	0	0	0	0	2	0	3	0	0	2	0	3	3	0	2	0	0	0	1	0	0	0	0	16	7
Artamus cyanopterus	**Dusky Woodswallow**	0	0	0	0	0	0	0	4	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	2	12	4
Eudynamys orientalis	Eastern Koel	12	0	1	0	1	1	0	0	1	0	1	1	0	2	0	0	0	1	0	1	1	0	0	1	0	0	24	12
Platycercus eximius	Eastern Rosella	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	1
Psophodes olivaceus	Eastern Whipbird	0	0	0	0	0	0	2	4	0	0	1	1	0	0	0	0	0	0	0	0	2	0	0	0	0	0	10	5
Eopsaltria australis	Eastern Yellow Robin	0	0	0	1	1	0	2	2	1	2	2	1	1	1	0	2	0	0	1	1	1	1	0	0	2	1	23	17
Petrochelidon ariel	Fairy Martin	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	5	2
Cacomantis flabelliformis	Fan-tailed Cuckoo	1	0	1	0	0	1	0	0	0	1	1	1	0	0	0	1	1	2	0	1	1	0	0	0	0	0	12	11
Eolophus roseicapillus	Galah	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	5	2
Cracticus torquatus	Grey Butcherbird	1	1	1	1	0	1	1	0	0	2	1	2	1	1	0	1	1	0	2	1	1	2	0	1	1	2	25	20
Rhipidura albiscapa	Grey Fantail	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	5	4
Colluricincla harmonica	Grey Shrike-thrush	0	0	0	0	1	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0	1	0	0	0	5	5
Pomatostomus temporalis	Grey-crowned Babbler	0	2	0	1	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	4	2	15	6
Chalcites basalis	Horsfield's Bronze-Cuckoo	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	0	1	1
Microeca fascinans	Jacky Winter	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	5	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	17	18	19	20	21	22	23	24	25	26	Total	No. sites
Dacelo novaeguineae	Laughing Kookaburra	2	2	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1	0	1	0	1	0	0	1	0	11	9
Meliphaga lewinii	Lewin's Honeyeater	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2
Grallina cyanoleuca	Magpie-lark	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	5	4
Vanellus miles	Masked Lapwing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1
Dicaeum hirundinaceum	Mistletoebird	0	1	0	0	1	1	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	2	0	0	0	0	9	8
Glossopsitta concinna	Musk Lorikeet	0	1	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	5	10	4
Philemon corniculatus	Noisy Friarbird	0	1	1	1	0	0	0	0	1	0	1	1	0	2	1	1	0	0	1	1	2	0	1	1	0	0	16	14
Manorina melanocephala	Noisy Miner	2	1	1	0	0	4	1	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	1	2	2	17	11
Oriolus sagittatus	Olive-backed Oriole	1	0	0	0	0	0	2	2	2	0	2	1	1	1	1	1	1	1	0	1	1	0	0	1	2	1	22	17
Anas superciliosa	Pacific Black Duck	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	2	1
Cacomantis pallidus	Pallid Cuckooo	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	1	0	4	4
Geopelia striata	Peaceful Dove	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	1	4	4
Cracticus nigrogularis	Pied Butcherbird	0	0	1	1	2	1	1	0	0	2	1	4	1	0	1	0	0	0	0	0	0	0	0	2	0	1	18	12
Strepera graculina	Pied Currawong	1	1	0	1	0	0	1	1	1	0	1	1	1	0	1	0	1	2	0	1	1	1	0	0	1	0	17	16
Merops ornatus	Rainbow Bee-eater	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	2	0	0	0	7	4
Trichoglossus moluccanus	Rainbow Lorikeet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	1
Neochmia temporalis	Red-browed Finch	0	0	4	0	0	0	0	1	2	0	3	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	12	6
Climacteris erythrops	Red-browed Treecreeper	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1
Petroica goodenovii	Red-capped Robin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1
Psephotus haematonotus	Red-rumped Parrot	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Pachycephala rufiventris	Rufous Whistler	1	2	1	2	2	2	5	3	2	3	3	2	1	1	1	2	1	0	2	1	2	2	0	0	3	2	46	23
Ptilonorhynchus violaceus	Satin Bowerbird	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	4	4
Myzomela sanguinolenta	Scarlet Honeyeater	0	0	0	0	1	0	0	2	0	0	2	1	0	0	0	0	0	0	0	0	0	2	0	0	0	0	8	5
Chalcites lucidus	Shining Bronze-Cuckoo	0	1	0	1	0	1	0	0	1	0	1	0	0	1	0	0	1	3	0	0	0	0	0	0	1	1	12	10
Zosterops lateralis	Silvereye	0	0	0	0	0	0	0	2	1	5	0	1	2	0	0	1	0	0	0	2	2	4	0	0	1	0	21	10
Chthonicola sagittata	**Speckled Warbler**	0	1	0	0	0	2	0	0	0	1	0	0	0	0	0	1	0	0	0	2	0	2	2	0	0	0	11	7
Acanthagenys rufogularis	Spiny-cheeked Honeyeater	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Pardalotus punctatus	Spotted Pardalote	0	1	1	1	0	0	0	0	1	1	0	2	0	1	0	1	0	0	0	1	1	0	1	2	0	0	14	12
Pardalotus striatus	Striated Pardalote	2	1	1	0	0	2	1	0	0	0	1	0	0	1	0	3	0	0	0	0	0	1	2	0	0	0	15	10
Acanthiza lineata	Striated Thornbill	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	1
Plectorhyncha lanceolata	Striped Honeyeater	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	1	0	0	1	0	0	0	0	0	1	1	7	7
Cacatua galerita	Sulphur-crested Cockatoo	0	1	2	1	0	1	1	0	1	0	0	0	0	0	1	0	1	1	0	0	0	0	0	1	0	0	11	10
Malurus cyaneus	Superb Fairy-wren	3	0	4	0	1	3	0	0	0	2	3	0	3	0	0	0	3	5	0	5	0	1	2	1	0	0	36	13
Daphoenositta chrysoptera	**Varied Sittella**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	3	1
Malurus lamberti	Variegated Fairy-wren	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	0	6	3

Scientific name	Common Name	Monitoring site and maximum count from the two bird surveys																											
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	Total	No. sites
Aquila audax	Wedge-tailed Eagle	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	1	0	0	0	0	0	0	0	2	6	4
Smicrornis brevirostris	Weebill	0	0	0	1	0	1	0	0	0	2	0	0	1	0	1	1	0	0	1	0	2	1	1	1	0	1	14	12
Hirundo neoxena	Welcome Swallow	0	0	10	0	0	0	0	1	1	0	10	3	0	1	0	0	0	1	0	1	0	0	0	0	2	16	46	10
Sericornis frontalis	White-browed Scrubwren	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2	2
Nesoptilotis leucotis	White-eared Honeyeater	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	2
Melithreptus lunatus	White-naped honeyeater	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	2
Ptilotula penicillata	White-plumed Honeyeater	1	0	1	0	0	0	4	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	11	6
Gerygone olivacea olivacea	White-throated Gerygone	1	0	1	1	0	1	0	0	0	0	0	1	0	0	1	0	0	0	0	1	0	0	0	0	1	0	8	8
Cormobates leucophaea	White-throated Treecreeper	0	0	0	1	1	1	1	1	1	1	1	1	0	1	0	1	0	0	0	2	1	0	0	0	1	1	16	15
Corcorax melanorhamphos	White-winged Chough	4	0	2	0	0	7	2	0	2	0	0	0	0	0	5	0	0	0	4	0	0	5	4	0	5	5	45	11
Lalage sueurii	White-winged Triller	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2	1
Rhipidura leucophrys	Willie Wagtail	2	0	1	0	0	2	2	2	1	0	1	0	0	0	0	0	0	2	0	0	0	0	1	0	1	1	16	11
Leucosarcia melanoleuca	Wonga Pigeon	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	3
Acanthiza nana	Yellow Thornbill	3	1	1	4	0	4	0	0	0	2	0	0	0	0	1	0	0	1	0	0	0	0	1	2	0	0	20	10
Caligavis chrysops	Yellow-faced Honeyeater	1	1	1	1	1	1	1	1	0	3	2	2	2	0	1	1	1	0	3	1	2	0	0	2	0	1	29	20
Acanthiza chrysorrhoa	Yellow-rumped Thornbill	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	6	2	0	0	10	4
Lichenostomus melanops	Yellow-tufted Honeyeater	0	0	0	0	0	0	1	3	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	4
TOTAL number of species recorded at site		**24**	**22**	**26**	**21**	**16**	**24**	**24**	**29**	**27**	**21**	**30**	**24**	**21**	**18**	**20**	**22**	**21**	**22**	**12**	**23**	**23**	**19**	**20**	**19**	**27**	**29**		

Bold denotes threatened species.

6.2 Targeted winter bird survey species list

Table 8: Bird species recorded during targeted winter bird survey August 2020

Scientific name	Common name	Scientific name	Common name
Tachybaptus novaehollandiae	Australasian Grebe	*Pardalotus striatus*	Striated Pardalote
Corvus coronoides	Australian Raven	*Acanthiza lineata*	Striated Thornbill
Chenonetta jubata	Australian Wood Duck	*Cacatua galerita*	Sulphur-crested Cockatoo
Geopelia humeralis	Bar-shouldered Dove	*Malurus cyaneus*	Superb Fairy-wren
Cygnus atratus	Black Swan	***Daphoenositta chrysoptera***	**Varied Sittella**
Coracina novaehollandiae	Black-faced Cuckoo-shrike	*Malurus lamberti*	Variegated Fairy-wren
Climacteris picumnus	**Brown Treecreeper**	*Aquila audax*	Wedge-tailed Eagle
Melithreptus brevirostris	Brown-headed Honeyeater	*Smicrornis brevirostris*	Weebill
Acanthiza reguloides	Buff-rumped Thornbill	*Hirundo neoxena*	Welcome Swallow
Anas castanea	Chestnut Teal	*Lichenostomus leucotis*	White-eared Honeyeater
Taeniopygia bichenovii	Double-barred Finch	*Lichenostomus penicillatus*	White-plumed Honeyeater
Psophodes olivaceus	Eastern Whipbird	*Cormobates leucophaea*	White-throated Treecreeper
Eopsaltria australis	Eastern Yellow Robin	*Corcorax melanorhamphos*	White-winged Chough
Petrochelidon ariel	Fairy Martin	*Rhipidura leucophrys*	Willie Wagtail
Eolophus roseicapillus	Galah	*Leucosarcia picata*	Wonga Pigeon
Pachycephala pectoralis	Golden Whistler	*Acanthiza nana*	Yellow Thornbill
Rhipidura albiscapa	Grey Fantail	*Lichenostomus chrysops*	Yellow-faced Honeyeater
Colluricincla harmonica	Grey Shrike-thrush	*Lichenostomus melanops*	Yellow-tufted Honeyeater
Anas gracilis	Grey Teal		
Microeca fascinans	Jacky Winter		
Meliphaga lewinii	Lewin's Honeyeater		
Grallina cyanoleuca	Magpie-lark		

Scientific name	Common name	Scientific name	Common name
Glossopsitta concinna	Musk Lorikeet		
Oriolus sagittatus	Olive-backed Oriole		
Anas superciliosa	Pacific Black Duck		
Geopelia striata	Peaceful Dove		
Strepera graculina	Pied Currawong		
Neochmia temporalis	Red-browed Finch		
Myiagra inquieta	Restless Flycatcher		
Pachycephala rufiventris	Rufous Whistler		
Chalcites lucidus	Shining Bronze-Cuckoo		
Zosterops lateralis	Silvereye		
Chthonicola sagittata	**Speckled Warbler**		
Pardalotus punctatus	Spotted Pardalote		

7. Nest box monitoring

7.1 Nest box monitoring photographs

Plate 201: Nest box 1

Plate 202: Nest box 2

Plate 203: Nest box 3

Plate 204: Nest box 4

Plate 205: Nest box 7

Plate 206: Nest box 8

Plate 207: Nest box 9

Plate 208: Nest box 10

Plate 209: Nest box 11

Plate 210: Nest box 12

Plate 211: Nest box 13

Plate 212: Nest box 16

Plate 213: Nest box 17

Plate 214: Nest box 18

Plate 215: Nest box 19

Plate 216: Nest box 20

Plate 217: Nest box 21

Plate 218: Nest box 22

Plate 219: Nest box 24

Plate 220: Nest box 26

Plate 221: Nest box 27

Plate 222: Nest box 28

Plate 223: Nest box 29

Plate 224: Nest box 30

Plate 225: Nest box 31

Plate 226: Nest box 32

Plate 227: Nest box 33

Plate 228: Nest box 34

Plate 229: Nest box 35

Plate 230: Nest box 36

Plate 231: Nest box 39

Plate 232: Nest box 40

Plate 233: Nest box 43

Plate 234: Nest box 44

Plate 235: Nest box 45

Plate 236: Nest box 46

Plate 237: Nest box 47

Plate 238: Nest box 48

Plate 239: Nest box 49

Plate 240: Nest box 50

Note: No photos of Micobat boxes: Box numbers – 5, 6, 14, 15, 23, 25, 37, 38, 41, 42.

APPENDIX G

WAMBO ANNUAL REVIEW GROUNDWATER ANALYSIS

WAMBO - 2020 ANNUAL REVIEW

Groundwater

Prepared for:

Wambo Coal Pty Ltd
Peabody Energy Australia
PMB 1, Singleton NSW, 2330

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BASIS OF REPORT

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

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

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

DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
665.10008.00315-R01-v3.0	29 March 2021	Emma Watts and Maxime Philibert	Adam Skorulis	Angus McFarlane

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APPENDICES

1 Introduction

1.1 Overview

The Wambo Coal Pty Ltd (WCPL) mining complex is located approximately 20 kilometres (km) north-west of Singleton, New South Wales (NSW). As part of compliance with mine approval conditions, routine groundwater monitoring is conducted across WCPL, and the data reviewed and analysed on an annual basis. The annual groundwater review is required to:

- Compare groundwater levels and quality to trigger levels. Recorded groundwater data is also compared to rainfall to identify trends. Modelled groundwater levels will also be compared to monitored data with model revisions recommended if necessary (Sections 4.1 and 4.2 of the WCPL Groundwater Management Plan (GWMP) (Peabody, 2020)).
- The annual review will also assess for lines of evidence for the seepage of mine water from the Chitter Dam (Glen Munro pit void) and South Wambo Dam towards Wollombi Brook (Section 6.1.3 GWMP).
- Assess volumes and water quality of inflows to Open Cut Pits and Underground Workings (Section 6.1.2 GWMP). Inflow volumes to underground workings are assessed against peak groundwater model inflow predictions.
- Report against specific performance indicators developed for the subsidence impact performance measures relating to groundwater for North Wambo Underground (NWU), South Wambo Underground (SWU), and South Bates Extension (SBX) mine areas (Sections 4.3 and 4.4 GWMP).

This report presents the annual groundwater review for WCPL, developed in accordance with the approval conditions and requirements outlined within the GWMP (Peabody, 2020).

1.2 Scope

This report contains the analysis and information required to address the following components of the Annual Environmental Management Review (AEMR) for WCPL for the 2020 calendar year:

1. Review hydrographs for relevant groundwater monitoring bores and conduct a cause-and-effect analysis to determine whether trends are due to climatic conditions or mining. (**Sections 5.1 to 5.3**)
2. Assess Vibrating Wire Piezometer (VWP) data quality to assist with optimization of the monitoring network. (**Section 5.6**)
3. Assess shallow bores for compliance with the groundwater level and water quality performance indicators (Tables 11 and 13 of the GWMP (Peabody, 2020)). (**Section 5.4**)
4. Assess shallow bores against relevant groundwater performance indicators defined for MOD16, NWU, and South Bates Extension (SBX) (Tables 14, 15, and 16 of the GWMP (Peabody, 2020)). (**Section 5.5**)
5. Assess lines of evidence for the seepage of mine water from Chitter Dam (Glen Munro pit) and South Wambo Dam towards Wollombi Brook (Section 6.1.3 GWMP). (**Section 5.7**)
6. Compare groundwater monitored levels to model predictions from the South Bates Extension LW21-24 Extraction Management Plan (SLR, 2020). (**Section 6**)
7. In line with the recommendations from the 2017 Independent Environmental Audit (**Section 7**)
   - Compare predicted and observed inflow to Wambo mine areas and assess the ongoing ability of the groundwater model to predict volumes of groundwater intercepted into the future, and

- Assess connectivity between open cut and underground mine areas at Wambo.

Each scope item is addressed separately in the following sections.

2 Wambo Complex

The following section provides a description of the WCPL Complex of relevance to this annual groundwater review. The general site layout is presented in **Figure 1**.

2.1 Mine operations

Table 1 presents a summary of mine areas across WCPL, approved mining timeframes and activities conducted over 2020. Overall, mining was active at South Bates Underground Extension during 2020.

Table 1 Summary of WCPL Activities

Mine Area	Seam Mined To	Approved Life of Mining	2020 Activities
North Wambo Underground (NWU)	Wambo Seam	2007 to 2015	Mining complete
South Bates Underground (SBU)	Wambo Seam and Whybrow Seam	2016 to 2018	Mining complete
South Bates Extension (SBX)	Whybrow Seam	2018 to 2024[1]	Mining of SBX LW19 and LW20 during 2020 LW19: Start 05/01/2020, Finish 18/05/2020. LW20: Start 17/08/2020, Expected Finish late March 2021.
South Wambo Underground	Arrowfield and Bowfield Seam	To 2042	Not yet active

[1] based on current Extraction Plan approvals.

WCPL was granted development consent in February 2004 (DA 305-7-2003). The approved development described in the Project EIS and subsequent sixteen modifications extend the underground mine life until 31 August 2042. Under the most recent modification (Modification 16, determined 28 August 2019) current operations at the Wambo Mine include underground mining and coal processing and handling activities. Open cut mining activities are managed by the United Wambo Joint Venture.

The approved operations are reflected in **Table 1**, which involves mining of the Whybrow Seam at SBX underground extension mine in 2020.

2.2 Groundwater Impacts

Groundwater impacts associated with the approved operations at WCPL have been progressively assessed for each mining area, including:

- Wambo Development Project Groundwater Impact Assessment (AGE, 2003);

- North Wambo Underground Mine Modification Groundwater Assessment (Heritage Computing, 2012);
- North Wambo Underground – Longwall 10A – Modification Assessment (HydroSimulations, 2014a);
- Wambo Coal Mine Open Cut Modification Groundwater Assessment (HydroSimulations, 2014b);
- South Bates Underground Mine Modification – Groundwater Assessment (HydroSimulations, 2015);
- South Wambo Underground Mine Modification Groundwater Assessment (HydroSimulations, 2016a):
- South Wambo Box Cut – Groundwater Assessment (HydroSimulations, 2016b);
- South Bates Extension Modification Groundwater Assessment (HydroSimulations, 2017); and
- Wambo Knowledge to inform North Wambo Creek GDE Study (HydroSimulations, 2019).

The most recent groundwater assessment that captures operations across Wambo is the Groundwater Assessment in Support of South Bates Extension LW21-24 Extraction Plan (SBX LW21-24 EP). The groundwater assessment for SBX LW21-24 EP was completed by SLR (2020) and included an updated version of the HydroSimulations (2017a) and HydroSimulations (2019b) numerical groundwater model to assess groundwater response to approved mine activities. Mining is expected to commence in Longwall 21 around April 2021.

The key findings of this groundwater assessment review are:

- The alluvium adjacent to the SBX footprint has been disconnected from the regional alluvial system due to the removal of alluvium downstream of the longwalls by the approved open cut mining operations (and associated construction of the NWCD).
- The alluvium adjacent to the SBX footprint has been affected by open cut mining activities, with several metres of drawdown in the alluvium and regolith observed to date.
- There is expected to be negligible impact on the highly productive alluvium associated with the Wollombi Brook and Hunter River as a result of extraction of Longwalls 21 to 24.
- Extraction of Longwalls 21 to 24 would not result in reduced beneficial uses of the alluvium (from a water quality perspective).
- There are no bores above the SBX footprint that are used for irrigation, domestic or stock use. There are no private registered bores that would be likely to be affected by 2 m drawdown or more if Longwalls 21 to 24 were to occur in isolation.
- Site monitoring bores have the potential to be impacted during mining, therefore review of the condition of the monitoring network will be undertaken during each sampling event, and bores remediated/replaced as required, to maintain a long-term monitoring network.
- Depressurisation of up to 200 m, due to extraction of Longwalls 21 to 24, are expected in the Whybrow Seam in accordance with the depth of cover.
- Extraction of Longwalls 21 to 24 would not have a significant impact on water levels in the Permian coal measures from a regional perspective due to the regional zone of depressurisation within the Permian coal measures created by historical and ongoing open cut and underground mining.
- Extraction of Longwalls 21 to 24 would not lower the beneficial use category of the groundwater within the Permian aquifers, as there would be no migration of groundwater away from the underground mining areas in the Permian aquifers either during mining or following completion of mining activities.

- There is an expectation of enhanced leakage from the NWC if the creek happens to flow during the period of extraction of Longwalls 21 to 24 underneath the diversion.
- Negligible loss of baseflow to the natural NWC is expected due to extraction of Longwalls 21 to 24, however, surface remediation may be required to maintain the long-term flow regime along NWC (MSEC 2020).

The groundwater data analysis, based on currently available records, has shown that there are no observed material impacts from longwall mining beyond what was foreseen for the cumulative impacts described in the South Bates Extension Modification – Groundwater Assessment (HydroSimulations, 2017a).

2.3 Groundwater Licensing

Under the *Water Act 1912* and *Water Management Act 2000*, adequate water licences are required for approval of the mine developments. Groundwater licenses held for WCPL are outlined in **Table 2**.

Table 2 WCPL Groundwater Entitlement and Licenses

Licence Number	Description	Expiry Date	Entitlement	Category	Access Licence	Nominated Water Supply Work Approval	Expiry date	Comment
Hunter Unregulated and Alluvial Water Sources (Lower Wollombi Brook Water Source)								
WAL18437 (20SL033872)	Wollombi Brook Pump	Perpetuity	350 unit shares	Unregulated River	20AL208641	20WA208642	31/07/2022	
WAL 23897 (20BL167737)	Well No. 2	Perpetuity	70 unit shares	Aquifer	20AL211371	20WA211372	31/7/2022	
North Coast Fractured and Porous Rock Groundwater Sources (Sydney Basin - North Coast Groundwater Source)								
WAL42373	Dewatering	Perpetuity	1549 unit shares	Aquifer	20AL219997	20MW065010	-	6 x WALs consolidated 20/12/18.
WAL41532 (20BL172156)[1]	Dewatering	Perpetuity	98 unit shares	Aquifer	20AL218994	20MW065010	-	
20BL168997	Piezometer	Perpetuity	Groundwater monitoring	NA		-	-	
20BL168998	Piezometer	Perpetuity	Groundwater monitoring	NA		-	-	
20BL168999	Piezometer	Perpetuity	Groundwater monitoring	NA		-	-	
20BL169000	Piezometer	Perpetuity	Groundwater monitoring	NA		-	-	
20BL170638	Piezometer	Perpetuity	Groundwater monitoring	NA		-	-	

Licence Number	Description	Expiry Date	Entitlement	Category	Access Licence	Nominated Water Supply Work Approval	Expiry date	Comment
20BL172237	Monitoring Bore (GW14, GW18, GW21)	Perpetuity	Groundwater monitoring	NA		-	-	
20BL172238	Monitoring Bore (GW12)	Perpetuity	Groundwater monitoring	NA		-	-	
20BL172240	Monitoring Bore (GW15)	Perpetuity	Groundwater monitoring	NA		-	-	
20BL172242	Monitoring Bore (GW16, GW17)	Perpetuity	Groundwater monitoring	NA		-	-	
20BL172244	Monitoring Bore (GW20)	Perpetuity	Groundwater monitoring	NA		-	-	
20BL172255	Monitoring Bore (GW22)	Perpetuity	Groundwater monitoring	NA		-	-	
20BL172256	Monitoring Bore (GW13)	Perpetuity	Groundwater monitoring	NA		-	-	
20BL172257	Monitoring Bore (GW19)	Perpetuity	Groundwater monitoring	NA		-	-	
20BL172332	Piezometer	Perpetuity	Groundwater monitoring	NA		-	-	
20BL173032	Monitoring		Groundwater monitoring	NA			-	
20BL173290	Monitoring Bore	Perpetuity	Groundwater monitoring	NA		-	-	
20BL173291	Monitoring Bore	Perpetuity	Groundwater monitoring	NA		-	-	
20BL173292	Monitoring Bore	Perpetuity	Groundwater monitoring	NA		-	-	
20BL173293	Monitoring Bore	Perpetuity	Groundwater monitoring	NA		-	-	
20BL173946	Monitoring	Perpetuity		NA				

Licence Number	Description	Expiry Date	Entitlement	Category	Access Licence	Nominated Water Supply Work Approval	Expiry date	Comment
20BL173999	Monitoring Bore	Perpetuity	Groundwater monitoring	NA		-	-	
20BL009818	Bore	Perpetuity	Stock	NA		-	-	
20BL009819	Bore	Perpetuity	Stock	NA		-	-	
20BL009820	Bore	Perpetuity	Stock	NA		-	-	
20BL009821	Bore	Perpetuity	Stock	NA		-	-	
20BL143779	Bore	Perpetuity	Stock/Domestic	NA		-	-	

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

2.4 Groundwater Conditions

In accordance with the development consent approval requirements of DA305-7-2003 (as modified) and various groundwater licences, WCPL are required to prepare and implement a Groundwater Management Plan (GWMP). **Table 3** presents a summary of the relevant groundwater conditions from the development consent and Version 2 of the GWMP (Peabody, 2020) approved on 20 November 2020.

Table 3 DA305-7-2003 Requirements for the GWMP

Condition	Condition Details*	GWMP Section
B66	(v) Groundwater Management Plan, which is consistent with Groundwater Monitoring and Modelling Plans – Introduction for prospective mining and petroleum activities (DPI Water, 2014) and includes:	Entire Document
	detailed baseline data of groundwater levels, yield quality for groundwater resources and groundwater dependent ecosystems potentially impacted by the development, including groundwater supply for other water users;	Section 3.4
	a detailed description of the groundwater management system;	Section 5.1
	groundwater performance criteria including trigger levels for identifying and investigating any potentially adverse groundwater impacts associated with the development, on: • Regional and local aquifers (alluvial and hardrock); • Groundwater supply for other water users such as privately-owned licensed groundwater bores; and • Groundwater dependent ecosystems	Section 4.0
	program to monitor and evaluate: • compliance with the relevant performance measures listed in Table 8, and the performance criteria established above, including monitoring of regional groundwater levels and quality during the life of the development and at least 10 years post-mining; • water loss/seepage from water storages into the groundwater system (particularly from South Wambo Dam and Montrose East Dam); • groundwater inflows, outflows and storage volumes to inform the Site Water Balance; • any hydraulic connectivity between the alluvial and hardrock aquifers; • impacts on groundwater dependent ecosystems; • impacts on groundwater supply for other water users; and • the effectiveness of the groundwater management systems;	Sections 6.0 and 9.2
	reporting procedures for the results of the monitoring program;	Section 9.2
	a plan to respond to any exceedances of the groundwater performance criteria, and repair, mitigate, compensate and/or offset any adverse groundwater impacts of the development; and	Section 7.0

Condition	Condition Details*	GWMP Section
	a program to periodically validate the groundwater model for the development, including an independent review of the model every 3 years, and comparison of monitoring results with modelled predictions; and	Sections 5.3 and 9.1.2
D5	**Management Plan Requirements** The Applicant must ensure that the management plans required under this consent are prepared in accordance with any relevant guidelines, and include where relevant: Section 2.1	Section 2.1
	(a) summary of relevant background or baseline data;	Section 2.4
	(b) details of: • the relevant statutory requirements (including any relevant approval, licence or lease conditions); • any relevant limits or performance measures and criteria; • the specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the development or any management measures;	Section 2.0 / Section 4.0
	(c) any relevant commitments or recommendations identified in the document/s listed in condition A2(c);	Section 2.0
	(d) a description of the measures to be implemented to comply with the relevant statutory requirements, limits, or performance measures and criteria;	Sections 5.0 and 6.0
	(e) a program to monitor and report on the: • impacts and environmental performance of the development; and • effectiveness of any management measures set out pursuant to paragraph (d)	Monitoring – Section 6.0 Reporting - Section 9.0
	(f) a contingency plan to manage any unpredicted impacts and their consequences and to ensure that ongoing impacts reduce to levels below relevant impact assessment criteria as quickly as possible;	Section 7.0
	(g) a program to investigate and implement ways to improve the environmental performance of the development over time;	Section 9.0
	(h) a protocol for managing and reporting any: • incident, non-compliance or exceedance of any impact assessment criterion and performance criterion; • complaint; or • failure to comply with other statutory requirements; and	Managing – Section 7.0 Reporting – Section 9.0 / Section 8.0 / Section 7.4
	(i) a protocol for periodic review of the plan.	Section 9.1.3

Groundwater monitoring is conducted in accordance with the United Wambo and Wambo Water Monitoring Program (WMonProg), a component of the WCPL Water Management Plan. The program outlines groundwater monitoring frequency, parameters to be tested, as well as groundwater triggers for electrical conductivity (EC) and pH. The WMonProg and GWMP were updated in November 2020, including updates and upgrades to the monitoring network, and development of performance indicators for alluvial aquifers and GDE's. This annual review is based upon the monitoring and reporting requirements documented within the November 2020 version of the GWMP. Further discussion on the groundwater monitoring program and triggers is included in **Section 4**.

2.5 Independent Environmental Audit Recommendations

An Independent Environmental Audit (IEA) conducted by Hansen Bailey in 2017 (in accordance with the requirements of DA305-7-2003 and DA177-8-2004) made recommendations relating to the GWMP. These recommendations and where they are addressed in the GWMP are presented in Table 3 of the GWMP (Peabody, 2020). GHD conducted the following IEA in 2020 and made no recommendations in relation to groundwater.

3 Hydrogeological Setting

This section presents a brief summary of the hydrogeological setting for WCPL. This includes discussion on climate, terrain, drainage, geology and groundwater bearing units.

3.1 Climate, Terrain and Drainage

3.1.1 Climate

The climate of the Wambo region can be classed as temperate and is characterised by hot summers and mild dry winters. Rainfall data is available from the Bulga, South Wambo (Bureau of Meteorology (BOM) Station: 0611191) which has been recording daily rainfall data since January 1959. Climatic data was obtained for 01/01/1959 to 31/12/2020. **Table 4** provides the average monthly rainfall data, as well as the 2020 monthly data from the Bulga, South Wambo station.

A cumulative rainfall deviation from mean (CRD) plot is provided as a comparative tool to illustrate long term climate trends and their influence on groundwater in the Wambo area. The CRD graphically shows trends in recorded rainfall compared to long-term averages and provides a historical record of relatively wet and dry periods. A rising trend in slope in the CRD graph indicates periods of above average rainfall, whilst a declining slope indicates periods when rainfall is below average. A level slope indicates average rainfall conditions.

Table 4 Long Term Average and 2020 Climate Data

Rainfall (mm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Average Historical	87	86.1	67.7	45.9	39.9	43.9	30.6	34.3	38.6	55	61.5	73.5	**662.2**
2020 Rainfall	65.4	*197.6*	*130.6*	43.0	16.6	30.6	*66.2*	*42.4*	*45.8*	*96.6*	*43.4*	*192.0*	***970.2***

Note: Data within the table which are in italics represent observations which have not been fully quality controlled by BoM

3.1.2 Terrain and Drainage

WCPL is located in the Upper Hunter Valley region where landforms are characterised by gently sloping floodplains associated with the Hunter River and the undulating foothills, ridges and escarpments of the Mount Royal Range and Great Dividing Range. Elevations in the vicinity of WCPL range from approximately 60 metres Australian Height Datum (mAHD) at Wollombi Brook to approximately 650 mAHD at Mount Wambo within the Wollemi National Park to the west of WCPL .

WCPL is situated adjacent to the Wollombi Brook, south-Nicwest of its confluence with the Hunter River (**Figure 1**). Wollombi Brook drains an area of approximately 1,950 square kilometres (km^2) and joins the Hunter River some 5 km north-east of Wambo. The Wollombi Brook sub-catchment is bound by the Myall Range to the south-east, Doyles Range to the west, the Hunter Range to the south-west and Broken Back Range to the north-east (Hunter Catchment Management Trust, 2002).

The majority of lands within WCPL mining tenements drain via Wambo, Stony, North Wambo and Redbank Creeks to Wollombi Brook, while Waterfall Creek drains directly to the Hunter River. These watercourses are generally characterised by ephemeral and semi-perennial flow regimes (Gilbert and Associates, 2003).

3.2 Geology

WCPL is situated within the Hunter Coalfield subdivision of the Sydney Basin, which forms the southern part of the Sydney-Gunnedah-Bowen Basin. The stratigraphy in the Wambo area comprises the Triassic Narrabeen Group, Permian coal measures, and more recent (Quaternary) alluvial deposits associated with major drainage pathways. Folding, faulting and igneous intrusions have affected the Permian sediments after deposition. The target Seams for WCPL underground mining lie within the Jerrys Plains Subgroup of the Wittingham Coal Measures.

Along the Wollombi Brook, Wambo Creek, North Wambo Creek, and Stony Creek thin Quaternary alluvial deposits unconformably overlie the Permian strata. The alluvial deposits comprise surficial fine-grained sediments (i.e. sands, silts and clays). Along major watercourses (i.e. Wollombi Brook) the surficial sediments overly basal sands and gravels that are between 7 m to 20 m thick. **Table 5** presents a summary of site geology.

Table 5 Wambo Generalised Stratigraphy

Age	Stratigraphic Unit		Description
Cainozoic	Quaternary sediments - alluvium (Qa)	Surficial alluvium (Qhb)	Shallow sequences of clay, silty sand and sand.
		Productive basal sands/gravel (Qha)	Basal sands and gravels along major watercourses (i.e. Hunter River).
	Silicified weathering profile (Czas)		Silcrete
	Alluvial terraces (Cza)		Silt, sand and gravel
Jurassic	Volcanics (Jv)		Flows, sills and dykes
Permian	Whittingham Coal Measures	Jerrys Plains Sub-group (Pswj)	Coal bearing sequences interbedded with sandstone and siltstone. Coal seams (youngest to oldest) include Whybrow Seam, Redbank Creek Seam, Wambo Seam, Whynot Seam, Blakefield Seam, Glen Munro Seam, Woodlands Hill Seam, Arrowfield Seam, Bowfield Seam, Warkworth Seam, Mt Arthur Seam, Piercefield Seam, Vaux Seam, Broonie Seam and Bayswater Seam.

3.2.1 Groundwater Units

The hydrogeological regime of the Wambo area and surrounds comprises two main systems:

- A Quaternary alluvial aquifer system of channel fill deposits associated with Wollombi Brook, North Wambo Creek, Wambo Creek, and Stony Creek; and
- Underlying Permian strata of hydrogeologically "tight" and hence very low yielding to essentially dry sandstone and lesser siltstone and low to moderately permeable coal seams which are the prime water-bearing strata within the Permian coal measures. Triassic strata, namely the Narrabeen Group, are present to the south-west of the North Wambo Underground Mine and underlie some parts of the alluvium.

3.2.2 Alluvium

Groundwater flow patterns within the shallow alluvial aquifer reflect topographic levels and the containment of alluvium within the principal drainage pathways. Evidence from temporal groundwater monitoring hydrographs (**Appendix A**) within the alluvium indicates that the shallow aquifer is responsive to rainfall recharge and it is likely that the alluvium plays an important role in supplying recharge to the underlying Permian strata as well as, in places, contributing to baseflow of the perennial surface water features. In some areas upward or lateral flow may occur from the Permian and Triassic rock, but downward leakage seems to be the more common behaviour.

3.2.3 Permian Coal Measures

Prior to the commencement of mining operations in the region, the piezometric surface within the Wambo area most probably reflected the topography, with elevated water levels/pressures in areas distant from the major drainages and reduced levels in areas adjacent to the alluvial lands. Historical and ongoing open cut and underground mining within the Wambo area and adjoining mining operations have now created significant groundwater sinks. This has generated a regional zone of depressurisation within the Permian coal measures.

The Permian groundwater system within the Wambo area is continuous through the major geological formations. The various sedimentary rocks at Wambo have low permeability due to their fine-grained nature, the predominance of cemented lithic sandstones and the common occurrence of a clayey matrix in the sandstones and conglomerates. The permeability of the groundwater system is related to the joint spacing and aperture width. Permeability of the rock units generally decreases with depth of burial as the joints tighten and become less frequent.

The laminated fabric of the interbedded sandstone/siltstone/mudstone strata suggests that vertical hydraulic conductivities are significantly lower than horizontal hydraulic conductivities. Due to the laminar nature of the coal measures, groundwater flow generally occurs within or along the boundaries between stratigraphic layers.

The permeability of the coal measures is generally low, with rock mass permeabilities more than two orders of magnitude lower than the unconsolidated alluvial aquifers. Within the coal measures, the most permeable horizons are the coal seams, which commonly have hydraulic conductivity one to three orders of magnitude higher than the siltstones, shales and sandstone units.

The coal seams are generally more brittle and therefore more densely fractured than the overburden and interburden strata, which causes the higher permeability. Within the coal seams, groundwater flows predominantly through cleat fractures, although there is some evidence of structure-related fracturing and this may play an important role in groundwater flow paths.

The impact of fault structures such as the Redmanvale Fault is not known with certainty. However, it is likely that groundwater flow dynamics are complex in the vicinity of these structures.

4 Groundwater Monitoring

4.1 Groundwater Monitoring Program

Groundwater monitoring is conducted at WCPL in accordance with the WMonPlan (Peabody, 2020). The purpose of the GWMP is to monitor and manage groundwater quality and levels to detect potential impacts on surrounding groundwater users, assess the performance of the mine against the performance indicators, and to ensure that relevant legislative and policy requirements are met.

The overall objectives of the GWMP are to establish baseline groundwater quality and water level data and implement a program of data collection that can be utilised to assess potential impacts of mining activities on the area's groundwater resources. From a hydrogeological perspective, the Wambo region is relatively complex. This is due to the various areas of alluvium, proximity to Wollemi National Park and number of historical and current mining developments.

The monitoring programme at WCPL measures the Standing Water Level (SWL) in monitoring bores, reported as elevation (in mAHD). The data is compared against background data, EIS predictions, and historical trends as a means of assessing any WCPL related impacts to the quantity of groundwater in the various aquifers.

Ongoing groundwater monitoring requirements at WCPL are as follows:

- Groundwater monitoring bores to monitor groundwater sources above and in close proximity to mine workings;
- Monitoring of potential groundwater leakage from Wollombi Brook and associated alluvial aquifers;
- Monitoring of groundwater inflows to underground and open cut mining operations; and
- Monitor for potential water loss from the Chitter Dam (Glen Munro pit) and Wambo South Water Dam, including potential migration of sub-surface water toward Wollombi Brook.

The monitoring programme at WCPL also assesses the quality of groundwater against background data and historical trends. Bi-monthly monitoring of groundwater levels, pH, and EC will be undertaken at all standpipe bores in the groundwater monitoring program. Comprehensive analysis of major ions is conducted at each standpipe bore annually.

From 2017 to 2019 a total of 13 investigative bores were drilled into the North Wambo Creek Alluvium to gain a better understanding of the nature of the alluvial groundwater system in this area (SLR, 2017; AGE, 2019a; AGE, 2019b). Four to five bores from each drilling investigation were converted into monitoring bores to allow assessment as to whether alluvial water levels are affected by mining activity occurring in the South Bates Extension underground mine and Montrose Open Cut. In addition to the existing monitoring network, between 2017 and 2020, WCPL installed a series ofstandpipes (nested and single) and VWPs in the following areas:

- Adjacent to South Wambo Dam (P316, P316 a,b,c, P319);
- To the north-west of the mining area (P320, P321, P327, P328, P329, P330, P408, and UG166A); and
- To the south of Wambo Creek (P318 and P325). Will help to estbalish baseline groundwater conditions prior the commencement of South Wambo Underground.

In 2020, two additional bores were installed within the channel of upstream reaches of North Wambo Creek. One site (GW36a) targeting unconsolidated alluvial material associated with North Wambo Creek, the other (GW36b) drilled in to weathered Permian strata underlying the alluvium. Depth, location, screen information, and thickness of alluvial material encountered at both sites provided in **Table 6**. Three monitoring sites, two VWP (**Table 7**) and one standpipe (**Table 6**), were installed above South Bates extension workings in mid-2020. The VWP sites are installed to provide operational groundwater information across an identified structure, while the standpipe will help inform the presence and magnitude of groundwater impacts to shallow overburden associated with South Bates Extension mining.

At North Wambo Creek, GW08.2, GW09.2, GW10.2 and GW10.2a have been installed in 2020 within the unconsolidated strata as replacements of bores GW08 and GW09. These bores serve as replacement sites for historical monitoring wells GW08 and GW09, with their depth, location, screen information, and thickness of alluvial material provided in **Table 6**.

Nested standpipe P316(a,b,c) was constructed during 2020 in the Wambo Creek alluvium to serve as a replacement for bores in the area screened across multiple strata (e.g. P114, P116). While P325a was installed further south adjacent to P325 (VWP) to monitor shallow strata overlying the approved South Wambo Project footprint. Depth, location, and screen information, at these sites provided in **Table 6.**

Not all of these new sites have been incorporated in to the bi-monthly monitoring regime. This is recommended so that their data can be assessed as part of future annual reviews.

Hydrographs showing available water level and EC data for North Wambo Creek monitoring sites are presented in **Appendix A**, and an assessment of this data is presented below. Refer to **Figure 1** for the geographical location of each of these bores.

Table 6 New Standpipe Monitoring Sites

Bore ID (Installation Report)	Wambo ID	Easting (m)	Northing (m)	Ground Elevation (mAHD)	Screen Interval (mbgl)	Target Geology	Data Collected
GW08.2	GW08.2	311869	6392326	N/A	2 - 3	NWC Alluvium	N/A
GW09.2	GW09.2	311743	6392326	N/A	4.5 - 7.4	NWC Alluvium	N/A
GW10.2a	GW10.2a	311872	6392264	N/A	2 - 3	NWC Alluvium	N/A
GW10.2a	GW10.2a				22 - 25	Permian	
P316a	P316a	311255	6391087	N/A	4 - 7	NWC Alluvium	N/A
P316b	P316b				10 - 13	Weathered Permian	
P316c	P316c				23 - 26	Permian	
SW30	P325a	312062	6390137	65.2	5 - 8	Wollombi Bk Alluvium	N/A
SBX-GW02	SBX-GW02	306905	6395946	108.92	10 - 20	Weathered Permian	Y (logger + manual)
In-Stream 4 (shallow)	GW36a	306247	6395906	113	4.9 - 7.9	NWC Alluvium	Y (logger + manual)
In-Stream 4 (deep)	GW36b	306248	6395901	113.05	13.6 - 16.4	Weathered Permian	Y (logger + manual)

Table 7 New VWP Monitoring Sites

Bore ID (Installation Report)	Wambo ID	Easting (m)	Northing (m)	Ground Elevation (mAHD)	Screen Interval (mbgl)	Target Geology	Data Collected
SBX_20_GW01 VWP		307010	6395886	107.95	43	Whybrow Overburden	N/A
SBX_20_GW02 VWP		306910	6395943	108.88	65.8	Whybrow Seam	N/A
					61.7	Whybrow Overburden	
					53.7	Whybrow Overburden	

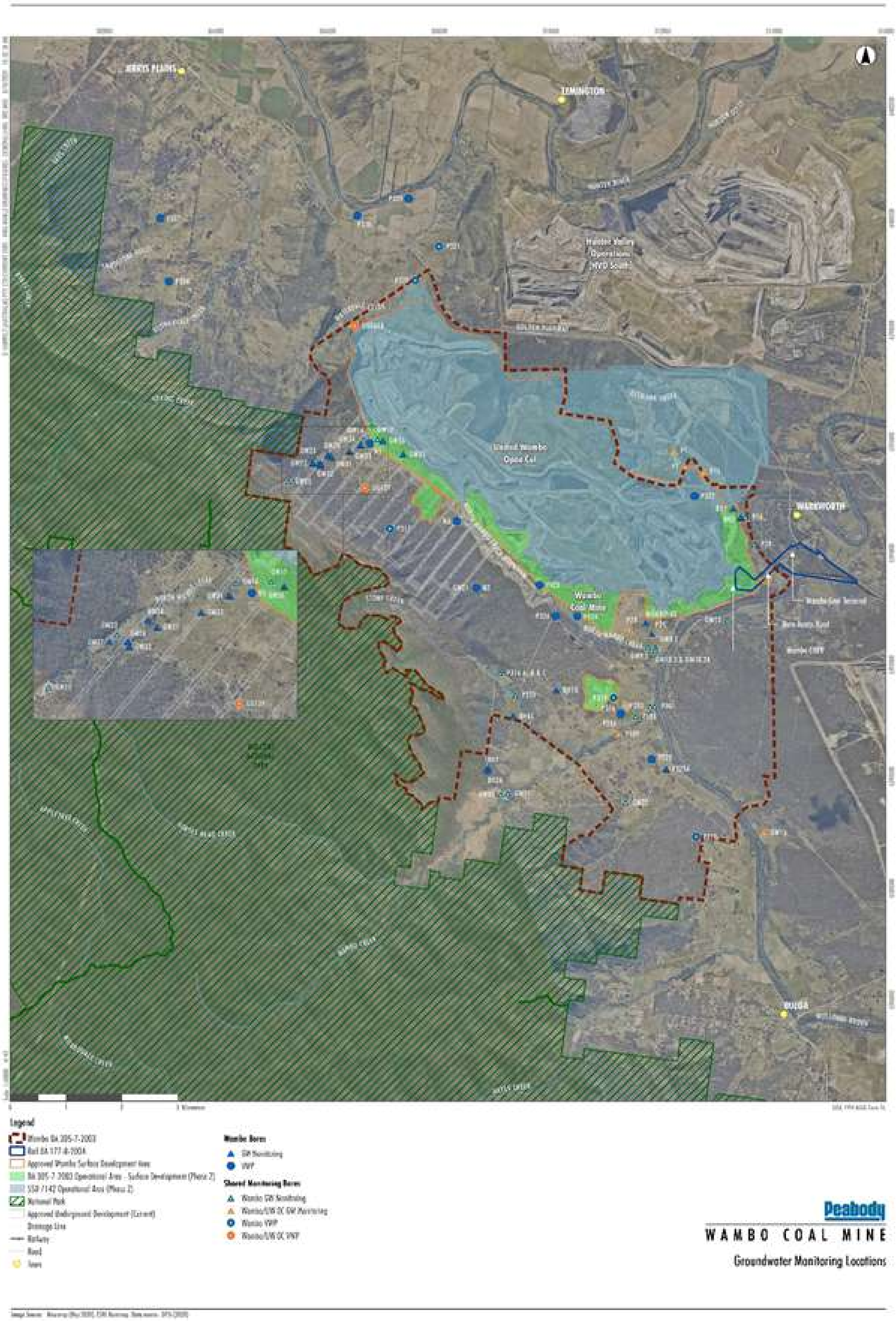

Figure 1 WCPL Monitoring Network

4.2 Groundwater Monitoring Methodology

Groundwater monitoring will consider the Murray-Darling Basin Groundwater Quality. Sampling Guidelines. Technical Report No 3 (Murray-Darling Basin Commission [MDBC, 1997]).

In general, the groundwater monitoring methodology will include the following:

- Gauging of groundwater levels;
- Grab sampling techniques using a bailer in accordance with WCPL instructions;
- Measurement of groundwater field parameters (pH and EC) using a calibrated water quality meter;
- If groundwater samples are to be collected, they are to be transferred into suitably preserved laboratory supplied sample containers once field parameters have stabilised;
- All sample containers are to be clearly labelled with sample number, sample location, sample depth and sample date. The sample containers are to be transferred to a chilled esky for sample preservation prior to and during shipment to the testing laboratory. A Chain-of-Custody (CoC) form should be forwarded with the samples to the testing laboratory; and
- Decontamination of all non-dedicated sampling equipment between monitoring locations.

4.3 Groundwater Trigger Methodology

Trigger levels are used to initiate investigations into the groundwater levels or groundwater quality at WCPL. The trigger levels, as specified by the WCPL Groundwater Monitoring Program (Peabody 2020), are based on statistical analysis on pre-mining baseline monitoring data.

The trigger levels are presented in **Table 8**. Trigger levels for groundwater levels occur when two consecutive bi-monthly observations exceed the maximum or falls below the minimum specified groundwater level. Triggers for EC occur when three consecutive bi-monthly observations (a 6-month period) exceed the specified trigger level. Triggers for pH occur when two consecutive bi-monthly observations (a 4-month period) exceed or fall below the specified trigger level.

As per the GWMP, several the bores (presented in Table 12 of the GWMP) are no longer assessed against the groundwater level trigger. The bores no longer assessed for groundwater level trigger are P106, P114, P116, P202, P206, P301, GW02, GW11, GW12, and GW13. Detailed justification for this is provided in the Table 12 of the GWMP.

Trigger exceedances and analysis for the 2020 monitoring period are presented in **Section 5.4.**

Table 8 Groundwater Level and Groundwater Quality Trigger Levels (Peabody, 2020)

Bore	Groundwater Level (mAHD)		Groundwater Quality		
	Maximum (10th percentile depth)	Minimum (90th percentile depth)	EC (µS/cm)	pH Minimum	pH Maximum
P109	57.8	55.7	695	6.5	7.6
P301	N/A	N/A	9200	6.1	7.2
P315[1]	N/A	N/A	552	6.0	7.4
GW08.2[2]	ND	ND	ND	ND	ND

Bore	Groundwater Level (mAHD)		Groundwater Quality		
	Maximum (10th percentile depth)	Minimum (90th percentile depth)	EC (µS/cm)	pH Minimum	pH Maximum
GW09.2[2]	ND	ND	ND	ND	ND
GW10.2[2]	ND	ND	ND	ND	ND
GW15	52.0	51.3	730	6.7	7.2
GW16[3]	N/A	N/A	N/A	N/A	N/A
GW17[3]	N/A	N/A	N/A	N/A	N/A
P16	50.4	49.7	10832	7.0	7.7
P20	50.3	49.2	10625	7.0	7.6

N/A= Not applicable
ND= Not disclosed
[1]P315 has dry observations prior to NWU mining activity. Therefore, a specific depth to water trigger is not appropriate to indicate Wambo mining impacts. Data will be reviewed as part of the Annual Review to determine whether there are changes in the relationship between climate and groundwater level that can be attributed to Wambo mining activity.
[2]GW08.2, GW09.2 and GW10.2 have been installed within unconsolidated strata near North Wambo Creek to serve as replacement bores to GW08 and GW09. Trigger levels for these bores will be established following the collection of baseline data and based on predicted drawdown from the revised groundwater model to be complete in Q4 2020.
[3]GW16 and GW17 are located upstream of the North Wambo Creek Diversion and in close proximity to the approved open cut. There are no groundwater users located in the vicinity of North Wambo Creek upstream of the North Wambo Creek Diversion. Therefore, a trigger level for these two bores is not considered warranted. Monitoring data will be reviewed annually at these bores.

4.4 Groundwater Performance Criteria

Version 2 of the GWMP, published in November 2020 (Peabody, 2020) includes three sets of performance indicators relevant to groundwater (**Table 9** and **Table 10**), the first set are performance indicators relevant to general water management performance (GWMP – Table 14). The second and third sets are specific performance indicators to monitor the subsidence impact for North Wambo Underground (GWMP – Table 15) and South Bates Underground and Extension longwalls (GWMP – Table 16) respectively.

An assessment of compliance with performance indicators relevant to groundwater (**Table 9** and **Table 10**) is presented in **Section 5.5**.

Table 9 Performance Indicators

Feature	Performance Indicator
Groundwater Management Performance Indicators	
Alluvial aquifers (including Wollombi Brook alluvium and excluding the North Wambo Creek alluvium)	The performance indicators will be considered to have been exceeded if the impacts are beyond those predicted in the documents listed in condition A2c) (of DA305-7-2003), including: A greater than negligible change in groundwater levels; A greater than negligible change in groundwater quality; and A greater than negligible impact to other groundwater users.
Groundwater dependent ecosystems	The performance indicators will be considered to have been exceeded if the impacts are beyond those predicted in the documents listed in condition A2c) (of DA305-7-2003), including: Greater than negligible environmental consequences, beyond those predicted in the documents listed in condition A2c); and Channel stability is not maintained or improved

Table 10 Subsidence Performance Indicators for Groundwater

North Wambo Underground Performance Indicators
- The performance indicators will be considered to have been exceeded if Wambo receive 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 11 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 13 of the GWMP.
South Bates Underground and South Bates Extension Underground Performance Indicators
- The performance indicators will be considered to have been exceeded if the groundwater levels in alluvial bores exceed the groundwater level criteria in the GWMP (Table 11 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 in the GWMP (Table 13 of the GWMP). - The performance indicators will be considered to have been exceeded if the impacts observed on riparian, aquatic or groundwater dependent ecosystems are beyond negligible.

5 Monitoring Results

A summary of the water level results is provided for each of the main water bearing units below. Routine water level readings for 2020 are tabulated in Section 5.4. Hydrographs for each key hydrogeological unit is shown in **Appendix A**.

Key data assessment results of time series groundwater level and electrical conductivity (EC) data, in relation to trigger levels prescribed in the GWMP (Peabody, 2020) for the 2020 monitoring period, are outlined below. Bores at key sites are selected to identify potential impacts from recent areas:

- North Wambo Underground (completed in 2016);
- Montrose Open Cut;
- South Bates Underground;
- South Bates Extension - LW19 and LW20 extracted in 2020.

5.1 Alluvium

5.1.1 Wambo Creek Alluvium

Groundwater associated with the Wambo Creek alluvium is monitored upstream of Wambo mine operations at GW02 and GW11, as well as adjacent to the NWU mine footprint area at P106.

Groundwater monitoring within the Wambo Creek alluvium upstream of WCPL operations (GW02 and GW11) has shown a sharp rise in water levels (approximately 4 m) following a period of above average rainfall in 2020. This event follows a period of below average rainfall between 2017 and early 2020, known as the NSW drought, which resulted in a gradual decline of groundwater levels (of approximately 3 m to 4 m) at these locations. Water levels within the Wambo Creek alluvium have shown a strong correlation between water level fluctuations and the rainfall trends since monitoring began in 2005, with no evidence of a WCPL mining impact. Evidence of landholder pumping from both of these bores was noticed in early 2020 and it is recommended that the pumps be removed, or a dedicated replacement monitoring bore be installed to mitigate any apparent impacts that may be due to pumping.

P106 is closer to WCPL mining operations, located 250m from NWU longwall 10A, which commenced extraction in July 2015. Fluctuations in groundwater levels of approximately 5 m are observed at P106 likely due to a component of recharge coming from Wambo Creek during periods of flow. An obstruction has been identified in P106, and a replacement bore is recommended to allow for ongoing assessment of water level trends in the Wambo creek alluvium adjacent to historical WCPL operations. It is noted that P109 is also due to be replaced as it is screened across both alluvial and Permian strata (Groundsearch, 1998), not conforming to the standards set out in the *Minimum Construction Requirements for Water Bores in Australia* (NUDLC, 2020). The P109 replacement bore is recommended to be a paired site, with a standpipe in the alluvium, and another in the in the underlying weathered Permian (Peabody, 2020). This site would be an appropriate replacement for both P109 and P106 in the Wambo Creek alluvium.

Monitoring from P316a should also commence and further increase the availability of alluvial groundwater data adjacent to Wambo Creek.

Groundwater within the Wambo Creek alluvium is generally fresh (<1,000 µS/cm) with minor fluctuations observed in response to climatic trends.

5.1.2 North Wambo Creek Alluvium

Groundwater level trends within the North Wambo Creek alluvium are discussed below, considering sites upstream of the North Wambo Creek Diversion (NWCD) and then sites downstream. At sites upstream of the diversion, there is limited historical groundwater level data within the alluvium. With dedicated alluvial bores only installed from 2017 to mid-2019. This limits the ability to assess long-term groundwater trends against climatic conditions or identify historical mining impacts but does allow for data to be collected prior to undermining by South Bates Extension. Data loggers were installed into four sites within alluvial and Permian strata at North Wambo Creek, upstream of the NWCD and have been used to assist with this analysis.

Most of the monitoring bores installed in the upstream reaches of the North Wambo Creek alluvium from 2017 to early 2020 were recorded as being dry. This has been attributed to a lack of rainfall and flow in North Wambo Creek associated with the NSW drought. In 2020, above average rainfall conditions resulted in several flow events occurring in North Wambo Creek and subsequent saturation of the adjacent alluvium.

Sites such as GW25 and GW23, located close to the Wollemi National Park (NP) escarpment, or sites within the North Wambo Creek channel (GW27, GW28, GW36a) were observed to respond strongly to the first rainfall and flow event in February 2020, with observed water level increases of >4 m. Subsequent rainfall and flow events result in similar responses at these sites (April and July 2020). Observations outside the periods of rainfall and flow are seen to decline rapidly, with observations declining by up to 1 m in a month.

Sites further from the channel, or closer to the NWCD or Montrose Open Cut further downstream (GW32, GW33, and GW35)[1] did not respond as strongly to the initial flow event in February 2020, with water level increases of 1-3 m. However, following further rainfall and flow events in April 2020, observations at these more downstream sites again increased by 1.5-5 m. These sites did not respond to subsequent rainfall or flow events in 2020 with GW32 returning to dry conditions while GW33 and GW35 maintained around 4 m and 1 m saturation respectively.

Observations at North Wambo Creek alluvial sites during 2020 indicate the importance of flow in North Wambo Creek as a recharge mechanism for the aquifer, with sites close to or within the creek channel receiving vertical leakage through the sandy creek bed. The delayed response and lower levels of saturation in sites further downstream and further from the channel may be related to the underlying weathered Permian strata recharging following the 2017-2020 drought, before recovery is seen in the overlying alluvium. The delayed response may also relate to the larger storage volume within the aquifer as the alluvial plain broadens downstream of the Wollemi NP escarpment, requiring larger volumes of water to cause the same increase in observed groundwater level.

Observations in 2020 will serve as a useful baseline dataset prior to SBX undermining of NWC, with no impacts from SBX mining apparent at NWC monitoring sites. Ongoing monitoring and revisions to the groundwater model will help determine the influence of the adjacent Montrose Open Cut on water level observations.

[1] These monitoring bore names are taken from the monitoring plan. It is noted that the GWMP (Peabody, 2020) has a different naming convention for these bores. GW32 is labelled as GW33 in the GWMP, GW33 as GW34, and GW35 as GW36. For the purposes of this report, and subsequent reports, it is advised that the bore names are classified as those in the monitoring plan, and it is recommended that the GWMP is updated to reflect these.

Historical monitoring wells GW08 and GW09 and newly installed monitoring bores GW08.2, GW09.2, GW10.2a monitor groundwater level in the alluvium downstream of the North Wambo Creek diversion. Observations at GW08 in 2020 showed some minor response to rainfall in 2020 (0.5 m) but remained near-dry, GW09 also remained dry 2020 and has been dry since early 2017. GW08.2 and GW09.2 were dry for the two observations taken in October and December 2020. Reduced catchment area for this section of the North Wambo Creek alluvium has been caused by open cut operations, the impact of nearby underground mining operations, and the performance of the North Wambo Creek Diversion and may all be contributing the lack of recovery observed within this section of the North Wambo Creek alluvium.

EC within the North Wambo Creek Alluvium, upstream of the North Wambo Creek diversion is generally fresh with observations <1000 µS/cm. Observations within GW08, downstream of the diversion were around 2000 µS/cm, consistent with historical observations.

5.1.3 Wollombi Brook Alluvium

Groundwater within the alluvium/unconsolidated material along Wollombi Brook is monitored at P325a, GW15, P20, and P16.

P325a was installed in the alluvium in 2020 and is located 1.2 km upstream of NWU longwalls and 175 m west of Wollombi Brook Creek. Limited data is currently available for this bore, with only two water level measurements. Ongoing monitoring will help to establish trends at this location.

The shallow groundwater on the western bank of Wollombi Brook is measured at P20 and P16. Both sites are observed to respond to rainfall recharge events and surface water levels within Wollombi Brook. Decline in groundwater levels is observed at these sites in response to the 2017 to early 2020 NSW drought, with declines ranging from approximately 2 to 3 m. Due to their proximity to WCPL mining activities, some of the groundwater level decline at P16 (in the range of 1 m) and less significantly at P20 was attributed to excavation at the South Wambo Boxcut.

The rainfall events in early 2020 have recharged the shallow aquifer monitored by P16 and P20 with a 2m increase observed in water levels. in. Groundwater levels at P20 have rebounded to a similar level as observed before the NSW drought. At P16, recharge to groundwater is not as significant, with groundwater levels approximately 1.5 m below observations in earlier periods of above average rainfall. This suggests some mining impact to the colluvium west of Wollombi Brook could be ongoing, associated with mine activity in the Glen Munro Pit.

To the east of Wollombi Brook, GW15 is observed to respond to groundwater responses to rainfall recharge and discharge to the alluvial aquifer from Wollombi Brook. During 2020 the groundwater level increased by 0.5 m, which is lower than other previously observed responses to periods of above average rainfall (2011 and 2015). Due to its location on the opposite bank of Wollombi Brook to WCPL mining operations, a WCPL mining impact is unlikely at this location. It is possible that the approaching Warkworth Open Cut may be responsible for some decline in groundwater levels during the NSW drought, and for limiting the response of groundwater level to rainfall recharge throughout 2020. However, the monitoring record does not include observations from before the millennium drought (2001-2007), so it is difficult to determine whether 2020 observations are normal for this location.

East of Wollombi Brook, alluvial groundwater is fresh at GW15 (EC ranges from 500 µS/cm to 900 µS/cm) with no significant variation in EC during periods of below or above average rainfall. Sites on the western bank, where aquifer material has a higher clay content, groundwater is brackish to saline (between 8,000 µS/cm and 10,000 µS/cm) suggesting, some contribution of Permian groundwater to the aquifer, or from nearby shallow weathered Permian material. During the NSW drought, groundwater at P20 freshens (EC decline from 10,000 µS/cm to 5,000 µS/cm), while EC at P16 declines from 8,000 µS/cm to 6000 µS/cm. This observation suggests the regional drawdown induced by mining may have reduced the upwelling of Permian groundwater, increasing the contribution of fresher surface water from Wollombi Brook to mix with groundwater locally at P20 and somewhat less significantly 500 m downstream at P16. Throughout 2020, groundwater in the vicinity of P20 and P16 has freshened to around 2,500 µS/cm and 5,500 µS/cm respectively.

Groundwater pH adjacent to Wollombi Brook has a similar pH to alluvial groundwater in the North Wambo Creek being near neutral to slightly acidic (pH from 6.5 to 7.5). In 2020, pH is rather stable with no significant changes due to wetter conditions.

5.1.4 Stony Creek Alluvium/ Colluvium

The steep gradient and narrow catchment at Stony Creek results in groundwater in unconsolidated material encountered at Stony Creek responding differently to the lower gradient, broader alluvial plains of Wambo and North Wambo Creeks. Groundwater associated with the Stony Creek alluvium/ colluvium is monitored at P315 and P301, located between 60 m and 70 m from Stony Creek and above NWU LW4 and LW6. GW12, located further downstream and 300 m east of the Creek, was removed from the network due to the screen construction being across alluvial and Permian strata (Peabody, 2020).

There is a strong relationship between the trends in rainfall and groundwater levels at P315 and P301, with large fluctuations in groundwater levels during periods of above average rainfall suggesting leakage of surface water from Stony Creek to the underlying alluvial/ colluvial aquifer. Groundwater level observations at both sites declined during the NSW drought by 3 m to 5 m, with P315 dry during 2018 and 2019. Above average rainfalls conditions in early 2020 have replenished the shallow aquifer associated with Stony Creek, with groundwater levels sitting at approximately the same level as before the NSW drought. Short-term fluctuations in groundwater levels are observed throughout 2020 comparing well with the rainfall trends.

EC has decreased dramatically in groundwater for both bores from 2018 and 2019 levels to 2020. In early 2020 groundwater from both bores showed a decrease of EC by up to 6,000 µS/cm, with both bores measuring salinities in 2020 beneath 1,000 µS/cm. Changes in EC in these bores correlate with the rainfall conditions, implying that increased rainfall has diluted and freshened the groundwater in these locations during 2020.

Groundwater samples recorded pH that were slightly acidic in both P315 and P301 during the 2020 annual reporting year. The pH of the groundwater in P315 has remained stable around 6.3 whilst the pH in P301 fluctuates in the range of 6.1 to 6.7.

5.2 Regolith – Shallow Weathered Sandstone

5.2.1 Wambo Creek

Groundwater associated with the weathered sandstone underlying the Wambo Creek alluvium has been monitored at P114, P116, and P109 since 1998. P316b was installed in 2020 in the weathered sandstone to replace P114, though no measurements have been taken at this bore to date. Groundwater levels versus rainfall residual mass are presented in **Appendix A**. Many of the sites mentioned in this section were formerly considered 'alluvial' monitoring sites due to their depth and geographical location. Subsequent analysis of construction logs identified that the bores had been installed across both Permian and alluvial strata, meaning that it is not appropriate to consider the bores as representative of alluvium. Work is underway to decommission sites screened across multiple aquifers, consistent with the *Minimum Construction Requirements For Water Bores In Australia* (NUDLC, 2020), and replace them with sites only screened in one aquifer.

Sites within shallow Permian strata overlying and adjacent to WCPL and historical longwall mining activity show drawdown associated with mining. Mining related drawdown and an ongoing impact is observed at P114 which is located over NWU longwall 10A, which commenced extraction in July 2015. Monitoring sites P116 and P109 are 100m and 210m from NWU longwall 10A respectively and show that impacts associated with nearby longwall mining decrease with distance from longwall activities, although impacts to P109 observations would likely be subdued by the contribution of surface water leakage from Wambo Creek.

A climatic response is observed at these locations, with the largest climatic influence observed in P109, with larger fluctuations in water levels likely indicative of ephemeral flow in Wambo Creek or a lower specific yield in the associated weathered sandstone. These three sites presented a decline in water levels during the NSW drought ranging from 1 to 4.5 m, with the 4.5 m drawdown in P114, the closest bore to mining interpreted as an NWU mining impact. From 2020, water levels in the weathered sandstone rise from approximately 1 m at P114 (above the base of the bore) to 2 m at P109 (closest to Wambo Creek). A less than 0.5 m rise is observed at P116. The increase in water levels is a result of above average rainfall condition in 2020.

EC trends within P109 have remained relatively stable and fresh over the entire history of monitoring, with EC levels in 2020 varying between 517 µS/cm (June) and 705 µS/cm (October), likely due to the contribution of surface water from Wambo Creek. EC trends away from Wambo Creek, within P114 and P116 show a steadily increasing trend over 2020, following on from the increasing trends identified within these bores in previous annual reports. Groundwater at these sites are generally brackish to saline in the order of 4000 µS/cm (P116) and 7000 µS/cm (P114) in 2020. As with previous changes in EC, the increased salinity for 2020 is highly likely to be controlled by low groundwater levels in each bore intercepting saline Permian groundwater below the base of the Wambo Creek Alluvium. This relationship between groundwater levels and salinity is consistent with assessments regarding the mechanisms of saline water observed at the mine conducted by HydroSimulations (2016, 2017b, 2019) and SLR (2020b).

pH in groundwater sampled from these bores remains stable with levels staying at similar levels during 2020 as to those in 2019, fluctuating around a neutral pH (7.0).

5.2.2 North Wambo Creek

Groundwater in the shallow overburden near North Wambo Creek is monitored upstream of the NWCD at GW23, GW25, GW36b, GW16, GW17 and SBX-GW02. Downstream of the North Wambo Creek Diversion this unit is monitored at GW10.2.

Despite relatively shallow construction depths (<20 m), nearby mining at SBX and Montrose Open, and the NSW drought from 2017-2020, the sites upstream of the NWCD maintained some level of saturation and provide useful baseline data prior to SBX undermining in the future. Groundwater level observations within these sites respond strongly to the climatic trend with response to rainfall recharge observed at GW16 and GW17 while response to rainfall recharge and leakage from North Wambo Creek is evident at GW23, GW25 and GW36b. Some evidence of a Montrose Open Cut mining effect is present at GW16 and GW17, with recovery following 2020 rainfall events slightly lower than observations in 2011 and 2013. Groundwater levels following rainfall events also appear to be declining at a faster rate than before nearby Open Cut Extraction.

EC is variable across these monitoring sites (from <1000 µS/cm to 4000 µS/cm) and was generally observed to decline in 2020. Indicating the influence of downward leakage of fresher water from overlying unconsolidated strata. Observations at the paired site GW36 and GW36b shows this downward flow gradient in its groundwater level observations.

pH in groundwater samples collected from these sites are near-neutral (6.5-7.5) with slightly basic pH observed at GW16 (~7.5). pH at these locations is generally stable with no clear departure from normal trends.

Downstream of the NWCD, GW10.2 is constructed to a depth of 25 m and was dry during the observations made in November and December 2020. Further conclusions regarding the impacts to groundwater from NWU and historical Homestead workings may be drawn once data is collected from GW10.2.

5.2.3 Wollombi Brook

Groundwater level and quality associated with shallow weathered strata present below the Wollombi Brook alluvial/unconsolidated material is monitored at GW13. GW13 is located 380 m west of Wollombi Brook, around 2.8 km east of the Warkworth Open Cut and ~1.2 km of WCPL mining activity.

At GW13, groundwater level trends are somewhat like those observed at GW15 in the shallower strata, although the magnitude of groundwater level change in response to climate or streamflow is less. Water levels compare well with the rainfall CRD prior to 2013 before declining by 2.5 m between 2013 and 2019. Groundwater response to the above average rainfall in 2020 is relatively minor, (an approximate 0.5 m water level rise) which could be influenced by the advancing Warkworth Open Cut.

EC levels in groundwater sampled have slowly declined in GW13 from 2019 levels during 2020, from 3,180µS/cm in February 2020 to 1,870 µS/cm in August 2020, with a small increase in EC levels at the end of 2020 to 1,993 µS/cm in December 2020. Changes in EC in this bore correlate well with the above average rainfall conditions in 2020, but the longer-term decline may relate to a reduced component of more saline Permian groundwater associated with regional depressurisation.

pH in groundwater samples collected from GW13 remains stable with levels staying at similar levels during 2020 as to those in 2019, fluctuating around a neutral pH (7.0).

5.3 Permian Coal Measures

Monitoring locations within the fresh Permian coal measures (both over/ interburden and coal seams) provide information on the timing, magnitude, and extent of mining impacts. While discussion around these monitoring sites have been reported on according to creek catchment area, specific reference is made to the WCPL mine(s) that may be influencing groundwater observations at these sites.

Division by catchment area allows for straight forward discussion at monitoring sites that may be impacted by multiple WCPL mining areas.

5.3.1 Wambo Creek Catchment

In the Wambo Creek catchment, groundwater associated with Permian Coal Measures is monitored at P202, P206, and P316c. There are also some recently installed VWPs in this area that will be included in future analysis once data quality at the sites has been adequately reviewed.

Bores P202 and P206 are somewhat offset (**Figure 1**) from WCPL mining activity and have shown some evidence of a WCPL mining impact in recent years. P206 was previously impacted by historical Homestead-Wollemi underground mining, with current observations ~15 m lower than those in the late 1990's. From 2015 to early 2020, groundwater level declined at P206 by about ~10 m and did not respond to above average rainfall in 2016/17, indicating a NWU mining impact that was likely enhanced by below average rainfall from 2017-2020. Both sites continue to respond to the long-term rainfall trend, and quality observations (EC and pH) do not show trends in 2020 outside of normal historical ranges. A similar decline but of a smaller magnitude (~2 m) was observed at P202 from 2015 to 2020. Both P202 and P206 recovered in response to the above average rainfall from February 2020 to levels consistent or above those observed in other wet periods.

No data is currently available at P316c to interpret groundwater levels or quality in the Permian Coal Measures overlying the NWU mine footprint. This site will be sampled from in 2021 and included into subsequent water level and quality analysis.

5.3.2 North Wambo Creek Catchment

In the North Wambo Creek catchment, groundwater associated with Permian Coal Measures, overlying NWU, SBU and SBX and adjacent to Montrose Open Cut is monitored at N2, N3 and N5 VWPs.

Data at the VWPs has been recorded since July 2015. N3 overlies the gate road to the north side of SBU Whybrow LW11, while N2 lies south-east of SBU Whybrow LW14 and is separated from SBU workings by a fault. N5 is located 2 km north of current mining in the South Bates Extension Underground Mine (SBX).

N5 has four vibrating wire piezometer sensors installed at depths of 30 m (N5-4: Permian Overburden), 73 m (N5-3: Whybrow Seam), 89.5 m (N5-2: Whybrow–Wambo Seam Interburden) and 133 m (N5-1: Wambo Seam) that have been recording since July 2015.

The shallowest Permian sensor (N5-4) has recorded generally consistent groundwater levels that show a good correlation with the rainfall residual mass until early 2019 (**Figure 2**). Following this time groundwater level has shown a gradual decline with a minor response to above average rainfall in early 2020. It is likely that this sensor is becoming impacted by approaching SBX mining. The middle two sensors (N5-3 and N5-2) similarly show gradual impacts from SBX mining, but at an earlier time to the uppermost sensor. The lowest sensor, N5-1, declined by ~20 m from 2015 to the end of 2019, likely associated with SBU mining in the Wambo Seam or SBX mining, but was observed to recover by 3 m in 2020. This may show recovery in the Wambo Seam following the completion of SBU mining. Ongoing monitoring will help determine the validity of this apparent recovery.

VWP N2 (**Figure 4**) is located between NWU and SBU (**Figure 1**), at an elevation of 122.5 mAHD. It is a multi-piezometer grouted array with six VWPs installed at depths of 40 m (N2-6: Permian overburden), 70 m (N2-5: Permian overburden), 100 m (N2-4: Permian overburden) and 140 m (N2-3: Whybrow Seam), 173 m (N2-2: Whybrow to Wambo Seam interburden), and 204 m (N2-1: Wambo Seam). These WVPs commenced recording in July 2015.

The upper two sensors N2-6, N2-5 show groundwater levels that at or near the sensor elevation and may no longer be recording reliable groundwater level data. N2-4 reported groundwater levels near the sensor elevation from late 2017 to early 2020 but has shown some response to above average rainfall from February 2020. Sensors N2-3 (Whybrow Seam) and N2-2 (Whybrow-Wambo Interburden) have both shown a gradual decline in groundwater levels since recording began in 2015 to the end of 2020 (~10 m and ~15 m respectively). These declines do not show a specific response to individual SBU longwall extraction and may be somewhat protected by the fault between NWU and SBU. An upward flow gradient from the Whybrow-Wambo seam interburden to the Whybrow seam is evident in the N2-2 and N2-3 data. No evidence of a mining impact is present in the Wambo Seam sensor (N2-1), however, due to the large fluctuations in recorded data (5-15 m), the quality of data at this sensor is uncertain.

VWP N3, located above the northern edge of SBU LW11, has a ground elevation of 104.9 mAHD. It is a multi-piezometer grouted array with six sensors installed at depths of 30 m (N3-6: Permian overburden), 55 m (N3-5: Permian overburden), 75 m (N3-4: Permian overburden), 109 m (N3-3: Whybrow Seam), 142 m (N3-2: Whybrow to Wambo Seam interburden) and 190 m (N3-1: Wambo Seam). Recording commenced in July 2015. Sensors at N3 are no longer recording accurate groundwater level data (generally since May 2016) (**Figure 3**). The behaviour of these sensors before failure described in previous Annual Reviews (HydroSimulations 2016, 2017 and SLR, 2020b).

5.3.3 Wollombi Brook Catchment

In the Wollombi Brook Catchment, groundwater associated with Permian Coal measures is currently monitored upstream of NWU longwalls at GW22. There are also some recently installed VWPs in this area that will be included in future analysis once data quality at the sites has been adequately reviewed. Permian bores in this area will provide baseline data for the approved South Wambo Project.

At GW22, upstream to mine operations, groundwater levels associated with the Whybrow Seam interburden show a good correlation to rainfall recharge events. During the NSW drought, water levels declined by 1 m before slightly responding by less than 0.5m to the wetter climatic conditions observed in early 2020. EC in this bore is shown to historically fluctuate but has an overall increasing trend. 2020 EC levels in groundwater sampled started off at approximately 7,000 µS/cm before falling to 6,600 µS/cm mid-year, and then climbing back to 7,000 µS/cm in December 2020. pH is stable, though slightly basic at 8.2.

The groundwater response at GW22 from the above average rainfall conditions in 2020 at suggests vertical connectivity between the Wollombi Brook alluvium/unconsolidated aquifer and the underlying Permian aquifer.

5.4 Trigger Level Exceedances

The 10th and 90th percentile statistics for groundwater levels at nominated water level trigger sites for the 2020 monitoring period are shown in **Table 11** below. Trigger levels for groundwater levels occur when two consecutive bi-monthly observation exceeds the maximum or falls below the minimum specified groundwater level (Peabody, 2020).

Table 11 2020 10th and 90th Percentile Groundwater Levels

Bore	Groundwater Level (m AHD)		Depth to Groundwater (m bToC)	
	2020 Minimum (90th percentile depth)	2020 Maximum (10th percentile depth)	2020 Minimum (10th percentile)	2020 Maximum (90th percentile)
P109	55.7	57.8	4.6	6.7
GW15	51.3	52.0	10.4	11.1
P16	49.7	50.4	7.1	7.8
P20	49.2	50.3	7.1	8.2

mAHD = metres above height datum

m bToC = metres below top of casing

Triggers for EC occur when three consecutive bi-monthly observations (a 6-month period) exceed the specified trigger level. Triggers for pH occur when two consecutive bi-monthly observations (a 4-month period) exceed or fall below the specified trigger level (Peabody, 2020). The number of maximum or minimum trigger level exceedances for groundwater level and groundwater quality over 2020 are shown in **Table 12** below.

Table 12 2020 Trigger Level Exceedances

Bore	Trigger Exceedances				
	2 Consecutive Depth to Water Minimum (10th percentile) *	2 Consecutive Depth to Water Maximum (90th percentile) **	3 Consecutive EC	2 Consecutive pH minimum	2 Consecutive pH maximum
P109		Y			
P301	N/A	N/A			
P315	N/A	N/A			
GW08.2	ND				
GW09.2	ND				
GW02	N/A	N/A			
GW15		Y			
GW16	N/A				
GW17	N/A				
P16		Y		Y	
P20		Y			

N/A = Not applicable

ND = insufficient baseline data to develop meaningful trigger level

*Minimum depth-to-water is equivalent to maximum groundwater level (mAHD)

**Maximum depth-to-water is equivalent to minimum groundwater level (mAHD)

Over 2020, groundwater levels in bores P109, GW15, P16, and P20 exceeded the trigger level for the 90th percentile (maximum) depth to water. Bore P16 exceeded the pH trigger during 2020. No trigger exceedances in EC were recorded during 2020.

5.4.1 Groundwater Level Trigger Exceedances

5.4.1.1 P109

Monitoring bore P109 is located 210 m from NWU longwall 10A, within the Wambo Creek alluvium.

Groundwater levels declined by approximately 1.5 m from 2017 to 2020, with the 90th percentile trigger level exceeded in two bi-monthly observations in December 2019 and February 2020. This ongoing drawdown in groundwater was likely caused by both a minor NWU mining impact and the 2017 to early 2020 NSW drought, although impacts to P109 observations would likely be muted by the contribution of surface water leakage from Wambo Creek.

Groundwater levels increased from March 2020 onwards, showing a recovery to within the trigger 10th and 90th percentile range, and around 0.5 m below peak groundwater levels observed during other periods of above average rainfall. Therefore, no long-term declining depth to groundwater trend is observed at this bore and it is expected that climate and rainfall trends were predominantly responsible for the drawdown experienced prior to March 2020. No further investigation is recommended at P109.

5.4.1.2 GW15

GW15 is located 275 m east of the channel of Wollombi Brook and 1.5 km west of the advancing Warkworth Open Cut. During 2020, all groundwater level observations at bore GW15 were below the 90th percentile trigger level. A slight recovery is observed during 2020, though groundwater recovery responses are limited in comparison to other bores.

As concluded in HydroSimulations (2019b) and SLR (2020b), the start of the decline in observed groundwater levels at GW15 corresponded to trends observed in the rainfall residual mass and the water levels within Wollombi Brook, both indicating declining levels since March 2016. However, when considering observations during 2020, a relatively wet year, the small magnitude of response to increased stream flow and rainfall recharge is not consistent with previous observations. Due to GW15's location on the opposite side of Wollombi Brook to WCPL, it is considered unlikely that WCPL mining activity is impacting GW15. Due to monitoring record at GW15 not including the millennium drought, it is possible that the response is normal following a long period of below average rainfall. However, it is also possible that the approaching Warkworth Open Cut may be responsible for some decline in groundwater levels at GW15.

The following further investigation is recommended:

- Confirmation of the validity of data collected at GW15 and to check if the bore is obstructed or compromised.
  - This should include consideration of groundwater level collected in the Wollombi Brook/ Warkworth Sands alluvium at other nearby mine sites, the Wollombi Brook water elevation, P16 and P20 groundwater level observations, and South Wambo Boxcut floor elevation and fill level.
- Confirmation of the nature of the material (alluvial or weathered sandstone) intersected by GW15.

5.4.1.3 P16

Bore P16 is located approximately 4.5 km from LW11, adjacent to Wollombi Brook and downstream of underground mining at WCPL (**Figure 1**). P16 is less than 200 m from the excavation that occurred for the South Wambo Boxcut, now known as Glen Munro Pit, which was completed in July 2017. Bore P16 was constructed as part of an assessment to identify whether the alluvial aquifer located to the east of Wollombi Brook extended to the west of the channel, overlying the United Underground longwalls (GeoTerra, 2003). The study found that colluvial and silty alluvial material ranging in thickness from 1.9 m to 11.5 m existed at sites to the west of Wollombi Brook, but that this material is not part of the Wollombi Brook Alluvial Aquifer. The colluvial and silty alluvial material in bore P16 was 11 m thick.

Previous rainfall and stream level trends from 2015 to 2020 indicate decreased recharge, with the lowest groundwater level on record at P16 occurring in late 2019 (approximately 1.4 m below the minimum observation recorded from 2005 to 2015). While some of the decline in groundwater level at P16 could be attributed to the low rainfall conditions as part of the 2017 to early 2020 NSW drought, excavation at Glen Munro Pit appears to have caused additional drawdown in the order of 1.2 m. Groundwater levels have increased during 2020, to 1.5m higher than late-2019 levels, however groundwater levels are still lower than the 90th percentile water level from the baseline period, likely indicating an ongoing mining impact on this bore.

The amount of drawdown in P16 is consistent with the groundwater assessment for the South Wambo Boxcut by HydroSimulations (2016) which predicted a small amount of additional drawdown in Permian strata at P16 due to the excavation of the boxcut, on top of broader regional depressurisation from mining activity such as NWU, United Underground and the United Wambo Joint Venture.

5.4.1.4 P20

Bore P20 is located approximately 3.5 km from LW11, adjacent to Wollombi Brook and downstream of underground mining at WCPL (**Figure 1**). P20 is less than 200 m from the excavation that occurred at the South Wambo Boxcut (also known as the Glen Munro Pit), which was completed in July 2017.

Groundwater levels declined by approximately 2.5 m from 2015 to 2020, with the 90th percentile trigger level exceeded in every bi-monthly observation from late-2017 to February 2020. This ongoing exceedance was likely caused by a NWU mining impact, Chitter Dam (Glen Munro Pit) impact, and the result of the 2017 to early 2020 NSW drought.

In 2020, groundwater levels increased from March 2020 to the end of the year, showing a recovery of groundwater levels to within the 10th and 90th percentile range of historical observations, within 0.5 m of observations from other periods of above average rainfall. This is not characteristic of a long-term large magnitude mining impact it is therefore expected that climate and rainfall trends were large contributors to the drawdown experienced prior to March 2020. HydroSimulations (2016b) predicted drawdown in Permian strata at bore P20 due to excavation of Glen Munro Pit, while no drawdown is predicted in unconsolidated material as is it simulated as dry. The predicted drawdown was of a smaller magnitude at P20 than at P16 due to the increased distance from the pit. This matches well with the observed data as the apparent impact at P20 is about a quarter of the impact at P16.

During 2020, groundwater levels recovered to within the baseline range, and any observed ongoing mining impact is less than or consistent with predictions. No further investigation is recommended at P20.

5.4.2 EC Trigger Exceedances

No EC trigger level exceedances were observed in the 2020 monitoring year.

5.4.3 pH Trigger Exceedances

Only bore P16 exceeded the pH trigger exceedance on two bi-monthly measurements of groundwater samples collected during 2020, these were marginally below the minimum pH trigger level of 7.0 (neutral). The pH at P16 fell below the minimum pH trigger of 7.0 in April 2020 (6.97) and in June 2020 (6.92), less than 0.1 pH units. With the change in pH being so minimal, it is not considered to have caused or be likely to cause a long-term, negative impact to the groundwater quality in the vicinity of these bores. In addition, pH rebounded back into the acceptable range for the last three measurements taken at the end of 2020 (August, October, and December).

The Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC, ARMCANZ, 2000) recommend that groundwater used for irrigation and stock watering falls within a pH range of 6 to 8.5 in order to prevent fouling or corrosion of infrastructure. The Australian Drinking Water Guidelines (NRMMC, 2011) outline that groundwater with a pH between 6.5 and 8.5 is fit for human consumption. The pH values at P16 that triggered the exceedance remain within the above bounds recommended for irrigation and stock watering as well as human consumption above.

5.5 Reporting against Groundwater Performance Criteria

The 2020 groundwater monitoring has been evaluated against the performance criteria, set up as part of the Version 2 GWMP (Peabody, 2020). **Table 13**,

Table 14, and **Table 15** below provide an assessment of compliance with the performance criteria defined for general water management performance, and subsidence impacts for North Wambo Underground and South Bates Underground and Extension longwalls.

Table 13 Performance Indicators

Feature	Performance Indicator	2020 Performance Indicator Observations	Overall Compliance
Groundwater Management Performance Indicators			
Alluvial aquifers (including Wollombi Brook alluvium and excluding the North Wambo Creek alluvium)	The performance indicators will be considered to have been exceeded if the impacts are beyond those predicted in the documents listed in condition A2c) (of DA305-7-2003), including: A greater than negligible change in groundwater levels;	There is an exceedance of groundwater level triggers in monitoring bores GW15 and P16 in the Wollombi Brook alluvium/ colluvium, which persisted through to the end of 2020. However, the drawdown in P16 is consistent with the groundwater assessment for the South Wambo Boxcut (HydroSimulations, 2016b) and is not considered an exceedance of performance indicator. The exceedance at GW15 may be due to WCPL mining effect or impacts from the approaching neighbouring mine. See **Section 5.4.1** for more details. Further investigation at GW15 is recommended prior to a determination of compliance with the Performance Indicator.	**Compliance with groundwater level performance indicator pending further investigation due to observations at GW15.**
	A greater than negligible change in groundwater quality	No EC trigger exceedances were observed in 2020, and only one negligible pH trigger exceedance in P16 (of approximately 0.1 pH Unit below trigger) was observed. See **Section 5.4** for more details.	**Compliant**
	A greater than negligible impact to other groundwater users.	Previous groundwater assessments for Wambo Coal predicted that some privately-owned bores may experience more than 2 m cumulative drawdown as a result of the approved operations (HydroSimulations, 2017a, 2019b and SLR, 2020). No complaints have been made to Wambo Coal during the 2020 AR period in respect to groundwater or water (WCPL, 2021).	**Compliant**
Groundwater dependent ecosystems	The performance indicators will be considered to have been exceeded if the impacts are beyond those predicted in the documents listed in condition A2c) (of DA305-7-2003), including: Greater than negligible environmental consequences, beyond those predicted in the documents listed in condition A2c)	Monitoring bores GW36a and GW36b were drilled in 2020 to monitor impacts at the River Oak GDE. Limited quantity and quality data exists for these bores, with only two quality measurements and 6-months of logger data taken to the end of 2020. However, observed depths to water are <3 mbgl, and likely accessible by the River Oak GDE. It is advised these are continued to be monitored in 2021 to observe groundwater fluctuations and determine whether SBX mining impacts on groundwater occur close to this GDE.	**Compliant**

Table 14 North Wambo Underground Performance Indicators

North Wambo Underground Performance Indicators		Overall Compliance
The performance indicators will be considered to have been exceeded if Wambo receive complaints from groundwater users.	Previous groundwater assessments for Wambo Coal predict that some privately-owned bores may experience more than 2 m cumulative drawdown as a result of the already approved operations. These drawdowns are due to the cumulative effects of all mining in the Wambo district. No additional impacts are predicted to third-party groundwater users from the underground mining operations (HydroSimulations, 2017a, 2019b and SLR, 2020). No complaints on the Wambo Coal Community Complaints Register 2020 (Wambo Coal, 2021) were made in respect to groundwater or water.	**Compliant**
The performance indicators will be considered to have been exceeded if monitoring data suggests significant divergences away from the modelled groundwater levels.	GW09 within the lateral extent of North Wambo Creek Alluvium, close to historical underground mine areas at Wambo, shows observed groundwater levels experiencing greater drawdown than predicted in the current groundwater modelling (SLR, 2020a), discussed in more detail in (**Section 6.2**). Indicating a possible exceedance of the performance indicator. However, GW09 has been investigated previously for potential impacts to the North Wambo Creek alluvium and potential licencing implications (HydroSimulations, 2015b and SLR 2020b, 2020c), with the 2019 trigger investigation (SLR, 2020c) identifying that the HydroSimulations (2019b) modelling successfully captures the timing of drawdown and desaturation of the alluvium at GW09 (**Figure 16**). The groundwater modelling for the approved South Bates Extension Modification (HydroSimulations, 2017a) similarly replicates the timing of drawdown at GW09. Rather than an exceedance of the performance indicator, this indicates that a review of the SLR (2020a) model assumptions near GW09 should be undertaken and considered in the groundwater modelling to be completed in 2021. It should be noted that calibration quality at nearby GW08 and at other North Wambo Creek monitoring locations has remained consistent between the model versions.	**Compliant** **(review of model should still be undertaken)**
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.	No longer applicable – Mining of NWU longwalls was completed in December 2015. Since then, the workings have been sealed and there has been no ongoing pumping.	**Compliant**
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 11 of the GWMP.	There is an exceedance of groundwater level triggers in monitoring bores GW15 (Wollombi Brook alluvium) and P16 (west Wollombi Brook colluvium) , which persisted through to the end of 2020.The exceedances at these sites may be due to a WCPL mining effect or impacts from the approaching neighbouring mine. It should be noted that impacts at P16 are consistent with the groundwater assessment for the South Wambo Boxcut (HydroSimulations, 2016b), which are not considered in the trigger level at this site and the trigger levels for P16 should therefore be reviewed. Further investigation is recommended at GW15 prior to the determination of compliance with the Performance Indicator. See **Section 5.4** for more details.	**Compliance with groundwater level performance indicator pending further investigation due to observations at GW15.**

North Wambo Underground Performance Indicators		Overall Compliance
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 13 of the GWMP.	No EC trigger exceedances were observed in 2020, and only one negligible pH trigger exceedance in P16 (of approximately 0.1 pH Unit below trigger) was observed. See **Section 5.5** for more details.	**Compliant**

Table 15 South Bates Underground and South Bates Extension Underground Performance Indicators

South Bates Underground and South Bates Extension Underground Performance Indicators		
The performance indicators will be considered to have been exceeded if the groundwater levels in alluvial bores exceed the groundwater level criteria in the GWMP (Table 11 of the GWMP).	There is an exceedance of groundwater level triggers in monitoring bores GW15 and P16 in the Wollombi Brook alluvium/ colluvium, which persisted through to the end of 2020. However, the drawdown in P16 is consistent with the groundwater assessment for the South Wambo Boxcut (HydroSimulations, 2016b) and is not considered an exceedance of performance indicator. The exceedance at GW15 may be due to WCPL mining effect or impacts from the approaching neighbouring mine. Further investigation is recommended prior to the determination of compliance with the Performance Indicator can be made. See **Section** 5.4 for more details.	**Compliance with groundwater level performance indicator pending further investigation due to observations at GW15.**
The performance indicators will be considered to have been exceeded if the groundwater quality in alluvial bores exceeds the groundwater quality criteria in the GWMP (Table 13 of the GWMP).	No EC trigger exceedances were observed in 2020, and only one negligible pH trigger exceedance in P16 (of approximately 0.1 pH Unit below trigger) was observed. See **Section 5.4** for more details.	**Compliant**
The performance indicators will be considered to have been exceeded if the impacts observed on riparian, aquatic or groundwater dependent ecosystems are beyond negligible.	Monitoring bores GW36a and GW36b were drilled in 2020 to monitor impacts at River Oak GDE. Limited quantity and quality data exists for these bores, with only two measurements taken at the end of 2020. It is advised these are continued to be monitored in 2021 to observe groundwater fluctuations and determine influences of mining on groundwater close to this GDE.	**Compliant**

5.6 Vibrating Wire Piezometer Data Review

In late 2020, SLR undertook work to rationalise the data collected at WCPL VWP locations, including a number that have been installed recently on the back of exploratory drilling across site. The table included in **Appendix C** provides detail on each of the VWP locations, and also provides a preliminary assessment of data quality collected at each of the sites. Key findings from the data quality assessment include:

- Unreliable data at VWP sites where sensors are within shallow overburden, Whybrow or Wambo seams. Sensors are dry or near-dry, likely associated with WCPL or regional mining activity. These sites are recommended to stay in the monitoring network while at least one of the sensors is collecting reliable data.
- Some sites near active underground mine operations are likely impacted by subsidence and are no longer providing reliable data. It is recommended that N3 and P317 are removed from the monitoring network.
- Older sites (MG06, MG08, MG09, GW20) and unlabelled sites are no longer collecting reliable data. It is recommended they are removed from monitoring network.

Detailed assessment of the observed groundwater level trends of VWP data have not been undertaken or presented in this report but will be included in future reporting once additional data is collected to confirm the findings of the data quality assessment. A summary of groundwater level observations from site VWPs are provided below:

- Most shallow VWP sensors (~10 m depth) are dry indicating greater depths to water table.
- Depressurisation associated with Wambo mining activity is observed within the Wambo and Whybrow seams and adjacent Permian Coal Measures in sites close to historical and current mining activity. This observed depressurisation is broadly consistent with current model predictions (SLR, 2020a) and will be assessed in more detail against predictions from the revised modelling.
- Deeper sensors, installed to monitor impacts of the Approved South Wambo Project, maintain significant pressure head in the absence of South Wambo Project mining activity.

5.7 Assessment of seepage from Chitter Dam and South Wambo Dam

Section 6.1.3 of the GWMP (Peabody, 2020) commits to assess lines of evidence for the seepage of mine water from the Chitter Dam (Glen Munro) and South Wambo Dam towards Wollombi Brook as part of the Annual Review. A detailed investigation of potential seepage from South Wambo Dam was undertaken by HydroSimulations (2018) and was presented and discussed in detail with the Natural Resources Access Regulator (NRAR) and DPIE-Water in August 2019, then again in April 2020. The investigation found no clear evidence of seepage from either South Wambo Dam or Chitter Dam (Glen Munro) towards Wollombi Brook.

The following section provides an overview of site activity relevant to both these Dams in 2020, assesses the likelihood of seepage, and provides recommendations relevant to the assessment.

5.7.1 South Wambo Dam

South Wambo Dam has not been used to store mine water since being drained prior to undermining by NWU longwalls 9 and 10 in 2014, in line with Condition 28c of the Development Consent. Any water within South Wambo Dam during 2020 will is most likely to have accumulated due to runoff associated with rainfall. Water quality observations during 2020 show EC to be <800 µS/cm and pH to be 8 - 8.4.

As mine water has not been stored in South Wambo Dam since 2014, the conclusions following the detailed investigation from HydroSimulations (2018) are considered valid, with no further investigation recommended.

5.7.2 Chitter Dam

Chitter Dam was excavated in 2016 to form the Boxcut for the Approved South Wambo Project. The excavation was undertaken to the base of the Glen Munro Seam, and as the South Wambo Project has not started, the void is currently known at the Glen Munro Pit. The storage of mine water in the Glen Munro Pit was considered in 2020, with a seepage investigation undertaken by SLR (2020d). The investigation aimed to identify the depth and thickness of alluvial or permeable strata intersected by Glen Munro Pit, and provide a maximum fill level within the pit that would avoid seepage through permeable strata or toward Wollombi Brook Alluvium.

SLR (2020) recommended that if Glen Munro Pit is used to store mine water, a fill level below 45 mAHD should be considered. This fill level is below the level of Wollombi Brook adjacent to the pit, and below the lowest mapped level of potentially permeably strata.

Some mine water was stored in Glen Munro Pit in 2020, with a maximum storage level of 29 mAHD, with an average EC of 3560 µS/cm and pH of 9. As this level is below the 45 mAHD identified in SLR (2020d) there was not a risk of seepage to Wollombi Brook or other key environmental receptors. No further investigation is recommended for the Glen Munro Pit, which is in the location of the former Chitter Dam.

6 Verification of Model Predictions

In February 2020, SLR undertook groundwater modelling as part of the Groundwater Assessment in Support of the South Bates Extension LW21-24 Extraction Plan. Detailed hydrographs of the modelled groundwater levels versus observed groundwater levels at key sites are presented in **Figure 5** to **Figure 15** located in **Appendix B**, with the remainder of Wambo monitoring sites presented after **Figure 35** in **Appendix B**.

The model predictions used in this report are from an updated version of the HydroSimulations (2017a) and HydroSimulations (2019b) which has been used as part of the South Bates Extension LW21-24 Extraction Management Plan (SLR, 2020). Key updates to this groundwater model since the HydroSimulations (2017a) include:

- Refined alluvial thickness and extent at North Wambo Creek;
- Revision of topography within the model to incorporate site LiDAR in the North Wambo Creek area;
- Quadtree refinement within the North Wambo Creek alluvial zone to improve representation of alluvial and channel topography; and
- A revision to the stress period timing within the model to include more temporal detail and better capture seasonal trends:
  - Transient historical period from January 2003 to December 2019 with monthly stress periods;
  - Transient predictive period from January 2020 to December 2029 with monthly stress periods; and
  - Transient predictive period from December 2029 to December 2040, with quarterly stress periods.

The following sections contain an assessment of the SLR (2020) modelled groundwater levels where mining impacts might be observed.

6.1 Montrose Open Cut

The elevation of modelled heads at GW16 (**Figure 5**) and GW17 (**Figure 6**) are reasonably close to the overall elevation of water levels observed at each monitoring location. However, the variability that appears in the observed data is not replicated by the model. The modelled water levels at GW16 and GW17 are also conservative, with the predicted mine impact being greater than observed. Both locations have observed groundwater level recovery in response to 2020 rainfall events and have not continued to decline as predicted. This overestimation of groundwater level decline is likely to be a function of simplified model layer discretisation at these locations not fully capturing local scale geology such as a weathered Permian layer.

Similarly, model predictions at other recently installed sites within shallow strata (GW24 and GW26), adjacent to the Montrose Open Cut, do not show the same fluctuation as observed throughout 2020 in response to above average rainfall.

Revision of alluvial aquifer properties and infiltration rates is being undertaken as part of groundwater model revision due for completion in mid-2021 with an aim of improving improve calibration quality at GW16 and GW17 and better understand impacts from Montrose Open Cut.

The performance of the modelled heads at N5 (**Figure 7**) is poor, with modelled heads much higher than those within the observed data. The timing of the observed drawdown due to the open cut is accurate, but the vertical hydraulic head gradients have not been reproduced. As reported in the 2018 and 2019 AEMR reports (HydroSimulations, 2019a and SLR, 2020b), the model requires lower vertical hydraulic conductivities in this area, which if implemented would have the effect of providing greater protection for the alluvium from underground mining effects.

The model revision currently being undertaken by SLR will review the hydraulic properties and layer discretisation adjacent to Montrose Open Cut mining, to better capture observed hydraulic gradients and the observed magnitudes of mining impacts.

6.2 North Wambo Underground

The performance of modelled heads at six standpipes in **Figure 9** to **Figure 13** (P114, P116, GW08, GW09, P106 and P109) have been assessed against observed data where historical North Wambo Underground (NWU) mining activity may impact groundwater levels.

Previous reporting for P114 (HydroSimulations, 2016) had underestimated the drawdown associated with NWU LW10a extraction. However, the currently presented modelled heads for P114 (**Figure 8**) are a weighted average from layer 1 and layer 2 heads according to the degree of partial penetration of the bore through both alluvial and Permian strata. The resulting calibration is a good representation of the observed magnitude and timing of the NWU mining effect. Minor saturation was observed in P114 in 2020 after being observed as dry throughout 2019 to levels consistent with predictions.

Modelled heads for P116 (**Figure 9**) are generally well correlated with observed heads. However, the magnitude of the gradual decline in simulated groundwater levels is less than the gradient of observed data. The same magnitude of climatic variation is also not as apparent in the modelled heads as it is in the observed heads. The lack of variation in the modelled data may be occurring for the flowing reasons:

- As in previous assessments, the SLR (2020) groundwater model simulates a constant long-term average stage height in Wambo Creek. This may suppress variation within the shallow groundwater system near Wambo Creek; and
- An overestimation of simulated specific yield may also be responsible for the overestimation of groundwater head elevation in the model, due to the location of the bore within the official alluvial extent but outside the limits determined by geophysics. Accordingly, it should be attributed to regolith instead of alluvium in future updates to the groundwater model.
- Like P114, P116 partially intersects weathered Permian strata below intersected Wambo Creek alluvium. Mining effects from NWU to these strata may not be replicated in predictions for model layer 1.

As P116 does not lie directly over NWU workings, predicted drawdown as a result of mining activity is limited compared with P114. Only a minor drawdown response in both simulated and observed heads following the extraction of NWU LW10a is shown.

Due to the intersection of multiple aquifer units, the construction of P114 and P116 is not consistent with the *Minimum Construction Requirements for Water Bores In Australia (*NUDLC, 2020). These bores have been removed from the monitoring program and future analysis will no longer consider these monitoring locations. The replacement site for these bores is the nested P316 (details can be found in **Table 6**)

Modelled heads at GW08 (**Figure 10**) show a good match with the overall trends seen in the observed data. The timing of mining related drawdown in both modelled and observed heads, following the extraction of NWU LW5 is well correlated despite simulated heads being lower than observed. At GW08, observed water levels fell below simulated heads in 2013. This relationship continues during the 2019 monitoring period with modelled heads showing a subdued response to drawdown than that seen in the observed heads. During 2020, a minor recovery in observed groundwater level, to near dry conditions, again aligns model predictions with observations. The faster rate of decline in observed data at GW08 may be related an underprediction of impacts, but also related to the below average rainfall conditions from 2017 to early 2020.

Calibration performance at GW09 (**Figure 11**) in SLR (2020) is poorer than previously reported in HydroSimulations (2017a). Simulated groundwater levels at GW09 show a response to climatic inputs of a similar magnitude to the observed data but do not show any drawdown associated with NWU LW5 mining. GW09 observations indicate drawdown in the order of 3 m at GW09 prior to going dry in December 2014 in response to NWU mining which has not been observed to recover in 2020. Further investigation is required to ensure the interaction between NWU and the overlying historical Homestead Underground Mine has been sufficiently captured within the SLR (2020) model (refer to **Table 14**). The revision of fracture zone parameters and extents associated with longwall extraction is being tested within the groundwater modelling work being undertaken in effort to better calibrate the model to observed impacts.

The simulated groundwater levels at P106 (**Figure 12**) follow the observed declining trend. However, the magnitude of water level change is not reproduced, this may be due to the absence of streamflow dynamics in the model, or specific yield values within the alluvium/regolith being too high. An obstruction has been identified in P106, and comparisons between modelled and observed data with a replacement bore are recommended.

There is a good correlation between simulated groundwater levels and observed groundwater levels at P109 (**Figure 13**) from 2003 to 2007. However, the model has a declining trend in contrast to generally higher and more dynamic water level observations. The model is probably missing a component of enhanced recharge from intermittent streamflow along Wambo Creek. As a result, the model overestimates drawdown impacts in this area. During the 2020 monitoring period, simulated groundwater level stabilises in response to the modelled average climatic conditions but does not match the observed increase in groundwater level related to observed above average rainfall.

6.3 South Bates Underground

The performance of modelled heads at N2 VWP (**Figure 14**), and N3 VWP (**Figure 15**) have been assessed against observed data where South Bates Underground (SBU) mining activity may impact groundwater levels.

There is difficulty with the modelled heads accurately representing groundwater levels in the Permian overburden sensors in VWP N2 (**Figure 14**) and VWP N3 (**Figure 15**) with three sensors from each VWP located within one model layer. The upper two sensors at N2 are now dry and all sensors at N3 are either dry or have failed, making ongoing assessment against model predictions difficult.

Prior to sensor failure, observed hydraulic gradients at N3 were well matched to that predicted within the model, with near-dry conditions in the Whybrow Seam and higher heads in the underlying interburden and Wambo seam sensors. The 70 m sensor at N2 (N2-5) shows a good match with level and magnitude of decline in observed data until the end of 2017 after which the sensor went dry. The modelled groundwater levels lower sensors in N2 overestimate observed groundwater levels but are accurate in indicating an ongoing mining effect from NWU that continues through the beginning of SBU mining. The modelled head in the Wambo Seam (N2-1) does not match the stable groundwater level observations to the end of 2020. This may be due to inherent difficulties in representing the fault that divides NWU and SBU. It may also be related to an inaccurate representation of the end of dewatering at NWU, which would limit the recovery of modelled heads to match observed data.

6.4 Assessment

The groundwater levels, as predicted by SLR (2020), generally show a good match with the magnitude and timing of impacts associated with mining at WCPL. Areas where the model is not performing well can be attributed to:

- Difficulties in accurately simulating complex geological features, such as the fault between SBU and NWU;
- Multiple sensors being simulated in a single model layer;
- Model parameters in surficial layers not configured to match the variations in observed data;
- Long-term average stage heights used in some watercourses within the model domain; or
- Issues related to the simplification of local geology within the groundwater model layering.

Overall, the groundwater model performs well and remains fit for purpose to predict the timing and magnitude of impacts to groundwater caused by mining at WCPL. Model updates due for completion in mid-2021 aim to keep the model predictions current and to address the identified outstanding issues.

7 Inflow to WCPL workings

Section 4.1 in the GWMP (Peabody, 2020) requires quantification of the volume and quality of groundwater inflows to both open cut and underground mine workings at WCPL. This section assesses compliance of WCPL against the requirements and measurement criteria in the GWMP (Peabody, 2020).

The assessment of licence compliance regarding the interception of groundwater is undertaken in **Section 6.5** of the main WCPL Annual Review document.

7.1 Inflows to Open-Cut pits

During dewatering (if any), metering of daily dewatered volumes from each of the Wambo open cut pits is recorded with these dewatered volumes incorporated into the site water balance on an annual basis to determine the inflows from groundwater sources, including alluvial aquifers, and to verify whether WCPL holds sufficient groundwater licence entitlements. During 2020 there was no direct dewatering of the Wambo open cut pits.

The water quality of inflows to the open cut are measured indirectly through monthly water quality monitoring of mine water storages. This is the most practical method to routinely sample for water quality. An unexpected increase in water make or change in water quality of mine water storages would be investigated by Wambo. If warranted, direct measurement of water quality at the source of inflow may be conducted.

7.1.1 Open Cut Inflow Assessment

Despite above active rainfall from 2020, active pumping of groundwater inflow from WCPL open cut operations was not required in 2020. Evaporation, the placement and development of spoil dumps, a lower than planned rate of mine progression, and the ongoing period of below average rainfall experienced from 2017 to 2019 are all likely to be factors contributing the apparent lack of groundwater inflow.

For water balance and licencing purposes, WCPL has estimated groundwater inflow to open cut operations using the Hydro Engineering & Consulting (2017) overall site water balance predictions, which accompanied the South Bates Extension Modification impact assessment. Groundwater inflow to WCPL open cut operations is estimated to be 184 ML.

The South Bates Extension Extraction Plan for Longwalls 21-24 (SLR, 2020) predicts flow from the shallow groundwater system near the NWCD into the open cut during 2020 to occur at around 0.2 ML/day. As the SLR (2020) model was developed in early 2020, these predictions include long-term average climatic inputs at a quarterly timestep, and do not include the above average rainfall observed throughout 2020. These climatic inputs are appropriate for use in predictive scenarios but may not replicate groundwater level or flow conditions under above or below average climatic conditions (rainfall, streamflow etc.).

Groundwater modelling scheduled for completion in mid-2021 incorporates contemporary climatic inputs for Wambo and will provide more robust predictions of take from the shallow groundwater system as well as revised predictions for inflow reporting to open cut workings.

7.2 Inflows to Underground Workings

Active SBX and SBU workings in the Whybrow and Wambo Seams are currently being dewatered, with dewatering volumes and underground water levels required to be recorded daily during pumping according to **Section 4.1.5** of the GWMP (Peabody, 2020. Annual assessments for mine inflows are assessed against the peak simulated mine inflow from HydroSimulations (2017) of 316 ML/yr (Peabody, 2018). An exceedance of this predicted inflow by greater than 50% (i.e. an annual inflow of > 474 ML/yr) will require WCPL to:

- Investigate if there is a change in the predicted take of water from the Lower Wollombi Brook Water Source from mining related activities;
- Where there is an increased take from the Lower Wollombi Brook Water Source, investigate any influence on low flow cease-to-pump criteria specified in the HUA WSP;
- Define the Mine inflow volume value triggering this response procedure; and Groundwater Monitoring Program WA-ENV-MNP-509.1 Version: 12 Uncontrolled when printed 45
- Submit a report summarising the assessment to DoI Water. WCPL must notify DoI Water as soon as practicable on becoming aware of any take of water in excess of its licensed entitlement.

Predictions of annual inflows based on the actual mine progression for 2019 and anticipated mine progression for 2020 was captured in modelling for the South Bates Extension Extraction Plan (SLR, 2020). This modelling predicted up to 74 ML/year inflows to the South Bates Extension and South Bates Underground mine areas over 2020.

This is significantly lower than the previously predicted inflows of 316 ML/year and is considered to be largely due to a reduction in the actual mined extent and below average rainfall conditions from 2017-2019 simulated in SLR (2020). Revised groundwater modelling, due for completion in the first half of 2021 is currently being undertaken by SLR. This modelling incorporates environmental observations from 2020 (including observed creek flow and rainfall) and should assist in providing more robust estimates of inflow under wetter conditions.

As with the open cut areas, the water quality of inflows to the underground workings are generally measured indirectly through monthly water quality monitoring of mine water storages. During 2020, WCPL staff attempted to take water quality samples directly from the underground workings but were unable to do so due to a lack of seepage in accessible areas. Despite above average rainfall conditions in 2020, WCPL staff confirmed there continued to be no observable seepage in South Bates Underground.

7.2.1 Underground Inflow Assessment

Modelled inflow values have been provided for 2020 based on the South Bates Extension LW21-24 Extraction Plan groundwater modelling (SLR, 2020). This groundwater model was revised to represent rainfall recharge for 2017-2019 that considers observed below average rainfall conditions, before returning to long-term average values for future predictions. These predictions are suitable for average climatic conditions. However, as described in **Section 7.1.1**, modelling due for completion in 2021 may provide more informative predictions for above average rainfall conditions, as observed in 2020.

As was described in the 2018 Annual Review (HydroSimulations, 2019), the modelled underground seepage values are calculated for the combined sources of SBU and SBX. This is done by calculating the volume of water intercepted by the MODFLOW Drain package, which is used within the model to represent areas of active mining/ dewatering in our groundwater models. In 2020, drain cells active in all historical SBU workings in the Whybrow and Wambo Seams, as well as all mined areas in the Whybrow Seam workings at SBX. The current conceptualisation of South Bates mining is that the mains at the north-eastern end of South Bates panels are required to be dry while any South Bates mining is progressing. This effectively limits the ability for groundwater to recover across the whole South Bates area, and justifies keeping the drain cells active across the whole mine area.

Total inflow values for 2020 (SLR, 2020) are simulated to occur at a rate of 73 ML/yr, with inflow to Whybrow seam workings predicted to occur at a rate of 30 ML/yr. These values are indicative of inflows to the South Bates underground associated with long-term average rainfall conditions. Simulated (73 ML) underground inflow estimates are below the 474 ML/yr required to trigger further investigation.

The water source for this groundwater is the Sydney Basin - North Coast Groundwater Source of the North Coast Fractured and Porous Rock Groundwater Sources - Water Sharing Plan, of which WCPL hold 1,647 units.

8 Independent Environmental Audit

In September 2017 an Independent Environmental Audit against Development Consents DA 305-7-2003 and DA 177-8-2004 was conducted for the Department of Planning & Environment (DP&E). Two recommendations relating to groundwater inflows and seepage were made as follows:

- Schedule 4, Condition 25: Improvements could be made in terms of the overall site water management if specific groundwater inflows to the open cut via alluvium and Permian could be pumped and/or metered.
- Schedule 4, Condition 34: Consideration should be made to directly monitor the quality of groundwater seepage reporting to the underground and open cut workings.

Both recommendations have been considered in the 2020 review.

8.1 Schedule 4, Condition 25

Due to the location of a spoil dump at the high wall near North Wambo Creek, the physical observation of seepage from the alluvium and Permian strata to the open cut is not feasible. Recent (SLR, 2020a) and scheduled model updates will be tailored to replicating groundwater conditions within and underlying the North Wambo Creek alluvium. This will provide reliable estimates of localised groundwater interception to the open cut.

8.2 Schedule 4, Condition 34

Attempts were made throughout 2020 to sample seepage from the active workings of SBU and SBX mine areas, in line with the Schedule 4, Condition 34 recommendation. However, no samples were able to be taken due to generally dry conditions within the underground. Regional depressurisation associated with historical and ongoing mining in the Wambo region, low rainfall from 2017 to 2019, and a lack of vertical connectivity between underground mine workings and strata recharged by above average rainfall in 2020 may be responsible for the dry underground conditions.

9 Conclusions

A summary of key findings from the review and analysis of WCPL groundwater data collected during 2020 is presented below:

- 2020 saw a return to above average rainfall conditions at Wambo and across most of NSW. This resulted in flow events occurring in ephemeral watercourses across site, and broad-scale recharge to shallow groundwater systems (**Section 3.1** and **Section 5**).
  - Only bores GW15 and P16 continue to exceed depth to water trigger levels, with other sites recovering to within the limits of baseline observations during 2020.
- New groundwater monitoring sites have been installed in key locations for the following purposes (**Section 4.1**):
  - Provide baseline/ pre-mining data in areas to be approached by WCPL mining activity.
  - Replace sites not constructed consistent with the *Minimum Construction Requirements for Water Bores In Australia (*ADIA, 2020), i.e. those screened across multiple aquifer units.
  - Replacement for monitoring sites as recommended in previous assessments.
- Further investigation is required to assess overall compliance with Performance Indicators. Groundwater exceedances may have occurred for trigger levels at GW15 and possible departures from model predictions at GW09 (**Section 5.5**).
  - Recommendations for further investigation at monitoring sites still exceeding trigger levels are presented below (**Section 10**) and in **Section 5.4**.
  - Recommendations for review of the SLR (2020a) model assumptions near GW09, to be addressed in model updates due for completion in mid-2021 is recommended in **Section 5.5**.
- The data quality assessment undertaken for WCPL VWPs will enable their ongoing inclusion in groundwater assessment work. Identifying arrays with failed/ poor quality sites will improve sampling efficiency (**Section 5.6.**).
- Groundwater model performance is consistent with previous Annual Review assessments. Generally good matches to absolute observed groundwater levels with improvements to be made in capturing vertical hydraulic gradients in deeper bores, and seasonality in shallower monitoring sites (**Section 6**).
- Predicted and inferred groundwater inflow volumes within limits of alluvial and rock water licences. Groundwater model updates will verify these predicted volumes under wetter climatic conditions for 2020 (**Section 7**).

10 Recommendations

- Paired P109 replacement is recommended for installation in 2021 to supplement data from both P109 and P106.
- Consider removing GW02 and GW11 from future revisions of the GWMP if pumping continues at both bores. A replacement monitoring bore may be useful in a nearby location.
- VWP locations identified with persistent poor-quality data should be removed from the monitoring network.
- As P202 and P206 are monitoring bores intersecting Permian strata, they should no longer be considered against GWL triggers.
- Top of Casing and ground elevation should be surveyed at recently installed standpipe monitoring bores (GW08.2, GW09.2, GW10.2(a), P316(a,b,c), SW30).
- Text within the GWMP should be updated to consider P316a a Wambo Creek Alluvium bore.
- Text within the GWMP should be updated to consider P325a (SW30) a Wollombi Brook Alluvium bore.
- Investigation, as detailed in **Section 5.4.1** is recommended for GW15 to determine whether these bores are accurately representing the groundwater levels in their surrounding aquifers and whether low groundwater level observations are related to Wambo mining activity or the approaching Warkworth Open Cut.
- A review of trigger levels at P16 is recommended. This should consider model results from the South Wambo Boxcut Groundwater Assessment (HydroSimulations, 2016b).

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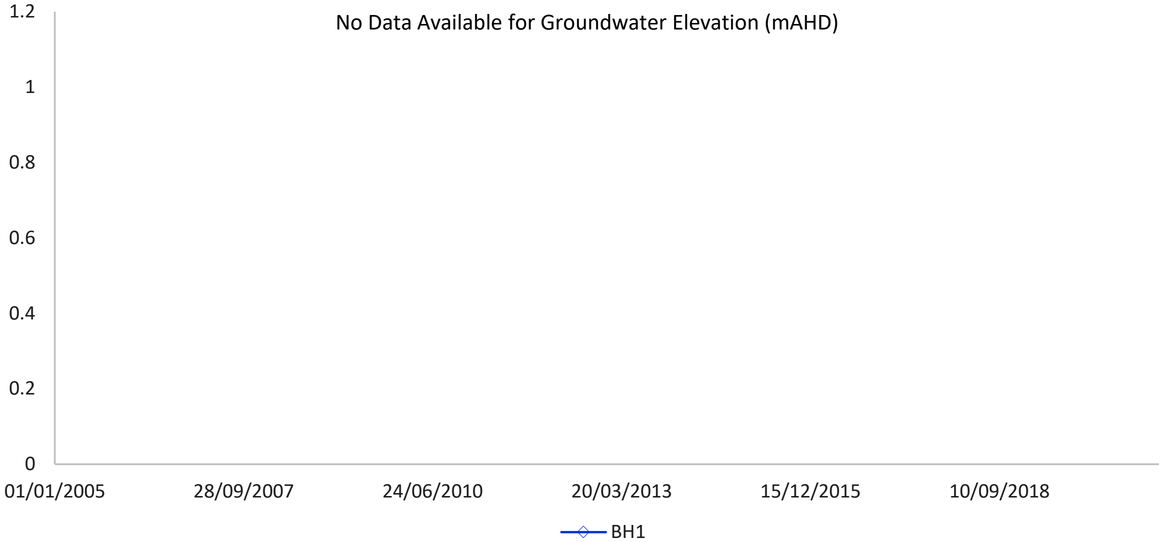
APPENDIX A

Groundwater Level and Groundwater Quality Graphs

BH1


No Data Available for Groundwater Elevation (mAHD)
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1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
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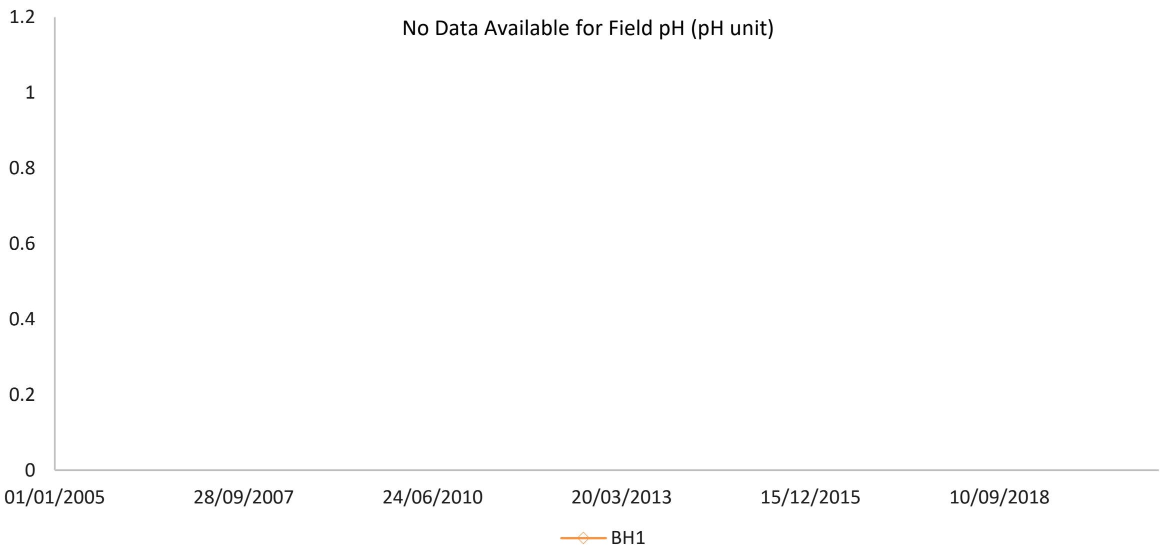
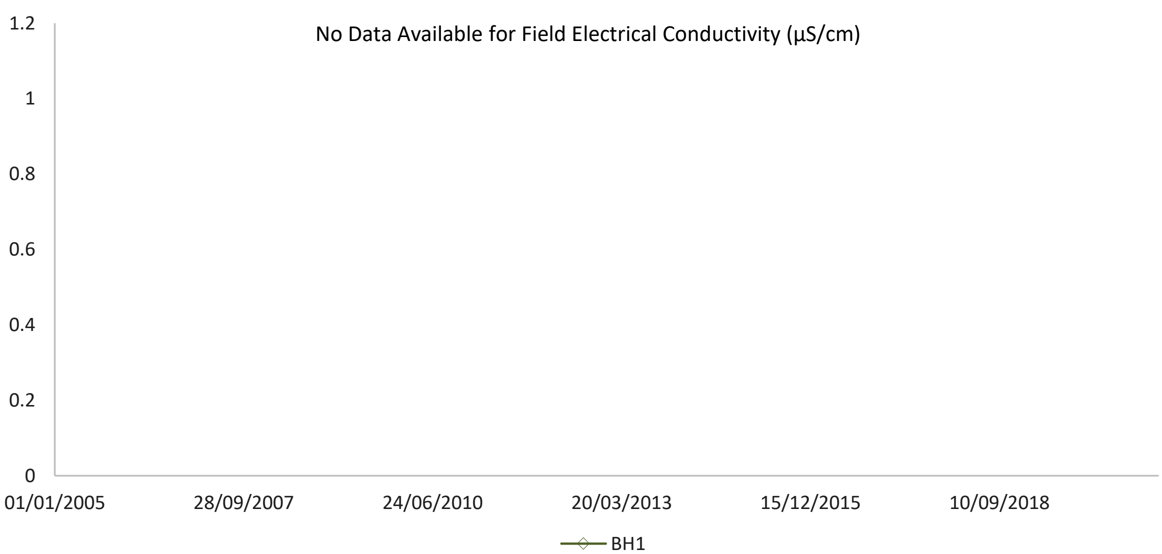
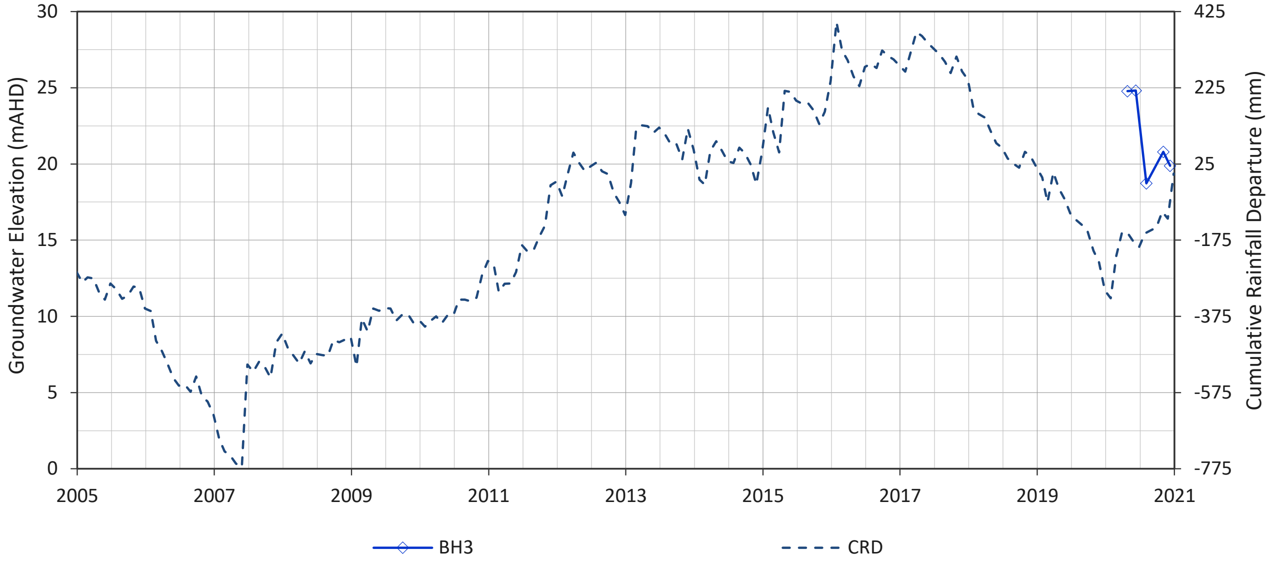
20/03/2013
15/12/2015
10/09/2018
BH1

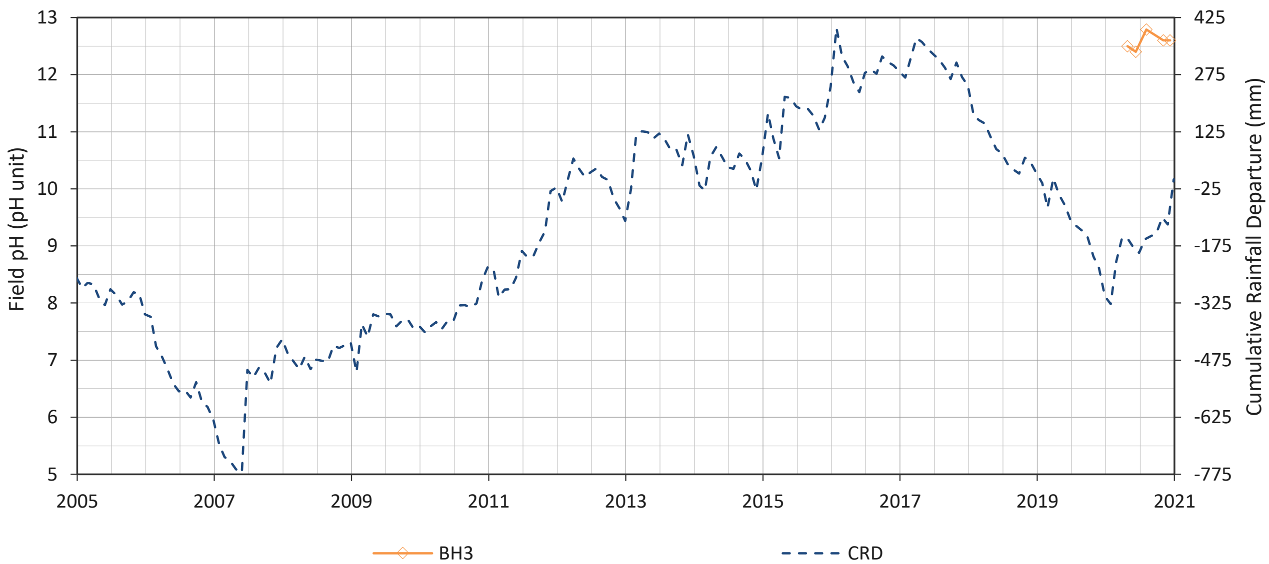

No Data Available for Field pH (pH unit)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
BH1


No Data Available for Field Electrical Conductivity (µS/cm)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
BH1

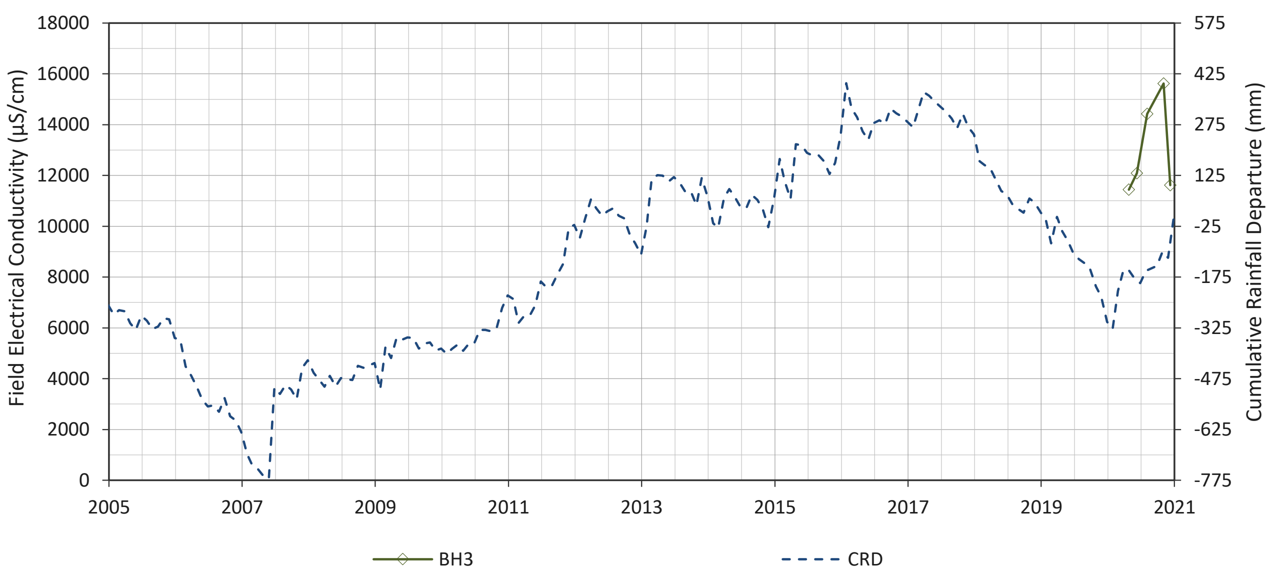
BH3



Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
30
25
20
15
10
5
0
425
225
25
-175
-375
-575
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
BH3
CRD

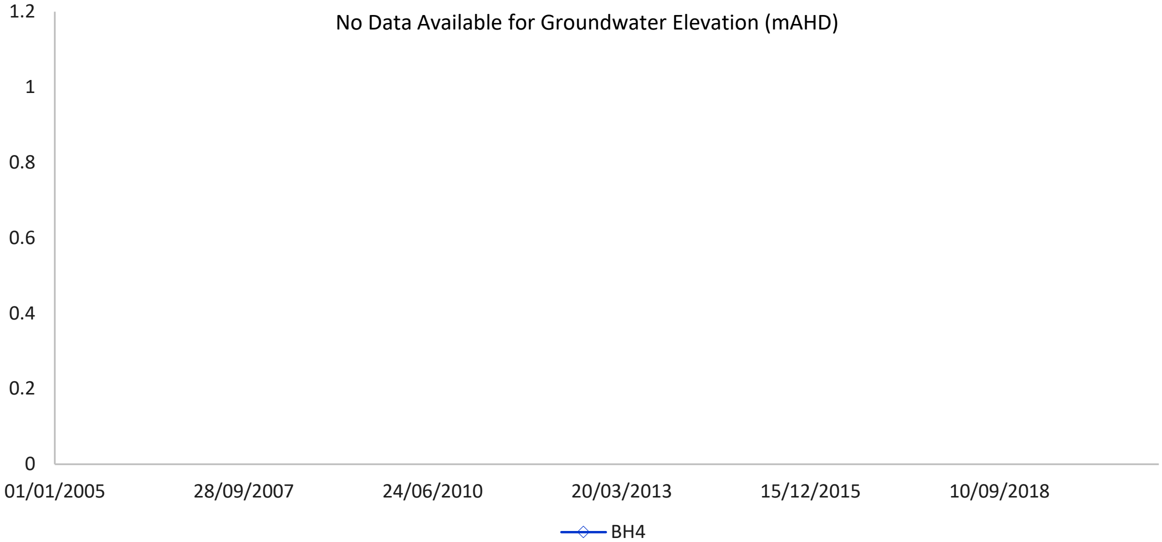


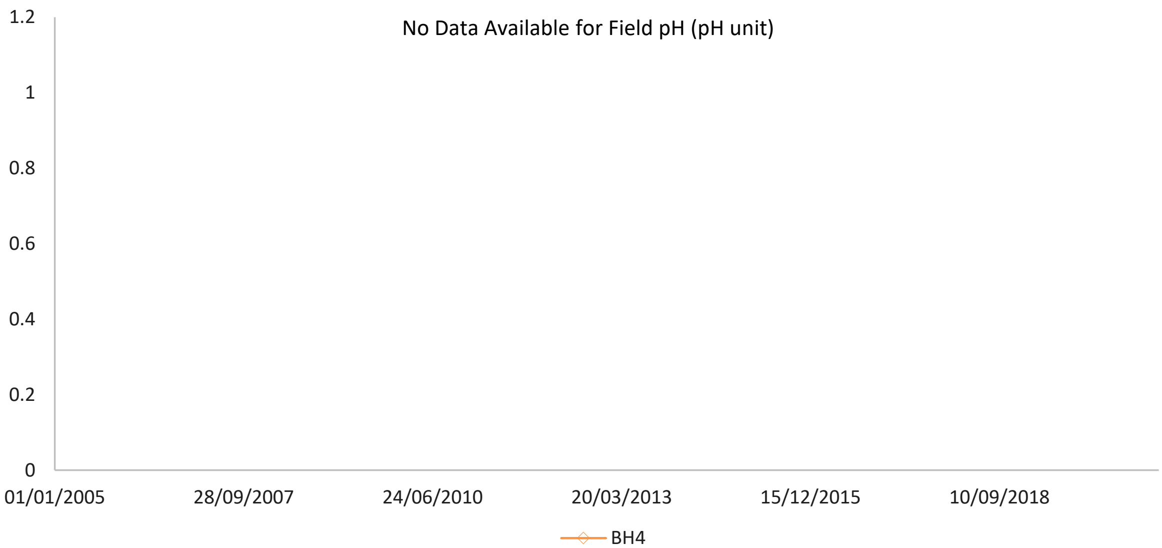
Field pH (pH unit)
Cumulative Rainfall Departure (mm)
13
12
11
10
9
8
7
6
5
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
BH3
CRD

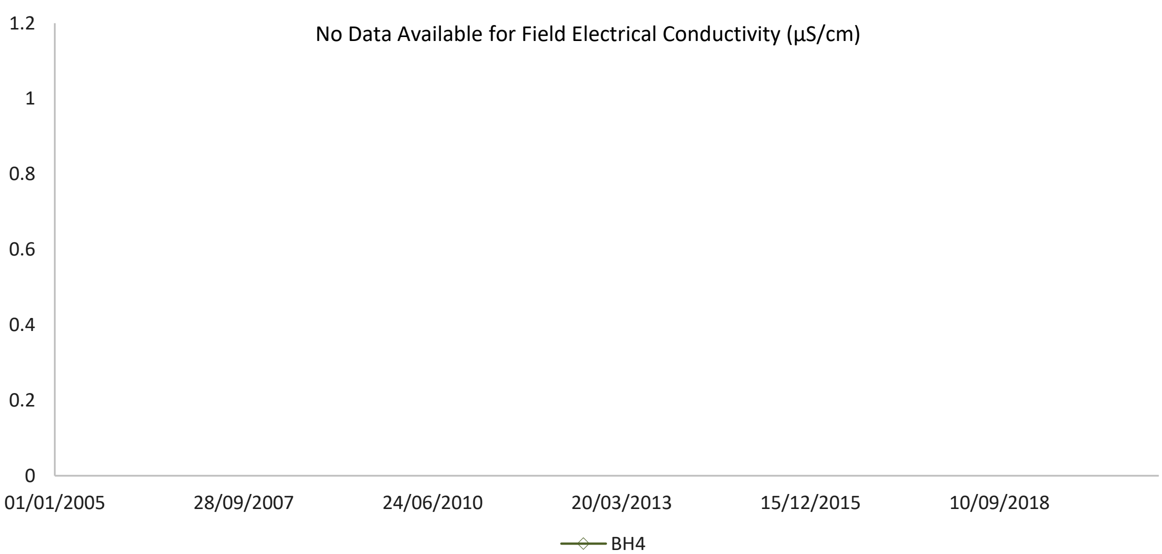


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
575
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
BH3
CRD

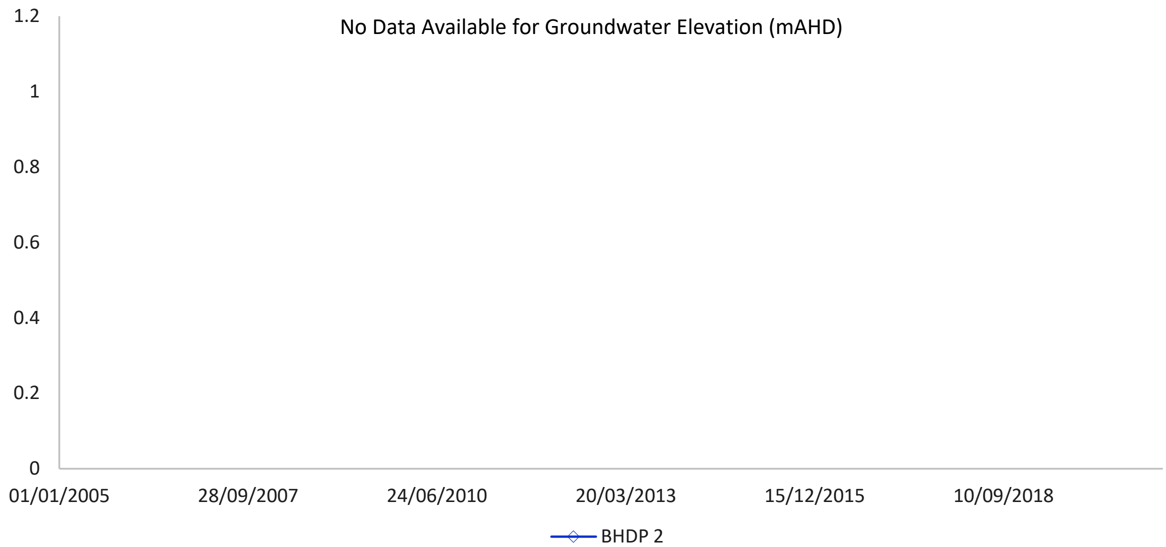
BH4

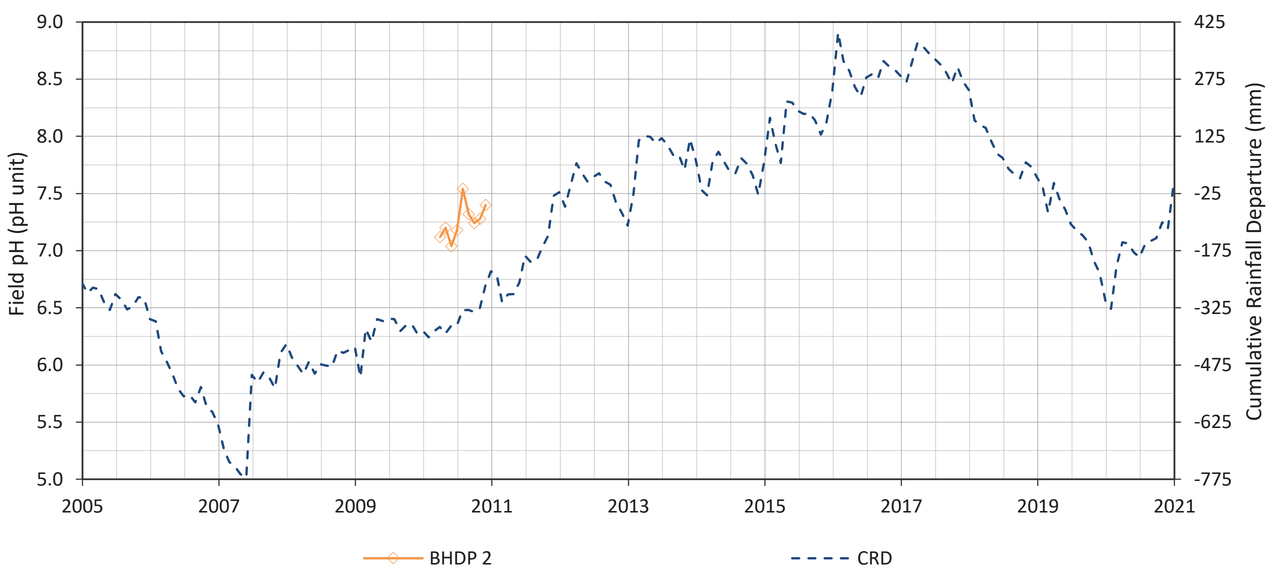

No Data Available for Groundwater Elevation (mAHD)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
BH4

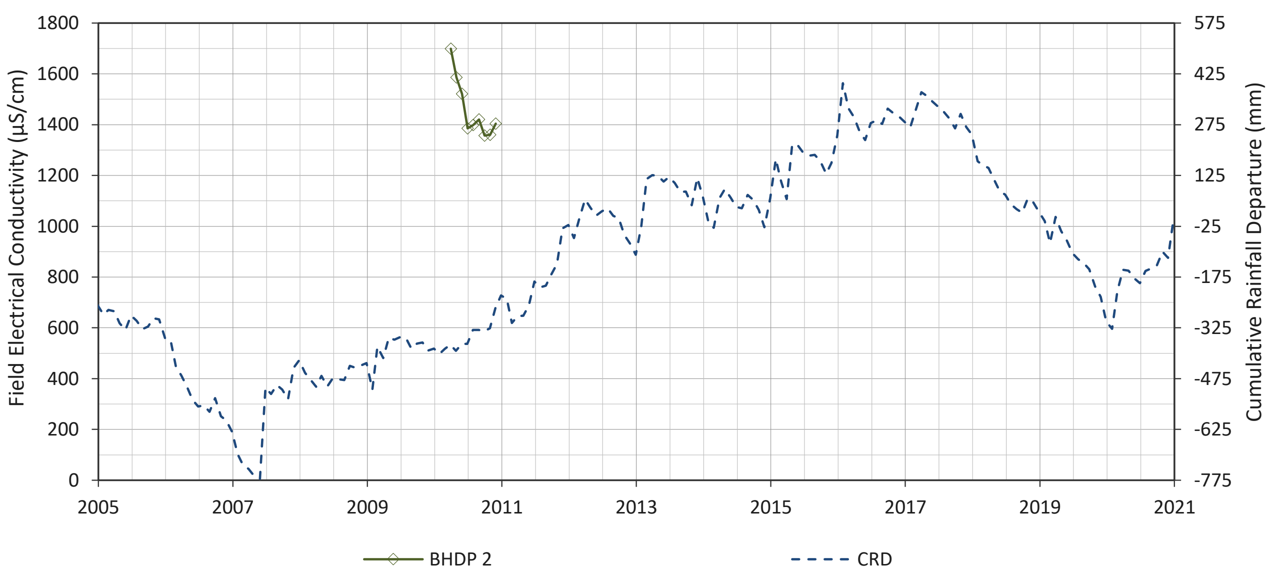

No Data Available for Field pH (pH unit)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
BH4


No Data Available for Field Electrical Conductivity (µS/cm)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
BH4

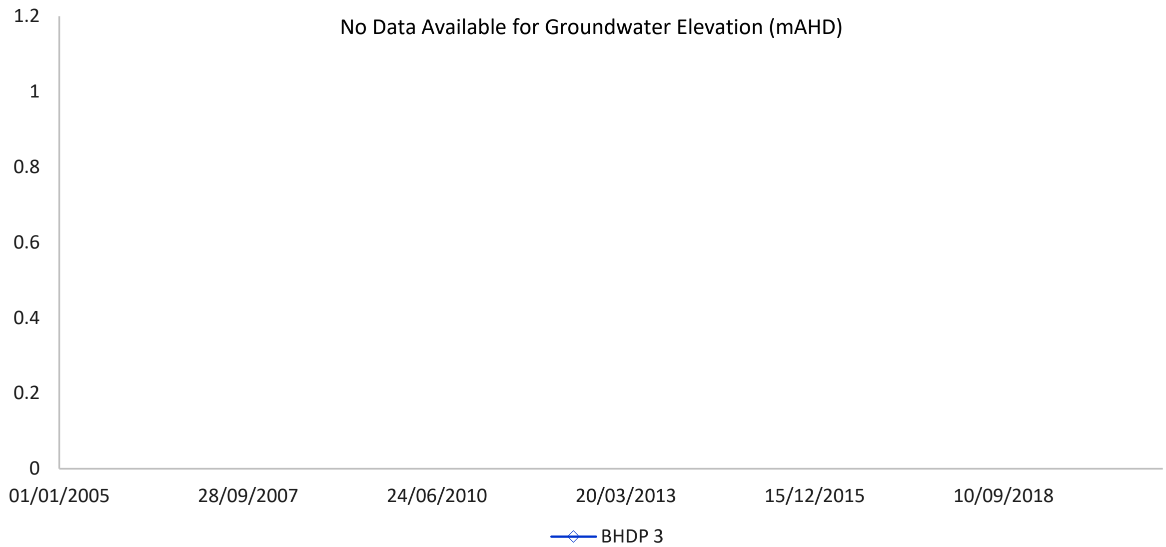
BHDP 2

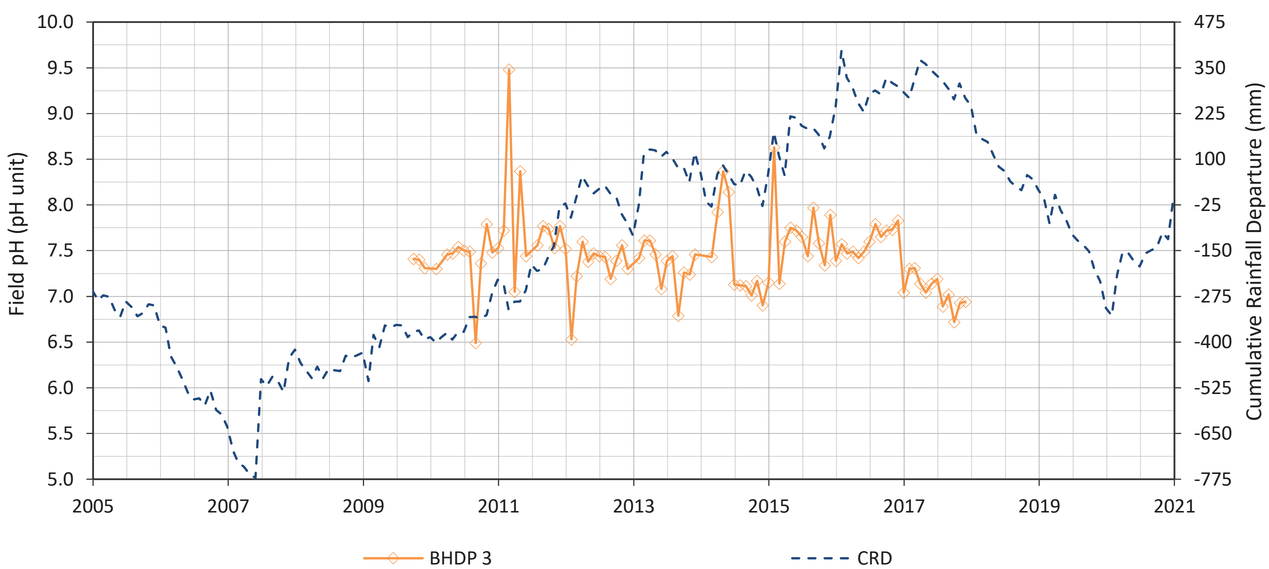

No Data Available for Groundwater Elevation (mAHD)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
BHDP 2

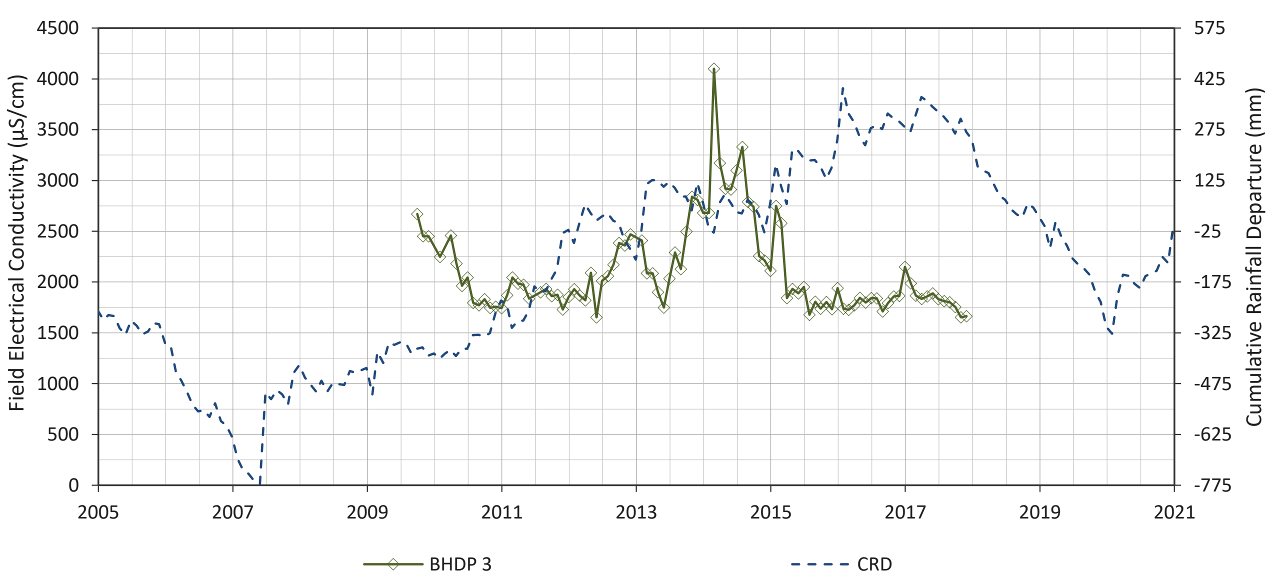

Field pH (pH unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
Cumulative Rainfall Departure (mm)
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
BHDP 2
CRD


Field Electrical Conductivity (µS/cm)
1800
1600
1400
1200
1000
800
600
400
200
0
Cumulative Rainfall Departure (mm)
575
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
BHDP 2
CRD

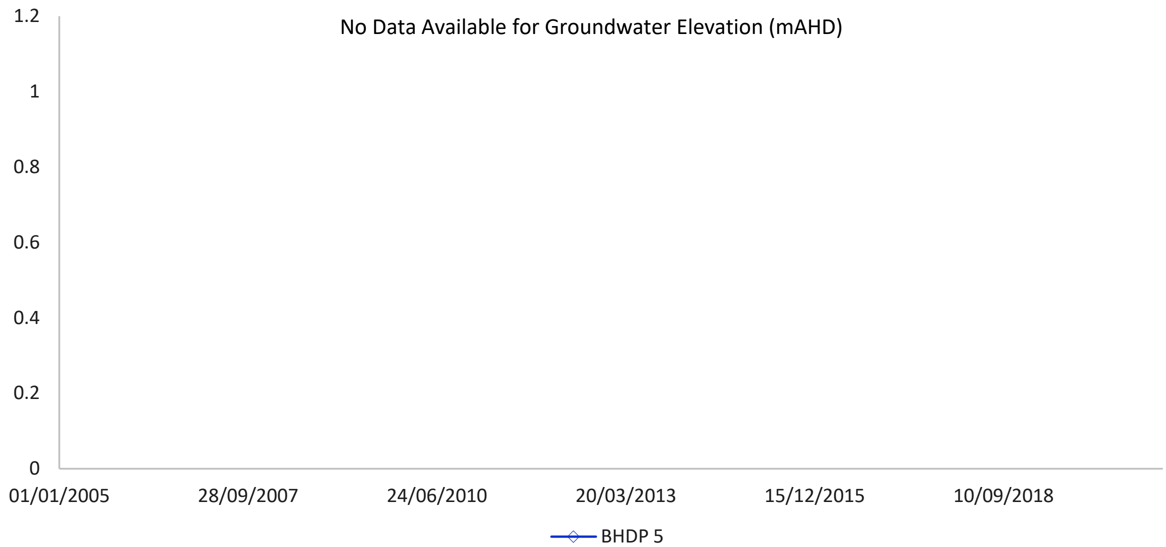
BHDP 3


No Data Available for Groundwater Elevation (mAHD)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
BHDP 3

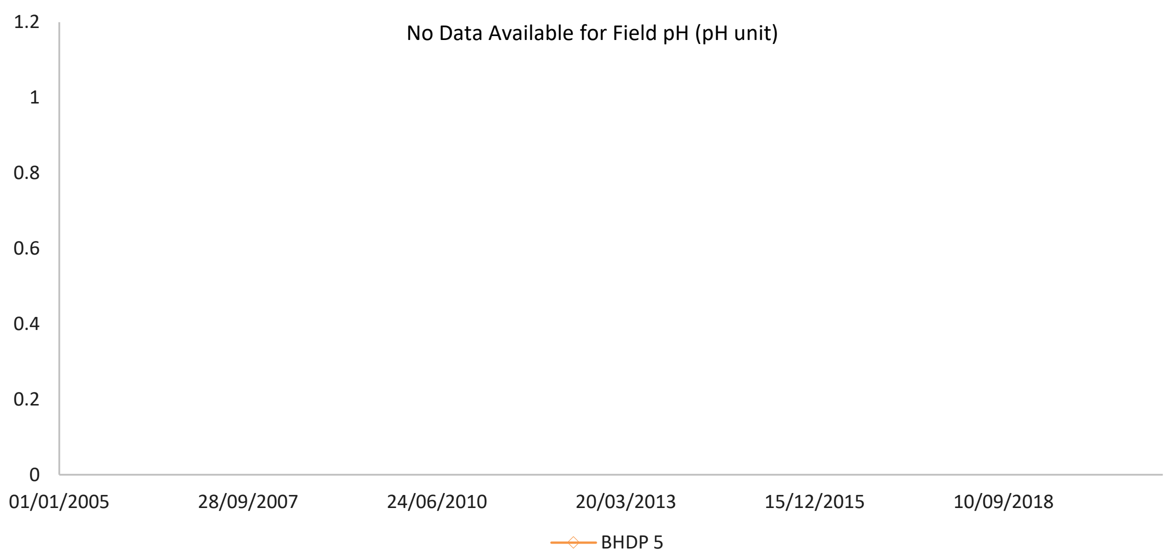

Field pH (pH unit)
Cumulative Rainfall Departure (mm)
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
475
350
225
100
-25
-150
-275
-400
-525
-650
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
BHDP 3
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
4500
4000
3500
3000
2500
2000
1500
1000
500
0
575
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
BHDP 3
CRD

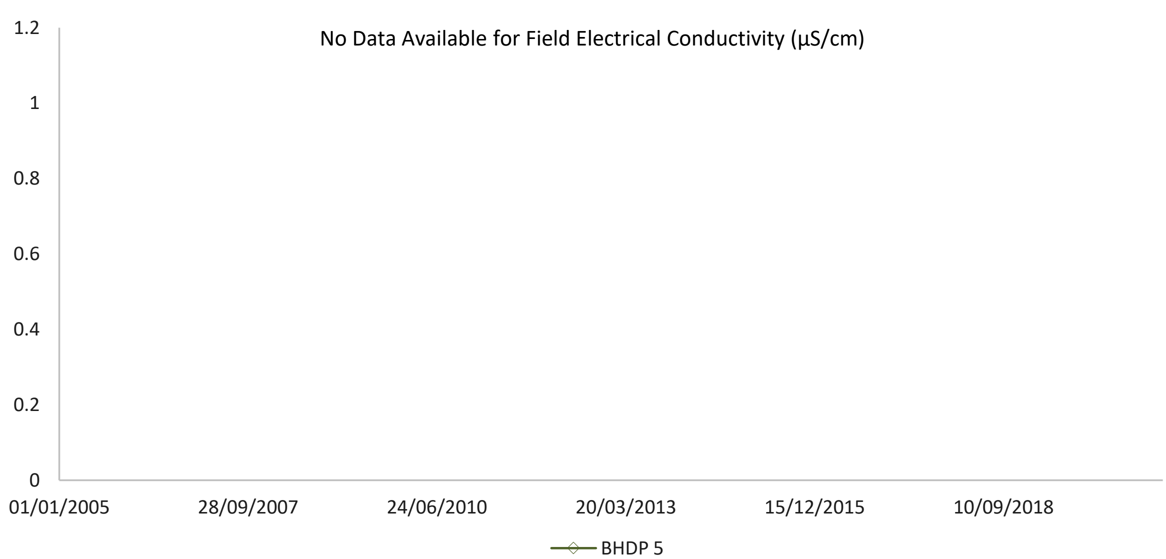
BHDP 5



No Data Available for Groundwater Elevation (mAHD)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
BHDP 5

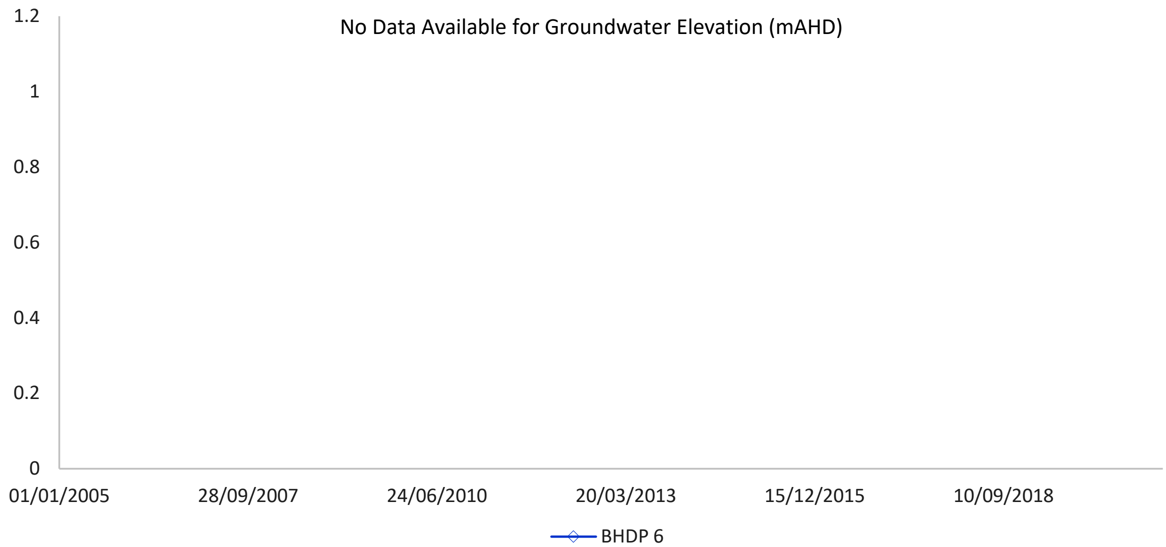


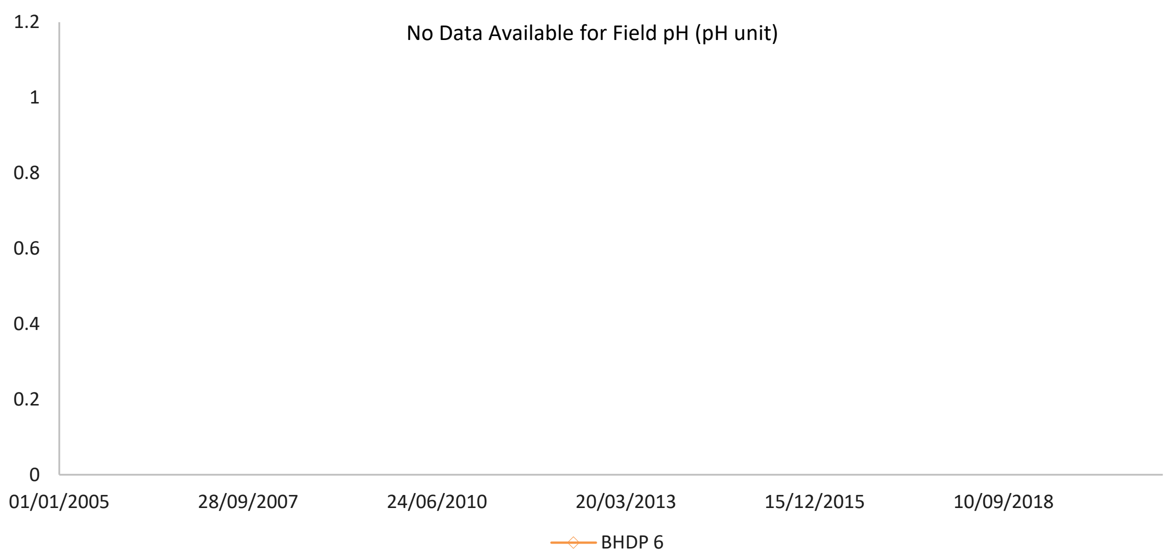
No Data Available for Field pH (pH unit)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
BHDP 5

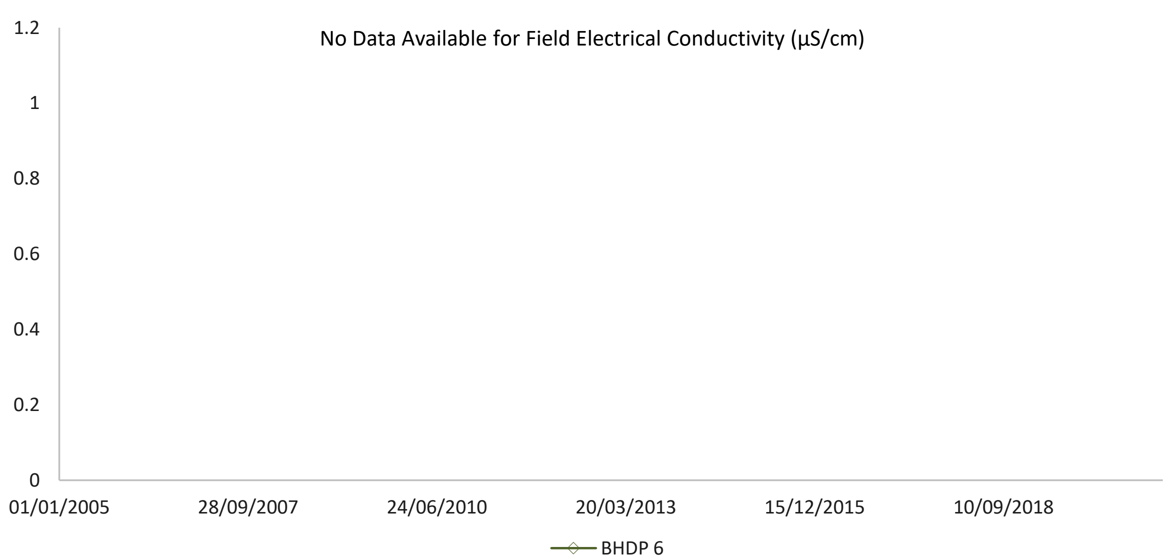


No Data Available for Field Electrical Conductivity (µS/cm)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
BHDP 5

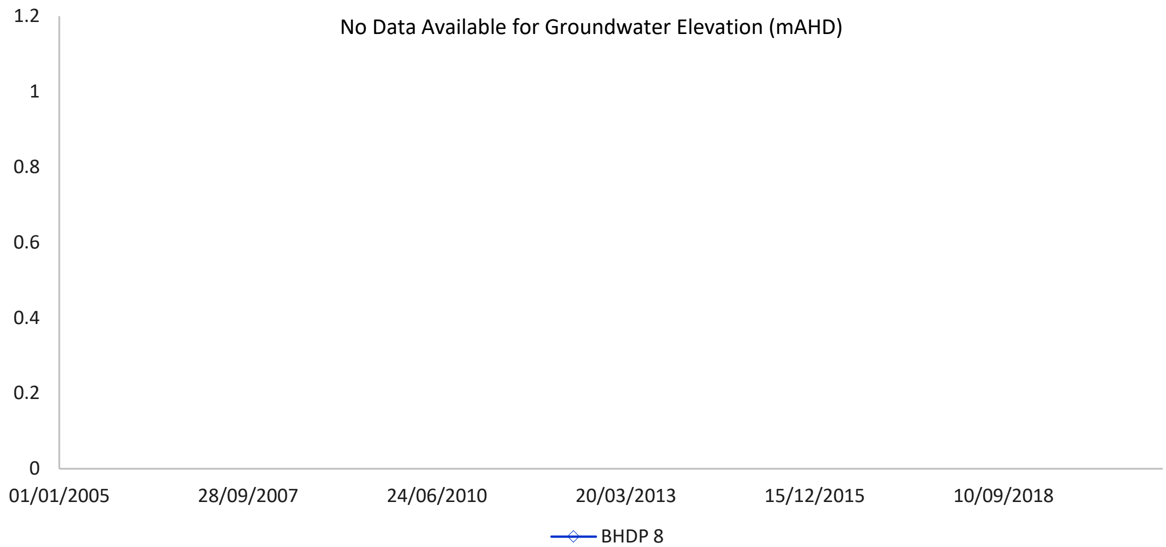
BHDP 6

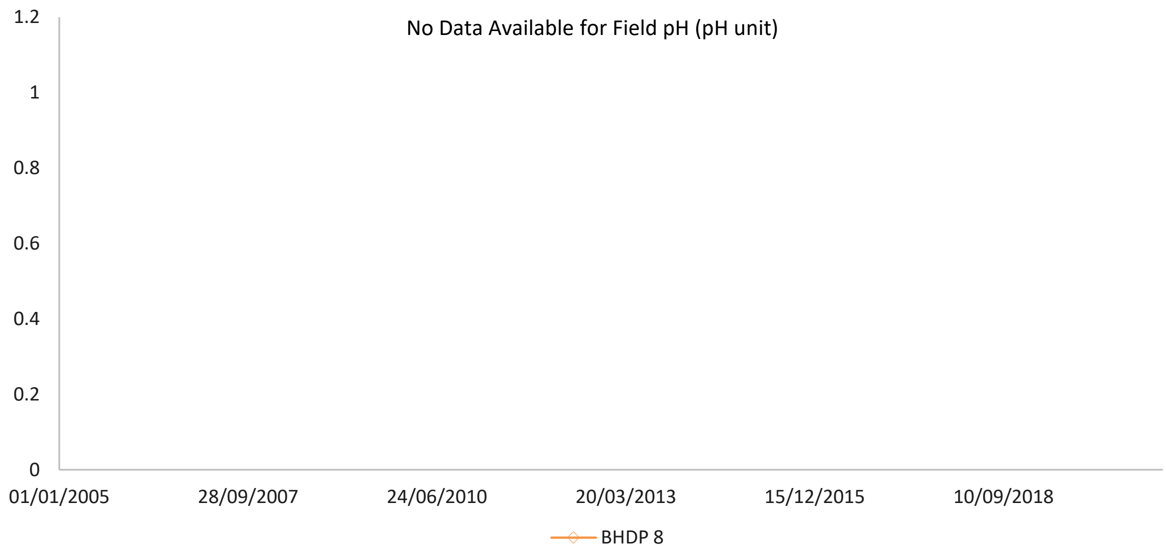

No Data Available for Groundwater Elevation (mAHD)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
BHDP 6

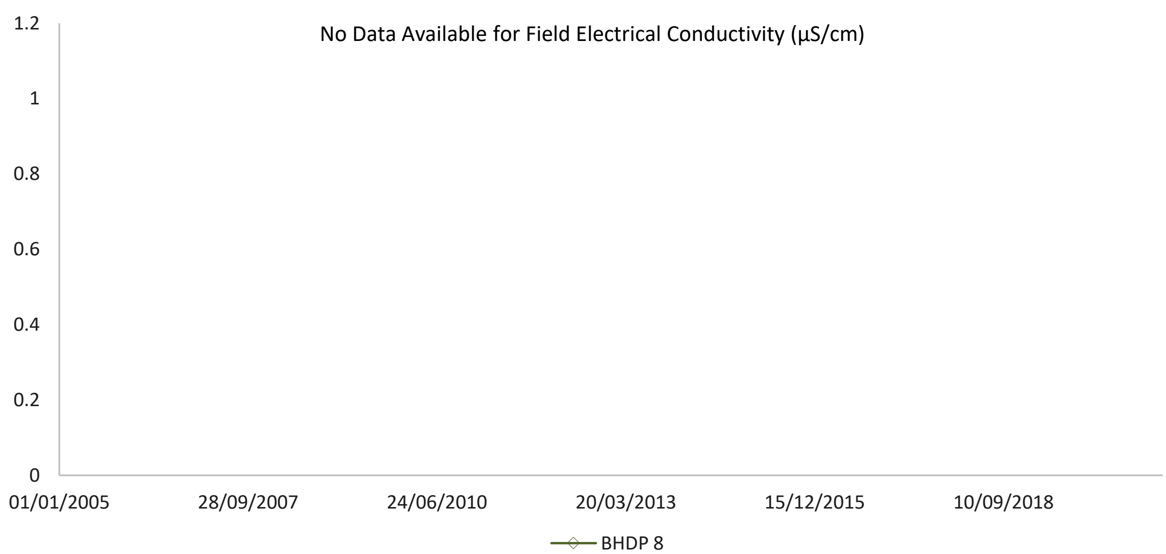

No Data Available for Field pH (pH unit)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
BHDP 6


No Data Available for Field Electrical Conductivity (µS/cm)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
BHDP 6

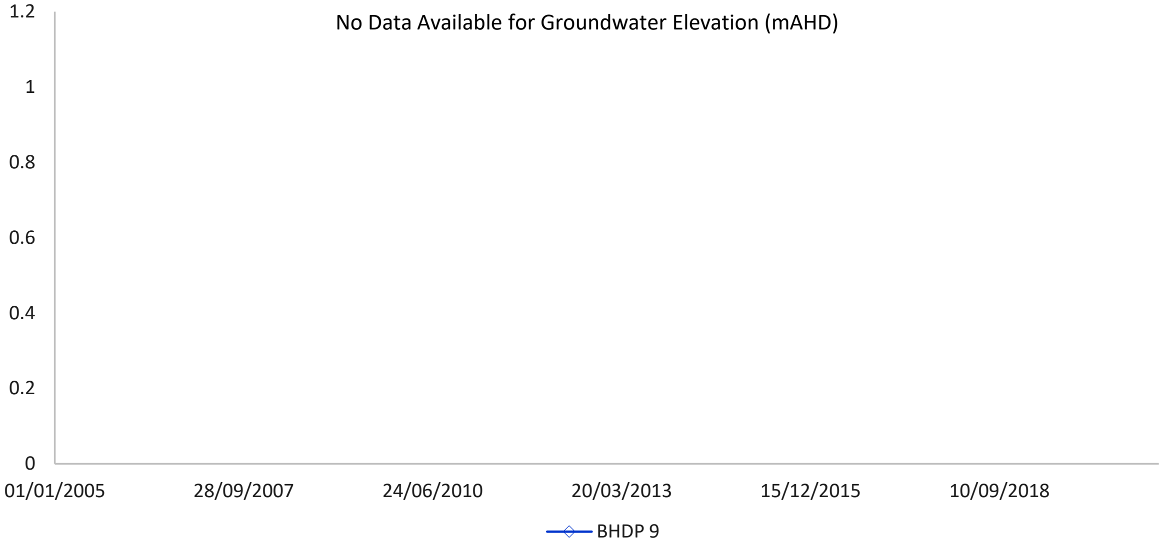
BHDP 8

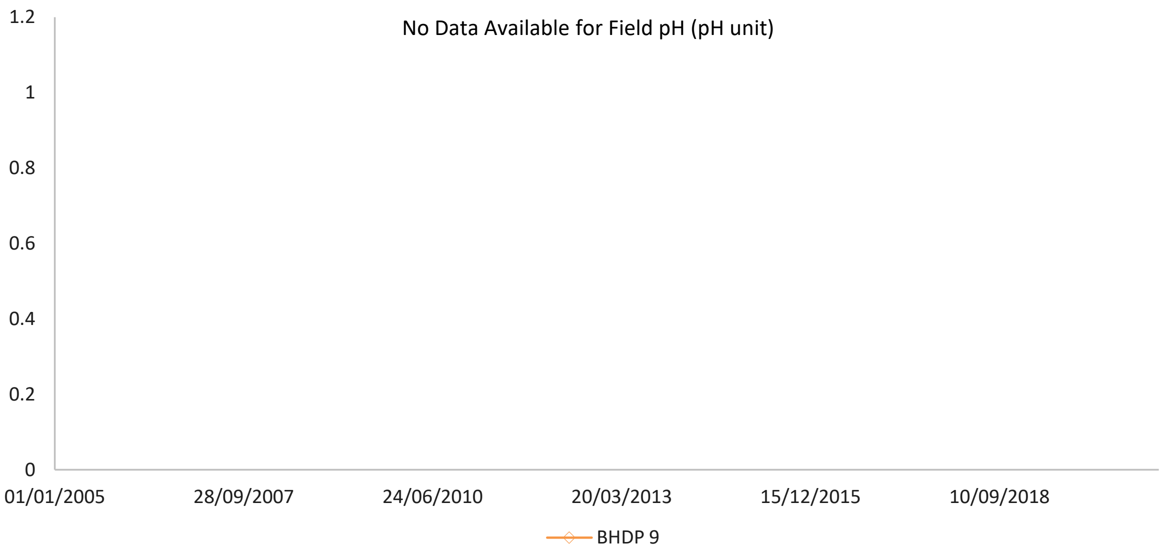

No Data Available for Groundwater Elevation (mAHD)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
BHDP 8

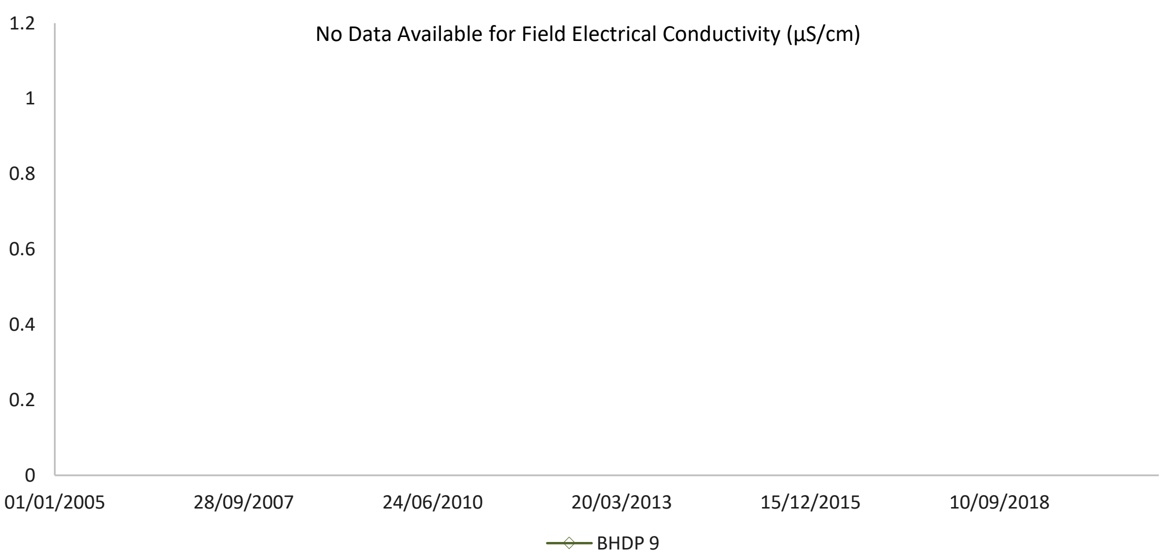

No Data Available for Field pH (pH unit)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
BHDP 8


No Data Available for Field Electrical Conductivity (µS/cm)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
BHDP 8

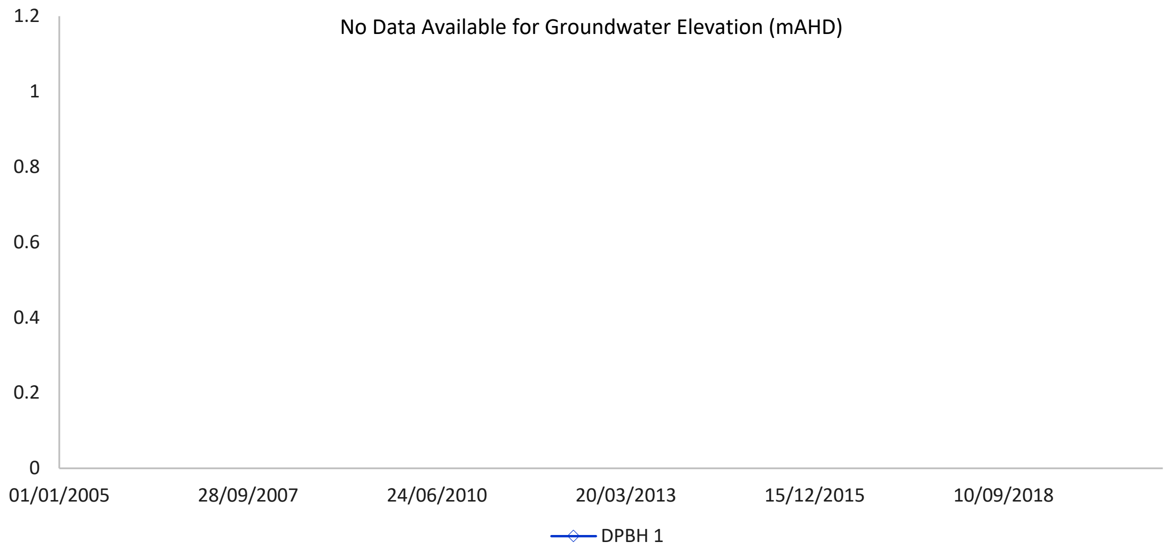
BHDP 9

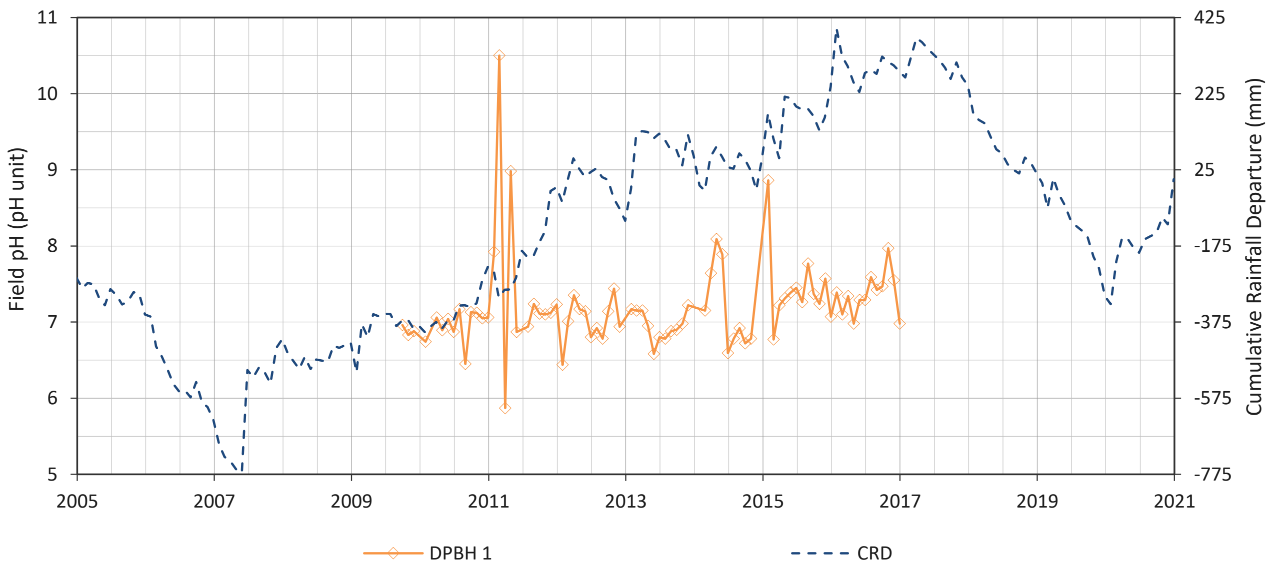

No Data Available for Groundwater Elevation (mAHD)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
BHDP 9

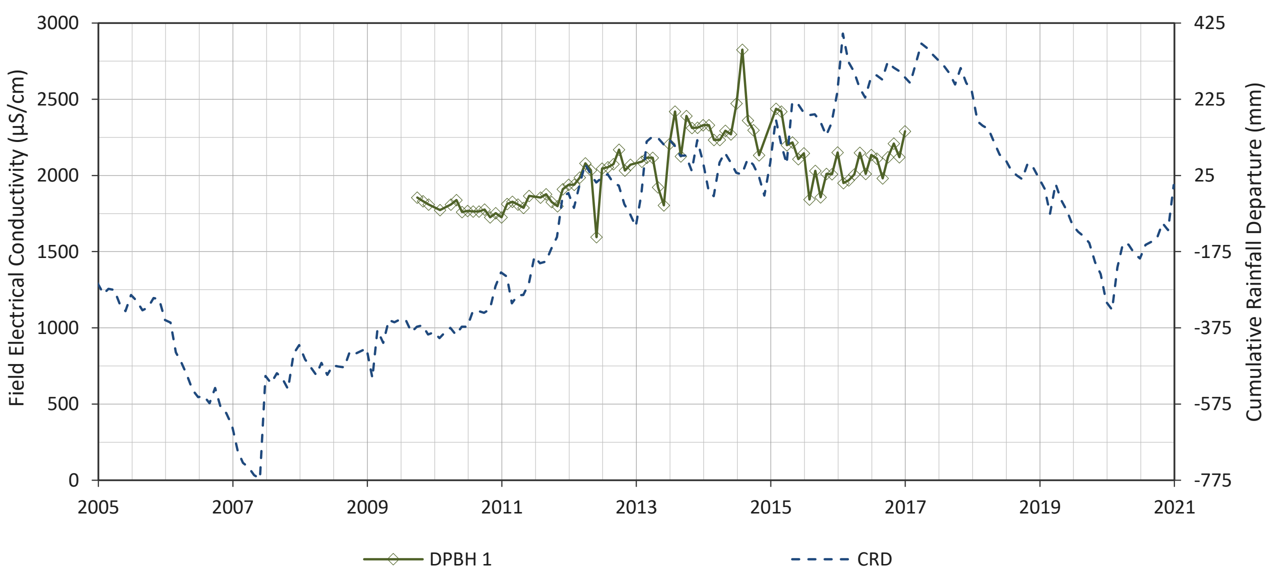

No Data Available for Field pH (pH unit)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
BHDP 9


No Data Available for Field Electrical Conductivity (µS/cm)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
BHDP 9

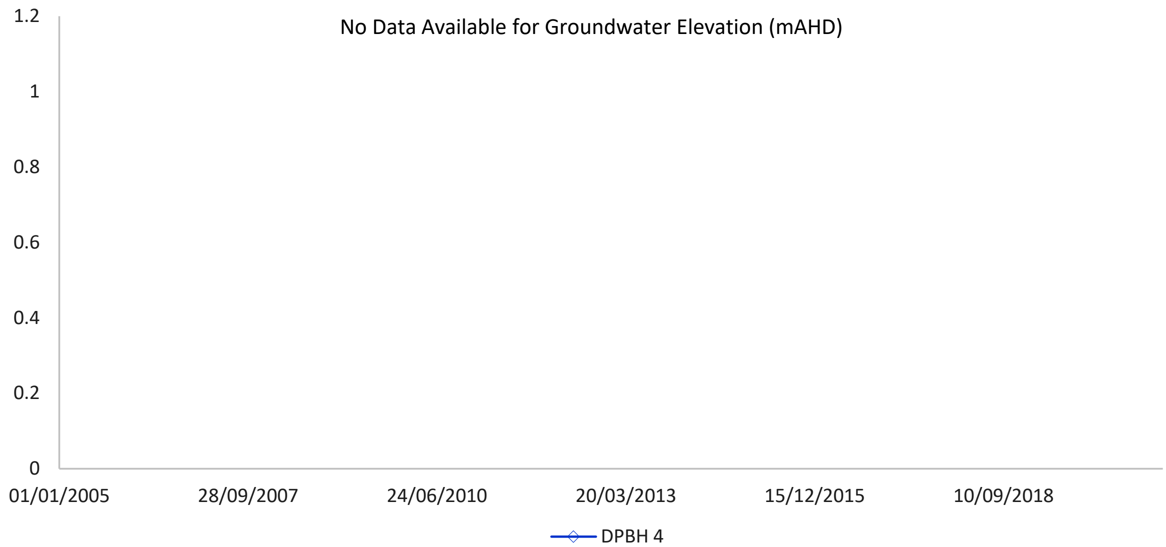
DPBH 1


No Data Available for Groundwater Elevation (mAHD)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
DPBH 1

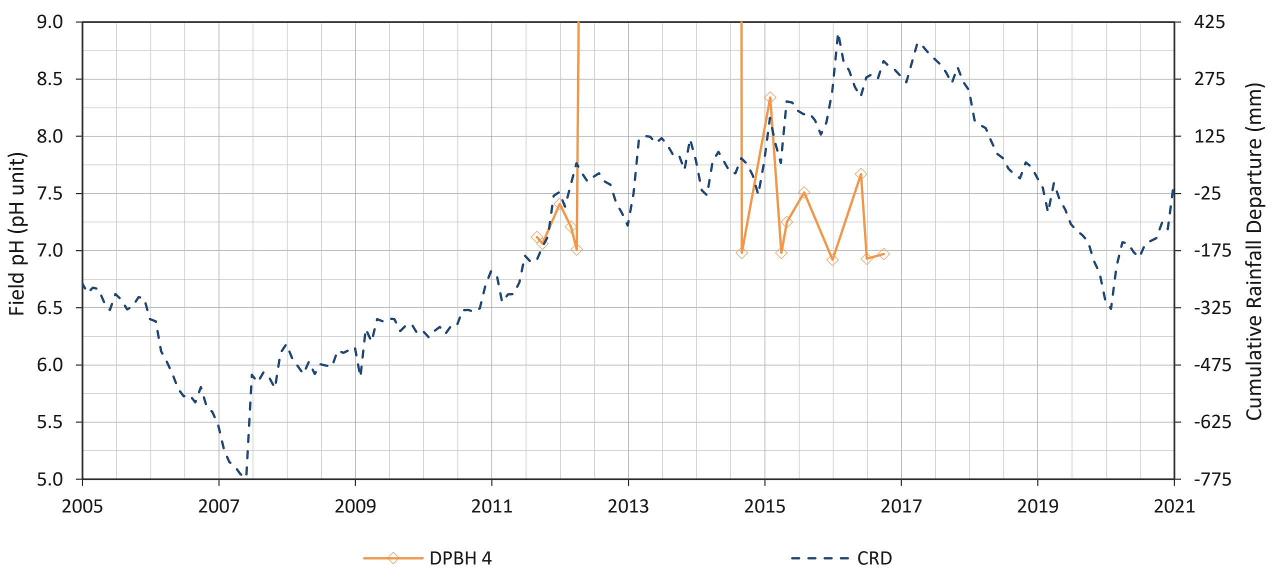

Field pH (pH unit)
Cumulative Rainfall Departure (mm)
11
10
9
8
7
6
5
425
225
25
-175
-375
-575
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
DPBH 1
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
3000
2500
2000
1500
1000
500
0
425
225
25
-175
-375
-575
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
DPBH 1
CRD

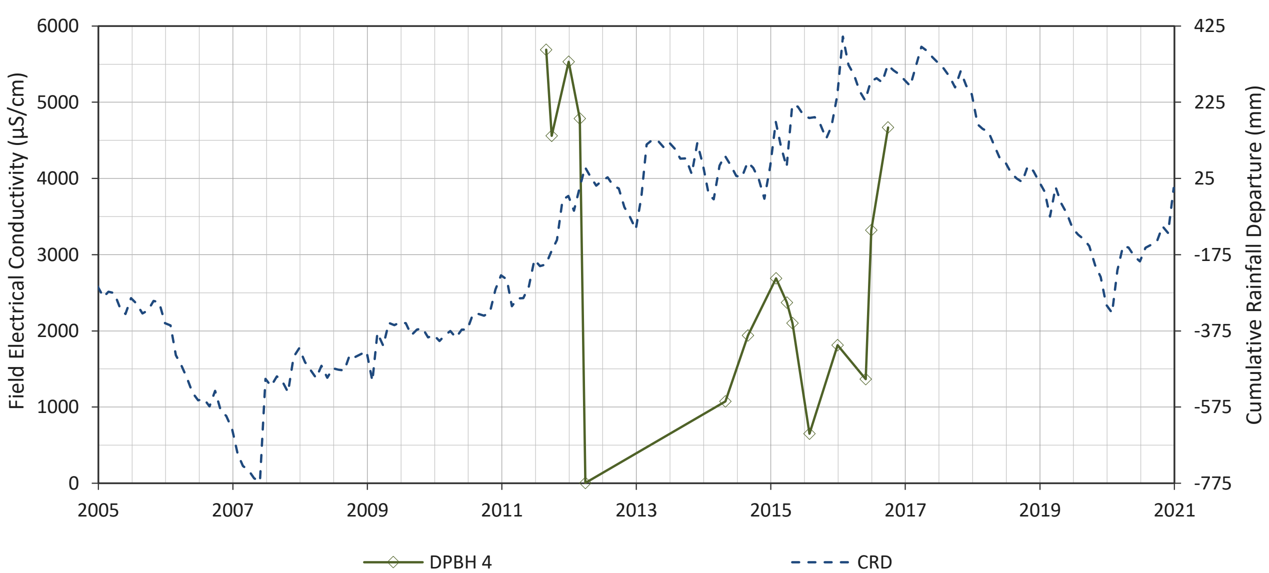
DPBH 4



No Data Available for Groundwater Elevation (mAHD)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
DPBH 4

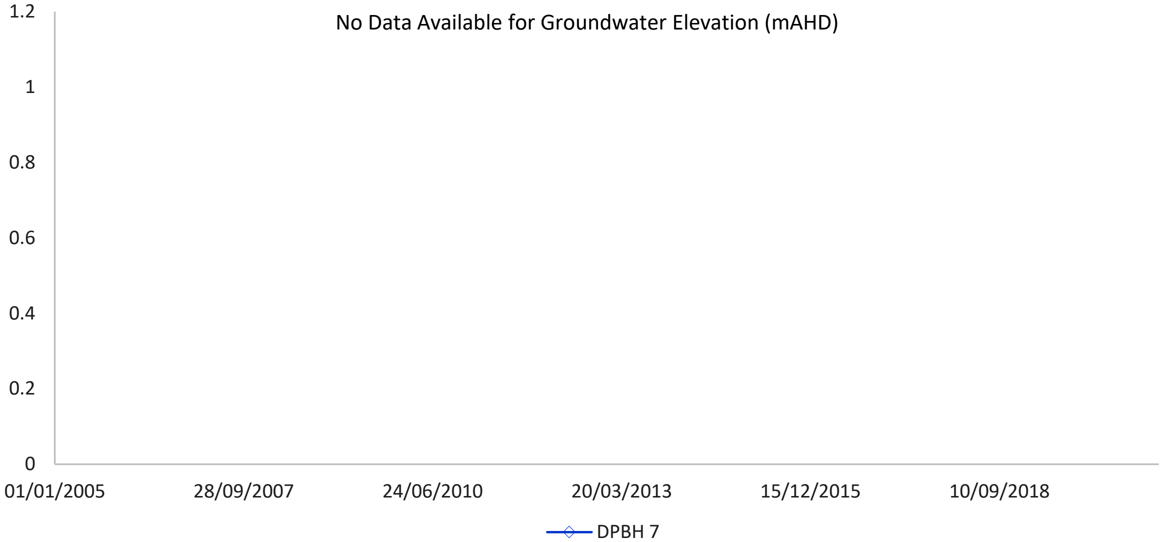


Field pH (pH unit)
Cumulative Rainfall Departure (mm)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
DPBH 4
CRD

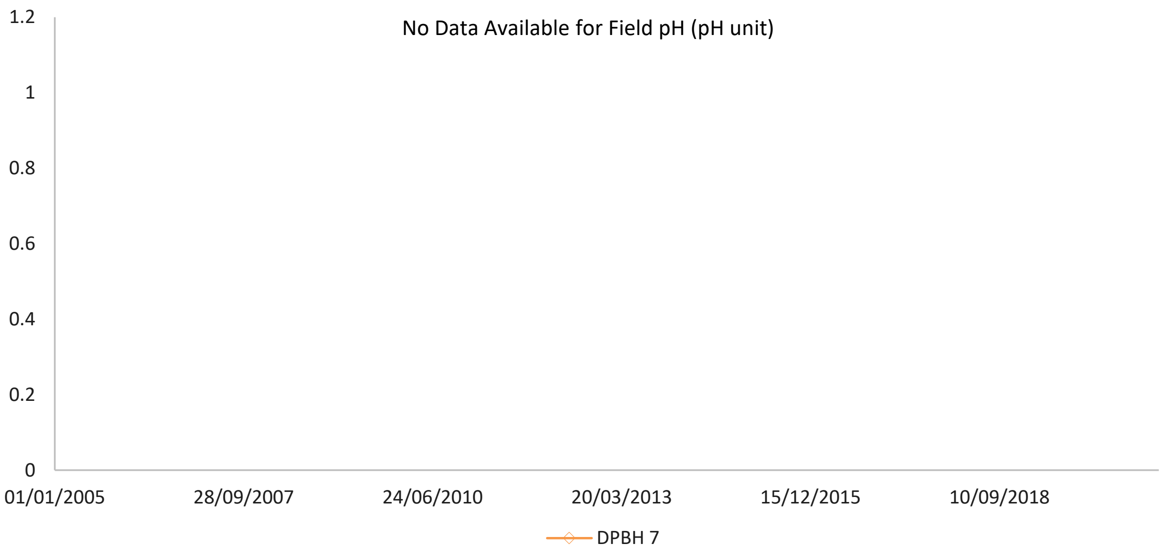


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
6000
5000
4000
3000
2000
1000
0
425
225
25
-175
-375
-575
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
DPBH 4
CRD

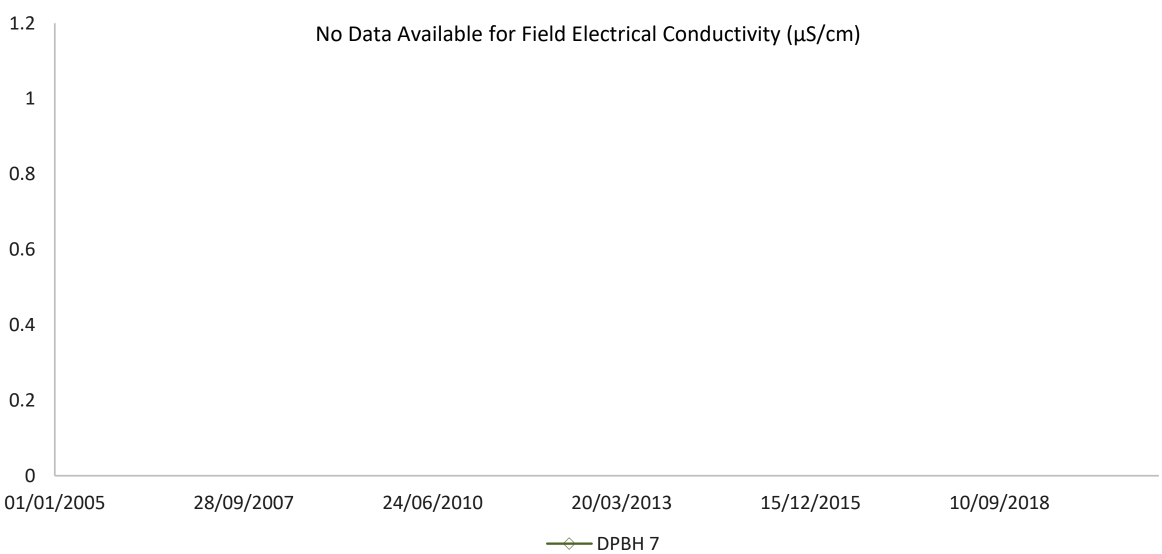
DPBH 7



No Data Available for Groundwater Elevation (mAHD)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
DPBH 7

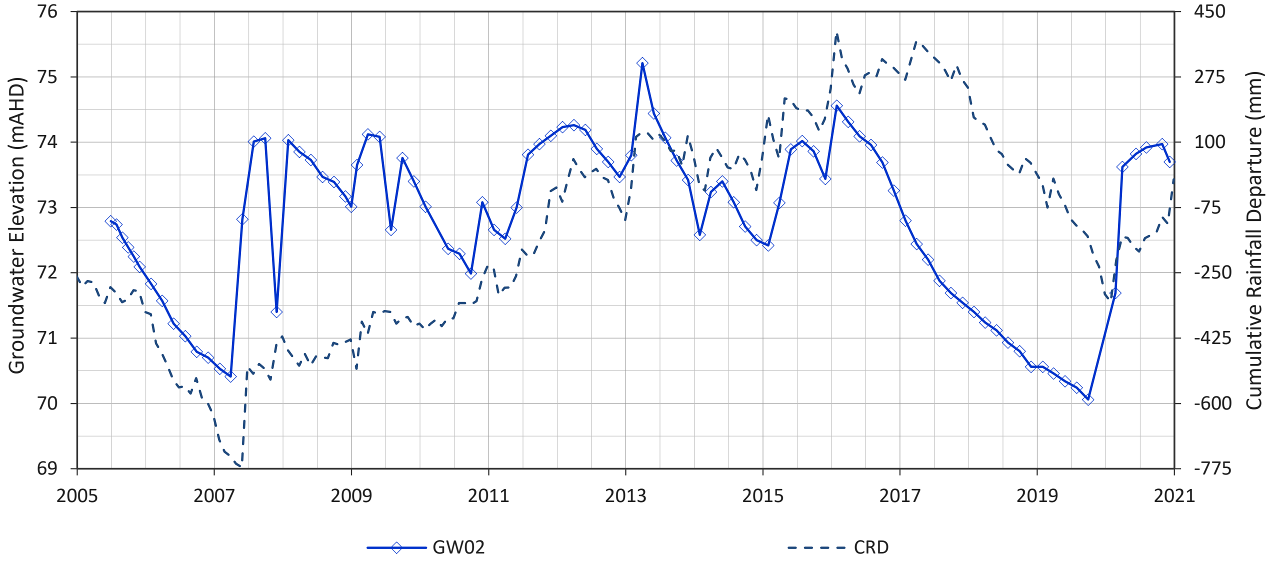


No Data Available for Field pH (pH unit)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
DPBH 7

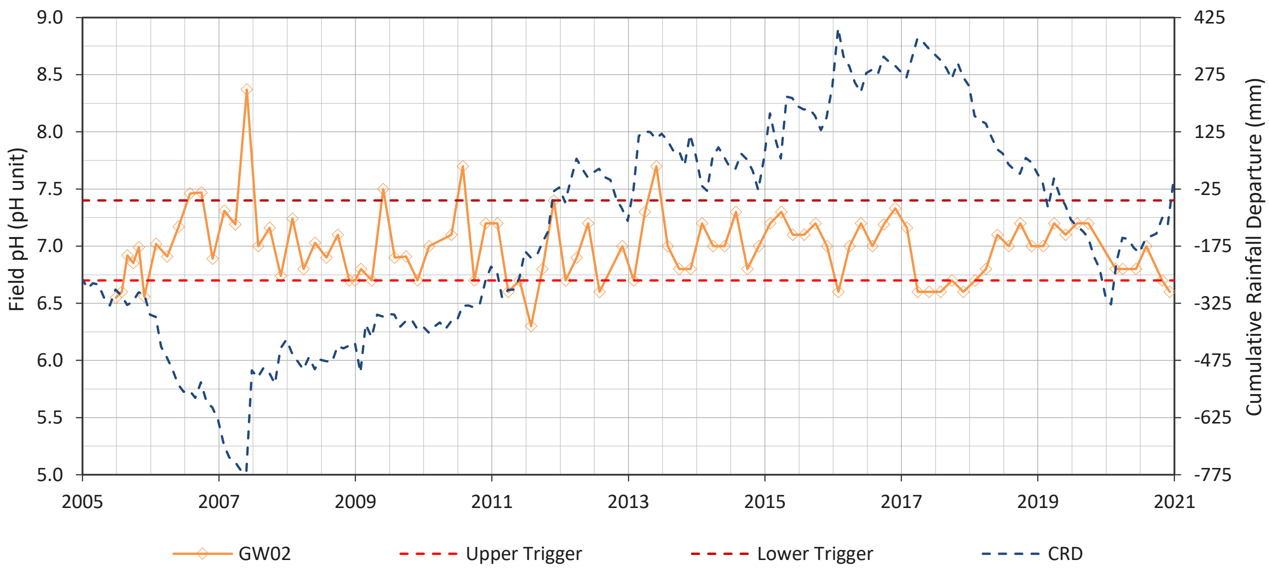


No Data Available for Field Electrical Conductivity (µS/cm)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
DPBH 7

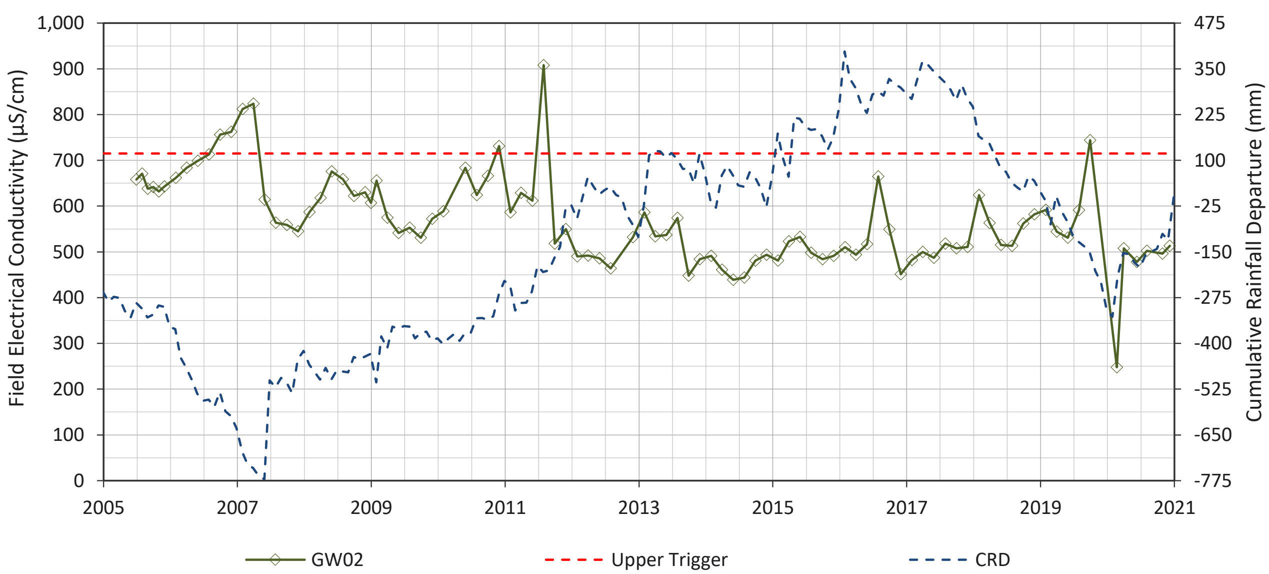
GW02



Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
76
75
74
73
72
71
70
69
450
275
100
-75
-250
-425
-600
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW02
CRD

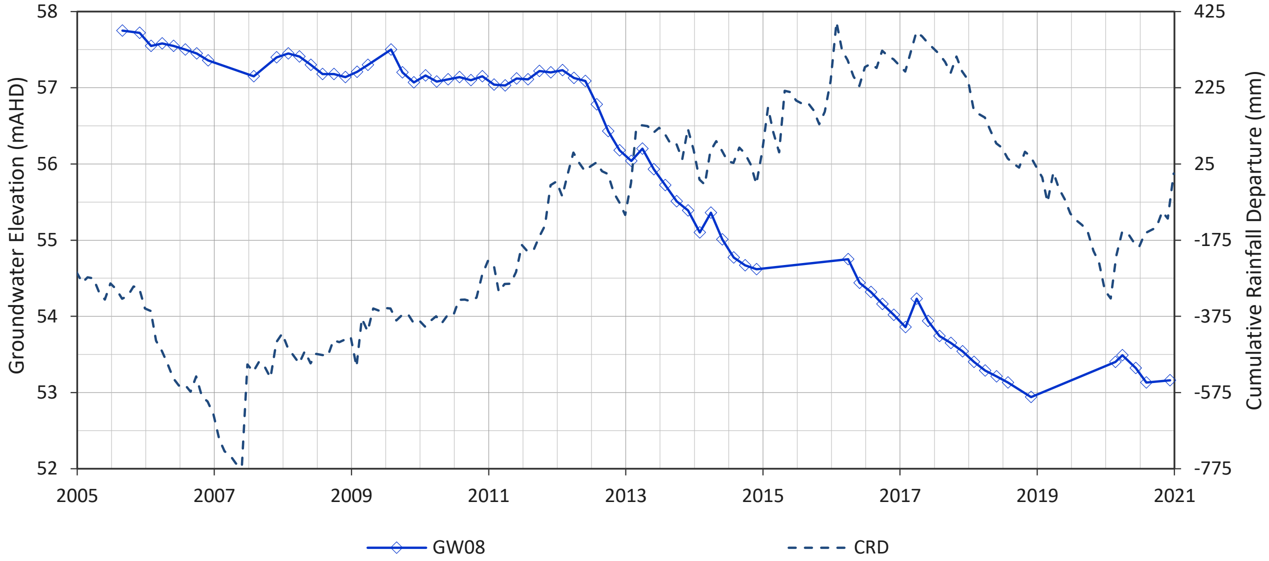


Field pH (pH unit)
Cumulative Rainfall Departure (mm)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW02
Upper Trigger
Lower Trigger
CRD

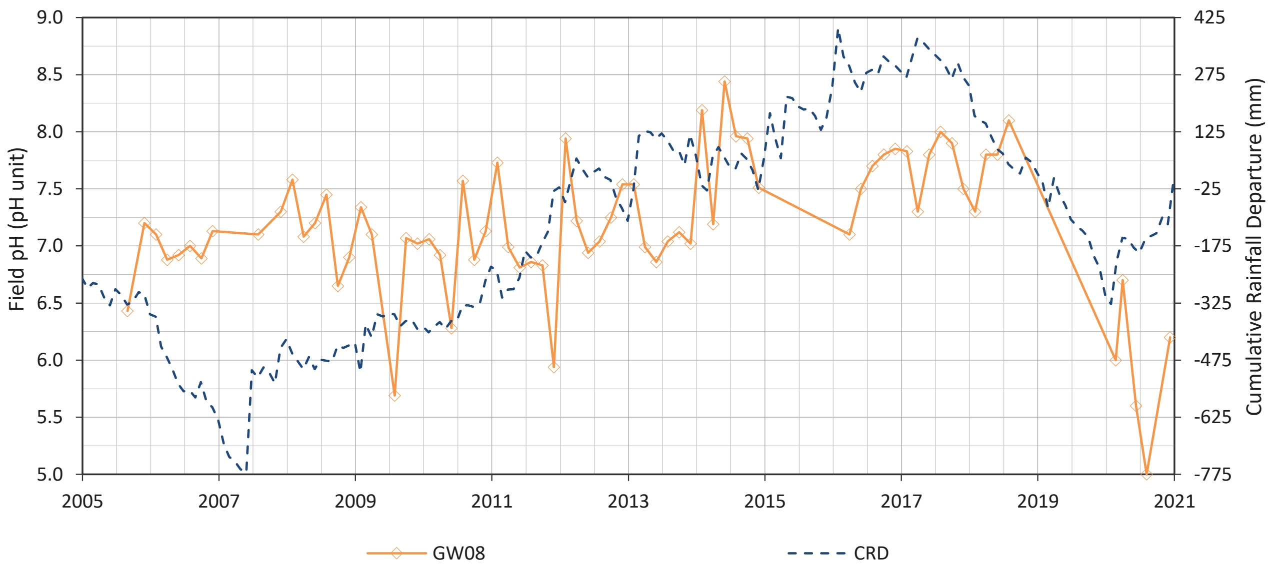


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
1,000
900
800
700
600
500
400
300
200
100
0
475
350
225
100
-25
-150
-275
-400
-525
-650
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW02
Upper Trigger
CRD

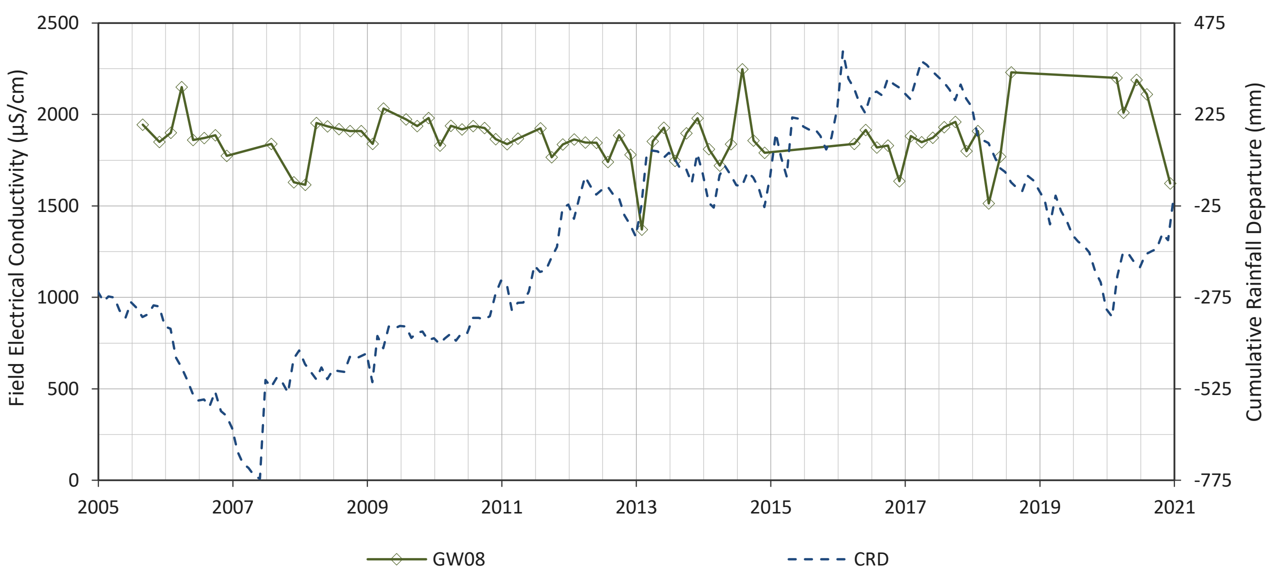
GW08



Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
58
57
56
55
54
53
52
425
225
25
-175
-375
-575
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW08
CRD

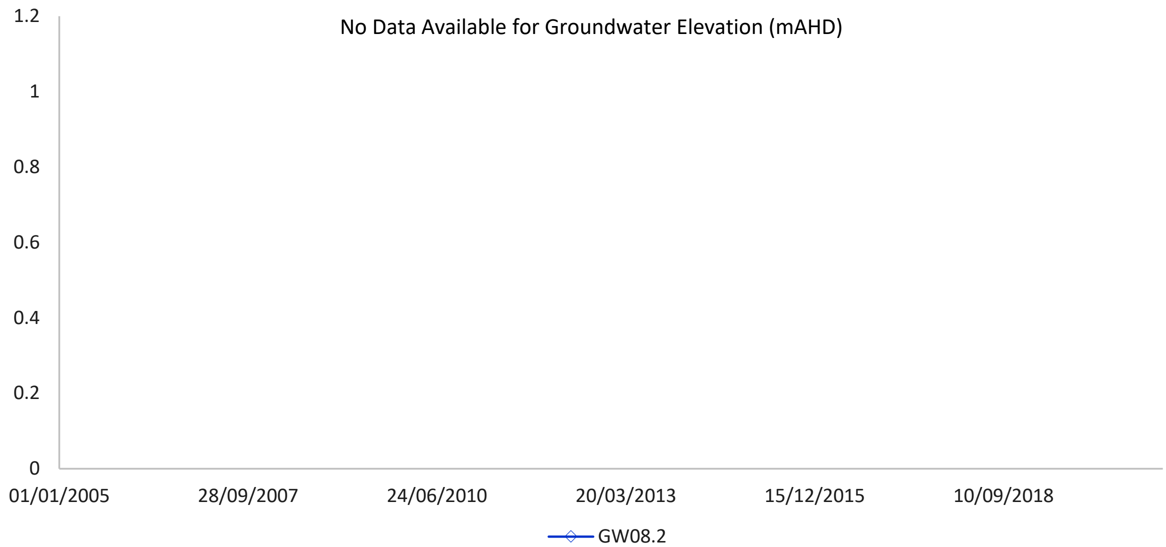


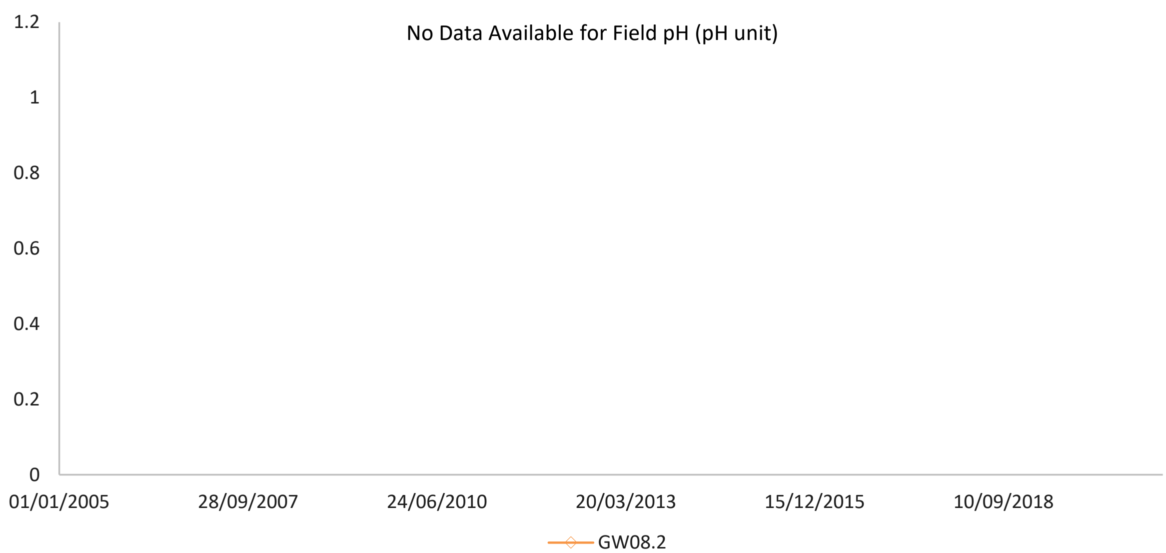
Field pH (pH unit)
Cumulative Rainfall Departure (mm)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW08
CRD

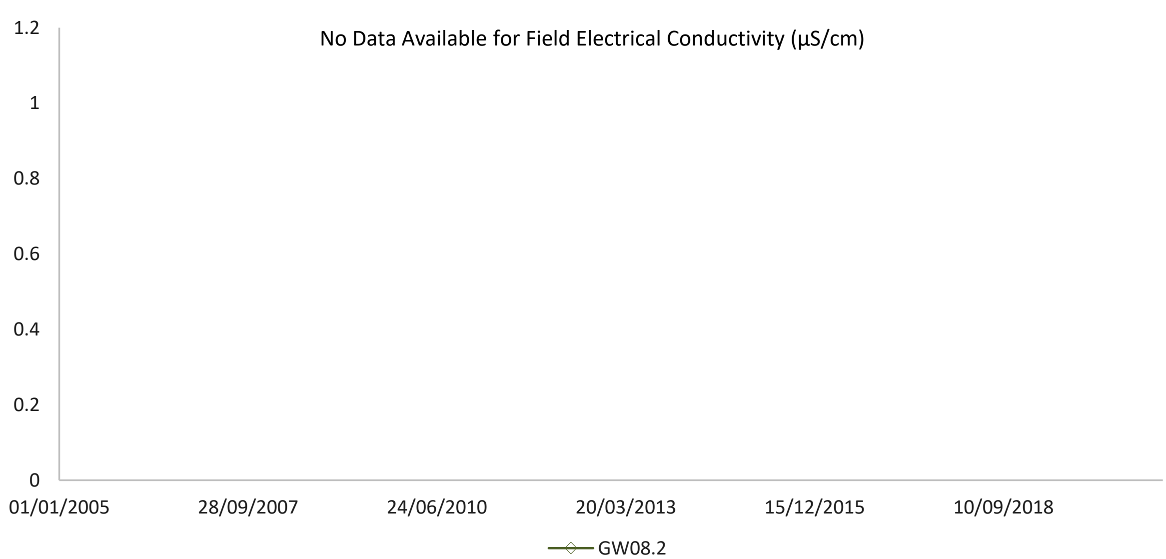


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
2500
2000
1500
1000
500
0
475
225
-25
-275
-525
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW08
CRD

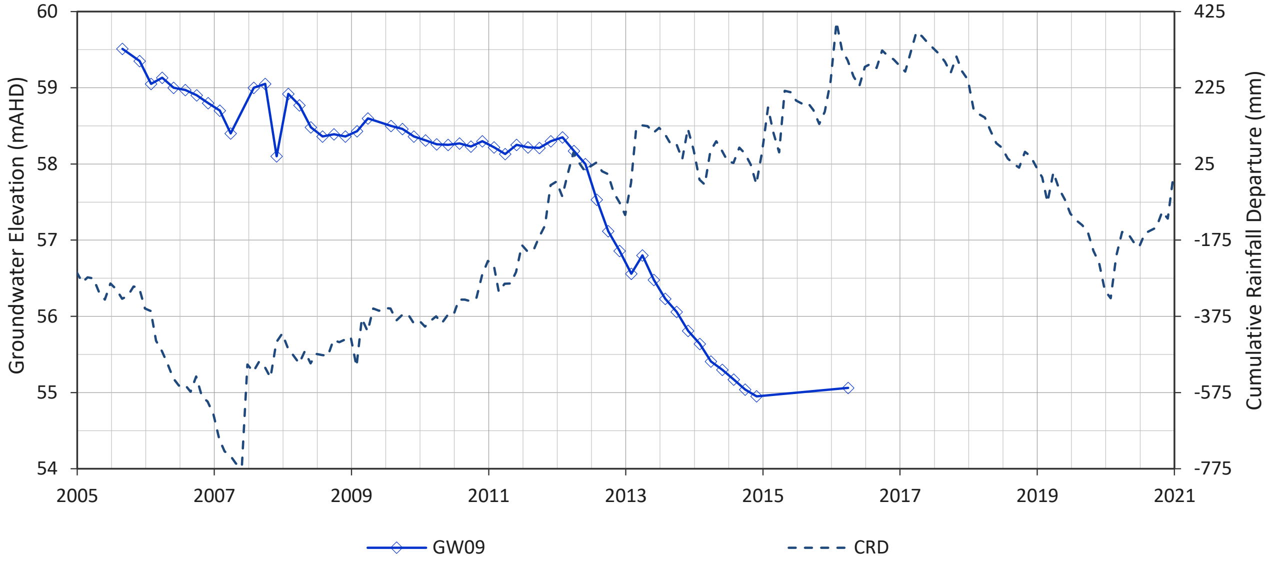
GW08.2


No Data Available for Groundwater Elevation (mAHD)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
GW08.2

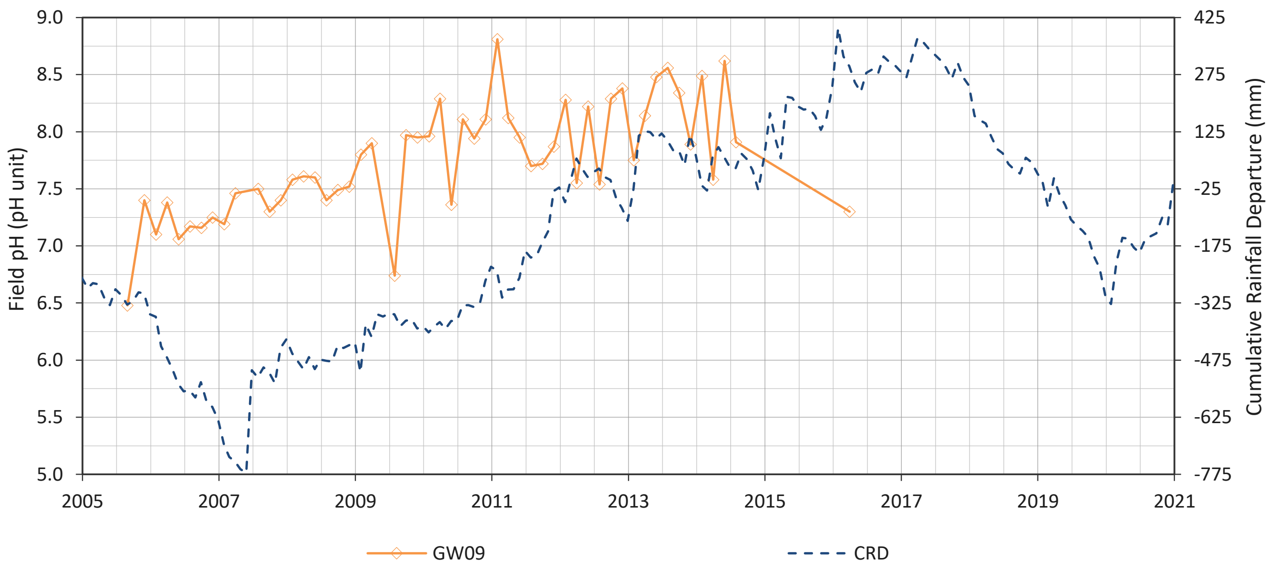

No Data Available for Field pH (pH unit)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
GW08.2


No Data Available for Field Electrical Conductivity (µS/cm)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
GW08.2

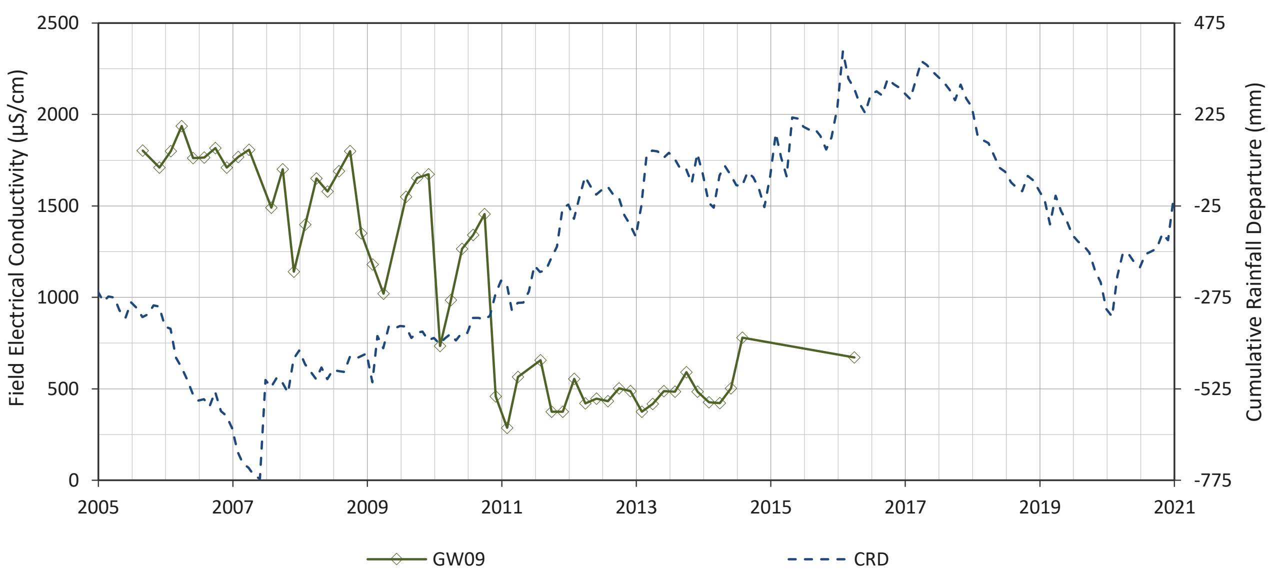
GW09



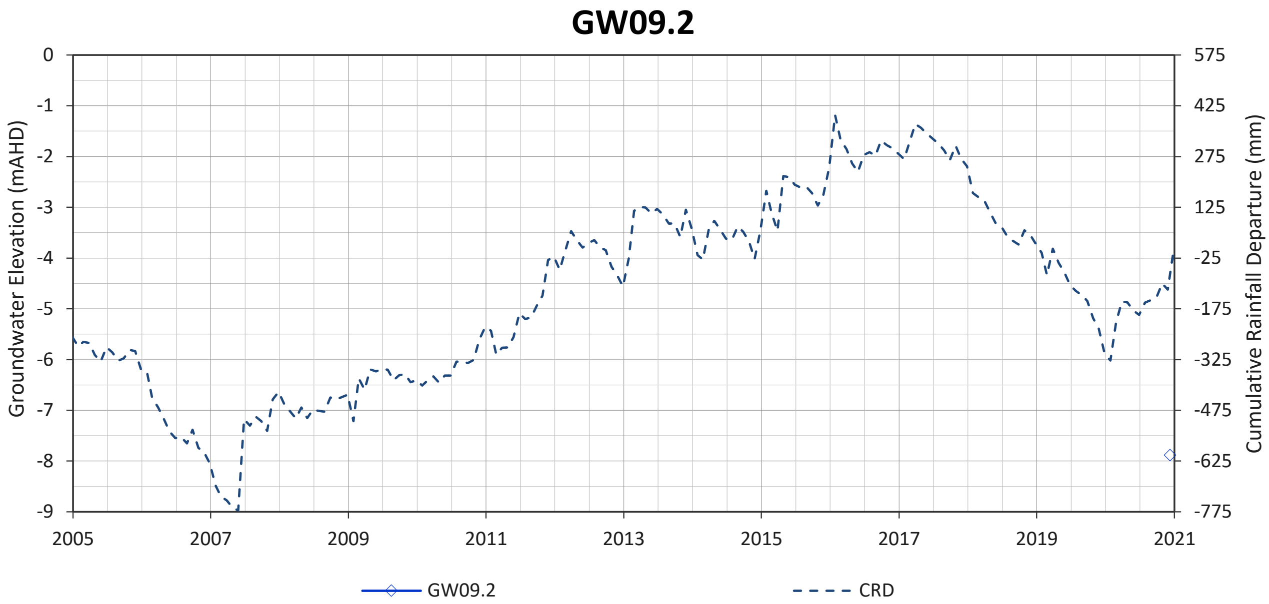
Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
60
59
58
57
56
55
54
425
225
25
-175
-375
-575
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW09
CRD

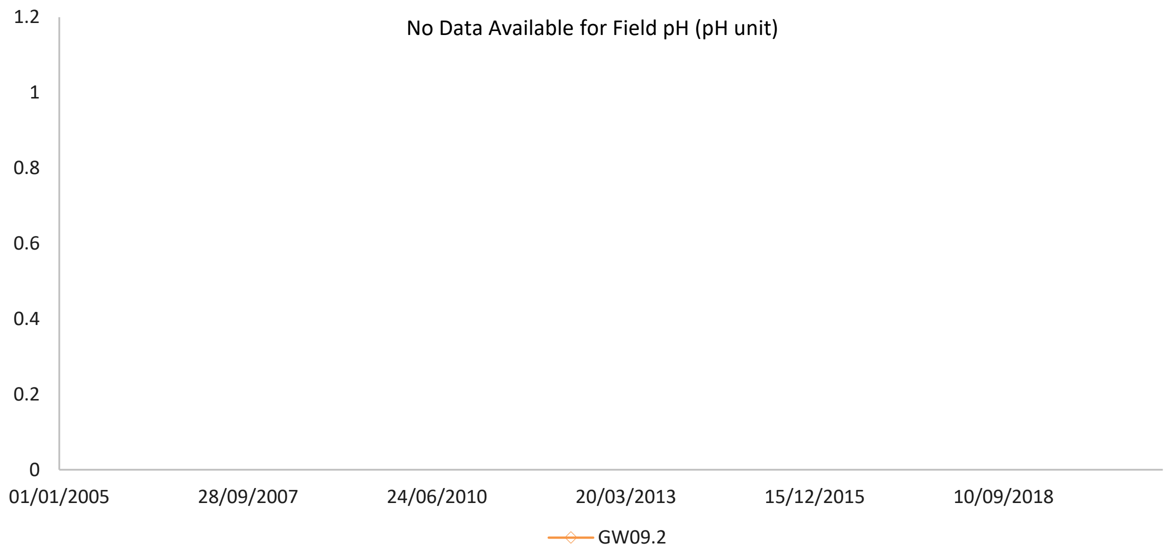


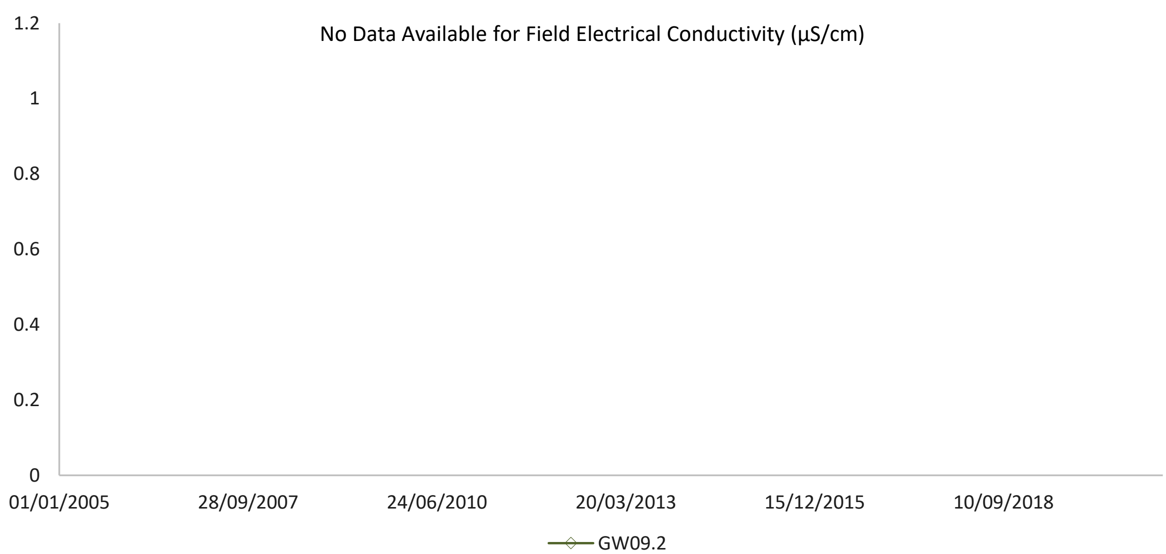
Field pH (pH unit)
Cumulative Rainfall Departure (mm)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW09
CRD



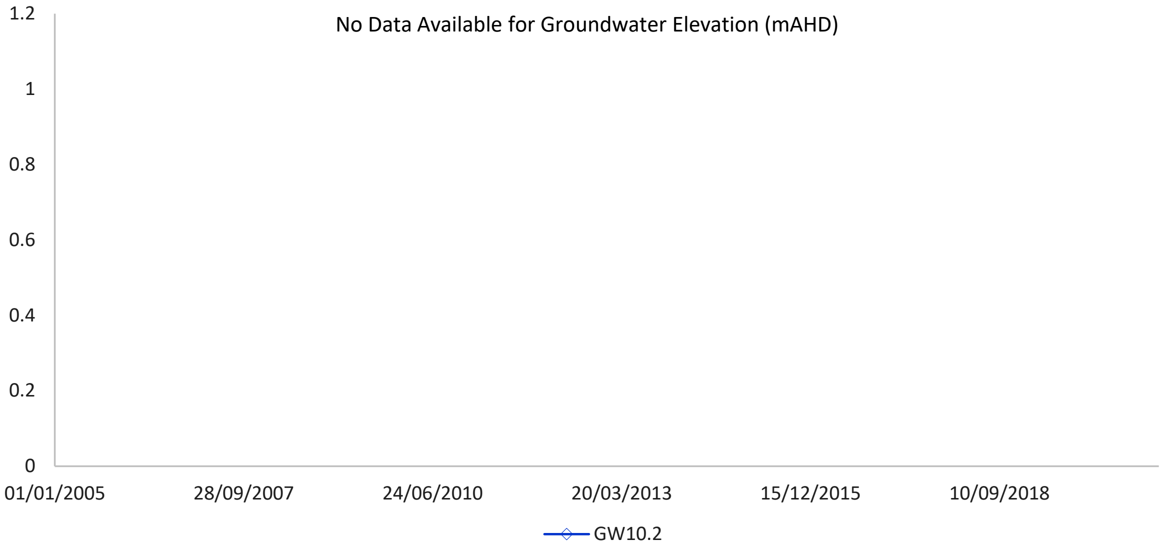
Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
2500
2000
1500
1000
500
0
475
225
-25
-275
-525
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW09
CRD

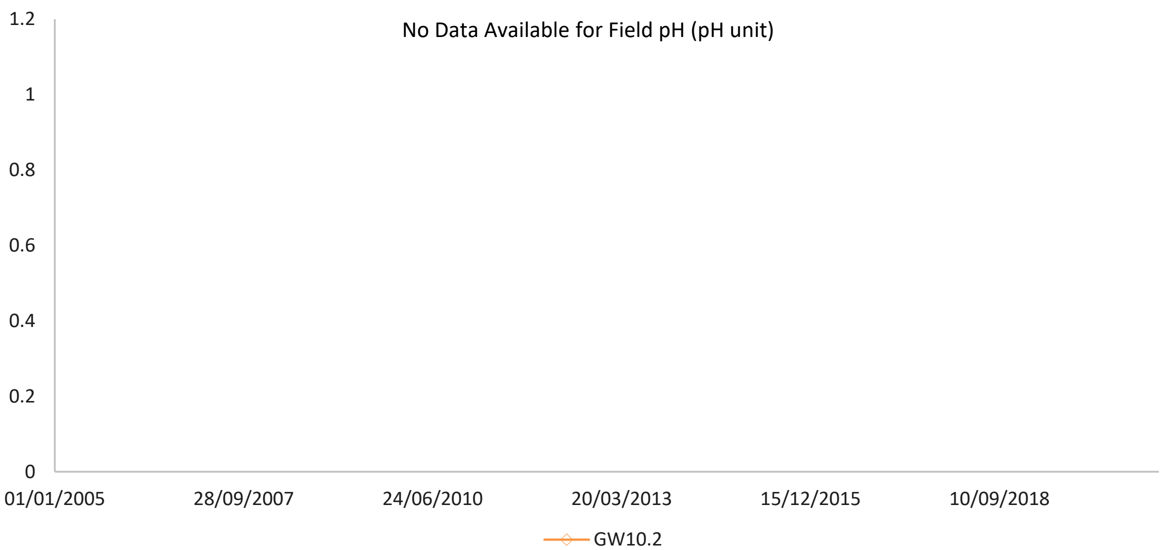

GW09.2
Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
575
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW09.2
CRD

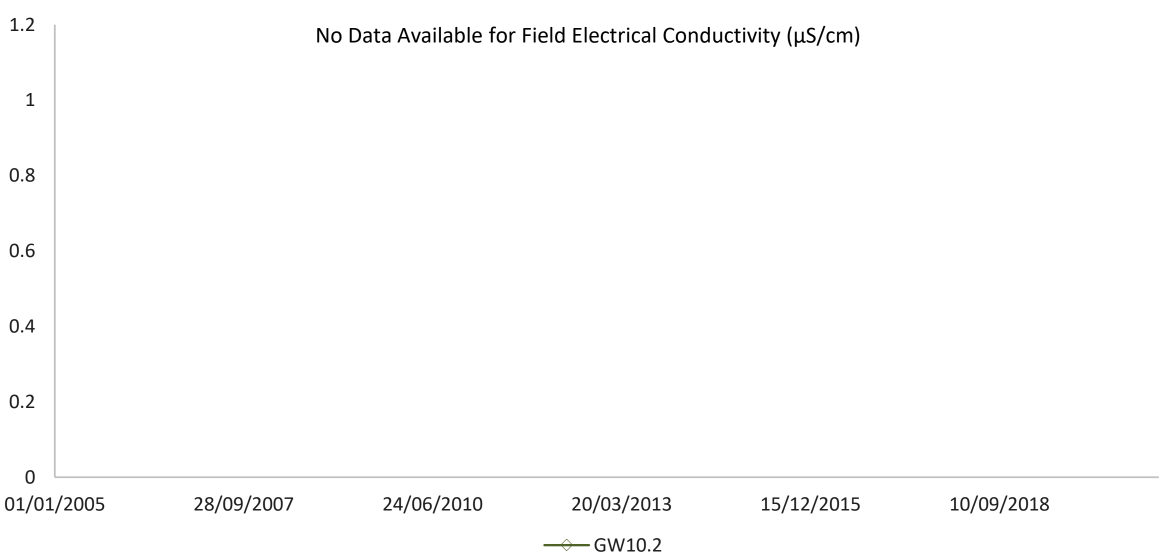

No Data Available for Field pH (pH unit)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
GW09.2


No Data Available for Field Electrical Conductivity (µS/cm)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
GW09.2

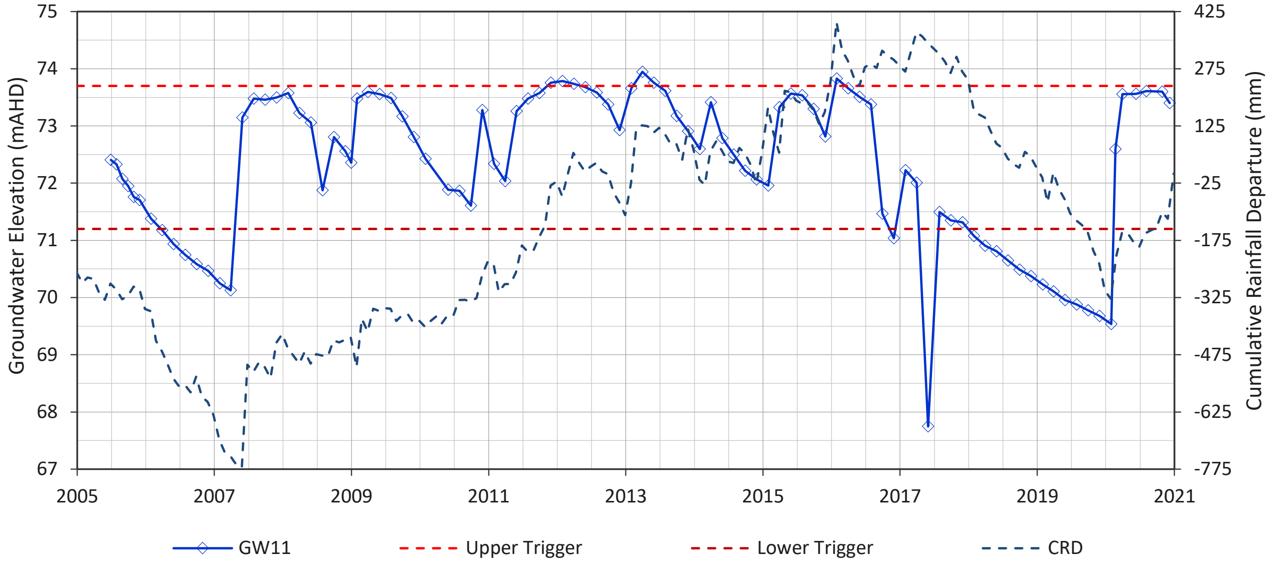
GW10.2

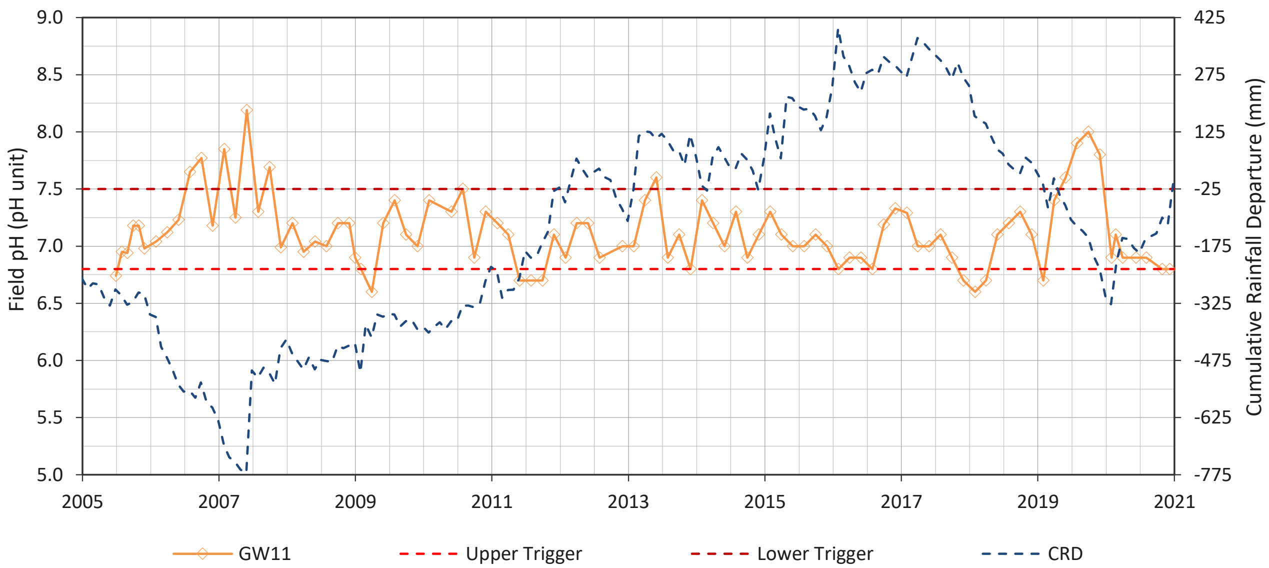

No Data Available for Groundwater Elevation (mAHD)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
GW10.2

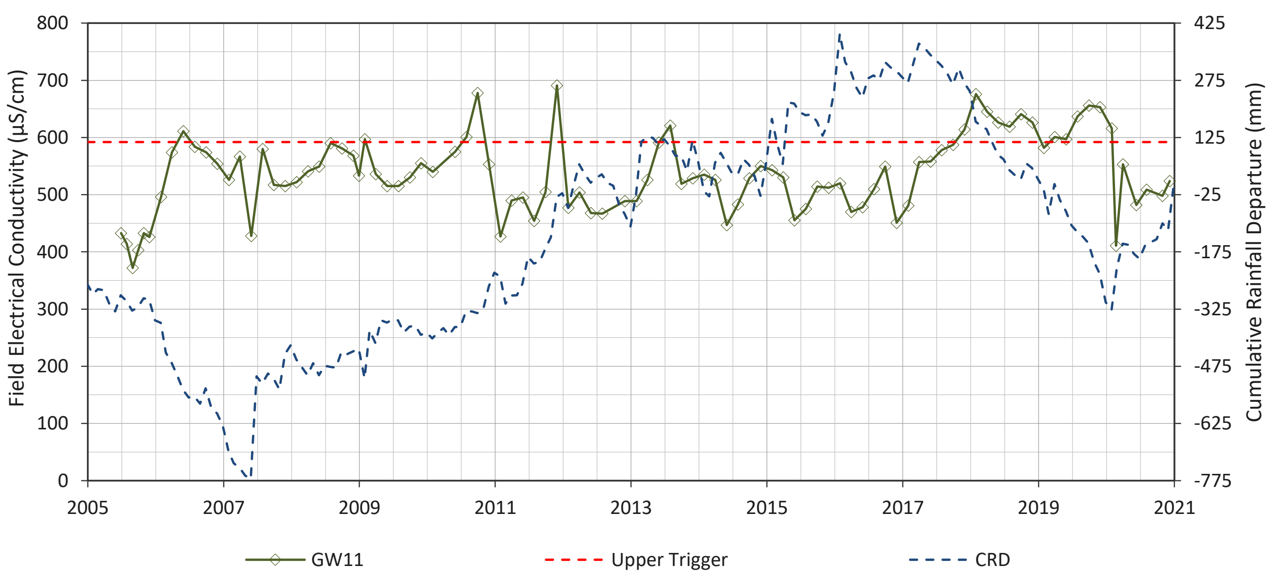

No Data Available for Field pH (pH unit)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
GW10.2


No Data Available for Field Electrical Conductivity (µS/cm)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
GW10.2

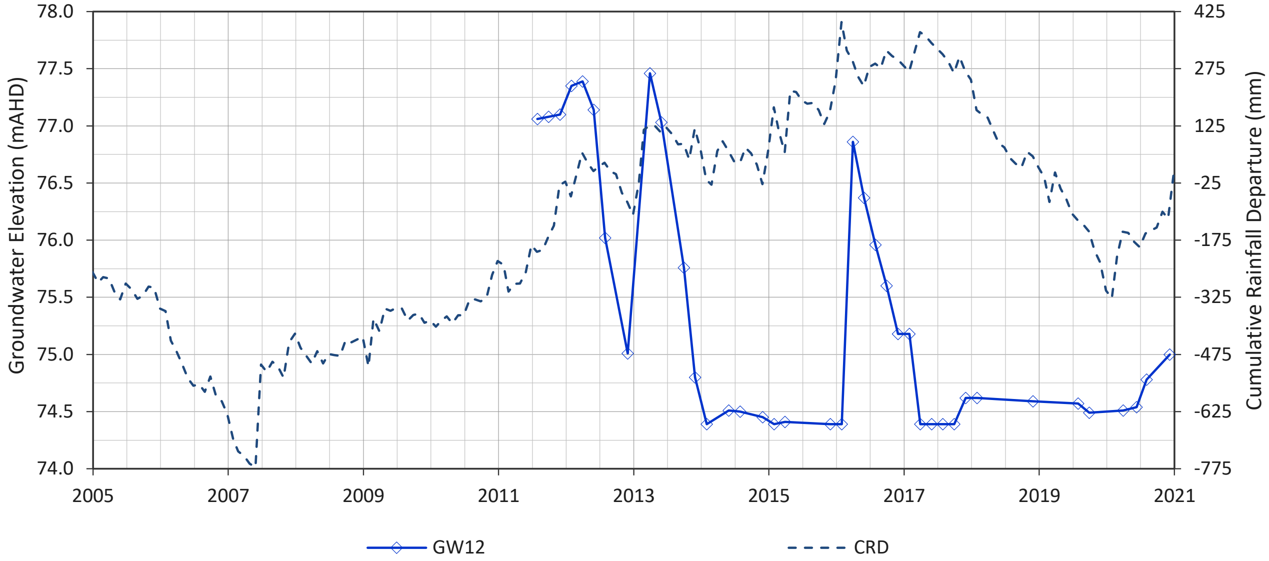
GW11


75
74
73
72
71
70
69
68
67
Groundwater Elevation (mAHD)
425
275
125
-25
-175
-325
-475
-625
-775
Cumulative Rainfall Departure (mm)
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW11
Upper Trigger
Lower Trigger
CRD

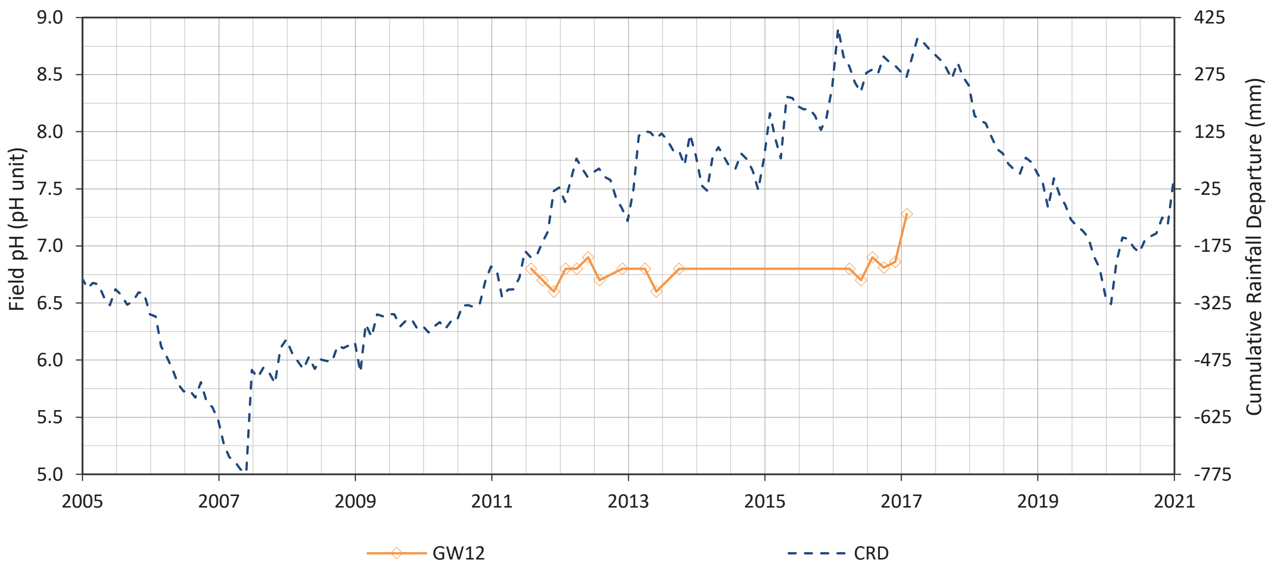

9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
Field pH (pH unit)
425
275
125
-25
-175
-325
-475
-625
-775
Cumulative Rainfall Departure (mm)
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW11
Upper Trigger
Lower Trigger
CRD


800
700
600
500
400
300
200
100
0
Field Electrical Conductivity (µS/cm)
425
275
125
-25
-175
-325
-475
-625
-775
Cumulative Rainfall Departure (mm)
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW11
Upper Trigger
CRD

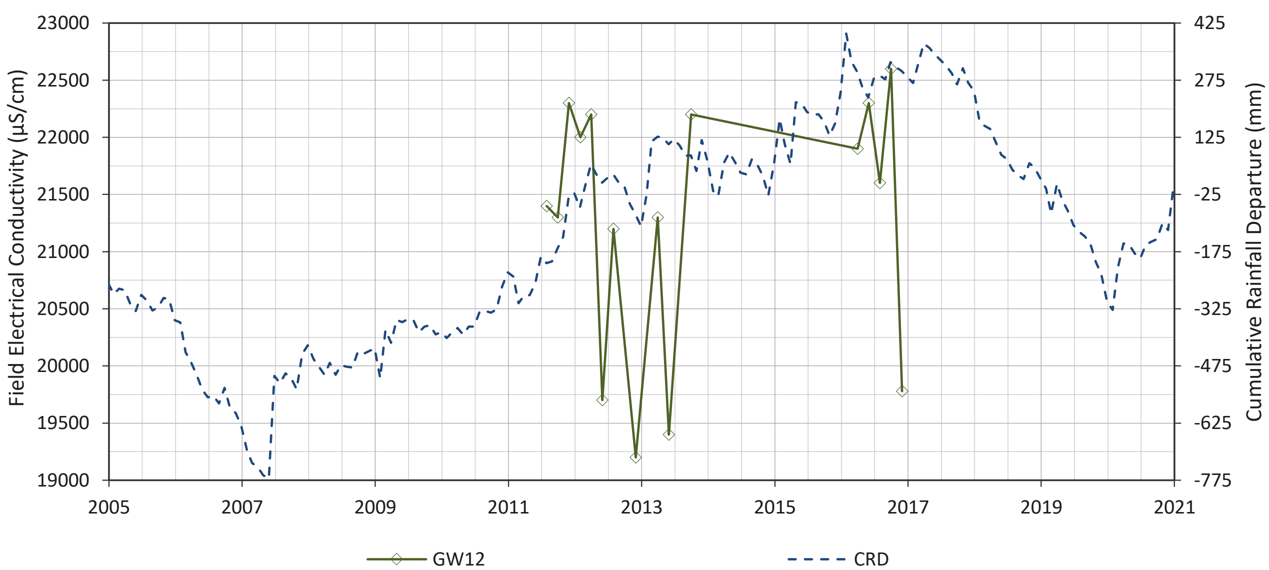
GW12



Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
78.0
77.5
77.0
76.5
76.0
75.5
75.0
74.5
74.0
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW12
CRD

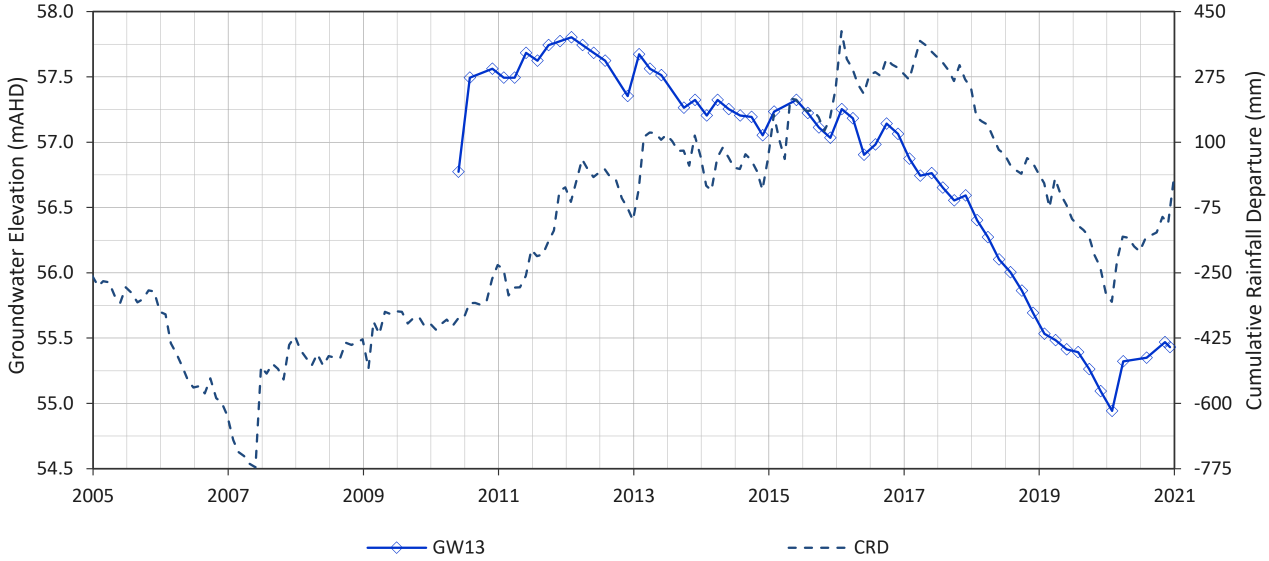


Field pH (pH unit)
Cumulative Rainfall Departure (mm)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW12
CRD

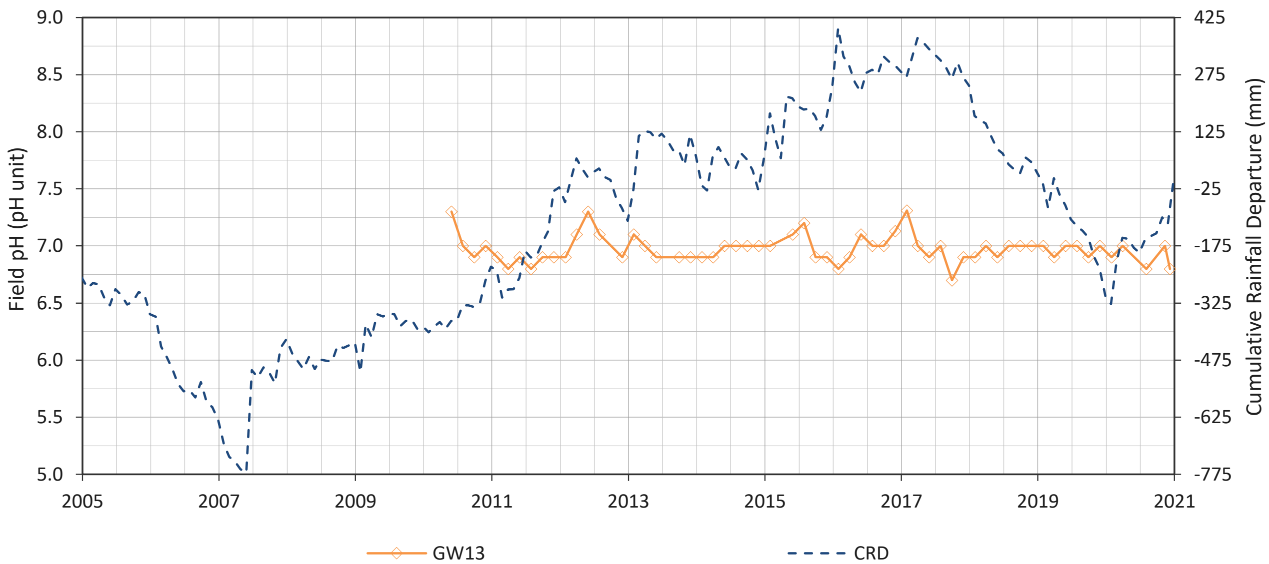


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
23000
22500
22000
21500
21000
20500
20000
19500
19000
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW12
CRD

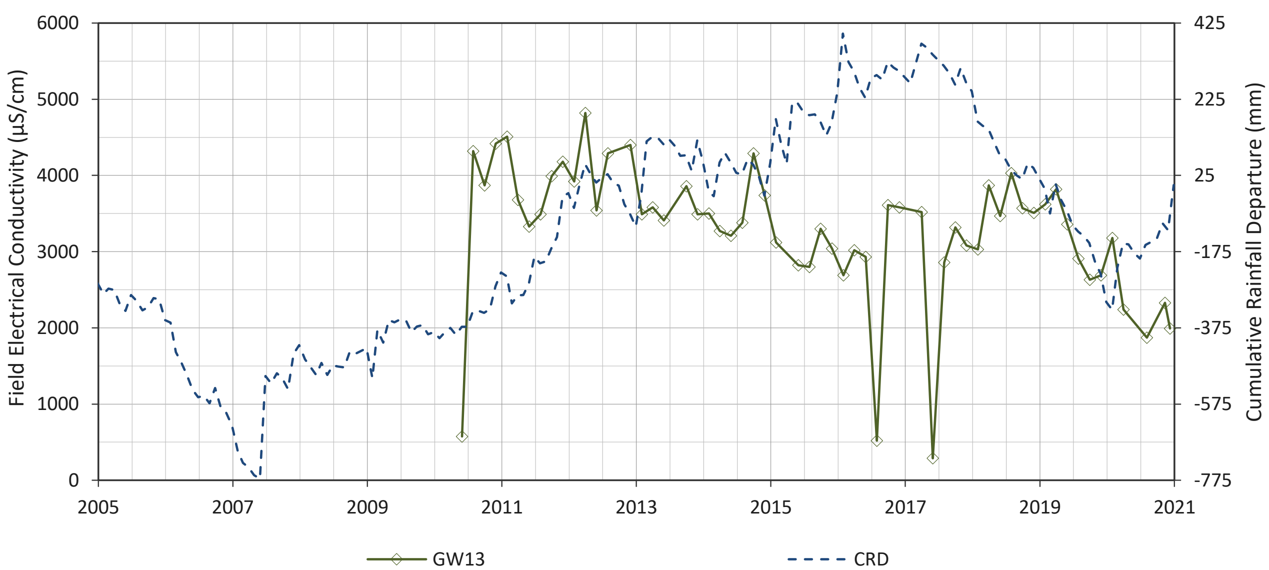
GW13



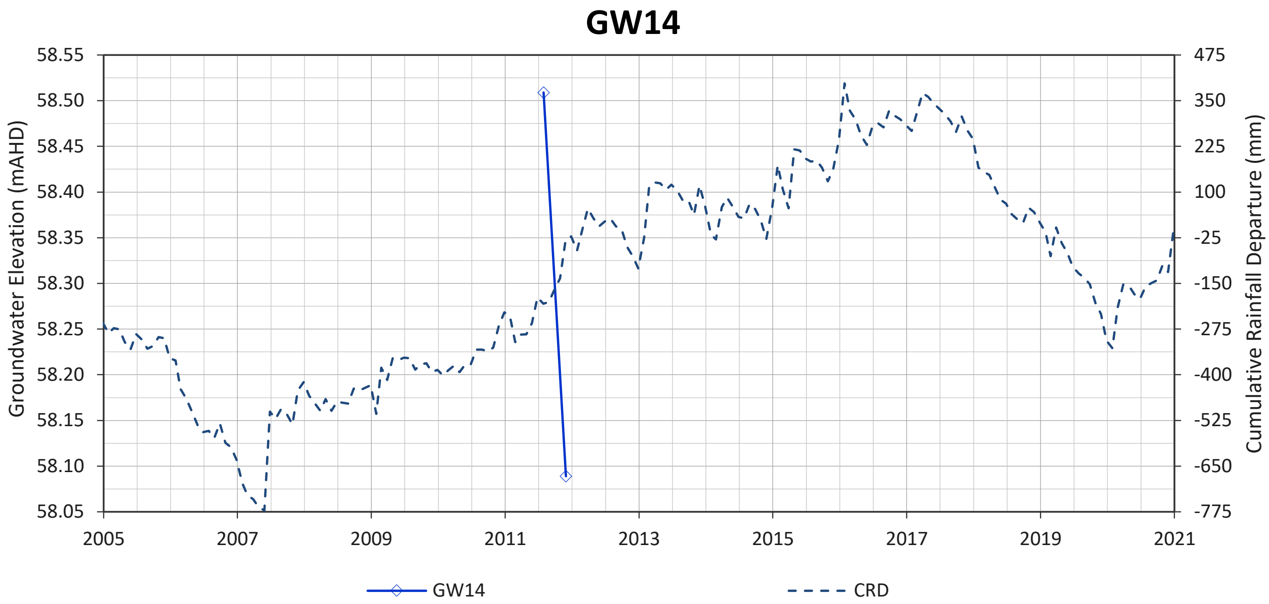
Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
58.0
57.5
57.0
56.5
56.0
55.5
55.0
54.5
450
275
100
-75
-250
-425
-600
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW13
CRD



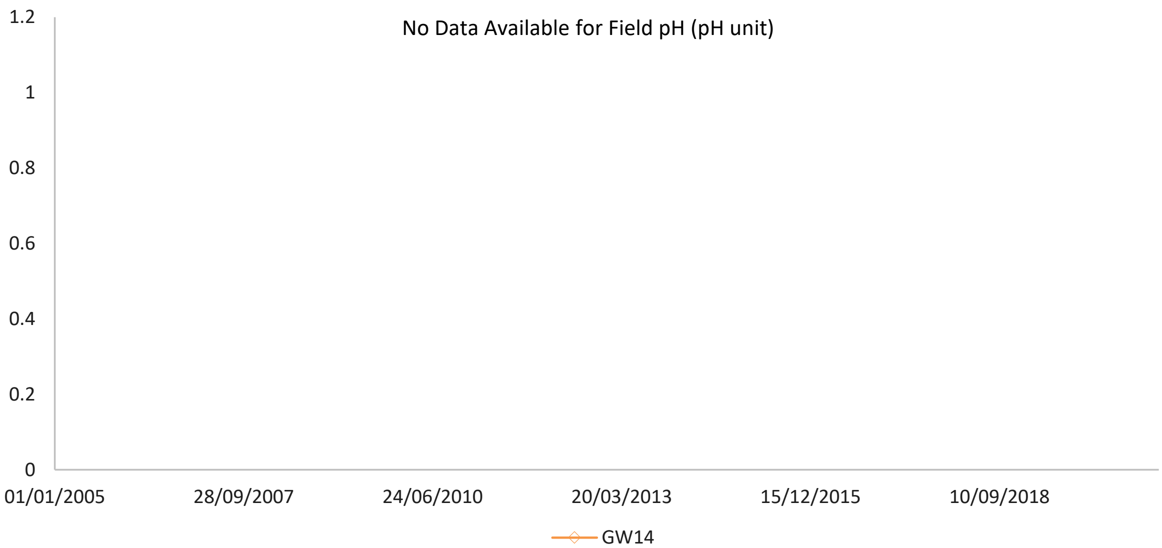
Field pH (pH unit)
Cumulative Rainfall Departure (mm)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW13
CRD



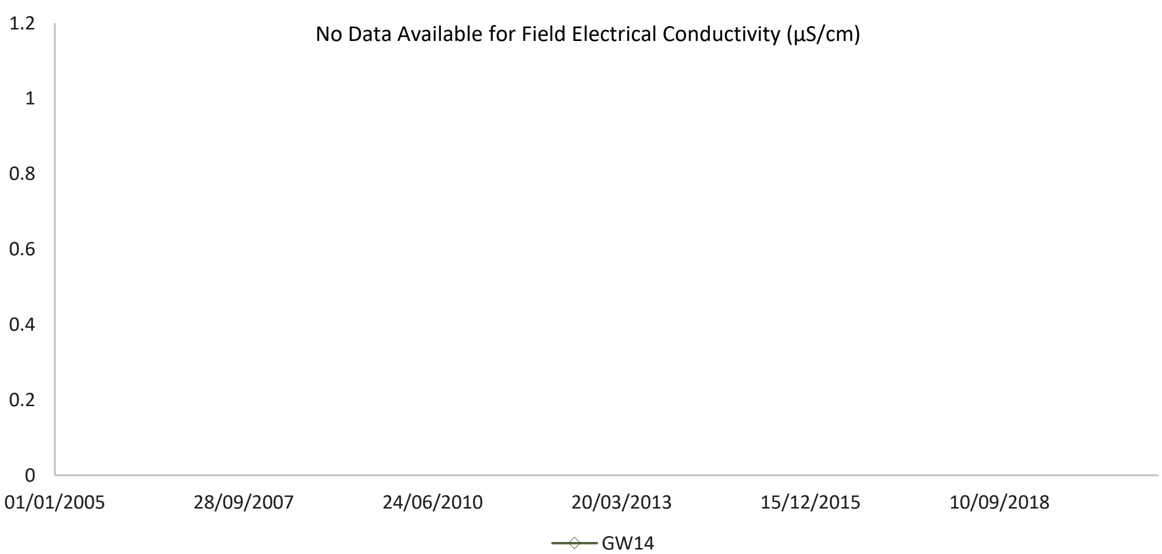
Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
6000
5000
4000
3000
2000
1000
0
425
225
25
-175
-375
-575
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW13
CRD



GW14
Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
58.55
58.50
58.45
58.40
58.35
58.30
58.25
58.20
58.15
58.10
58.05
475
350
225
100
-25
-150
-275
-400
-525
-650
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW14
CRD

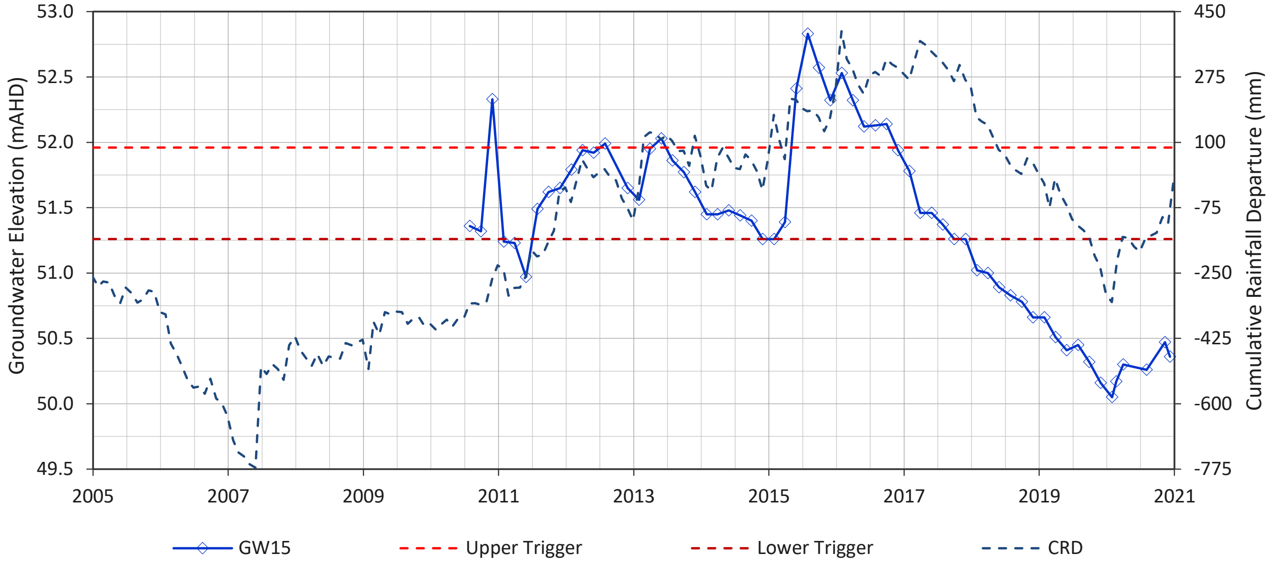


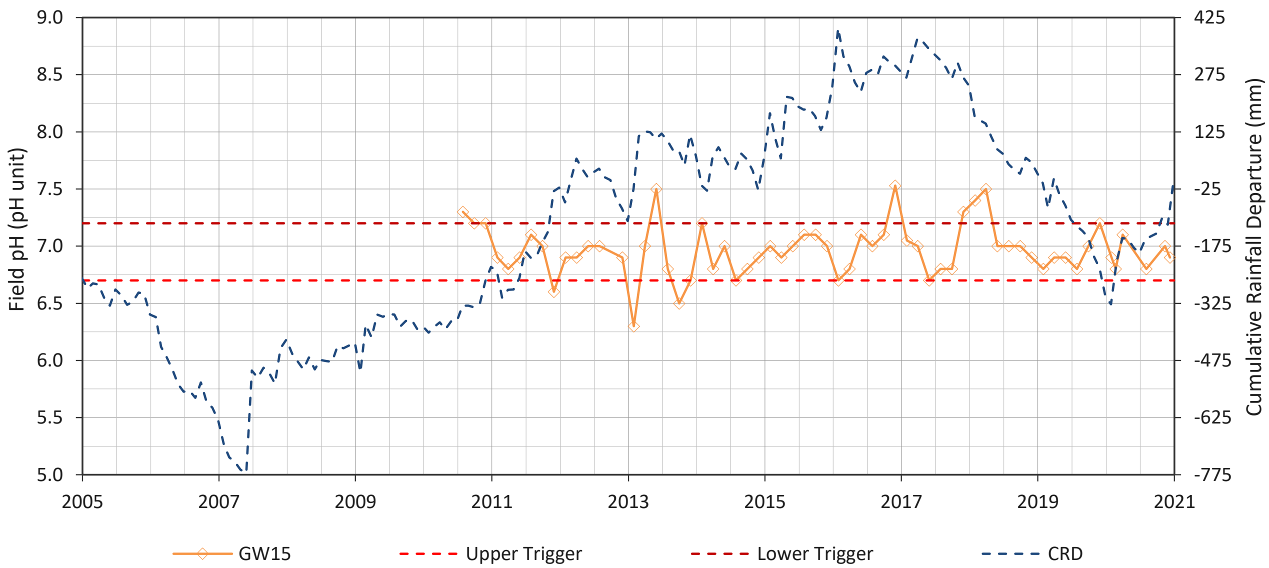
No Data Available for Field pH (pH unit)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
GW14

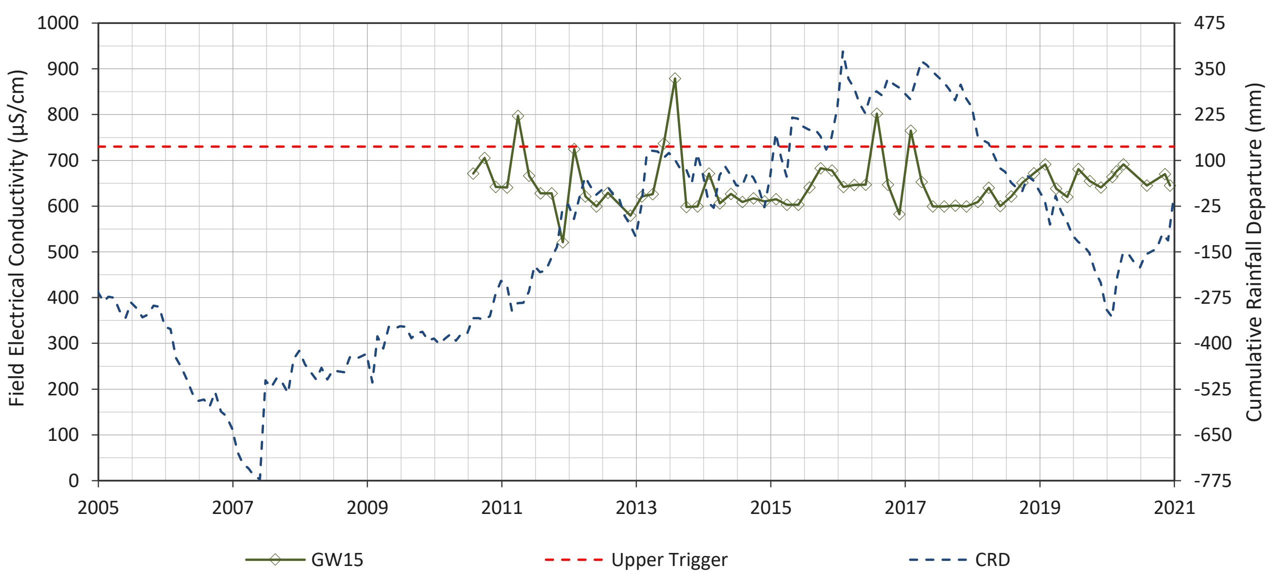


No Data Available for Field Electrical Conductivity (µS/cm)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
GW14

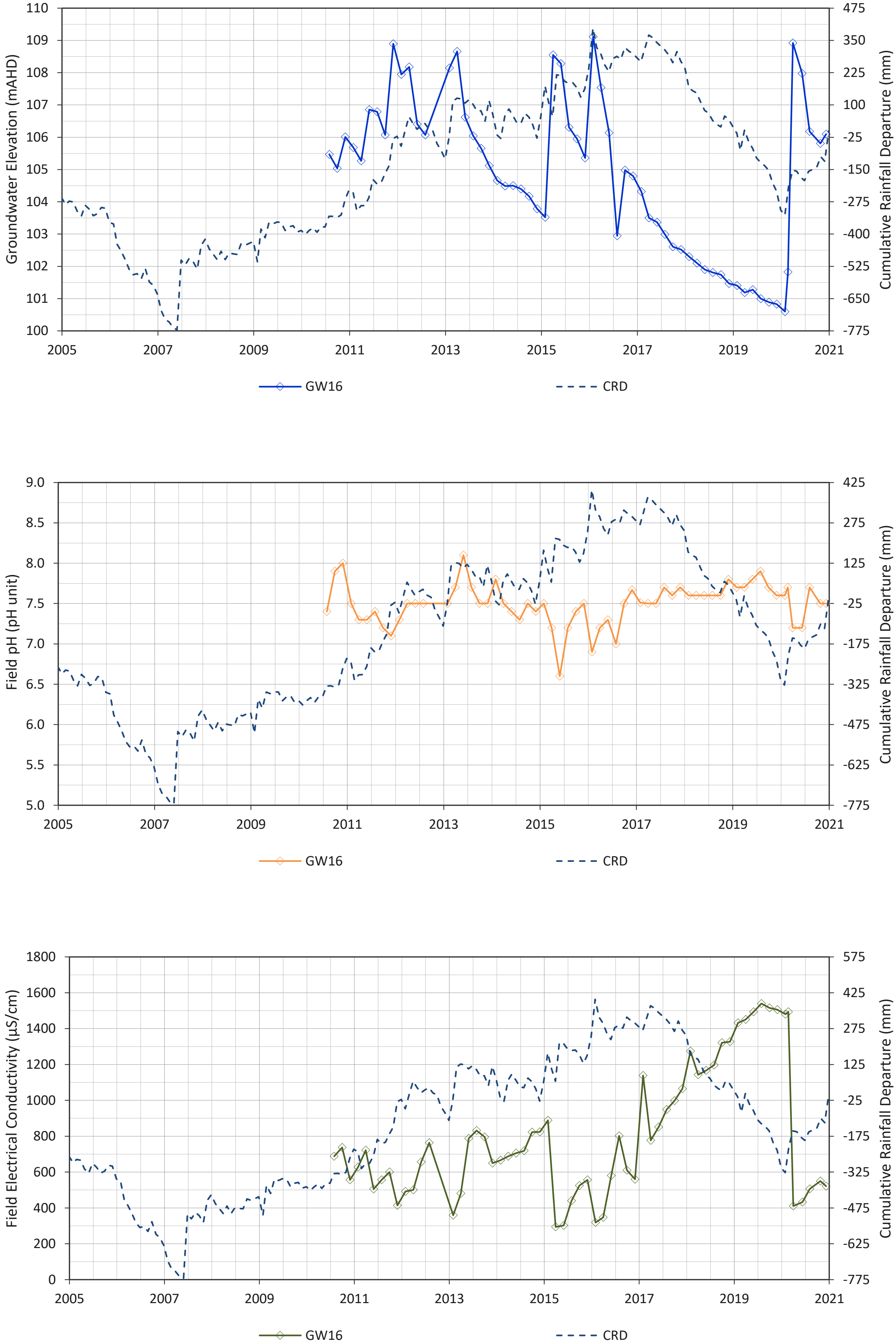
GW15


Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
53.0
52.5
52.0
51.5
51.0
50.5
50.0
49.5
450
275
100
-75
-250
-425
-600
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW15
Upper Trigger
Lower Trigger
CRD


Field pH (pH unit)
Cumulative Rainfall Departure (mm)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW15
Upper Trigger
Lower Trigger
CRD

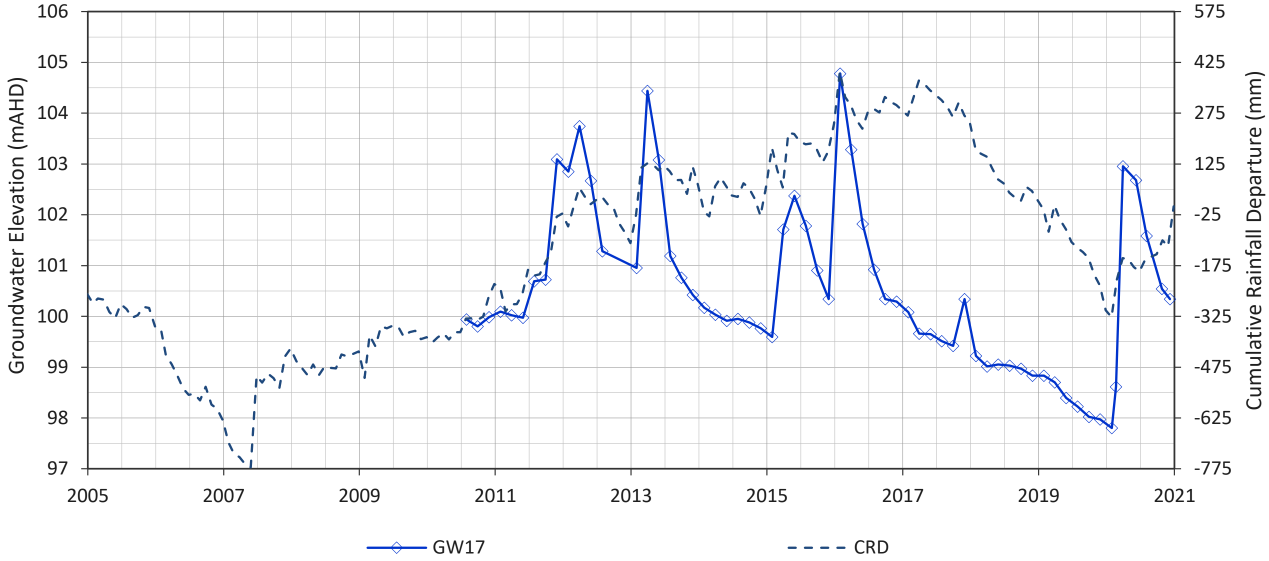

Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
1000
900
800
700
600
500
400
300
200
100
0
475
350
225
100
-25
-150
-275
-400
-525
-650
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW15
Upper Trigger
CRD

GW16

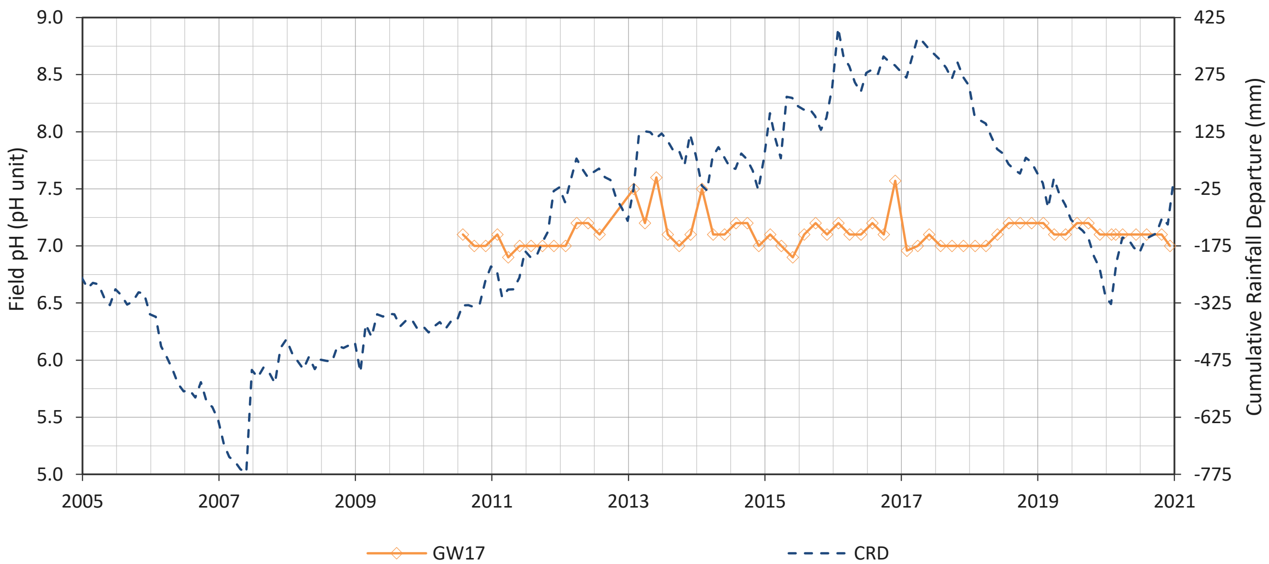


Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
110
109
108
107
106
105
104
103
102
101
100
475
350
225
100
-25
-150
-275
-400
-525
-650
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW16
CRD
Field pH (pH unit)
Cumulative Rainfall Departure (mm)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
425
275
125
-25
-175
-325
-475
-625
-775
GW16
CRD
Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
1800
1600
1400
1200
1000
800
600
400
200
0
575
425
275
125
-25
-175
-325
-475
-625
-775
GW16
CRD

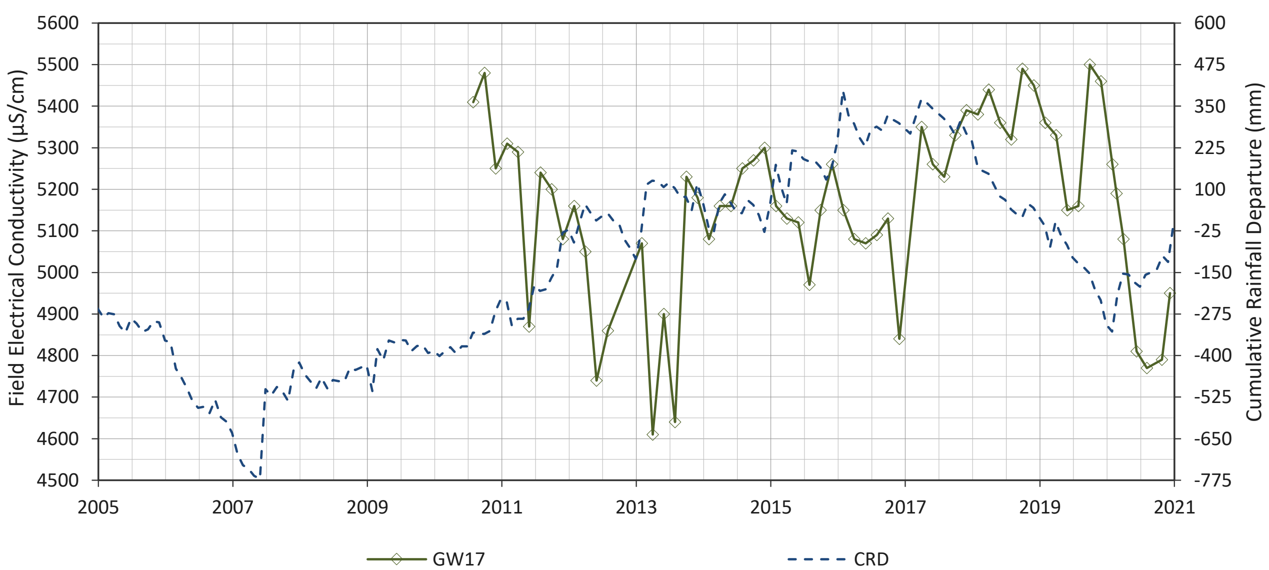
GW17



Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
106
105
104
103
102
101
100
99
98
97
575
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW17
CRD

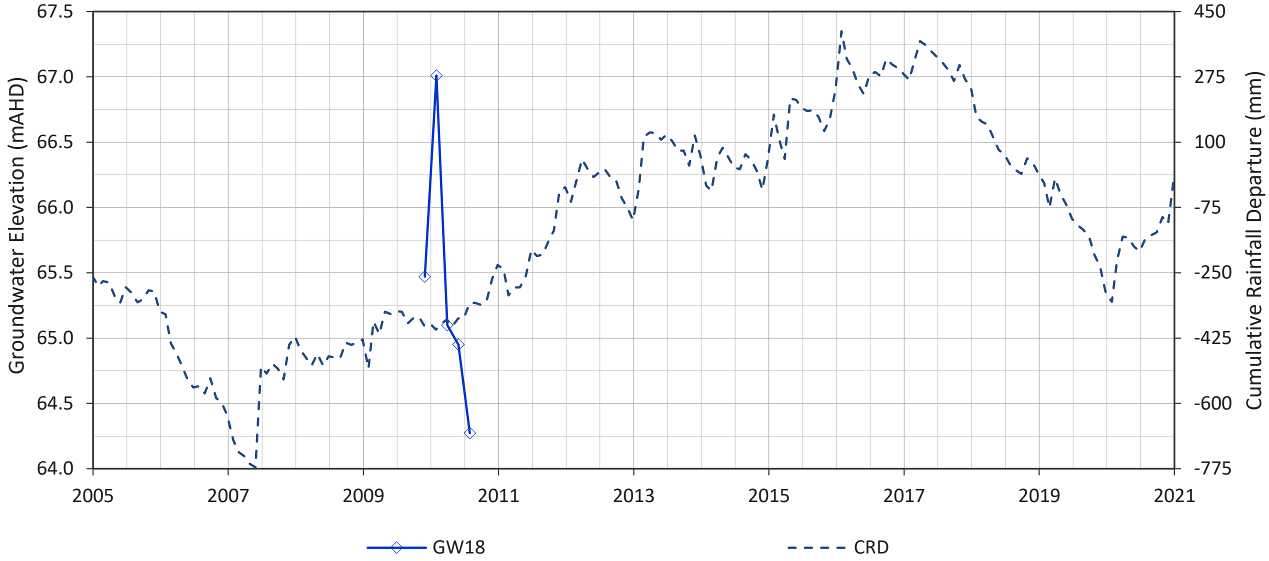


Field pH (pH unit)
Cumulative Rainfall Departure (mm)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW17
CRD

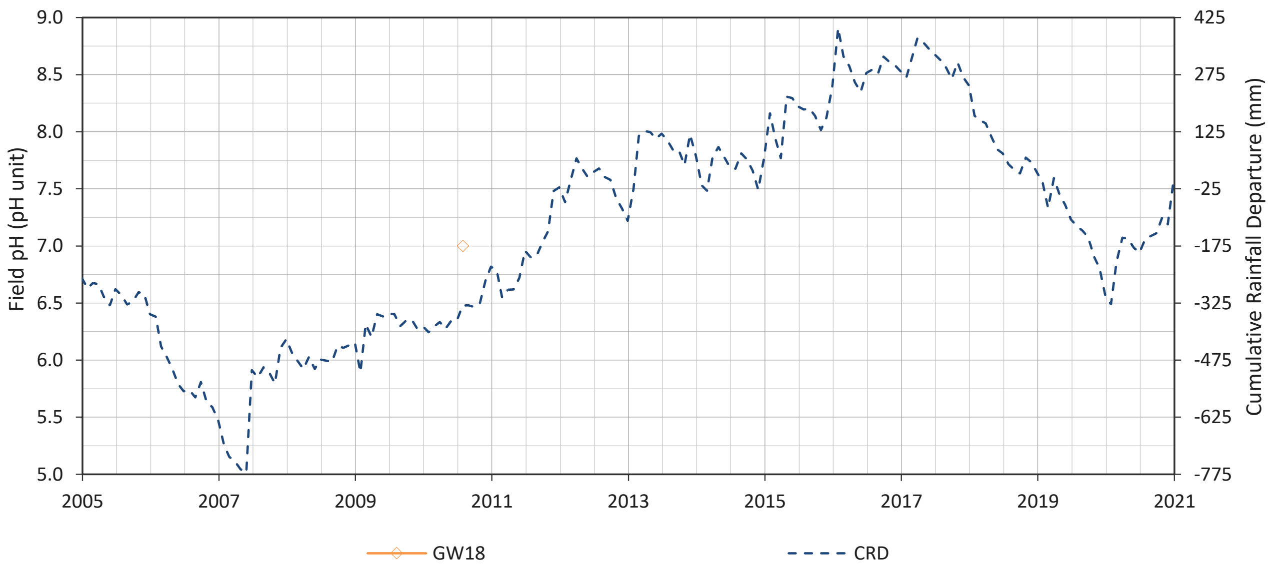


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
5600
5500
5400
5300
5200
5100
5000
4900
4800
4700
4600
4500
600
475
350
225
100
-25
-150
-275
-400
-525
-650
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW17
CRD

GW18



Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
67.5
67.0
66.5
66.0
65.5
65.0
64.5
64.0
450
275
100
-75
-250
-425
-600
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW18
CRD



Field pH (pH unit)
Cumulative Rainfall Departure (mm)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW18
CRD

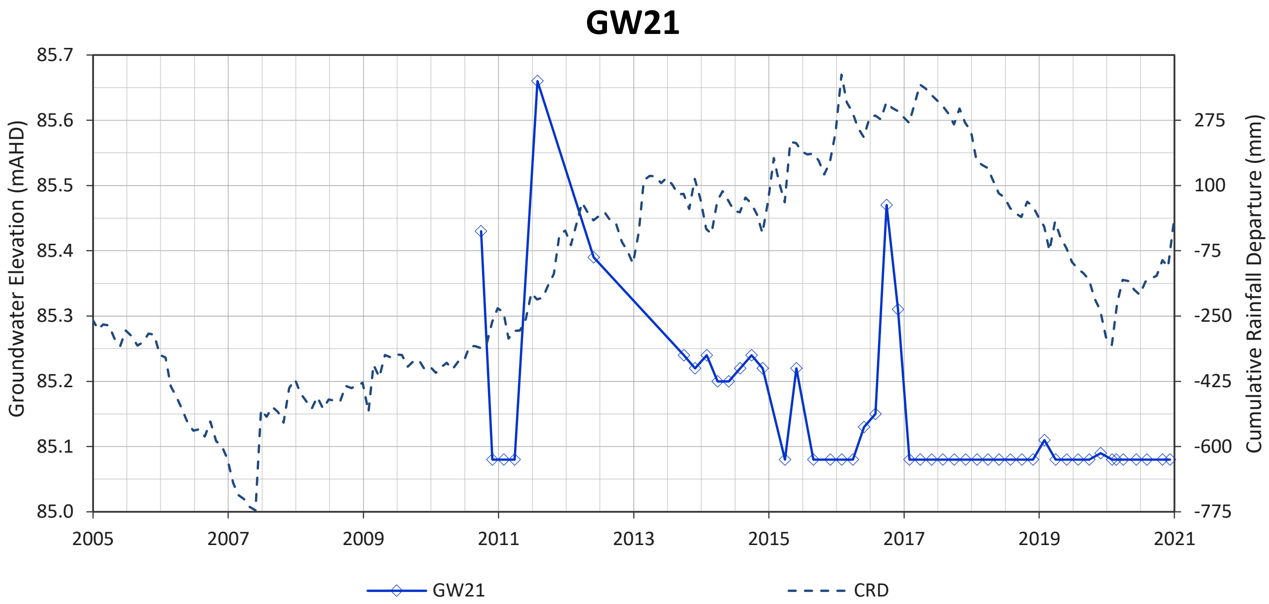
Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
575
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW18
CRD

GW19

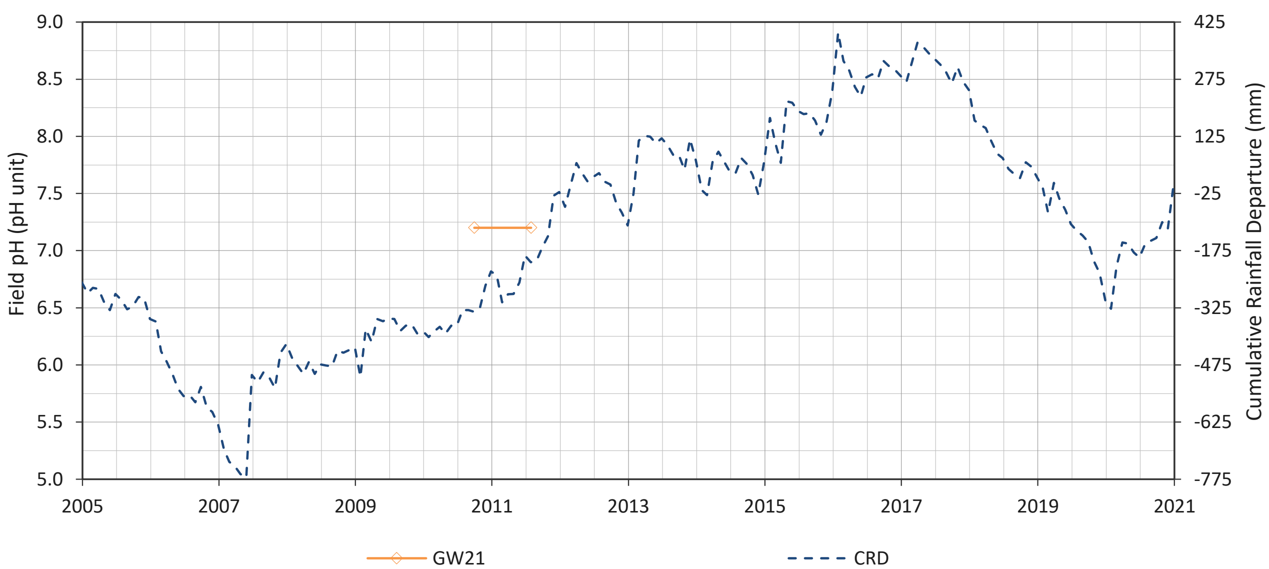
No Data Available for Groundwater Elevation (mAHD)

No Data Available for Field pH (pH unit)

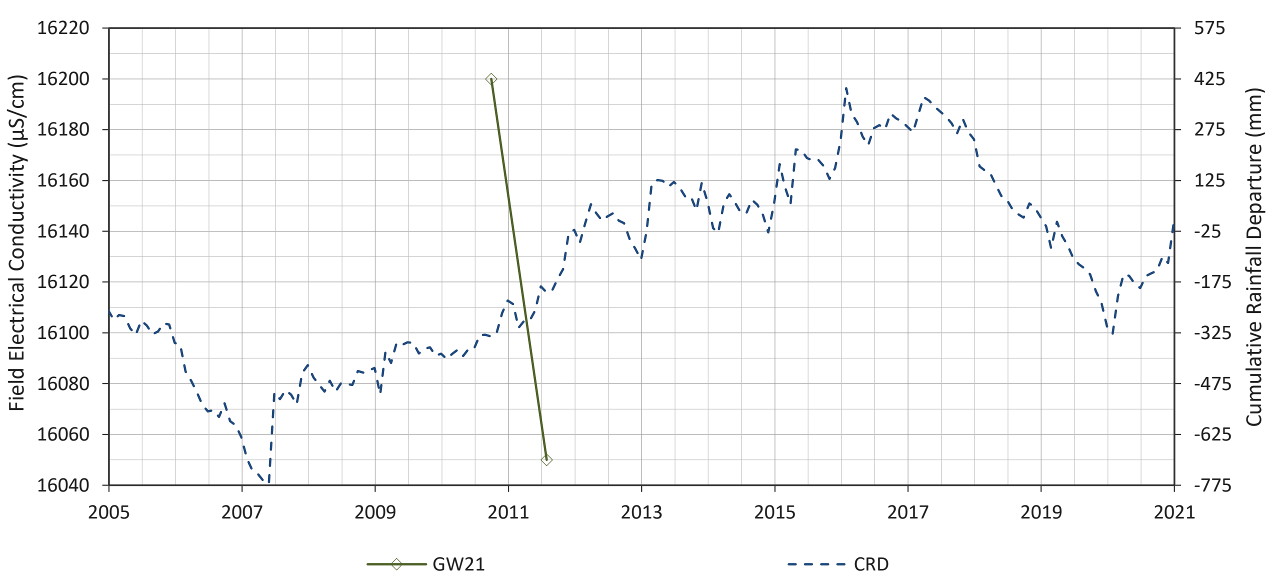
No Data Available for Field Electrical Conductivity (µS/cm)



GW21
85.7
85.6
85.5
85.4
85.3
85.2
85.1
85.0
275
100
-75
-250
-425
-600
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
GW21
CRD

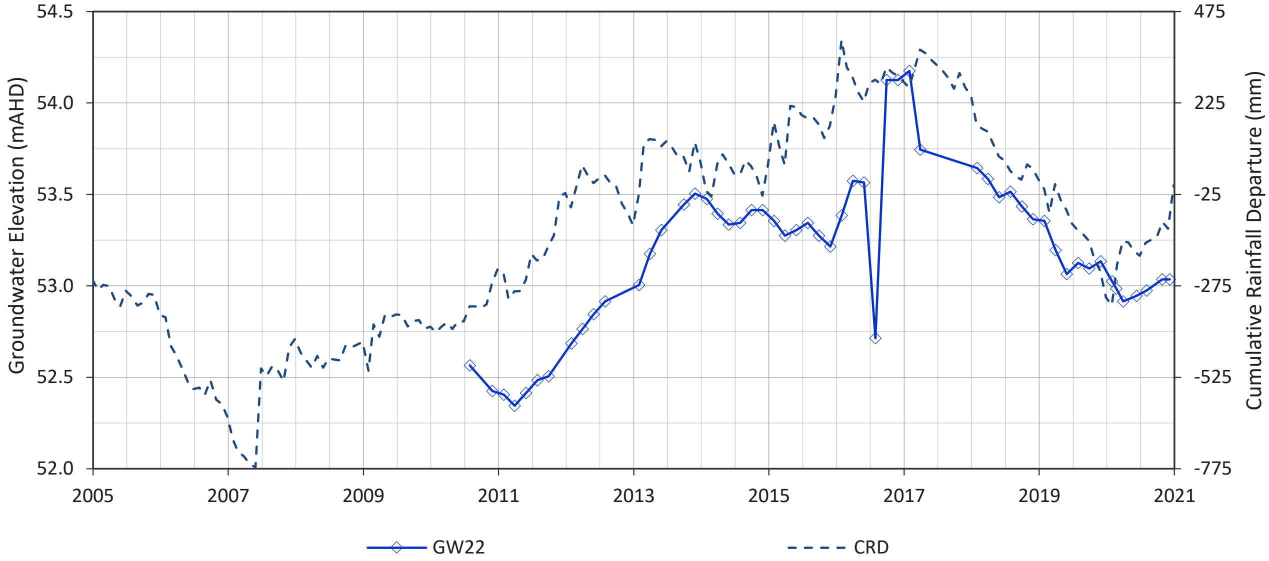


9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
Field pH (pH unit)
Cumulative Rainfall Departure (mm)
GW21
CRD

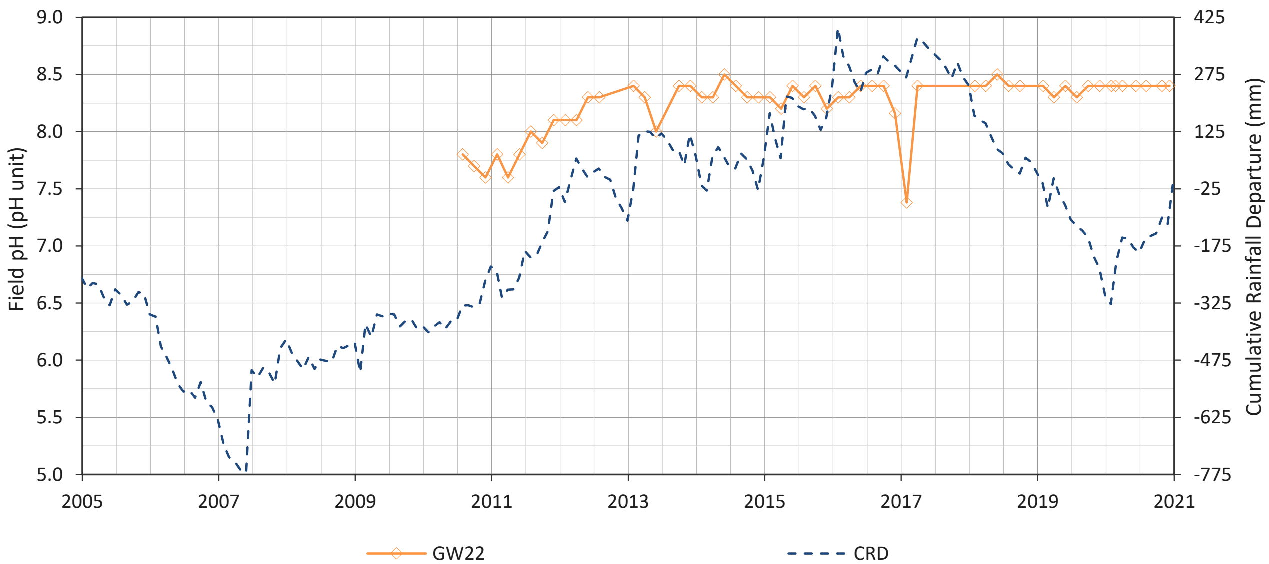


16220
16200
16180
16160
16140
16120
16100
16080
16060
16040
575
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
GW21
CRD

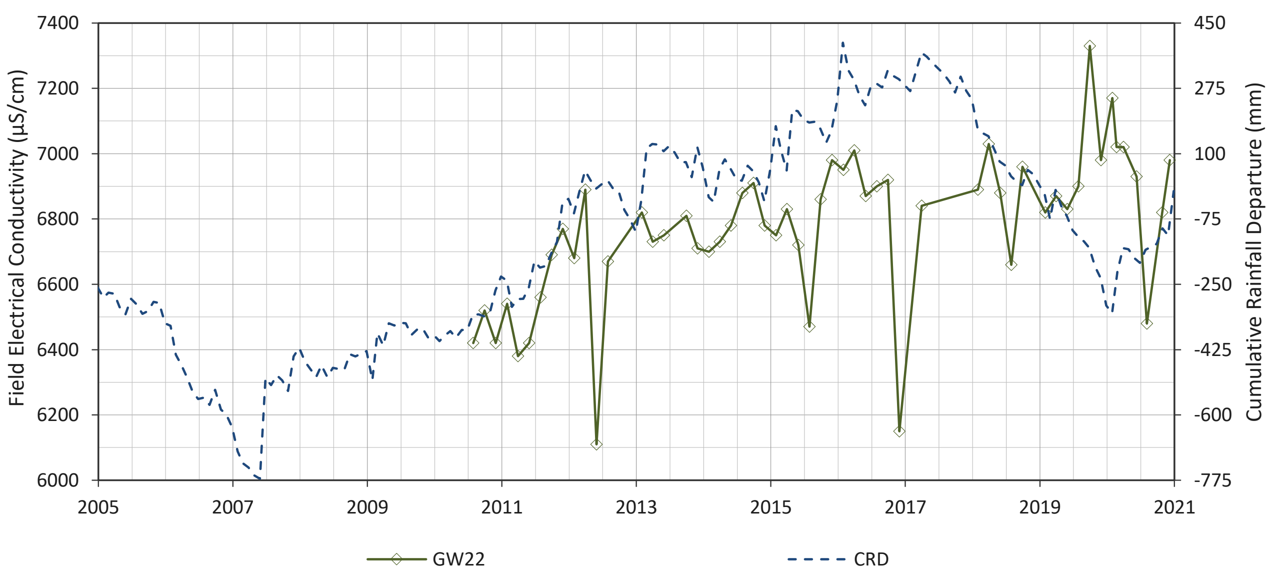
GW22



Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
54.5
54.0
53.5
53.0
52.5
52.0
475
225
-25
-275
-525
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW22
CRD

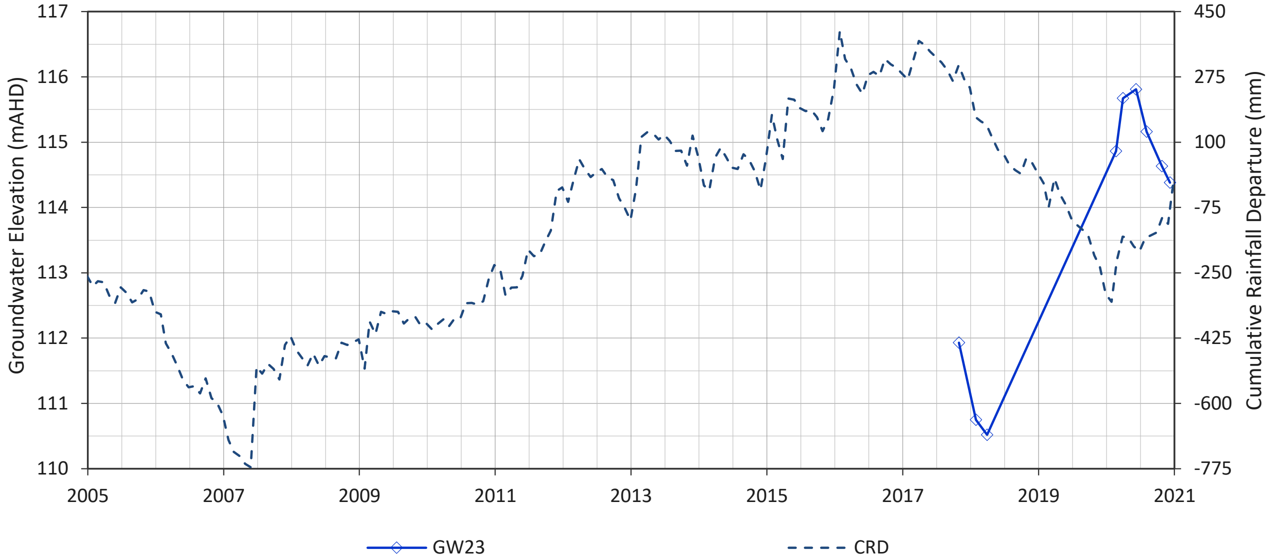


Field pH (pH unit)
Cumulative Rainfall Departure (mm)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW22
CRD

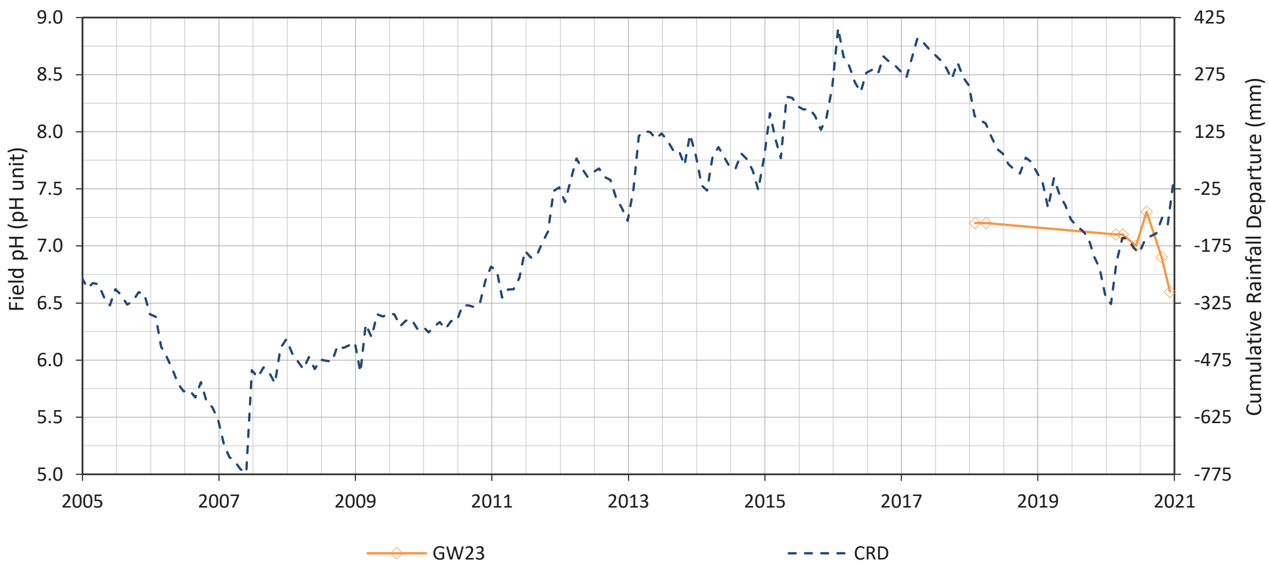


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
7400
7200
7000
6800
6600
6400
6200
6000
450
275
100
-75
-250
-425
-600
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW22
CRD

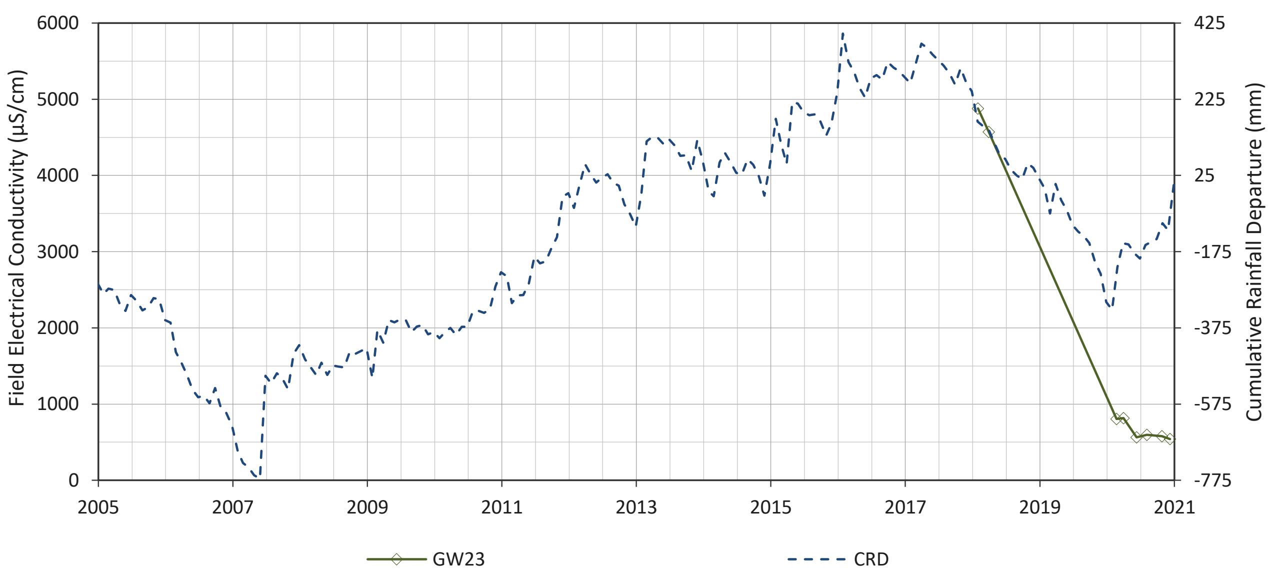
GW23



Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
117
116
115
114
113
112
111
110
450
275
100
-75
-250
-425
-600
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW23
CRD

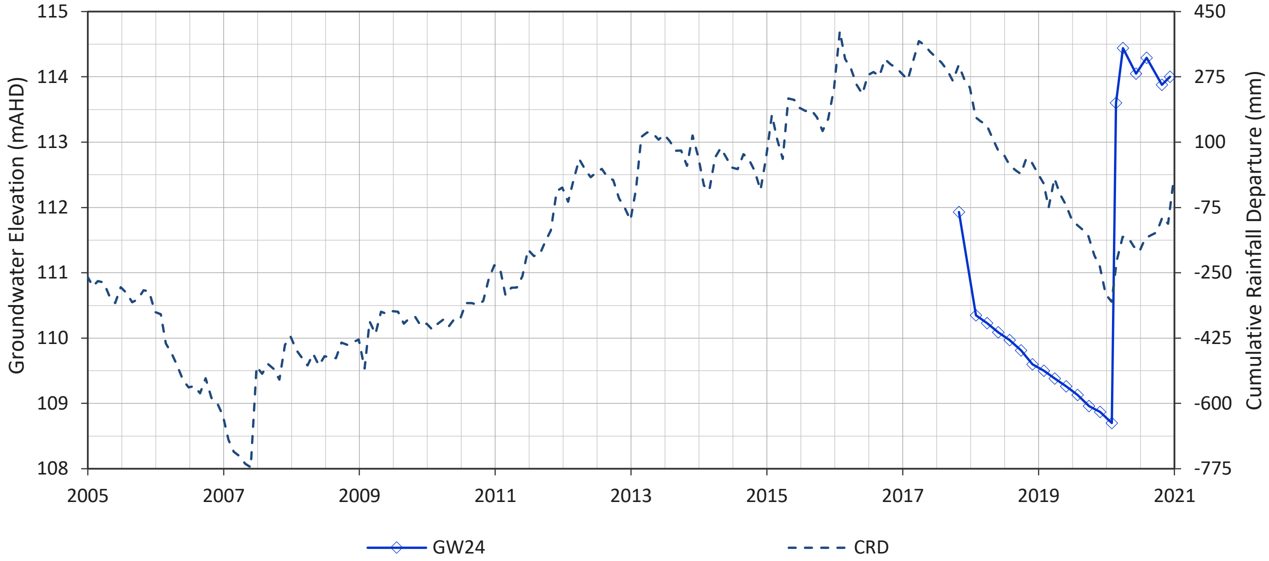


Field pH (pH unit)
Cumulative Rainfall Departure (mm)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW23
CRD

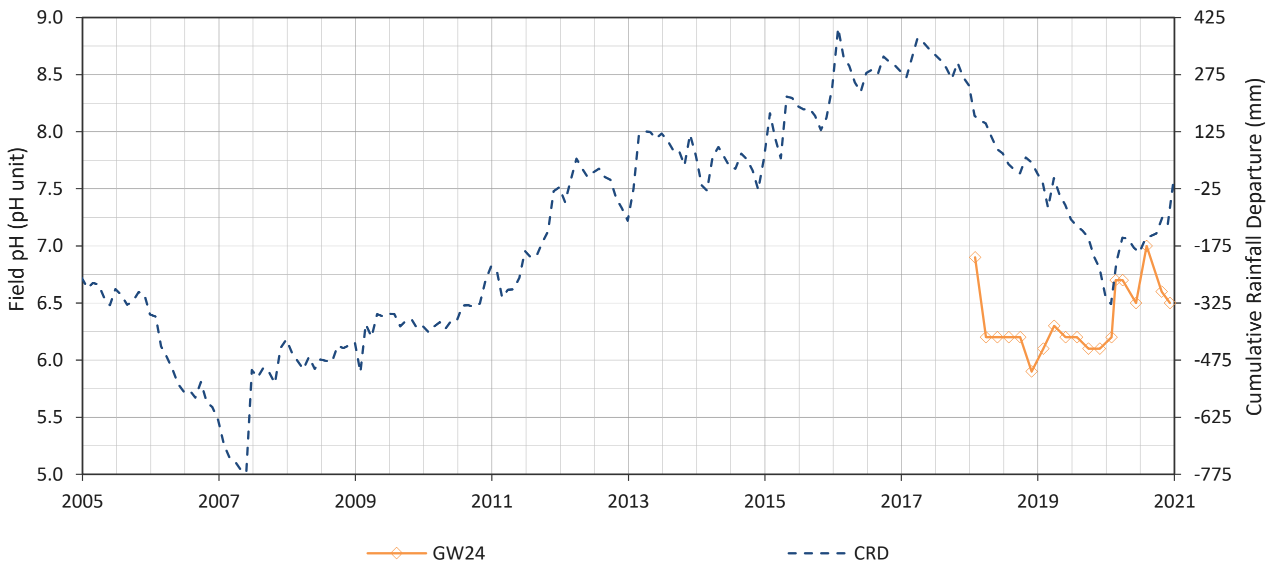


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
6000
5000
4000
3000
2000
1000
0
425
225
25
-175
-375
-575
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW23
CRD

GW24



Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
115
114
113
112
111
110
109
108
450
275
100
-75
-250
-425
-600
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW24
CRD

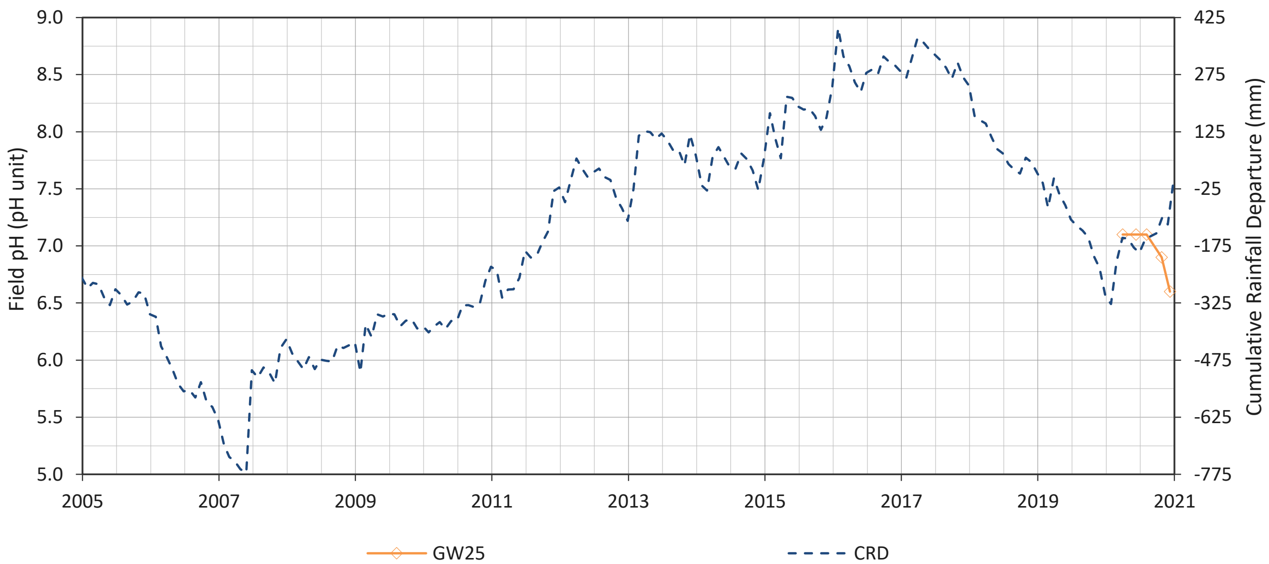


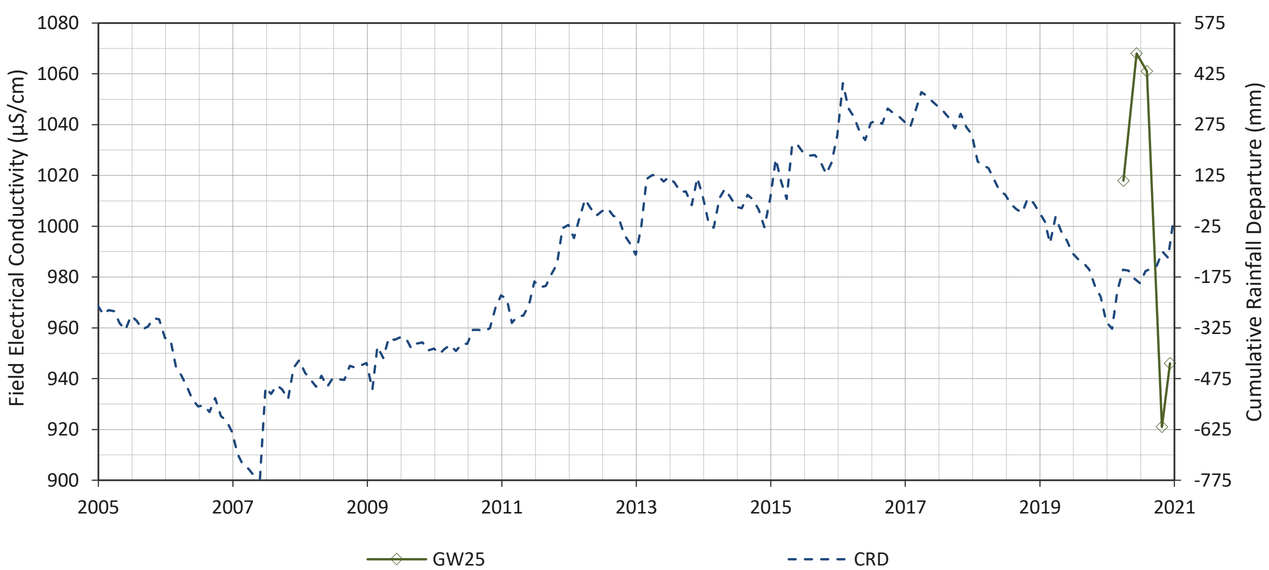
Field pH (pH unit)
Cumulative Rainfall Departure (mm)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW24
CRD

Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
4000
3500
3000
2500
2000
1500
1000
500
0
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW24
CRD

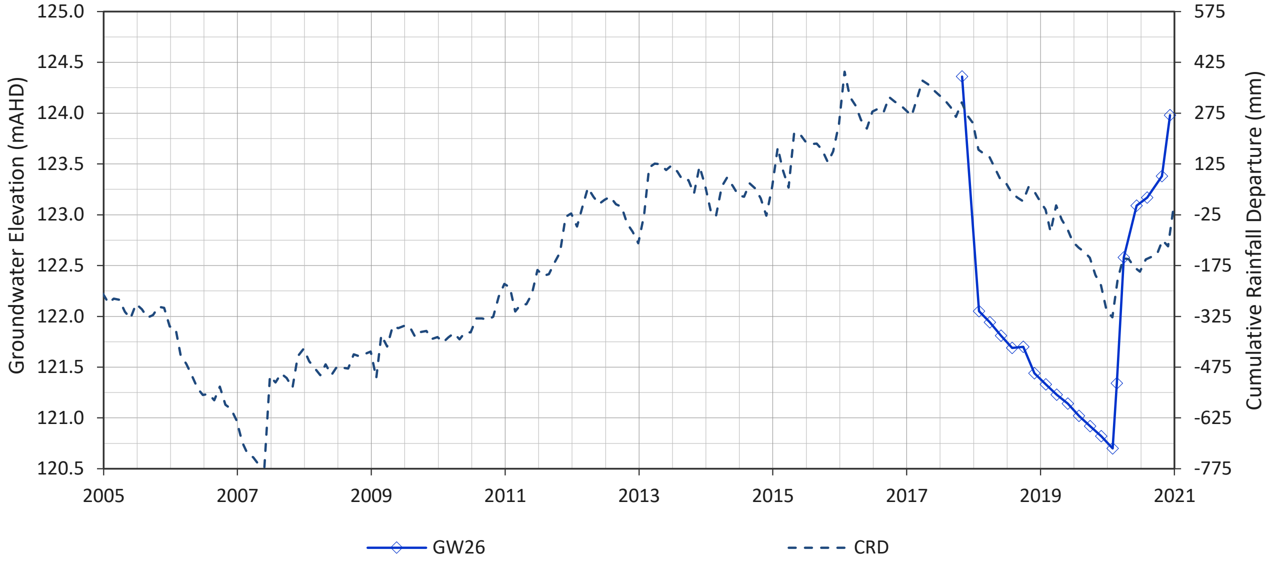
GW25

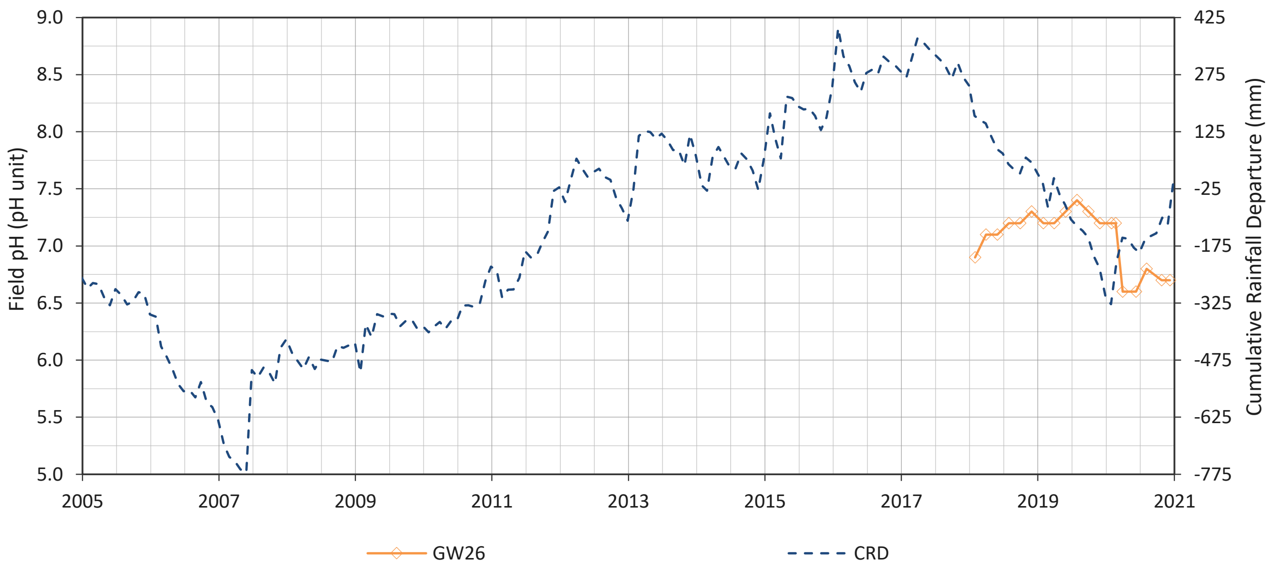

Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
125.8
125.6
125.4
125.2
125.0
124.8
124.6
124.4
124.2
124.0
123.8
123.6
600
475
350
225
100
-25
-150
-275
-400
-525
-650
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW25
CRD


Field pH (pH unit)
Cumulative Rainfall Departure (mm)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW25
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
1080
1060
1040
1020
1000
980
960
940
920
900
575
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW25
CRD

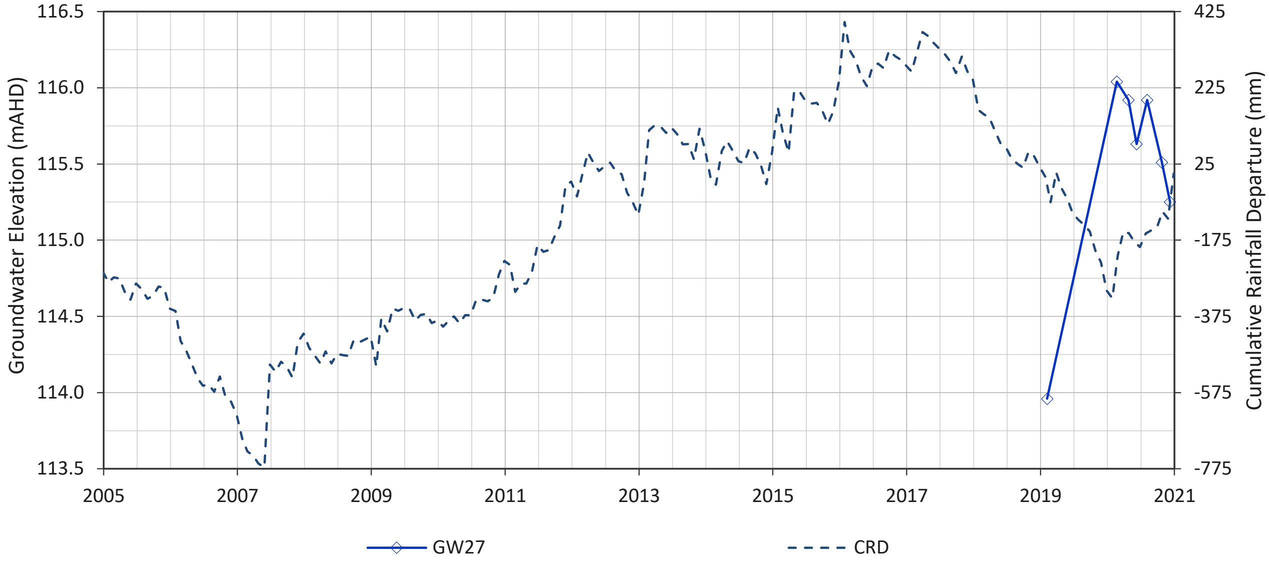
GW26


Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
125.0
124.5
124.0
123.5
123.0
122.5
122.0
121.5
121.0
120.5
575
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW26
CRD

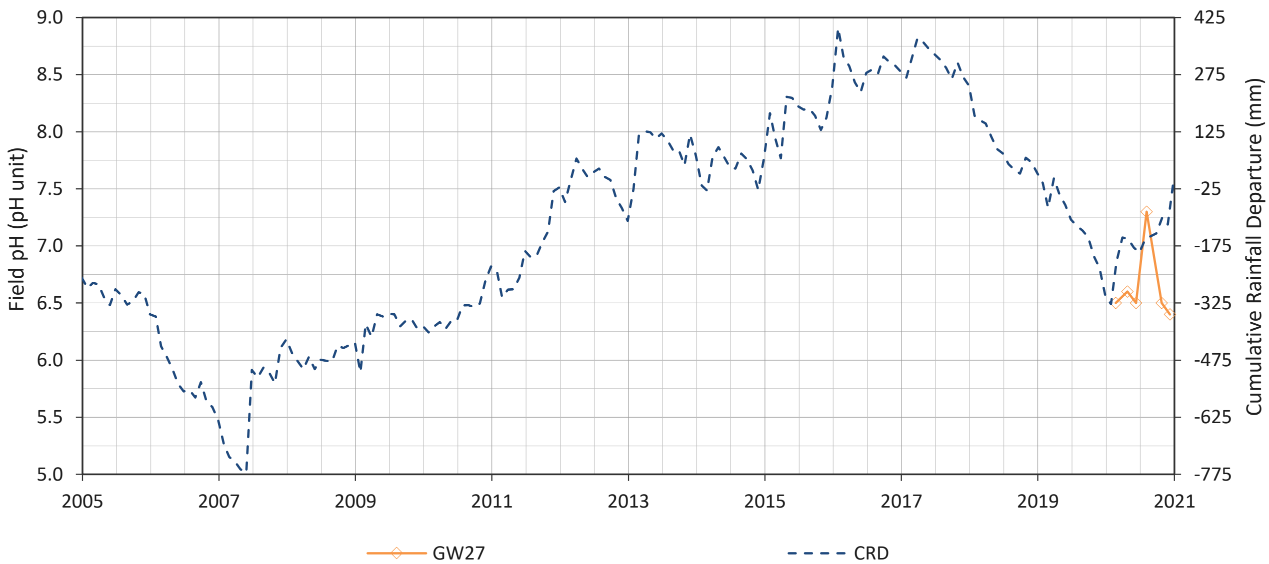

Field pH (pH unit)
Cumulative Rainfall Departure (mm)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW26
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
1600
1400
1200
1000
800
600
400
200
0
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW26
CRD

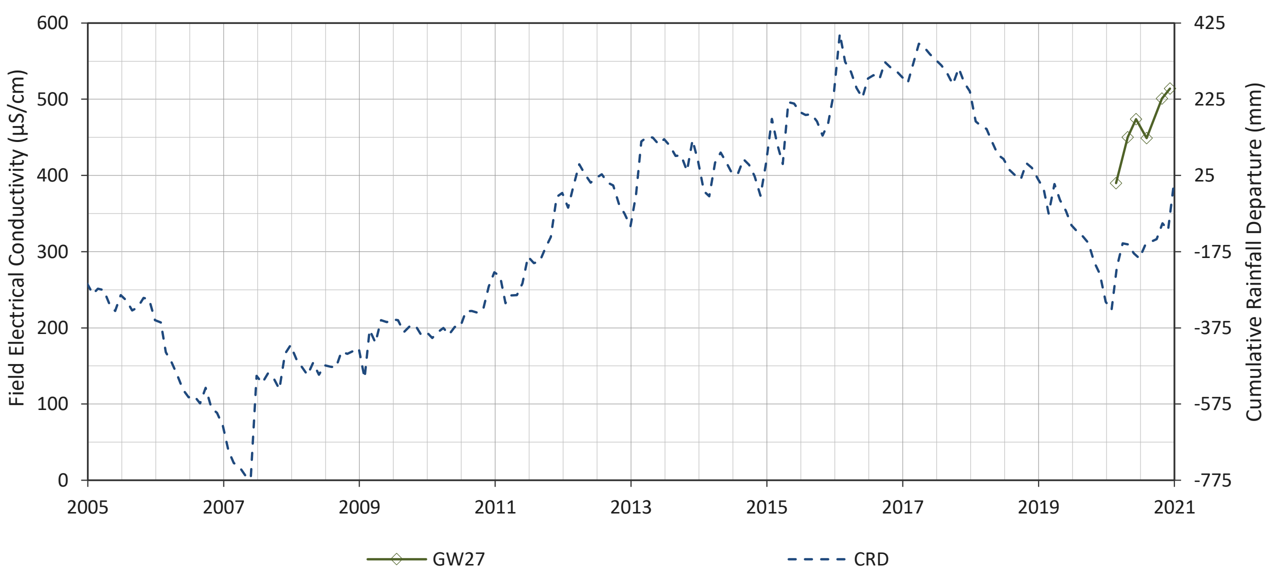
GW27



Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
116.5
116.0
115.5
115.0
114.5
114.0
113.5
425
225
25
-175
-375
-575
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW27
CRD

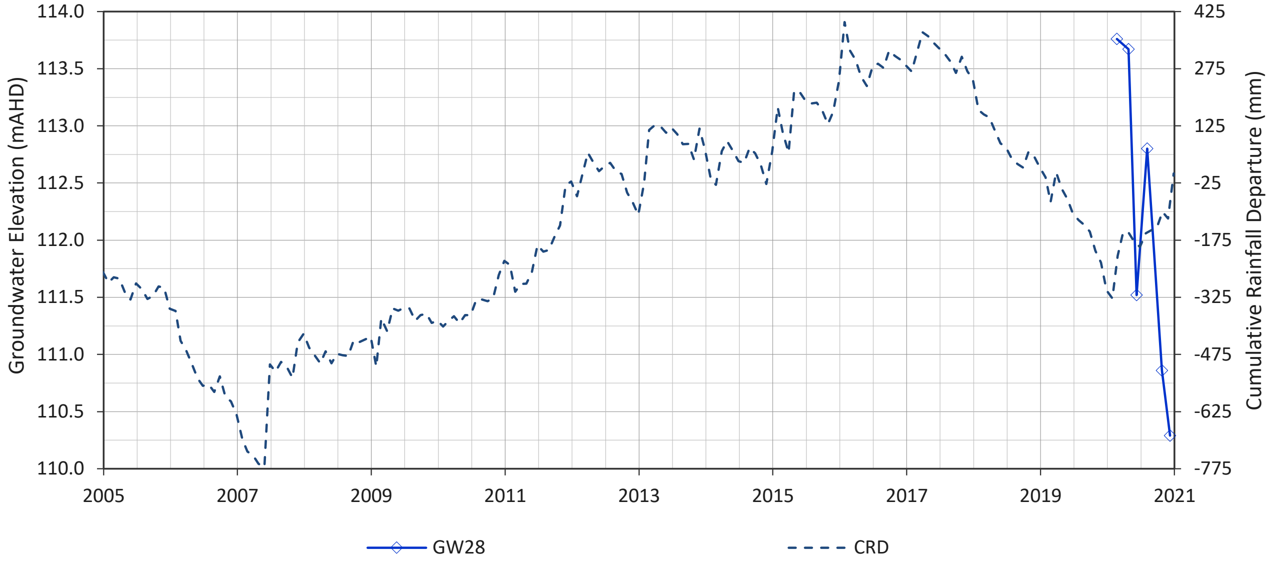


Field pH (pH unit)
Cumulative Rainfall Departure (mm)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW27
CRD

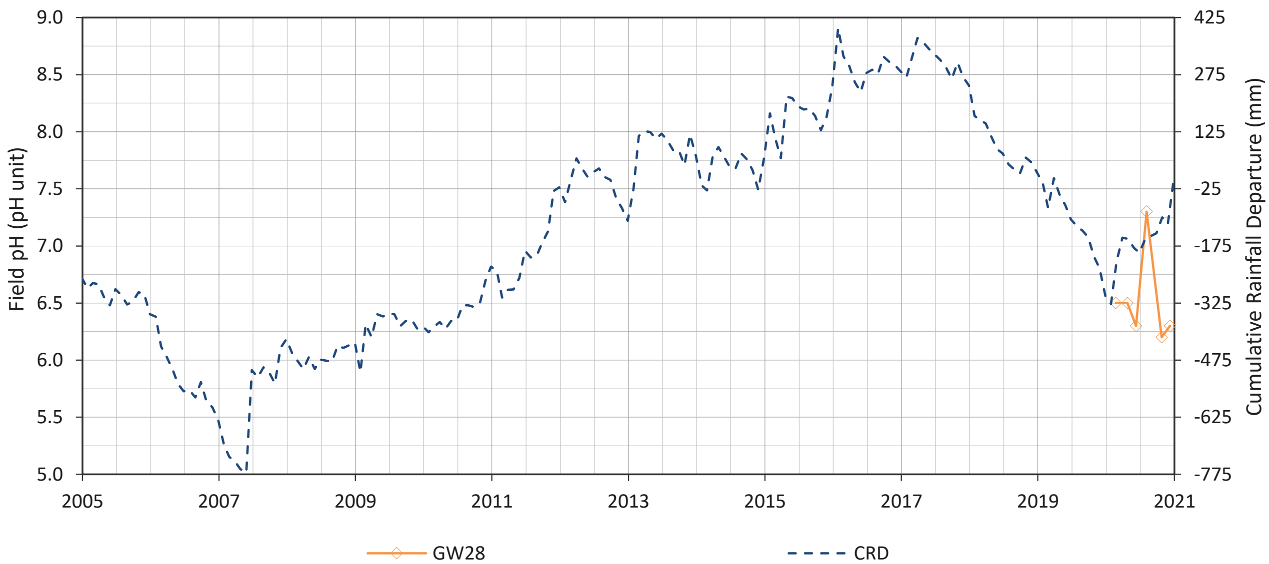


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
600
500
400
300
200
100
0
425
225
25
-175
-375
-575
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW27
CRD

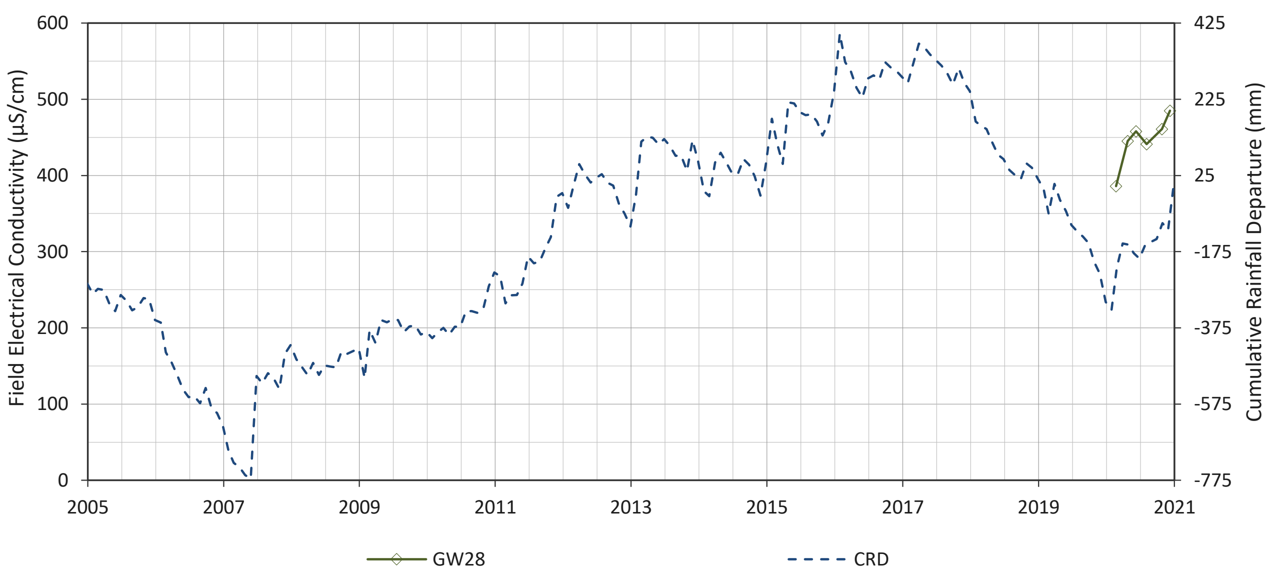
GW28



Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
GW28
CRD

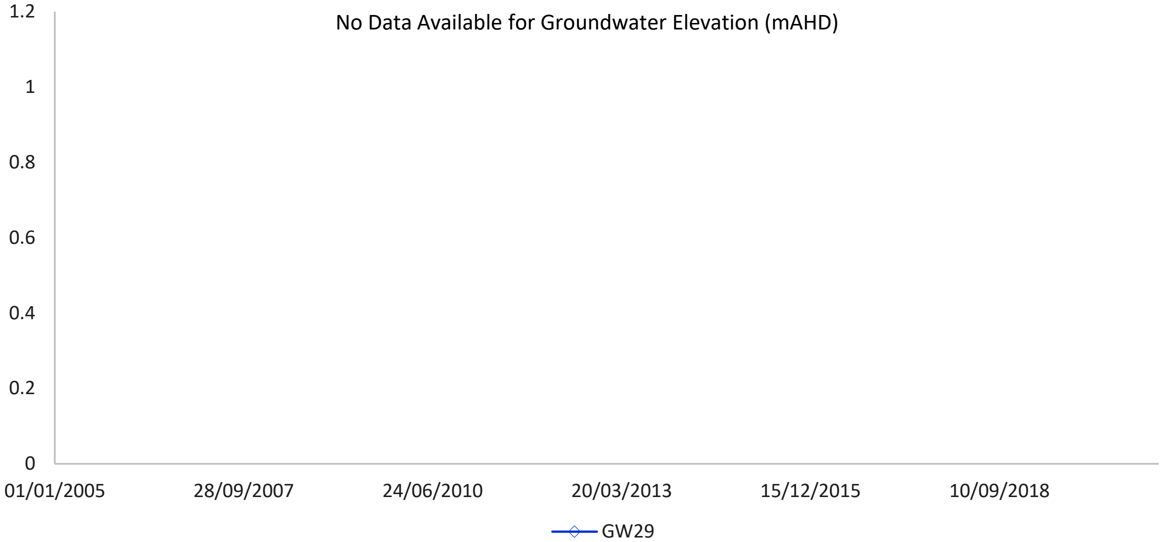


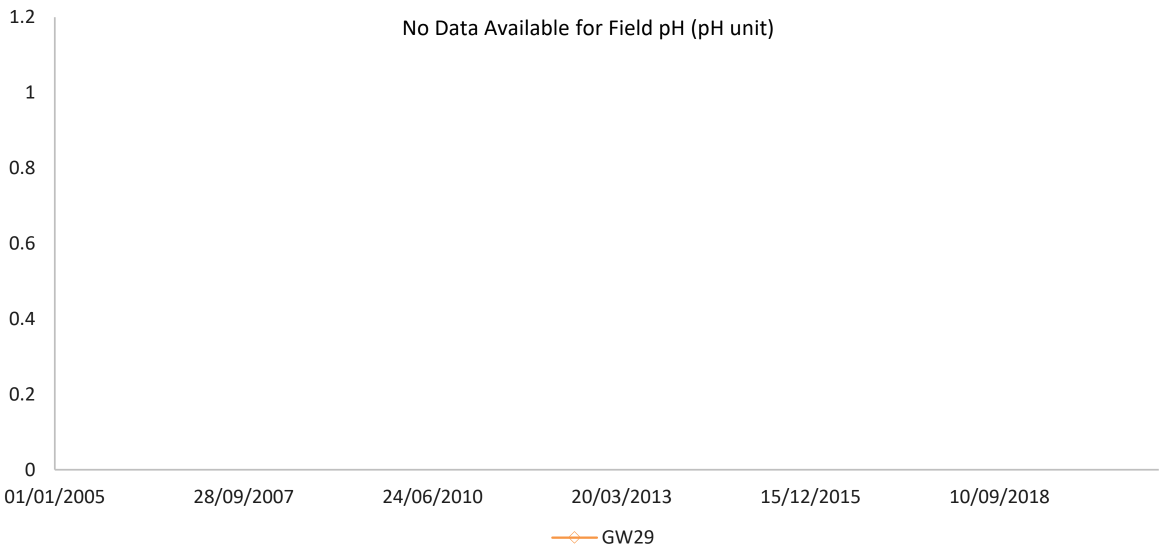
Field pH (pH unit)
Cumulative Rainfall Departure (mm)
GW28
CRD

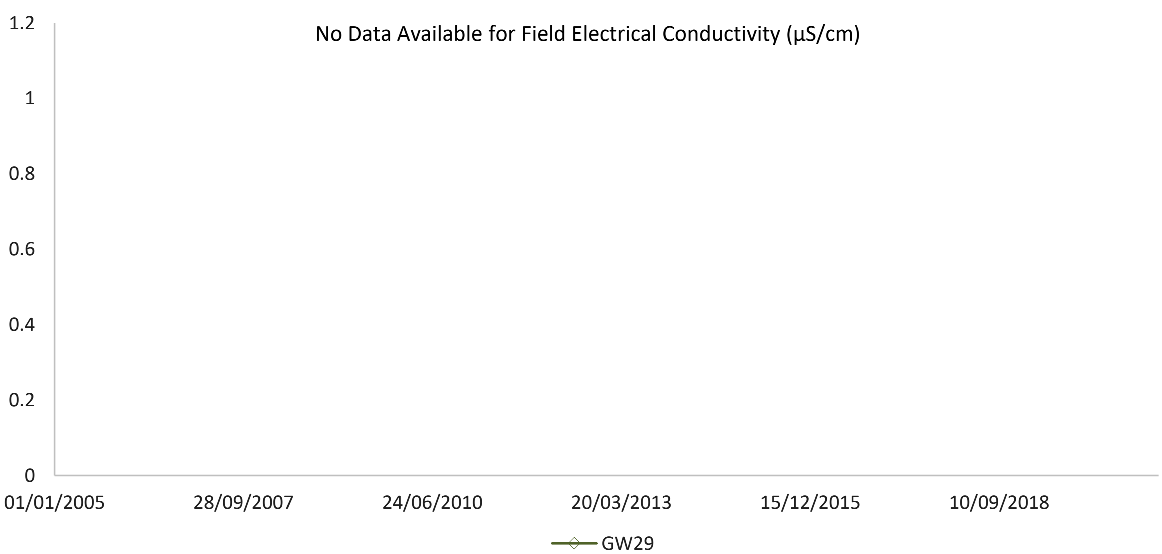


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
GW28
CRD

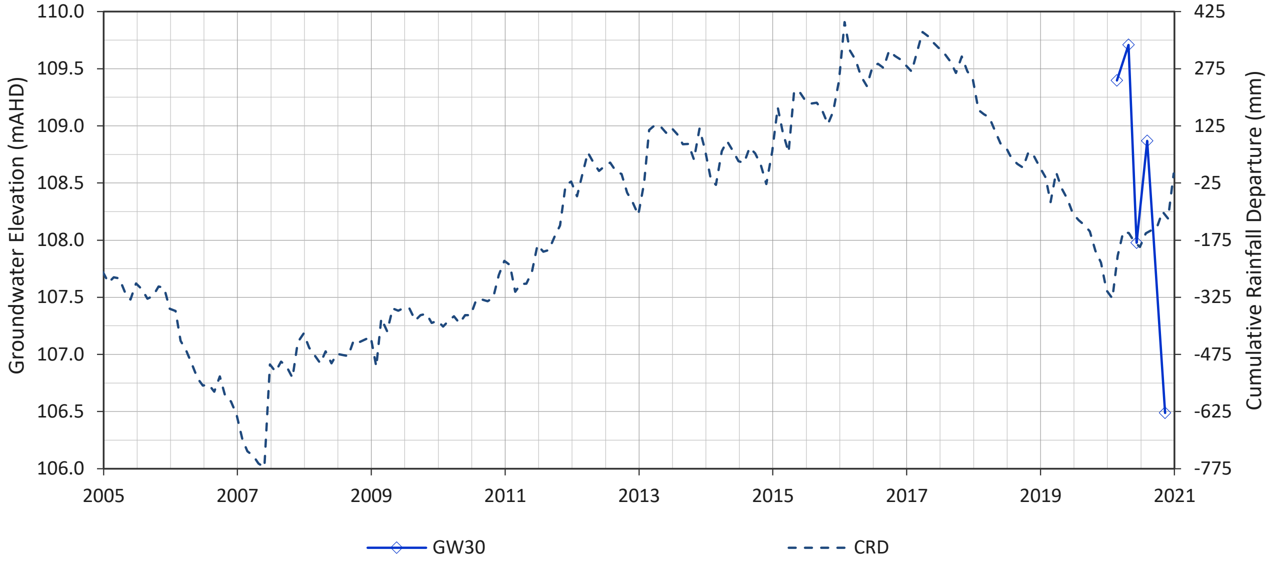
GW29

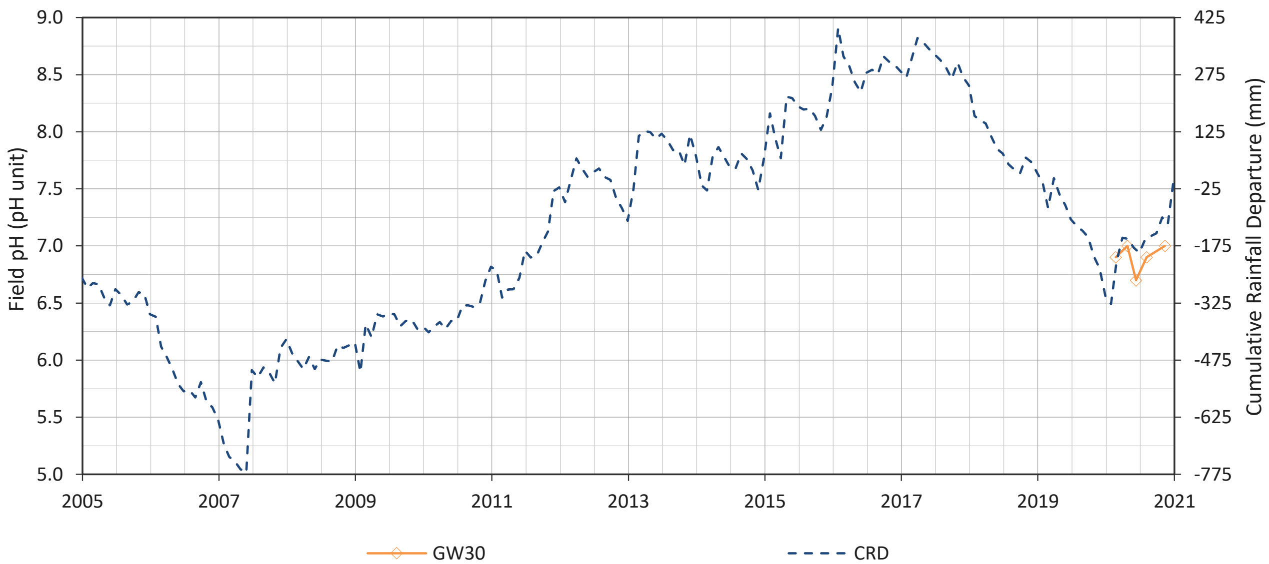

No Data Available for Groundwater Elevation (mAHD)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
GW29

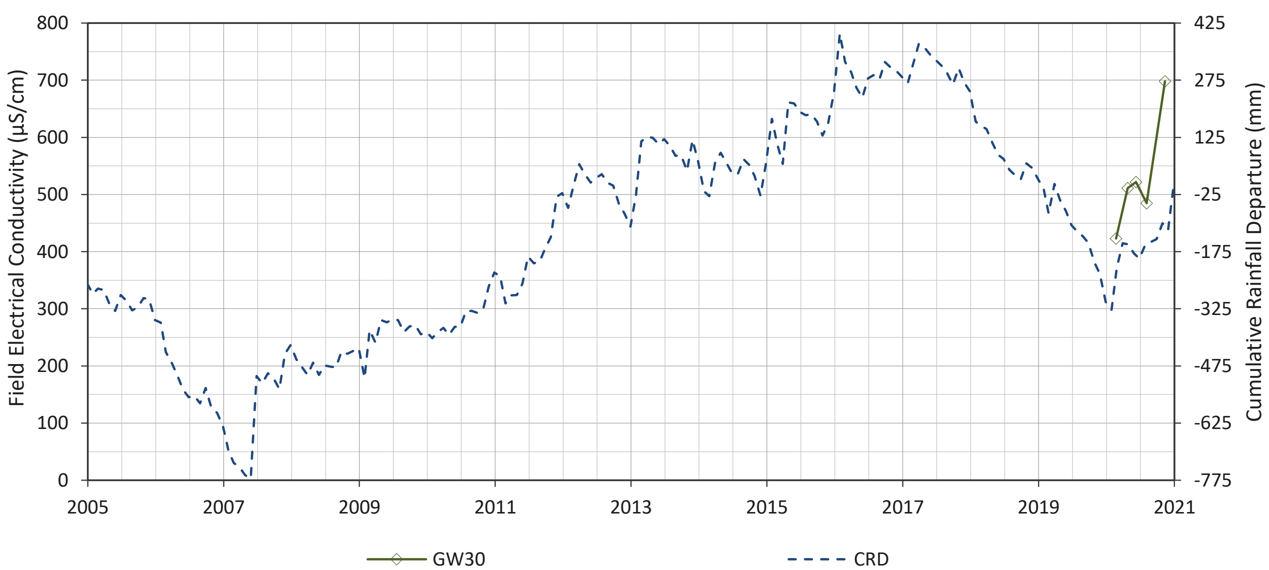

No Data Available for Field pH (pH unit)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
GW29


No Data Available for Field Electrical Conductivity (µS/cm)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
GW29

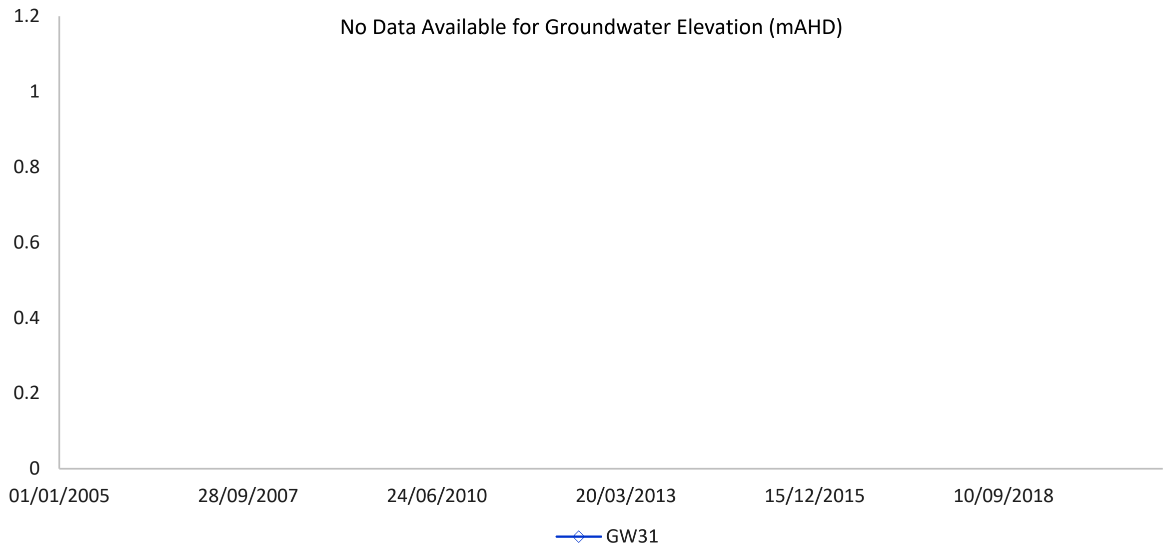
GW30

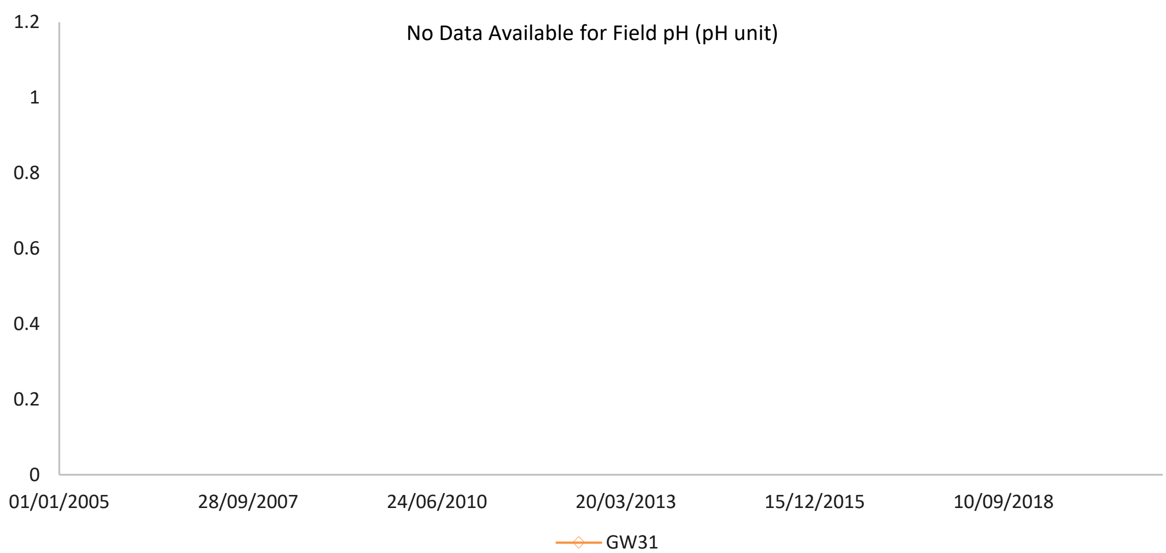

Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
110.0
109.5
109.0
108.5
108.0
107.5
107.0
106.5
106.0
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW30
CRD

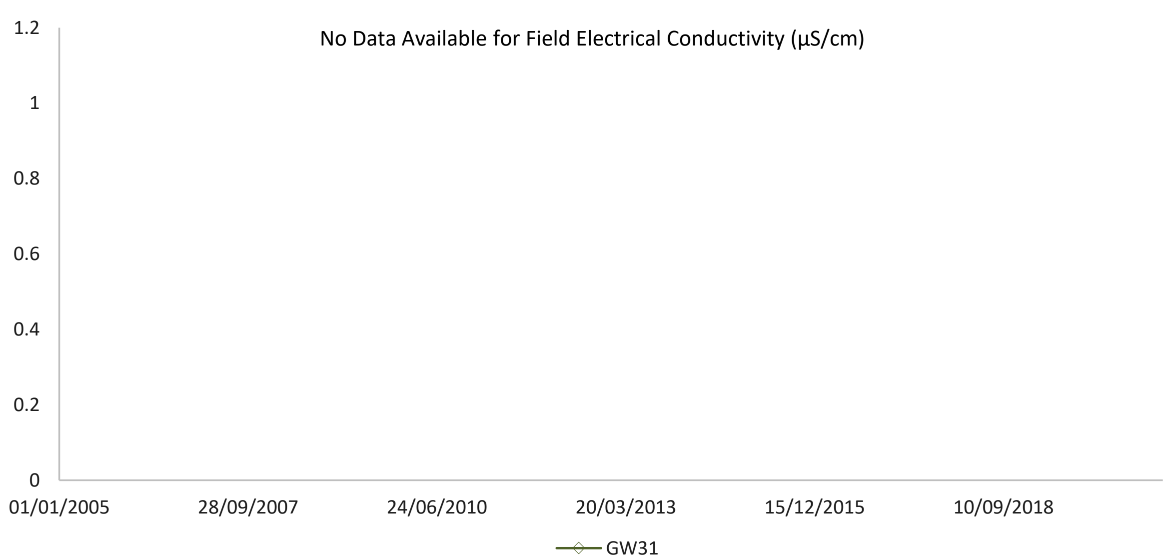

Field pH (pH unit)
Cumulative Rainfall Departure (mm)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW30
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
800
700
600
500
400
300
200
100
0
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW30
CRD

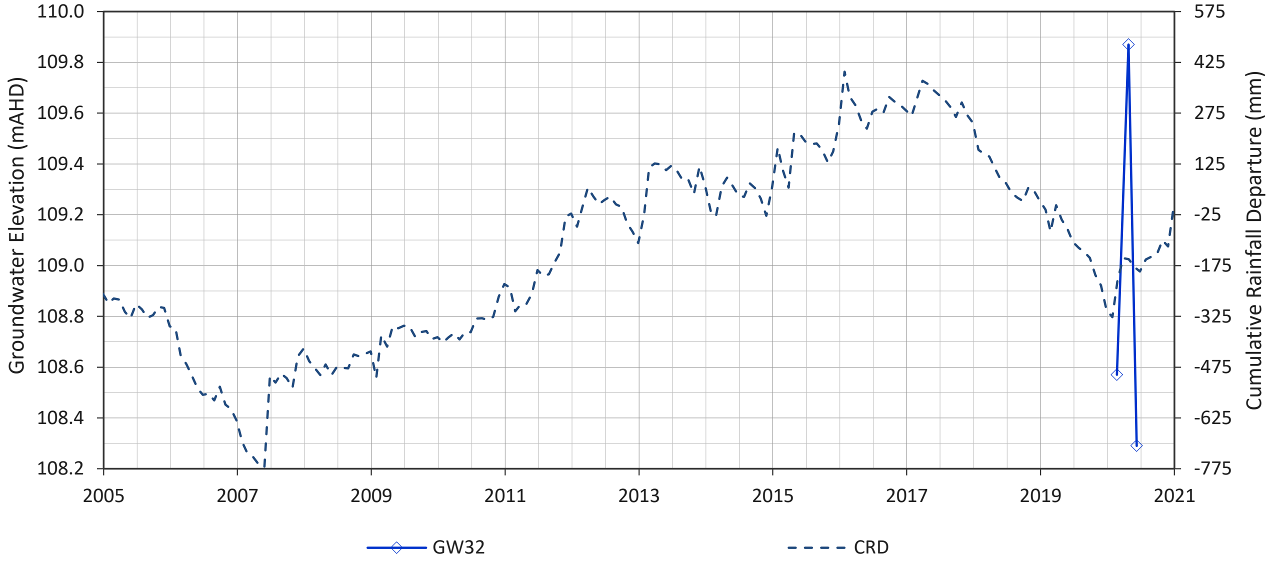
GW31

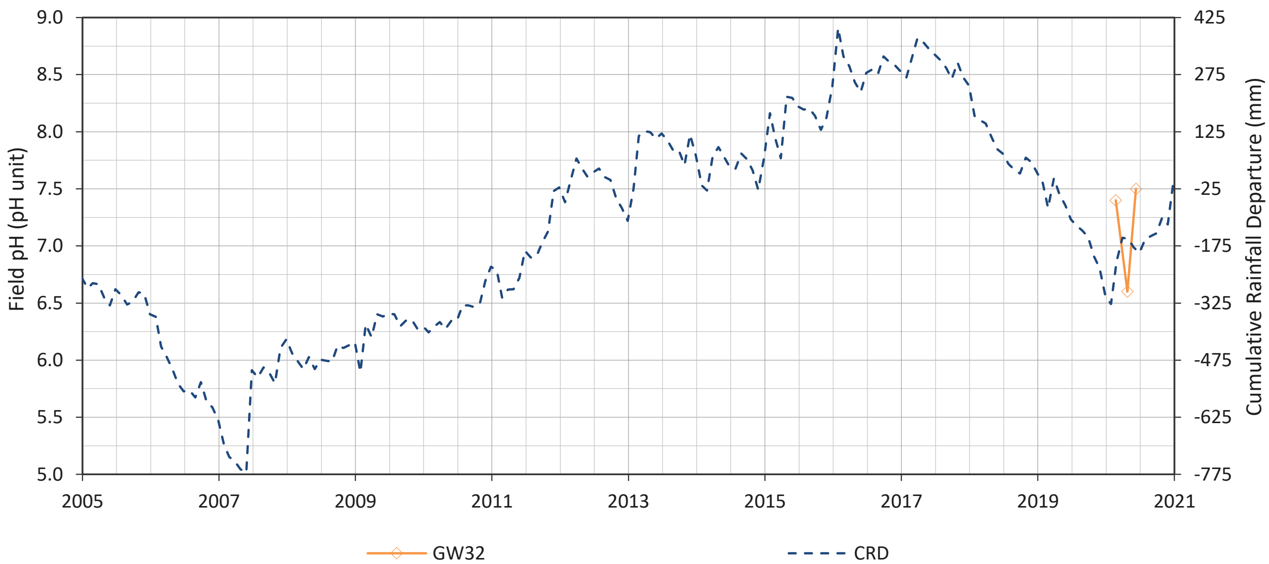

No Data Available for Groundwater Elevation (mAHD)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
GW31

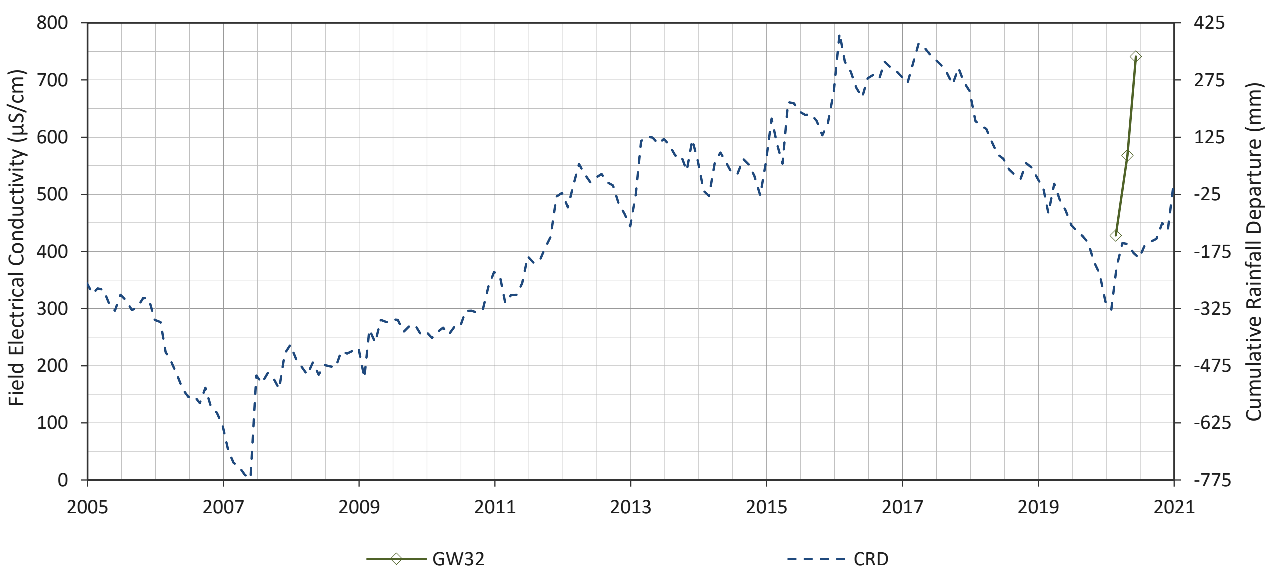

No Data Available for Field pH (pH unit)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
GW31


No Data Available for Field Electrical Conductivity (µS/cm)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
GW31

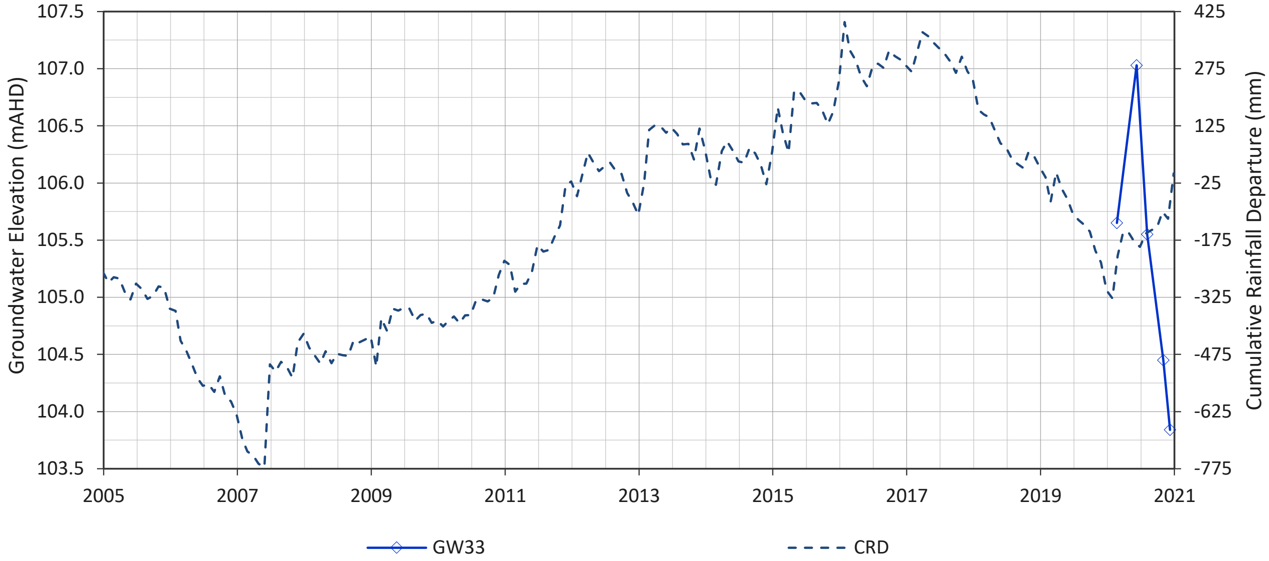
GW32

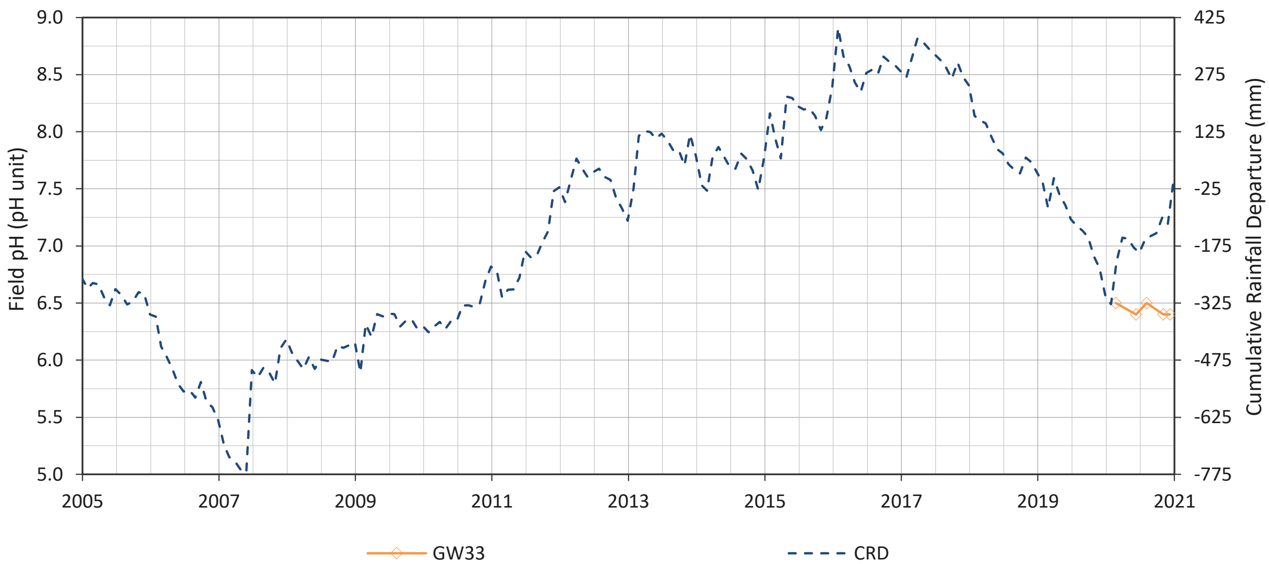

Groundwater Elevation (mAHD)
110.0
109.8
109.6
109.4
109.2
109.0
108.8
108.6
108.4
108.2
Cumulative Rainfall Departure (mm)
575
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW32
CRD

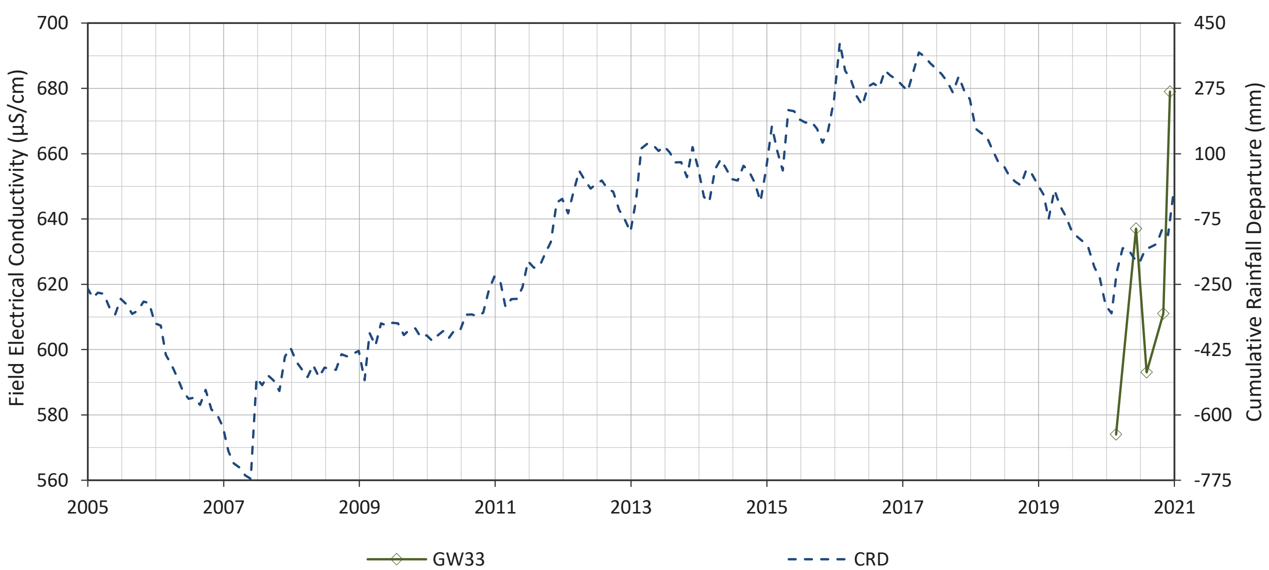

Field pH (pH unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
Cumulative Rainfall Departure (mm)
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW32
CRD


Field Electrical Conductivity (µS/cm)
800
700
600
500
400
300
200
100
0
Cumulative Rainfall Departure (mm)
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW32
CRD

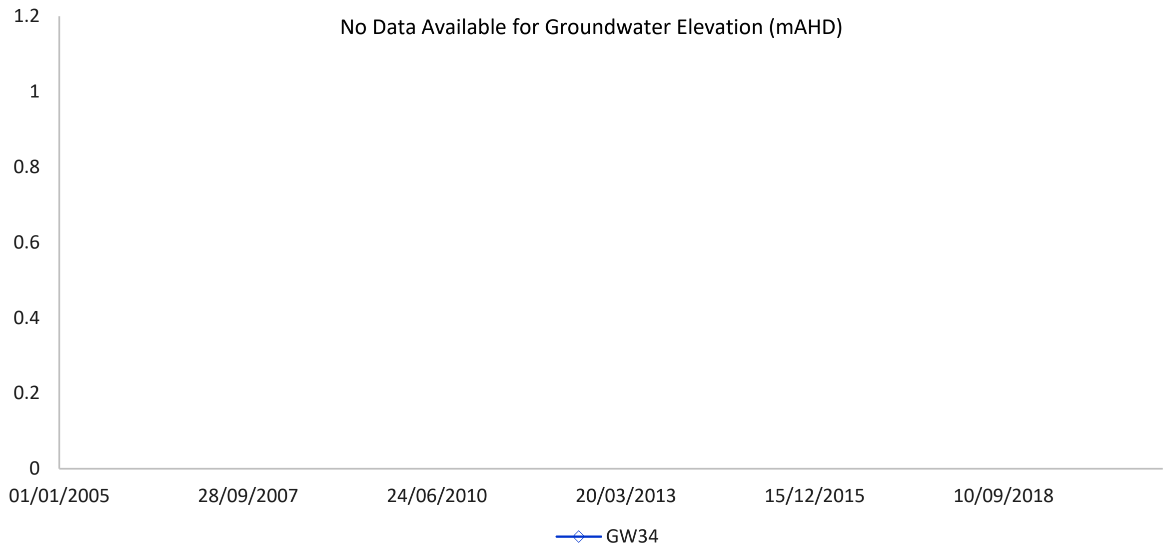
GW33

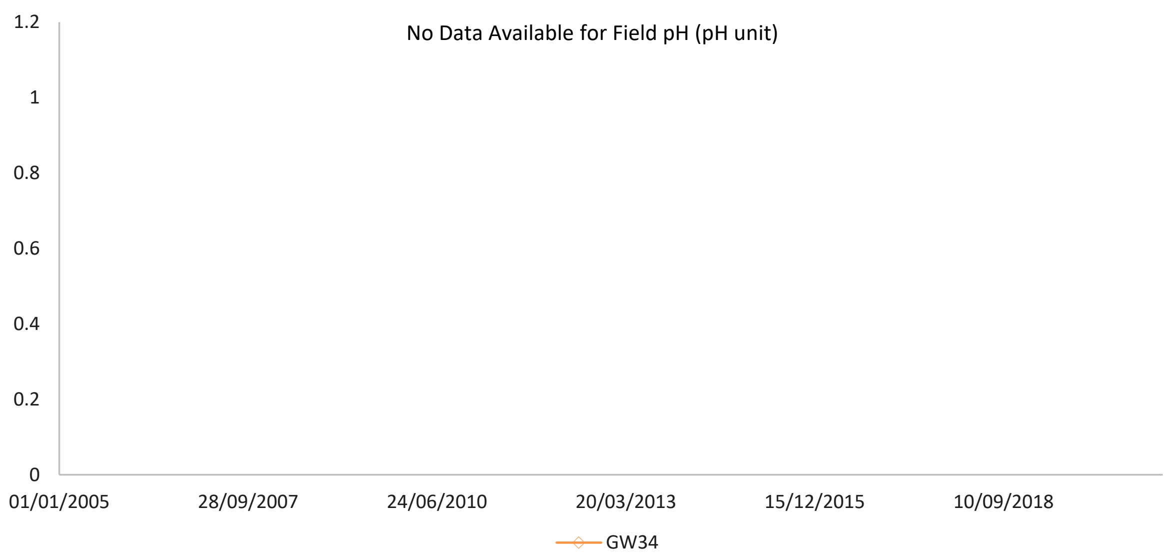

Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
107.5
107.0
106.5
106.0
105.5
105.0
104.5
104.0
103.5
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW33
CRD

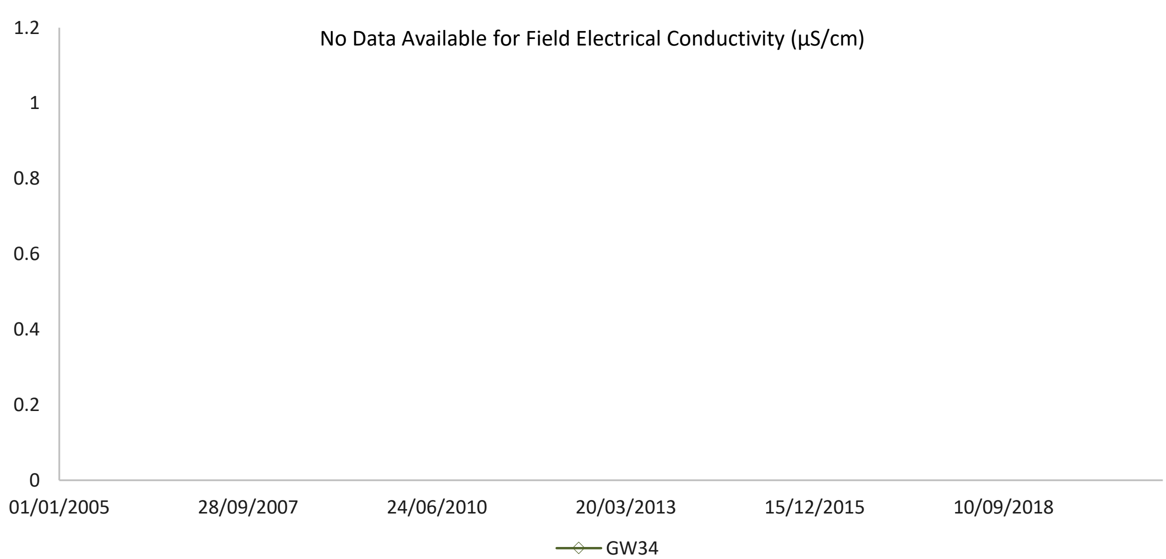

Field pH (pH unit)
Cumulative Rainfall Departure (mm)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW33
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
700
680
660
640
620
600
580
560
450
275
100
-75
-250
-425
-600
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW33
CRD

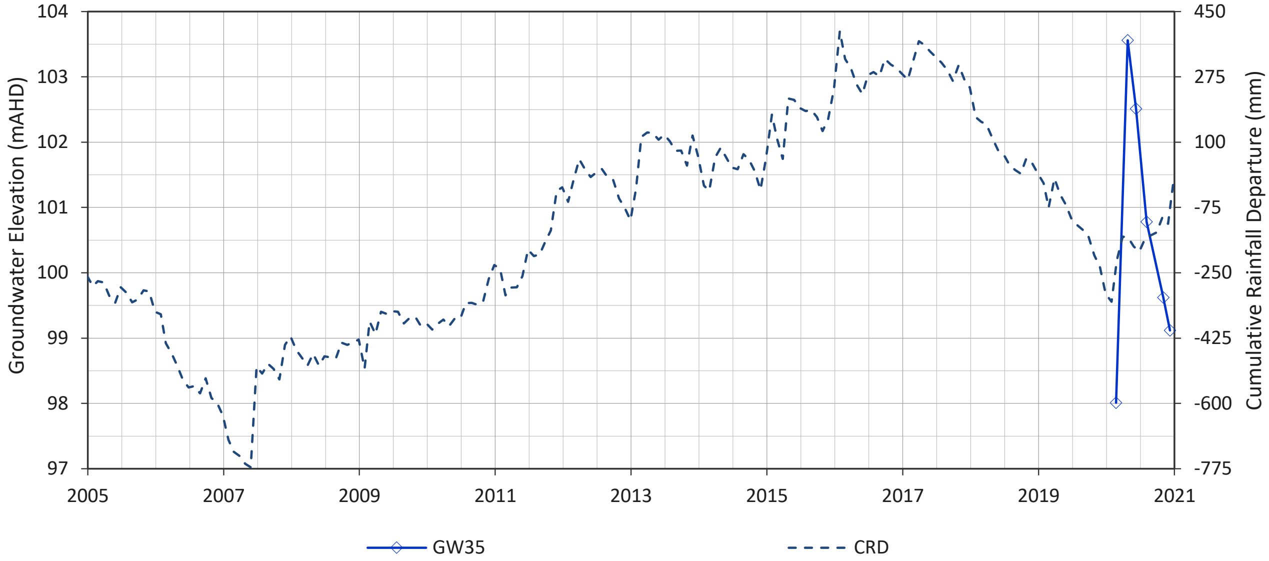
GW34


No Data Available for Groundwater Elevation (mAHD)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
GW34

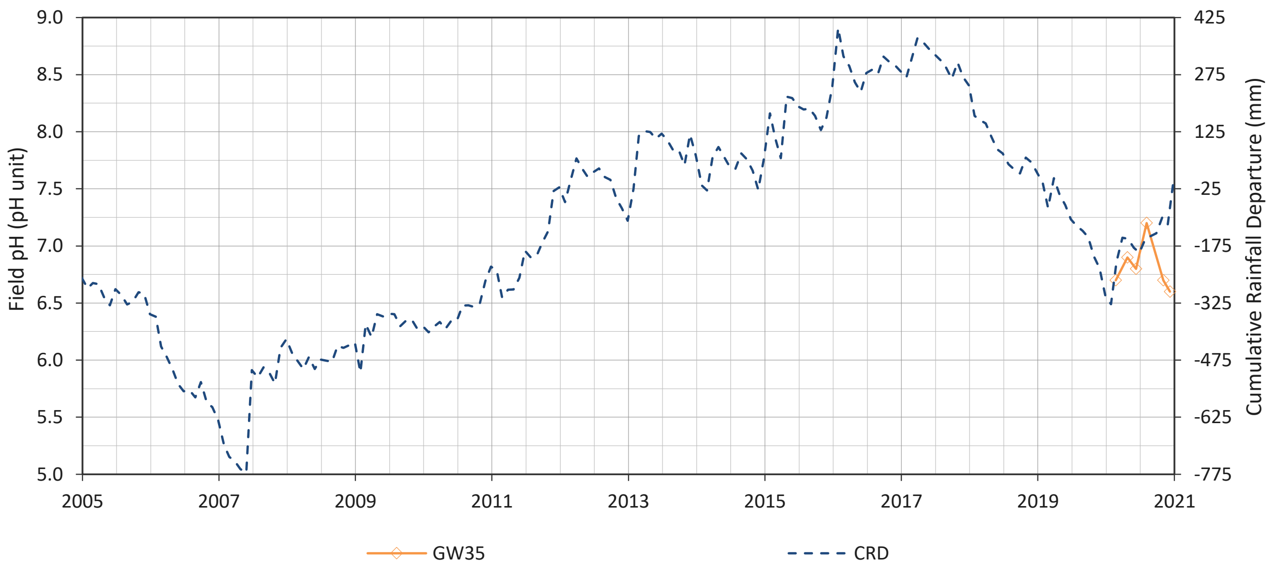

No Data Available for Field pH (pH unit)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
GW34


No Data Available for Field Electrical Conductivity (µS/cm)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
GW34

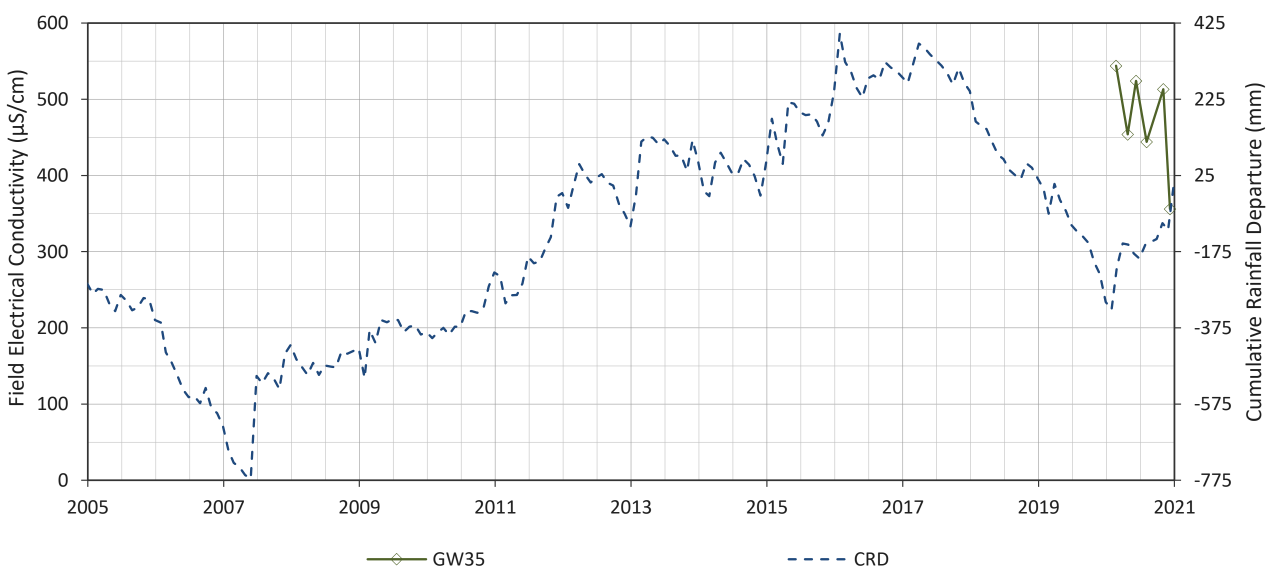
GW35



Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
104
103
102
101
100
99
98
97
450
275
100
-75
-250
-425
-600
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW35
CRD

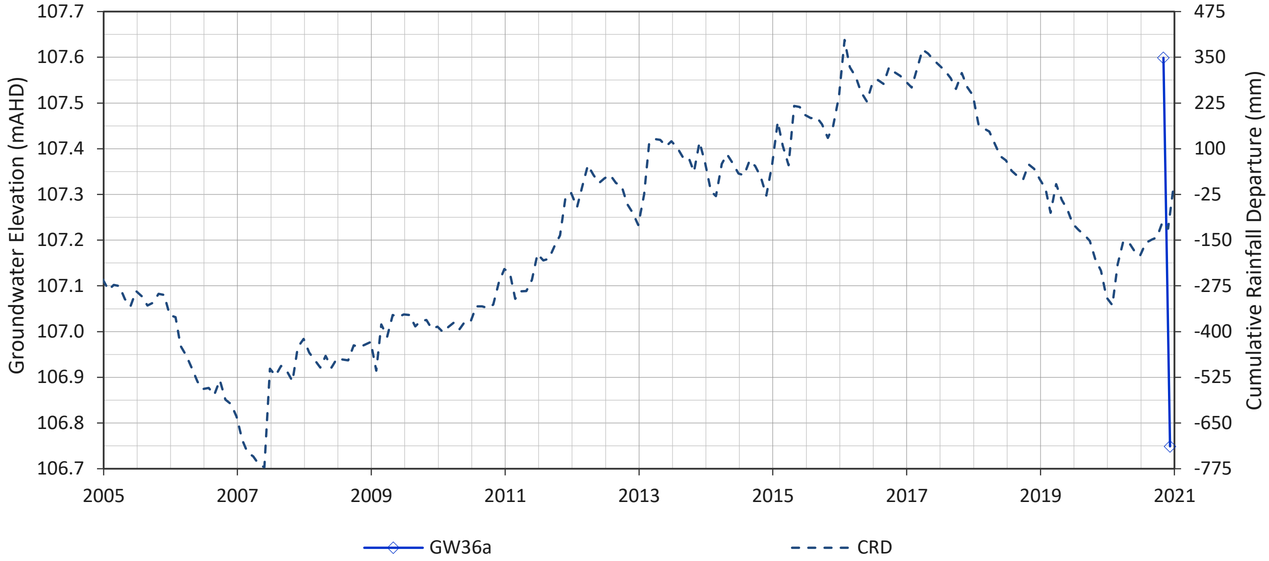


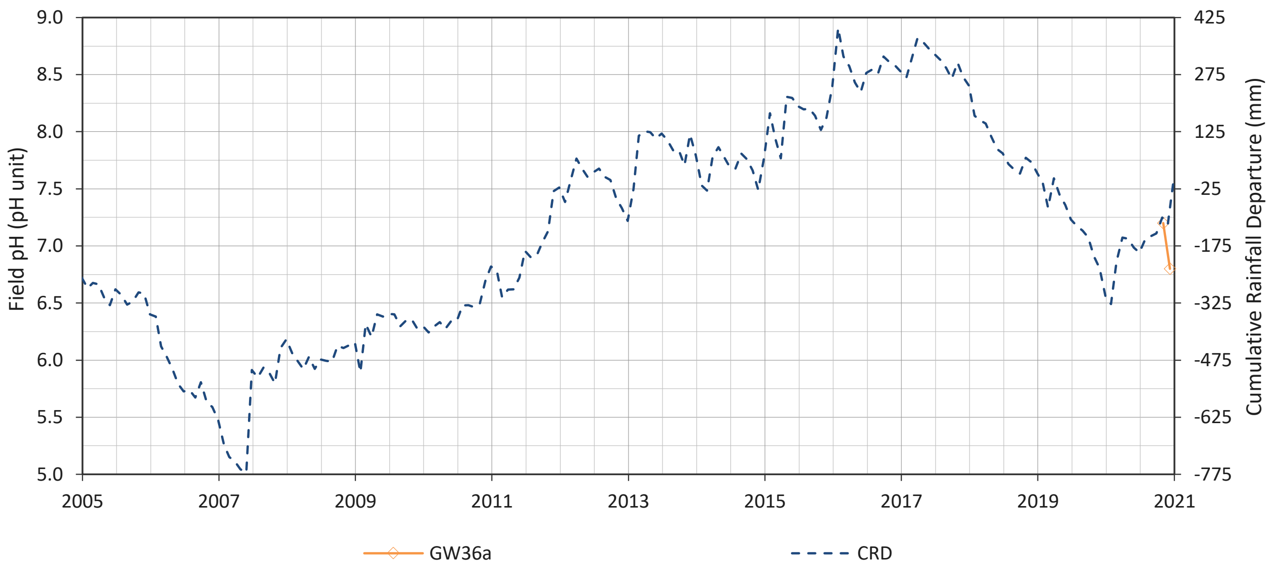
Field pH (pH unit)
Cumulative Rainfall Departure (mm)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW35
CRD



Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
600
500
400
300
200
100
0
425
225
25
-175
-375
-575
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW35
CRD

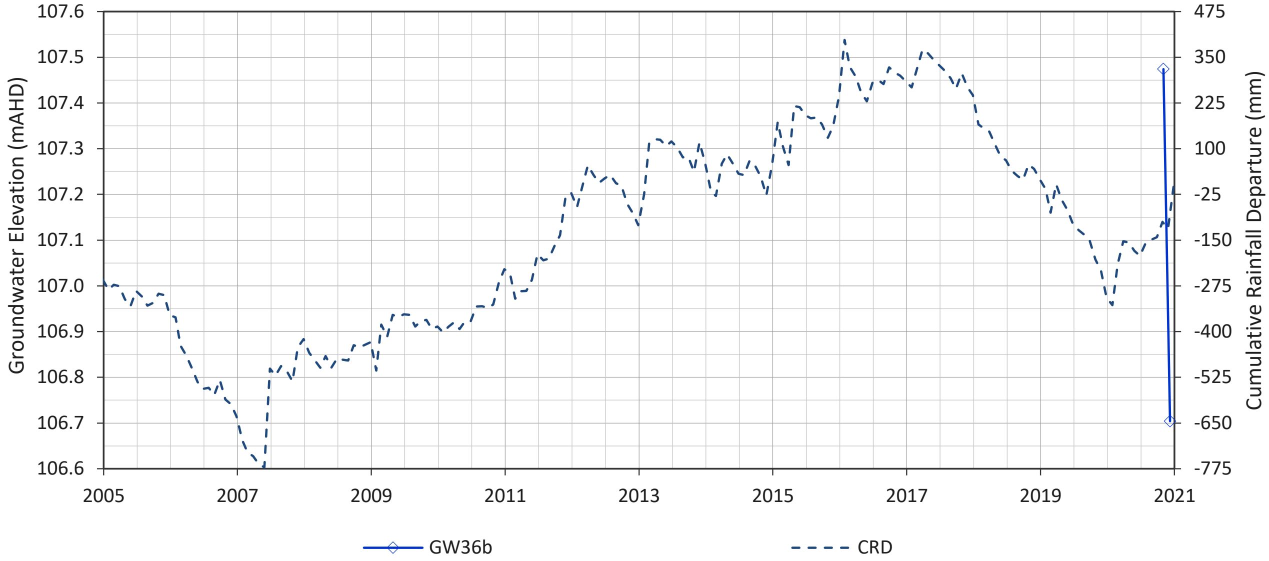
GW36a


Groundwater Elevation (mAHD)
107.7
107.6
107.5
107.4
107.3
107.2
107.1
107.0
106.9
106.8
106.7
Cumulative Rainfall Departure (mm)
475
350
225
100
-25
-150
-275
-400
-525
-650
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW36a
CRD

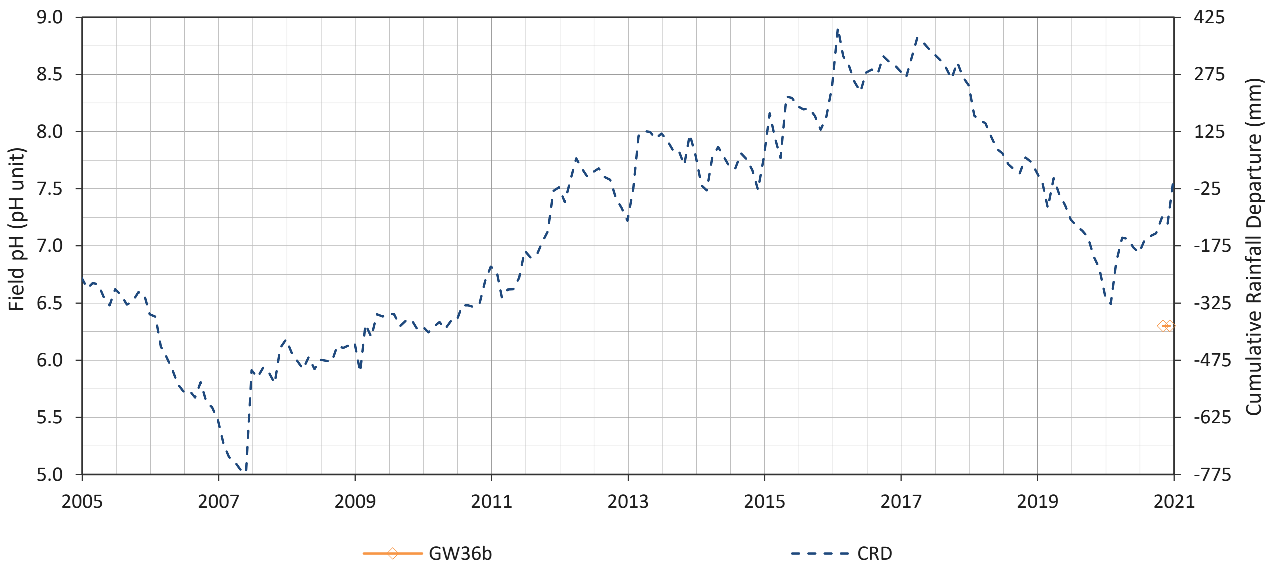

Field pH (pH unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
Cumulative Rainfall Departure (mm)
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW36a
CRD


Field Electrical Conductivity (µS/cm)
3000
2990
2980
2970
2960
2950
2940
2930
2920
2910
2900
2890
Cumulative Rainfall Departure (mm)
600
475
350
225
100
-25
-150
-275
-400
-525
-650
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW36a
CRD

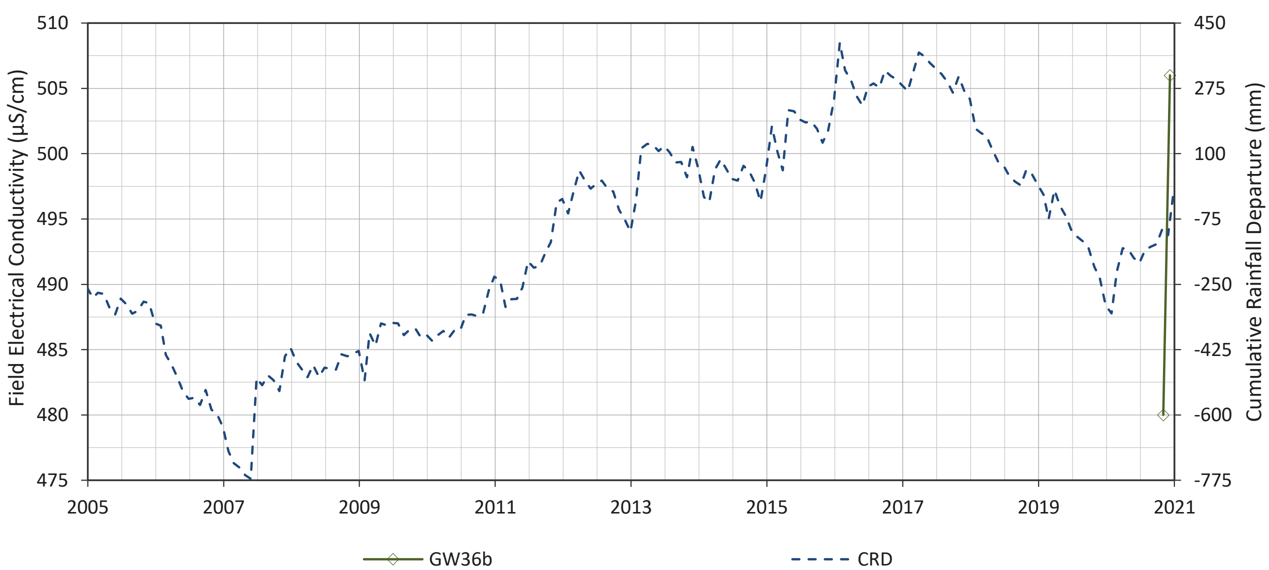
GW36b



Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
107.6
107.5
107.4
107.3
107.2
107.1
107.0
106.9
106.8
106.7
106.6
475
350
225
100
-25
-150
-275
-400
-525
-650
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW36b
CRD

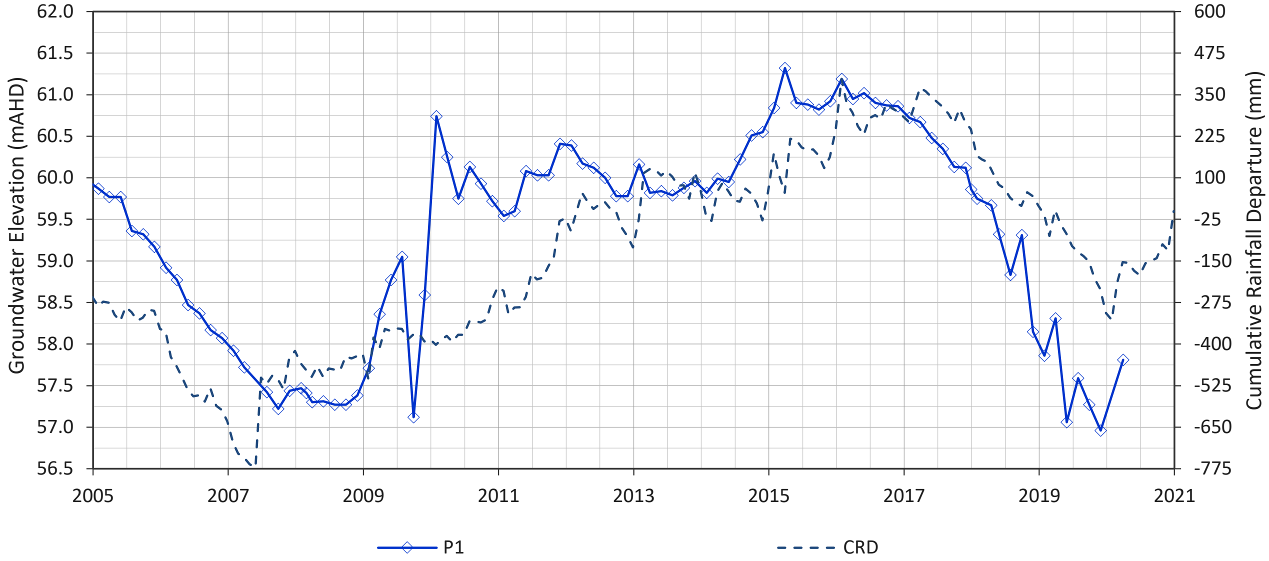


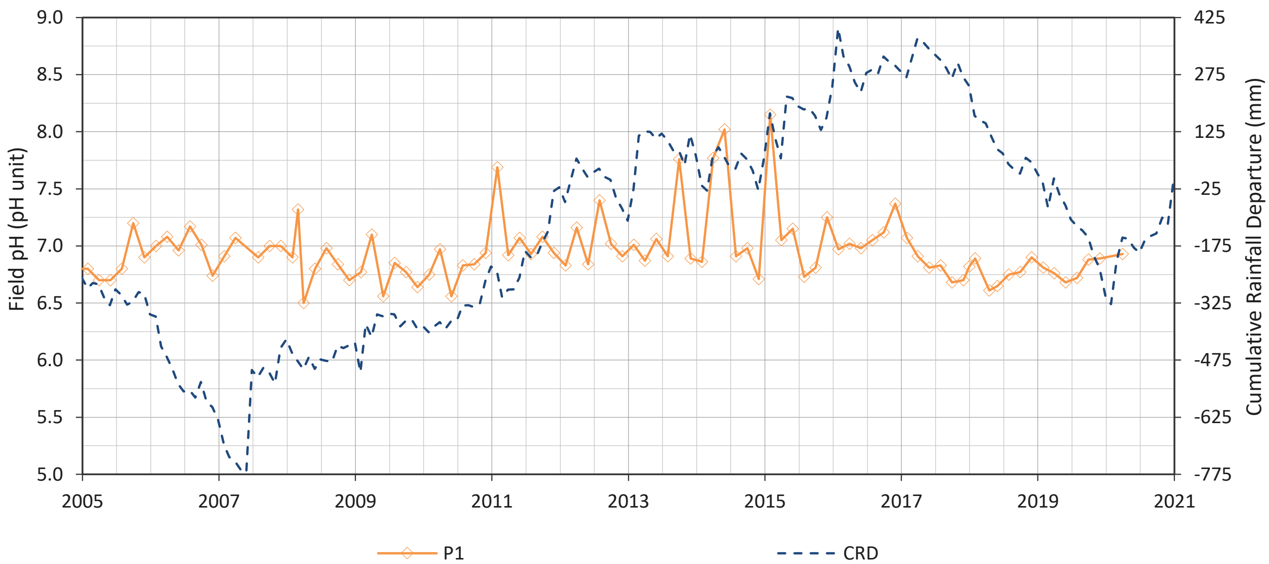
Field pH (pH unit)
Cumulative Rainfall Departure (mm)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW36b
CRD

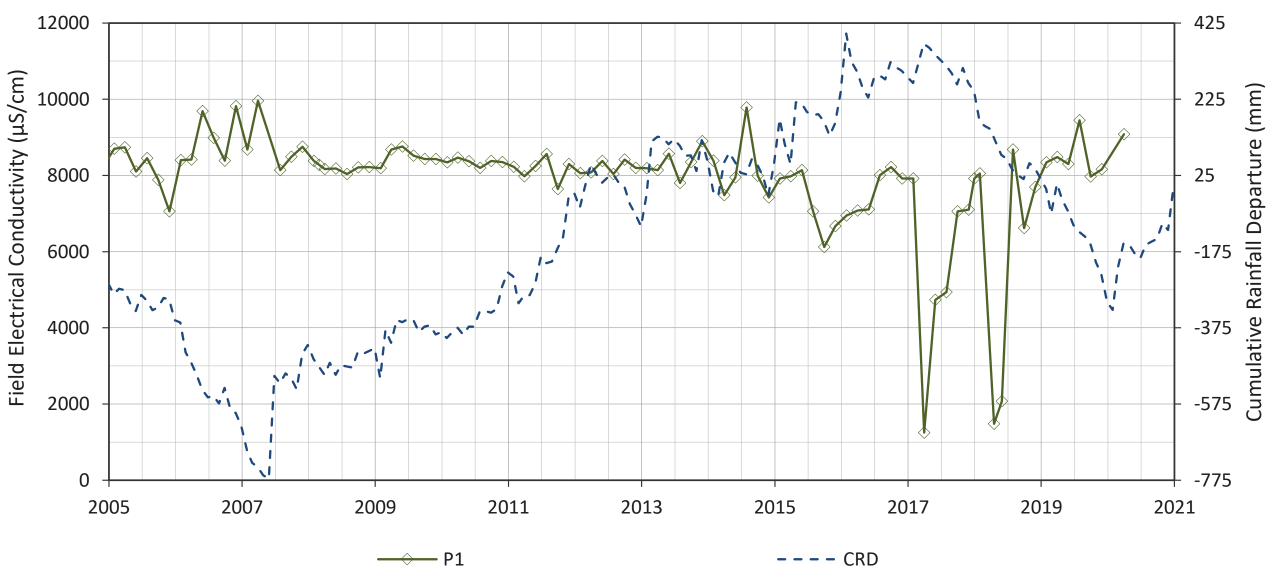


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
510
505
500
495
490
485
480
475
450
275
100
-75
-250
-425
-600
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
GW36b
CRD

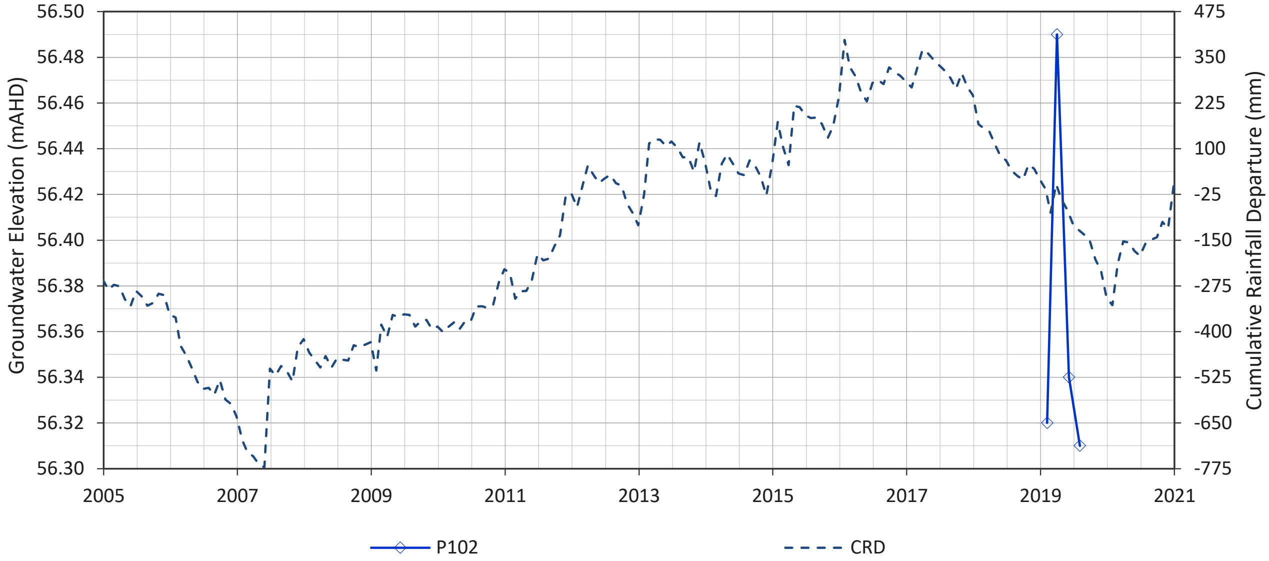
P1


Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
P1
CRD

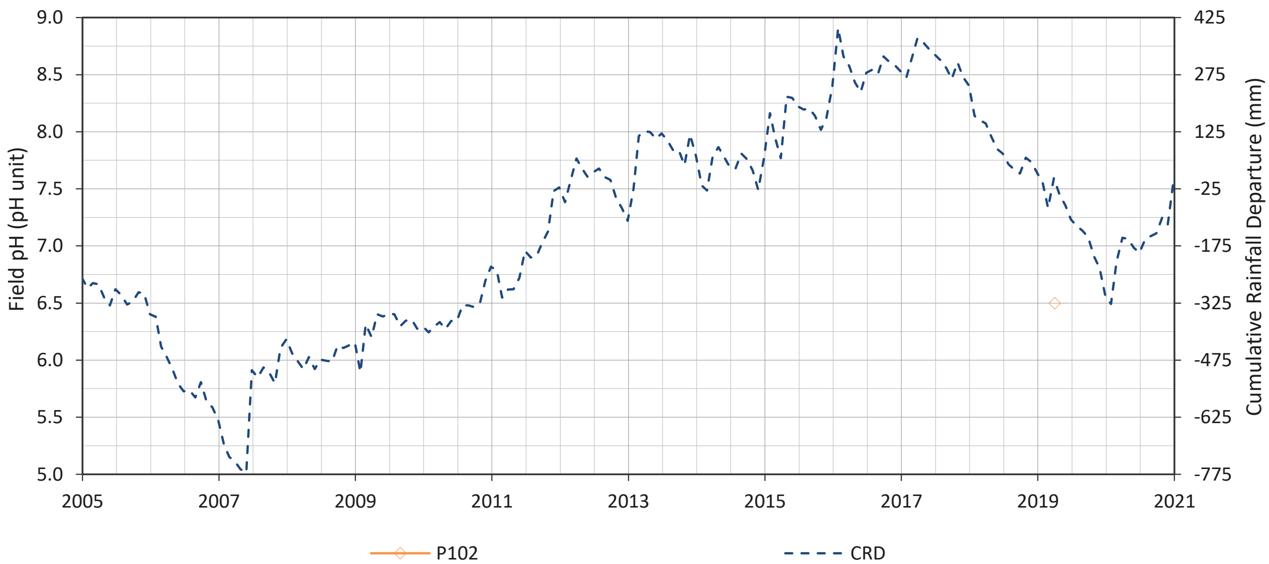

Field pH (pH unit)
Cumulative Rainfall Departure (mm)
P1
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
P1
CRD

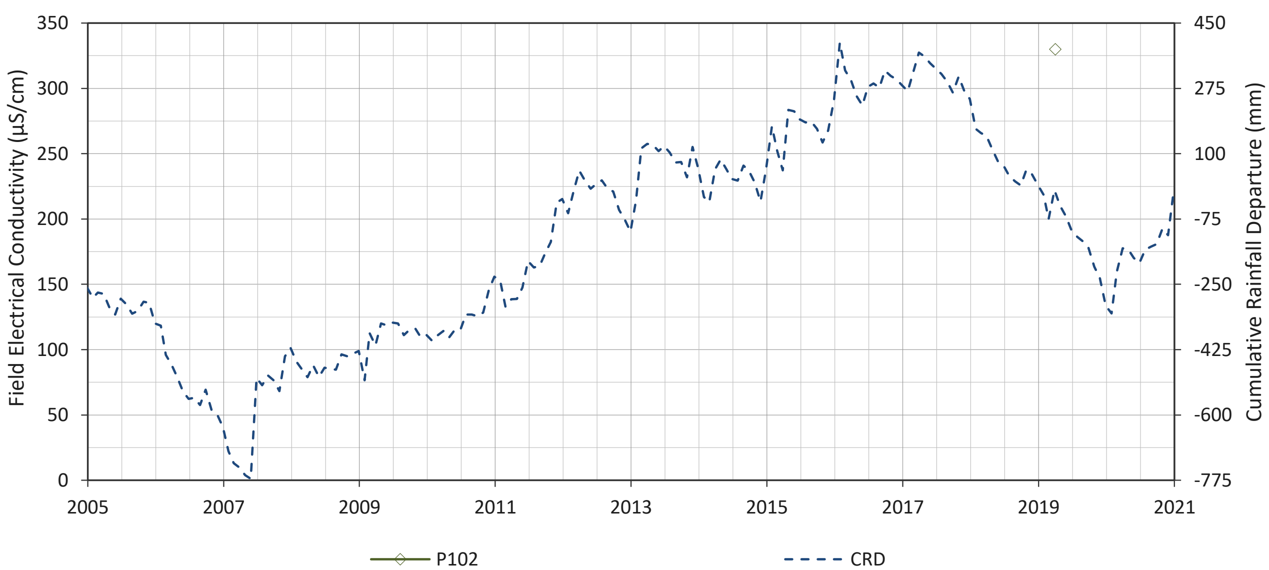
P102



Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
56.50
56.48
56.46
56.44
56.42
56.40
56.38
56.36
56.34
56.32
56.30
475
350
225
100
-25
-150
-275
-400
-525
-650
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P102
CRD

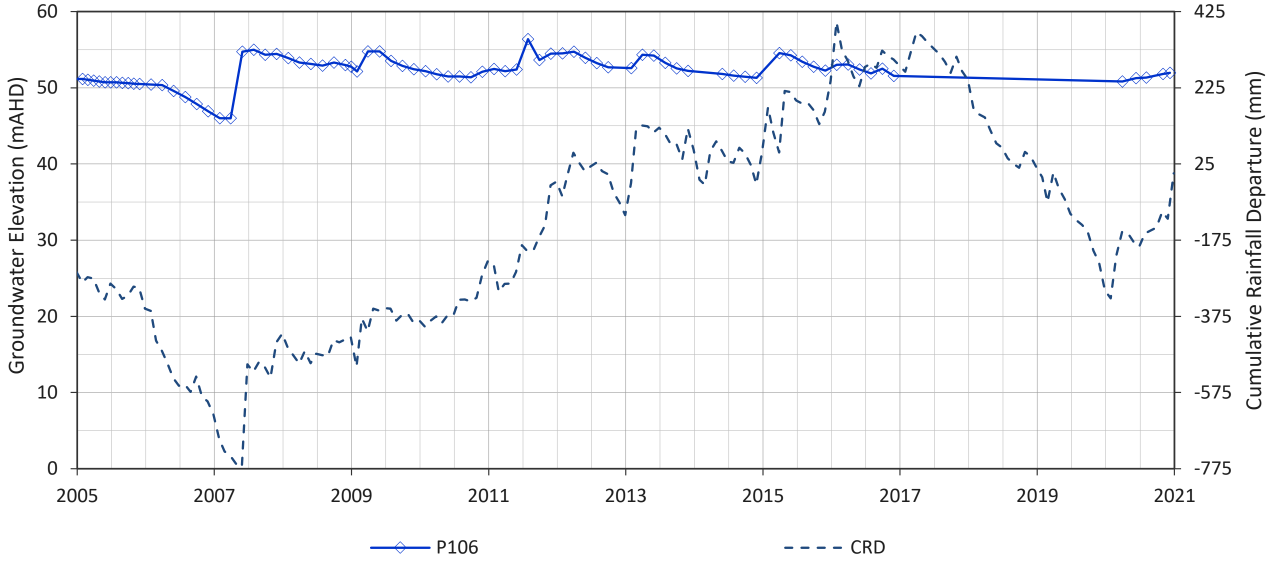


Field pH (pH unit)
Cumulative Rainfall Departure (mm)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P102
CRD

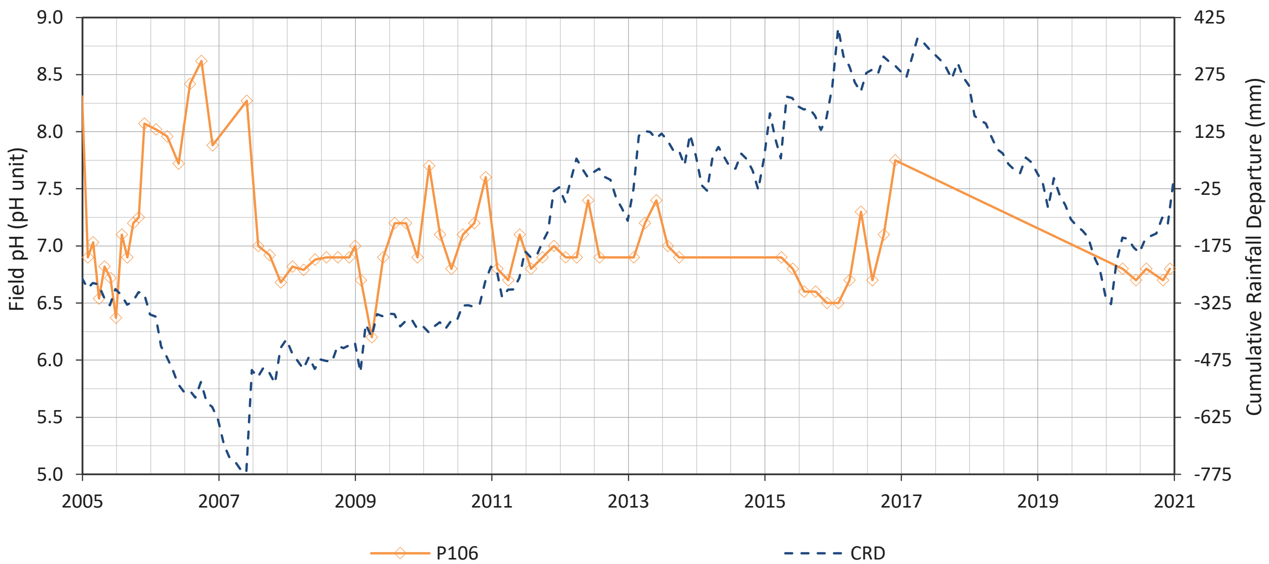


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
350
300
250
200
150
100
50
0
450
275
100
-75
-250
-425
-600
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P102
CRD

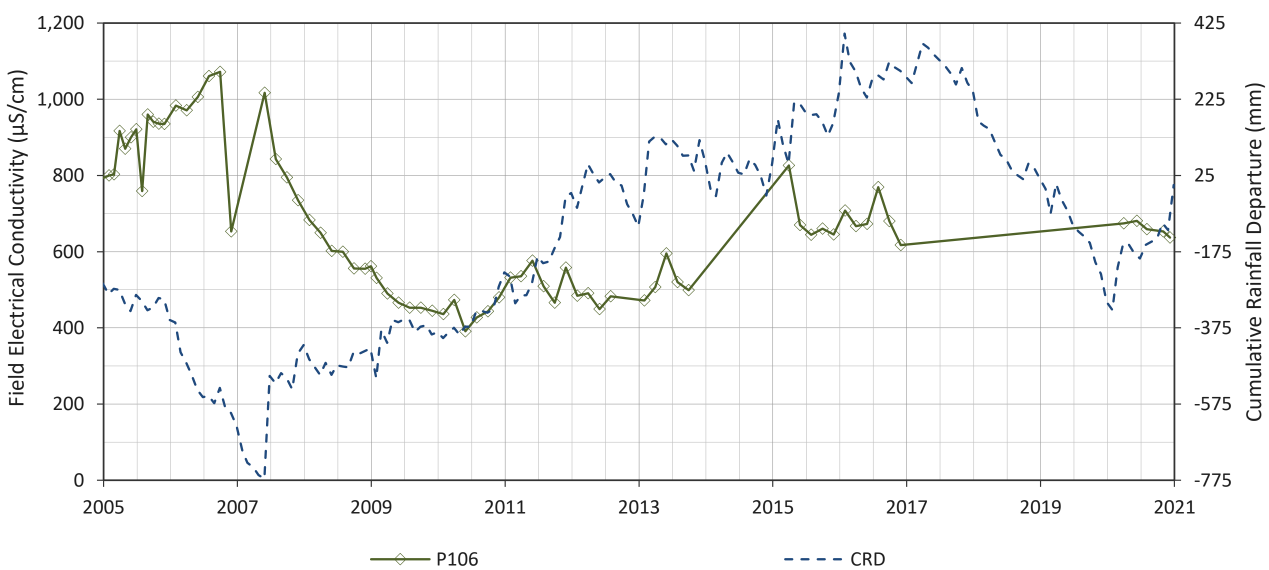
P106



Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
60
50
40
30
20
10
0
425
225
25
-175
-375
-575
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P106
CRD

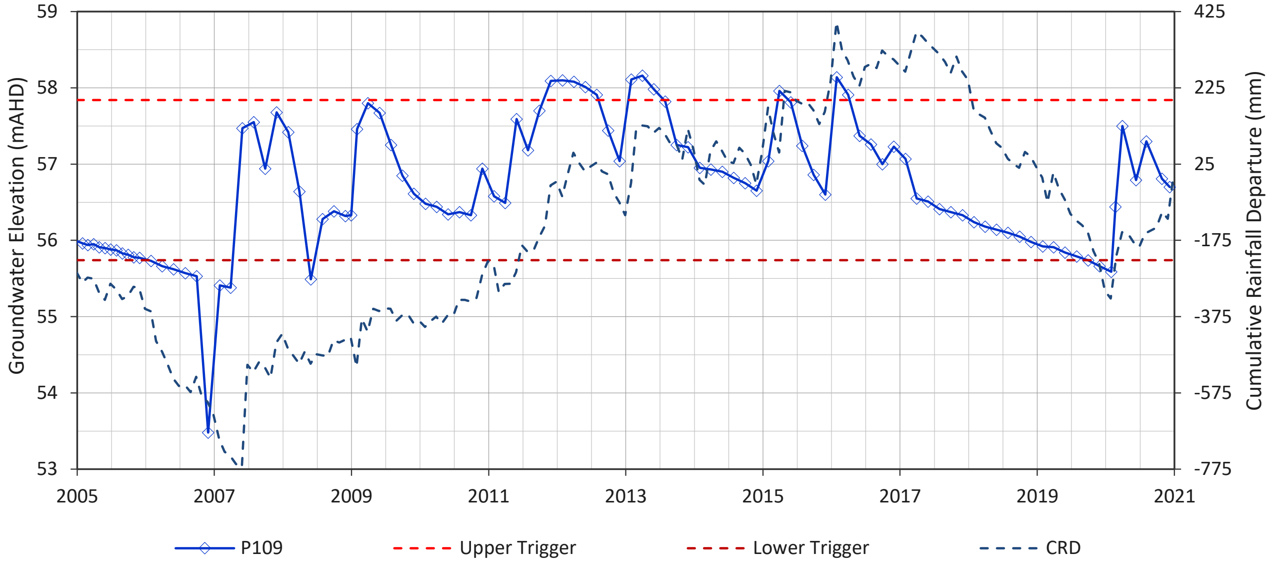


Field pH (pH unit)
Cumulative Rainfall Departure (mm)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P106
CRD

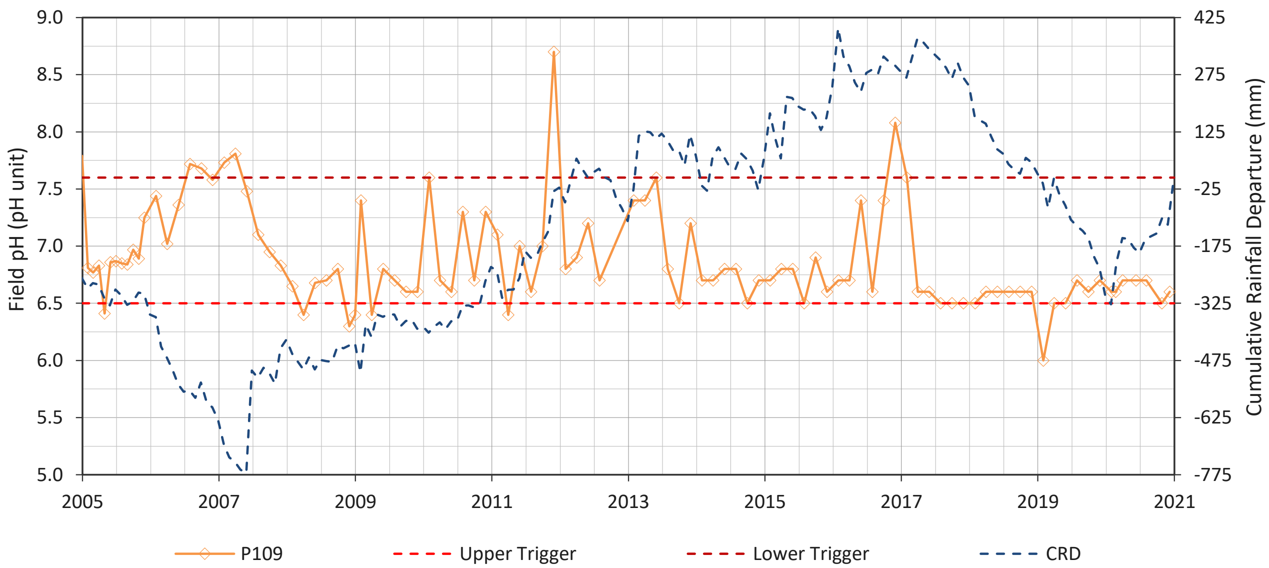


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
1,200
1,000
800
600
400
200
0
425
225
25
-175
-375
-575
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P106
CRD

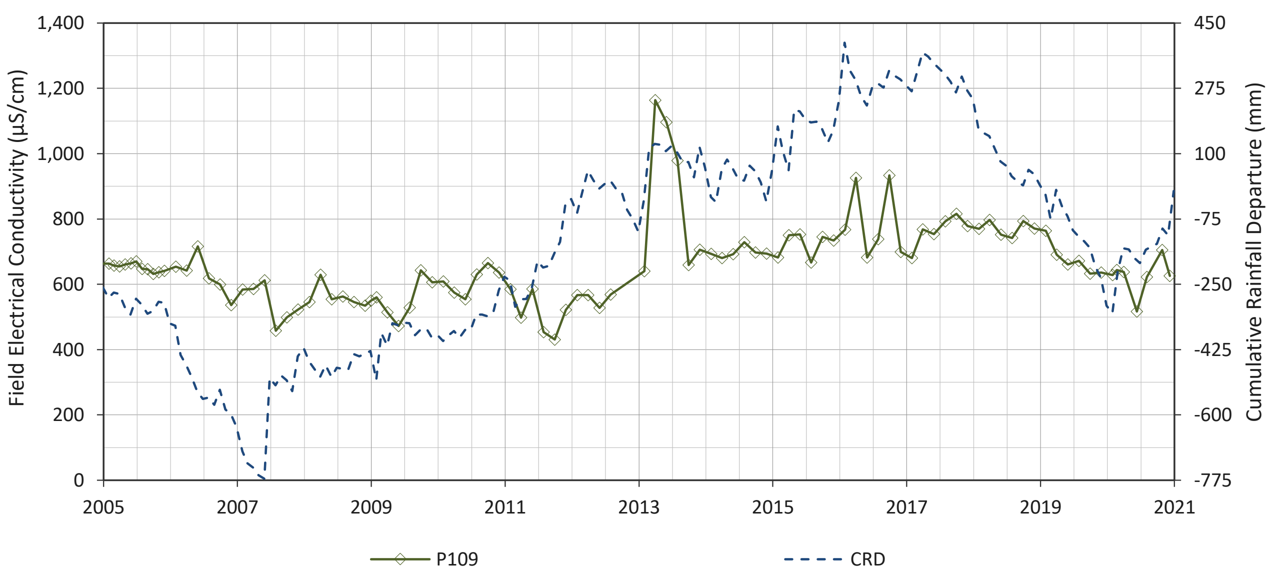
P109



Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
59
58
57
56
55
54
53
425
225
25
-175
-375
-575
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P109
Upper Trigger
Lower Trigger
CRD

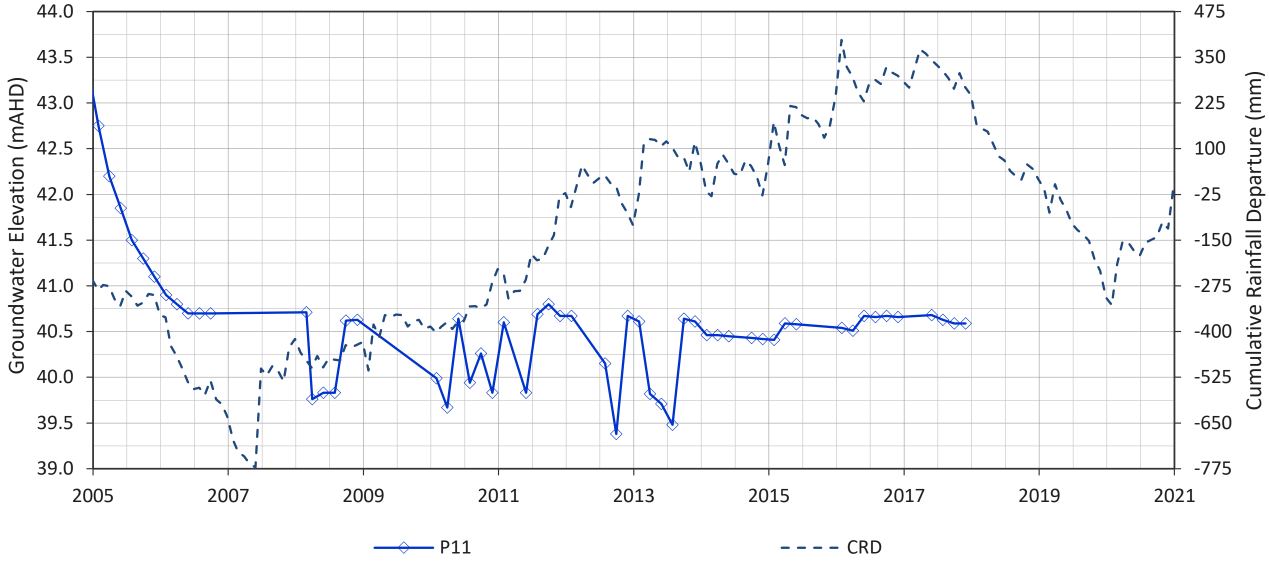


Field pH (pH unit)
Cumulative Rainfall Departure (mm)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P109
Upper Trigger
Lower Trigger
CRD

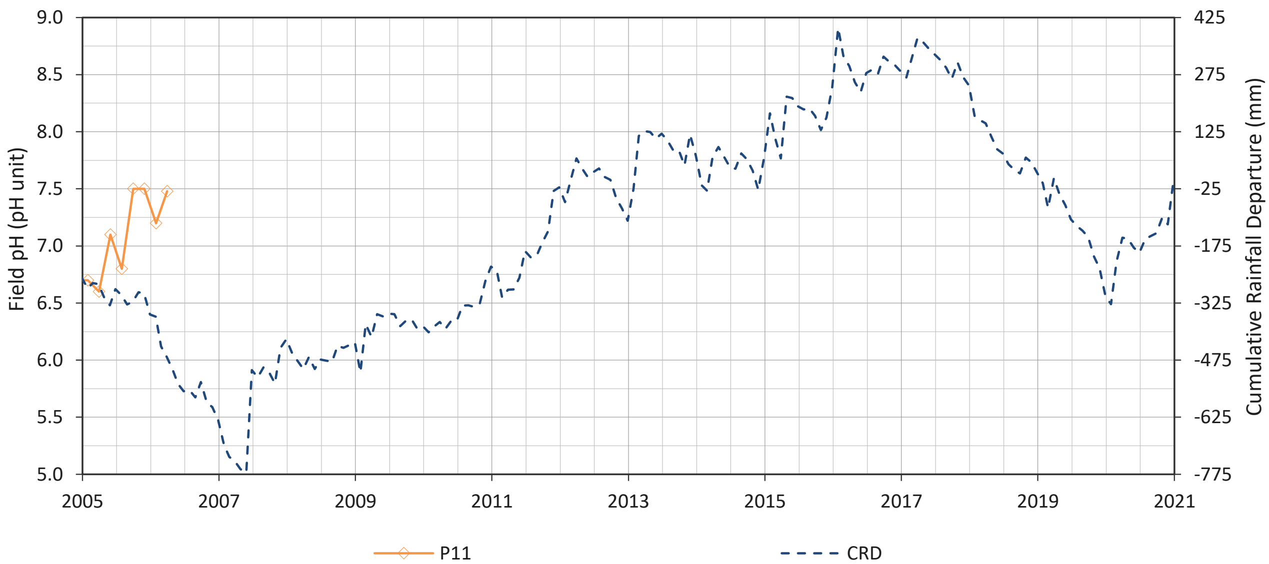


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
1,400
1,200
1,000
800
600
400
200
0
450
275
100
-75
-250
-425
-600
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P109
CRD

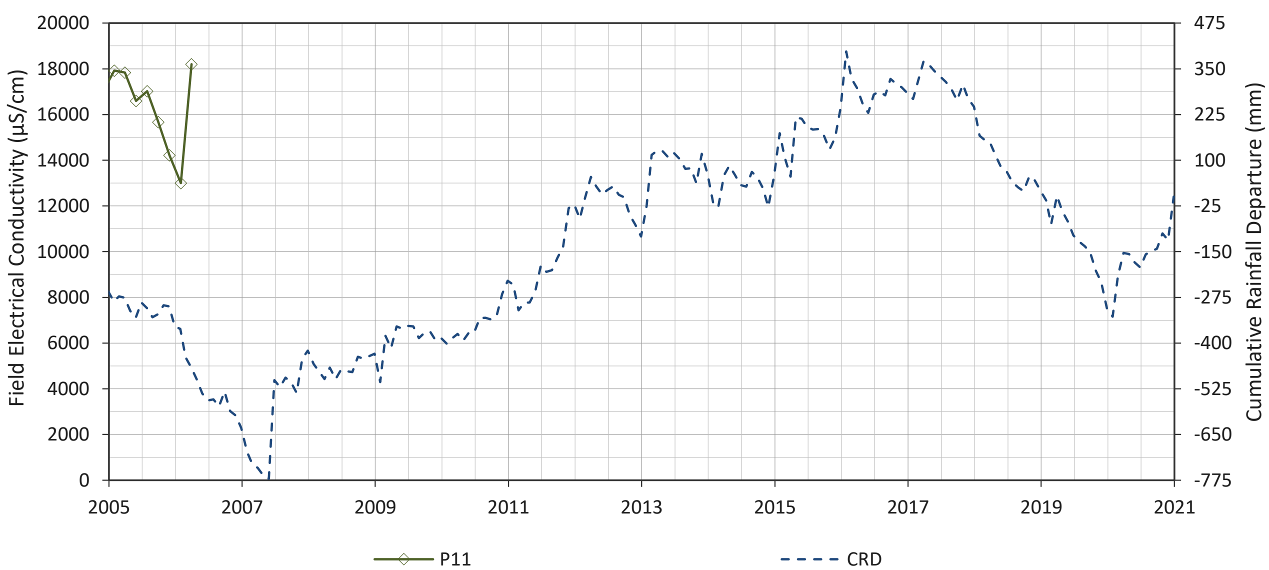
P11



Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
44.0
43.5
43.0
42.5
42.0
41.5
41.0
40.5
40.0
39.5
39.0
475
350
225
100
-25
-150
-275
-400
-525
-650
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P11
CRD

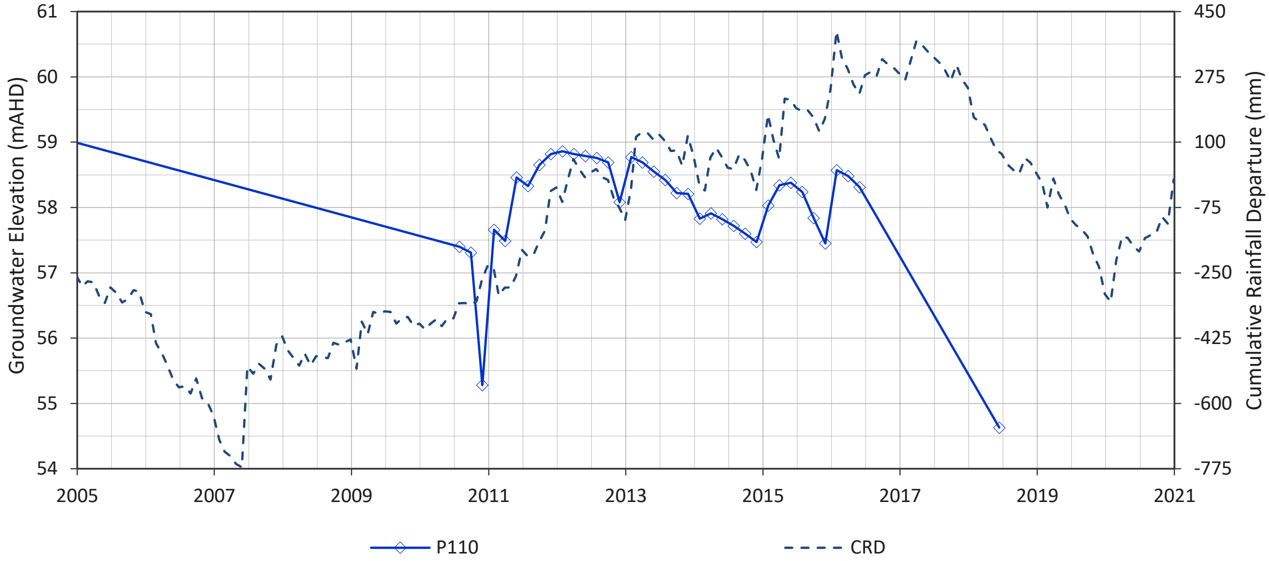


Field pH (pH unit)
Cumulative Rainfall Departure (mm)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P11
CRD

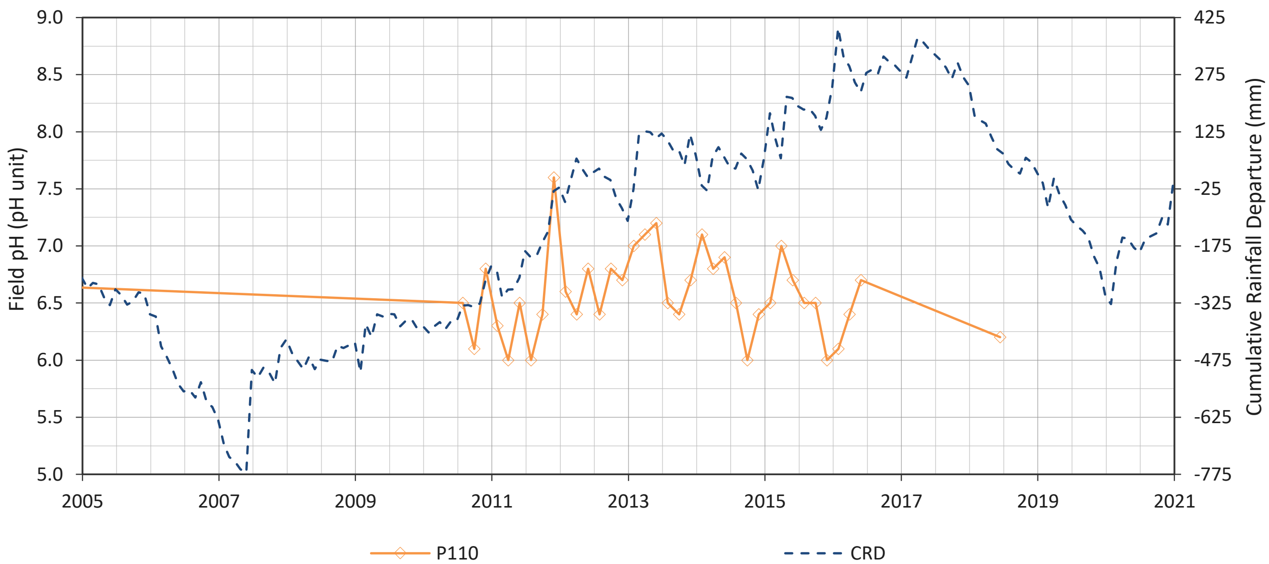


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
475
350
225
100
-25
-150
-275
-400
-525
-650
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P11
CRD

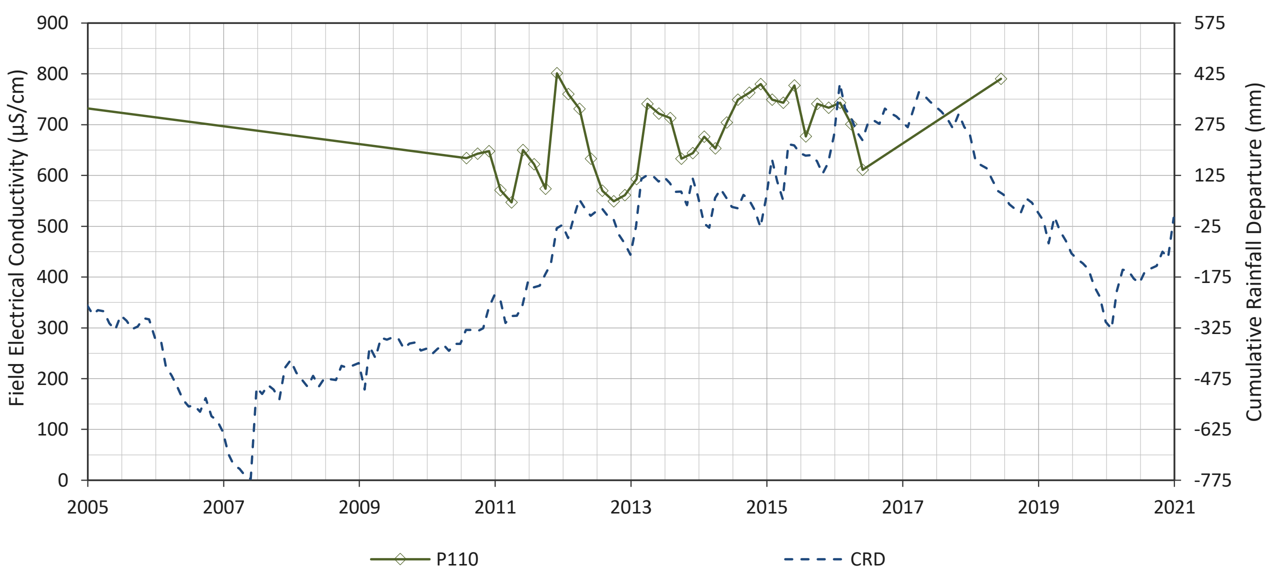
P110



Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
61
60
59
58
57
56
55
54
450
275
100
-75
-250
-425
-600
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P110
CRD

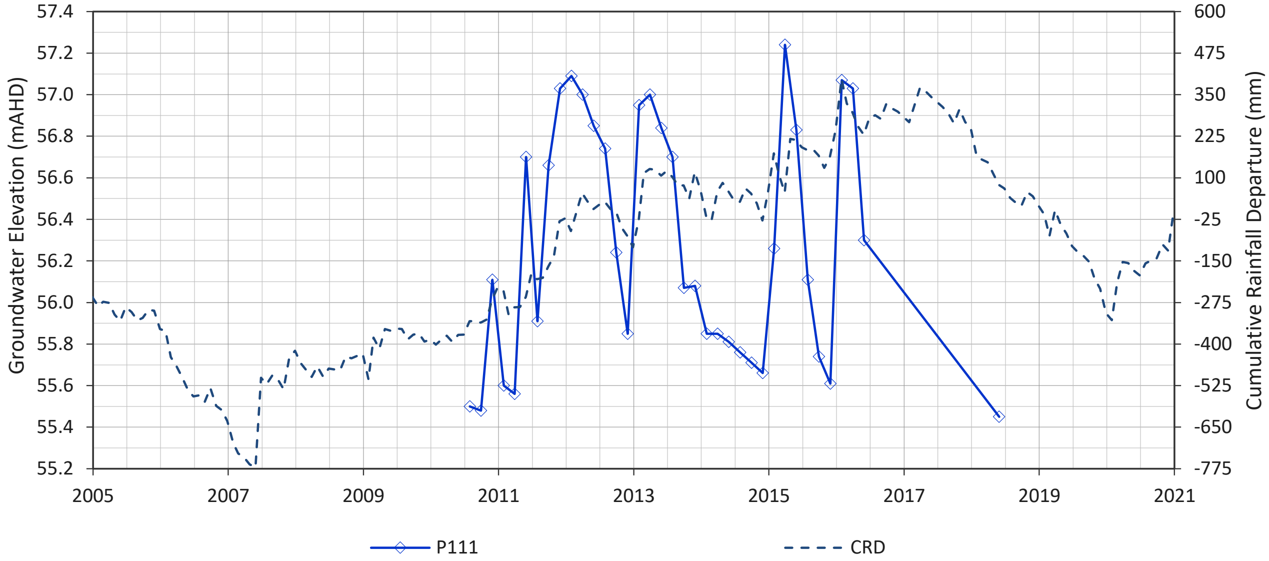


Field pH (pH unit)
Cumulative Rainfall Departure (mm)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P110
CRD

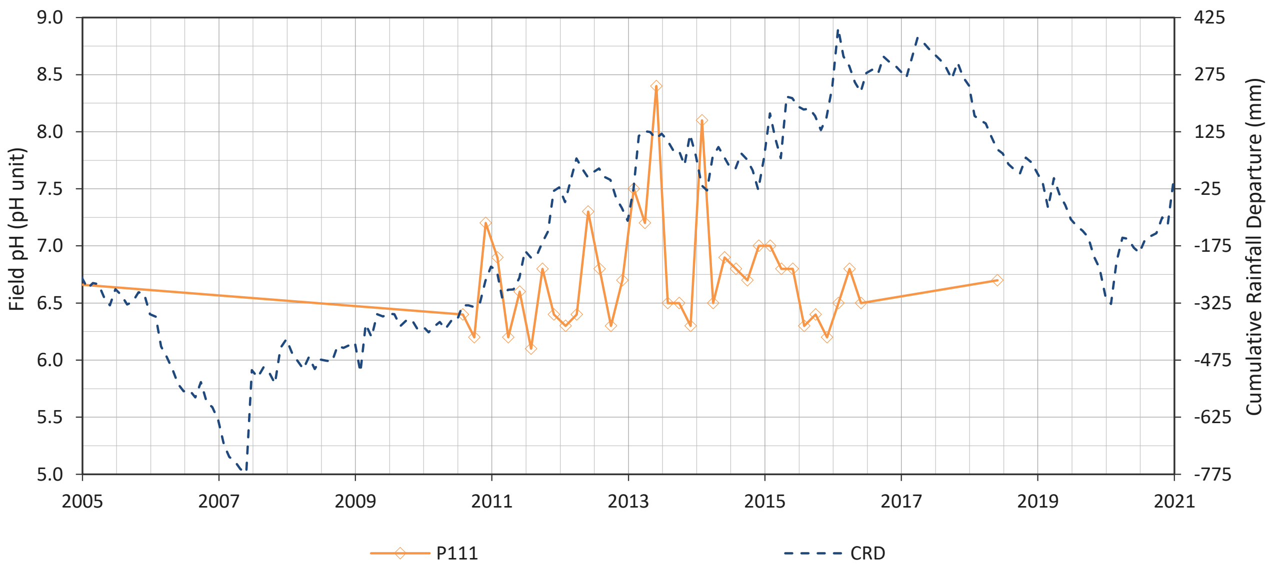


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
900
800
700
600
500
400
300
200
100
0
575
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P110
CRD

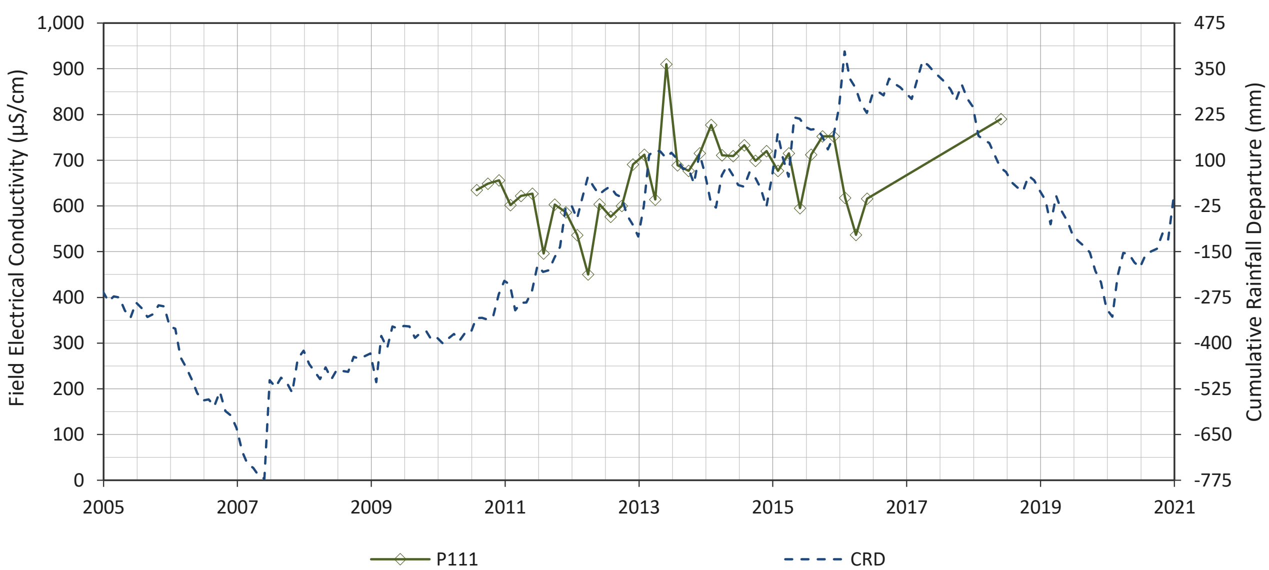
P111



Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
57.4
57.2
57.0
56.8
56.6
56.4
56.2
56.0
55.8
55.6
55.4
55.2
600
475
350
225
100
-25
-150
-275
-400
-525
-650
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P111
CRD

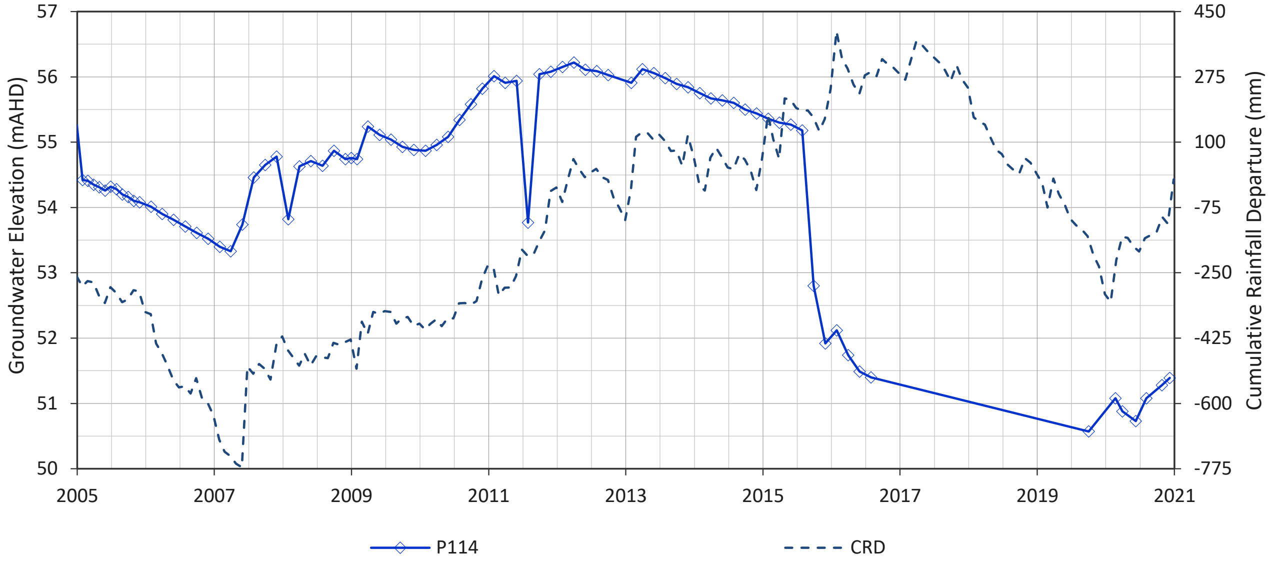


Field pH (pH unit)
Cumulative Rainfall Departure (mm)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P111
CRD

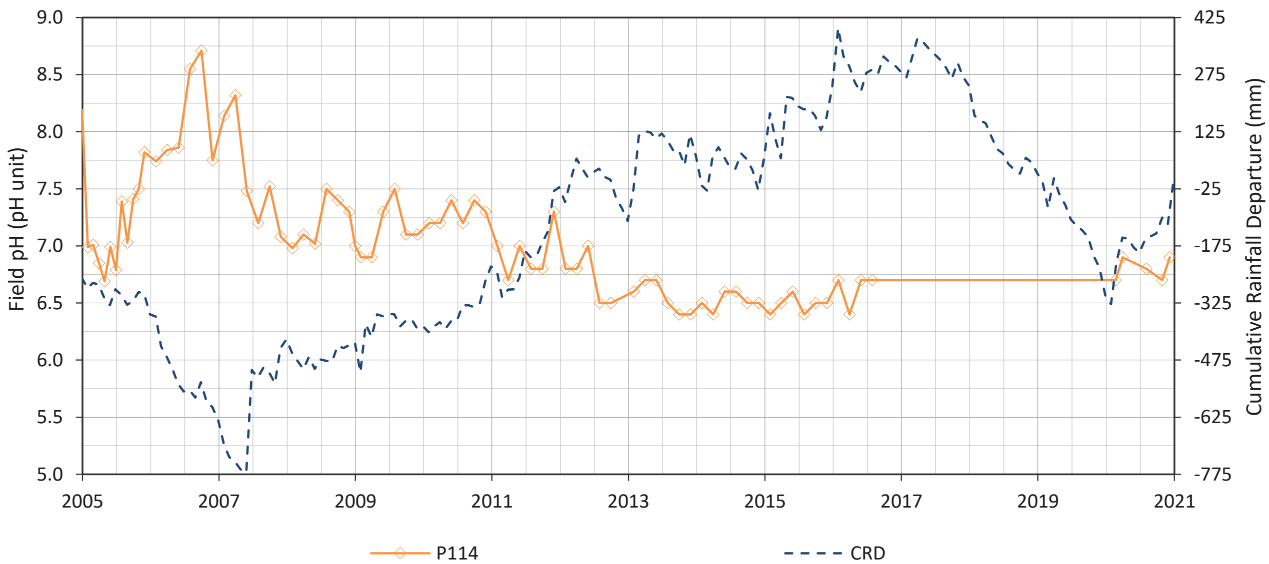


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
1,000
900
800
700
600
500
400
300
200
100
0
475
350
225
100
-25
-150
-275
-400
-525
-650
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P111
CRD

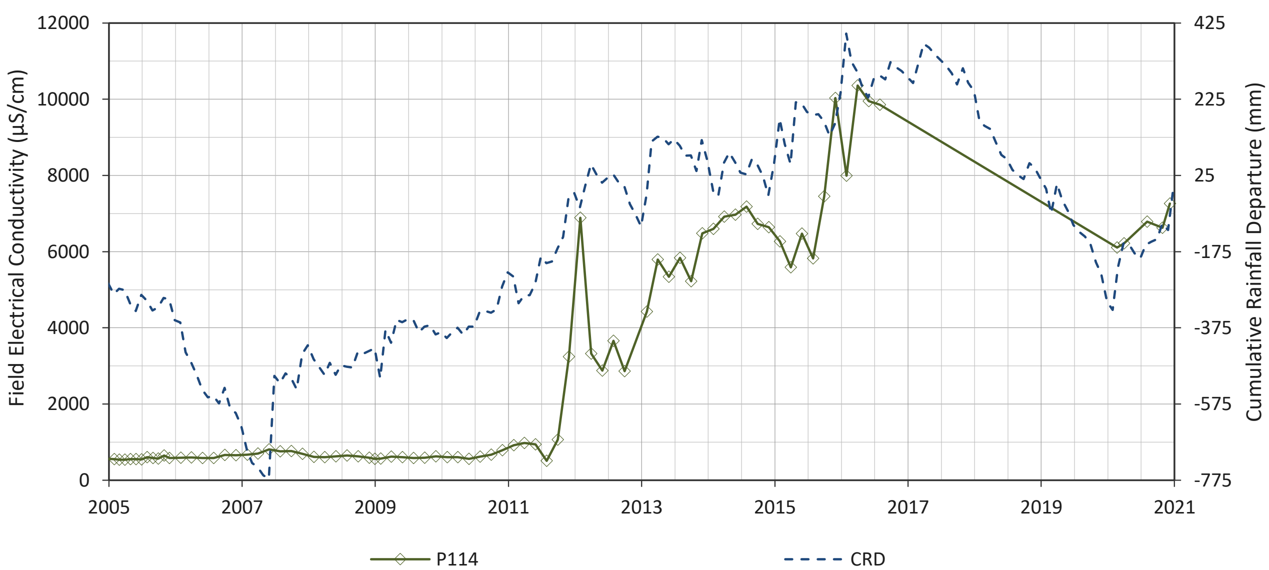
P114



Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
57
56
55
54
53
52
51
50
450
275
100
-75
-250
-425
-600
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P114
CRD

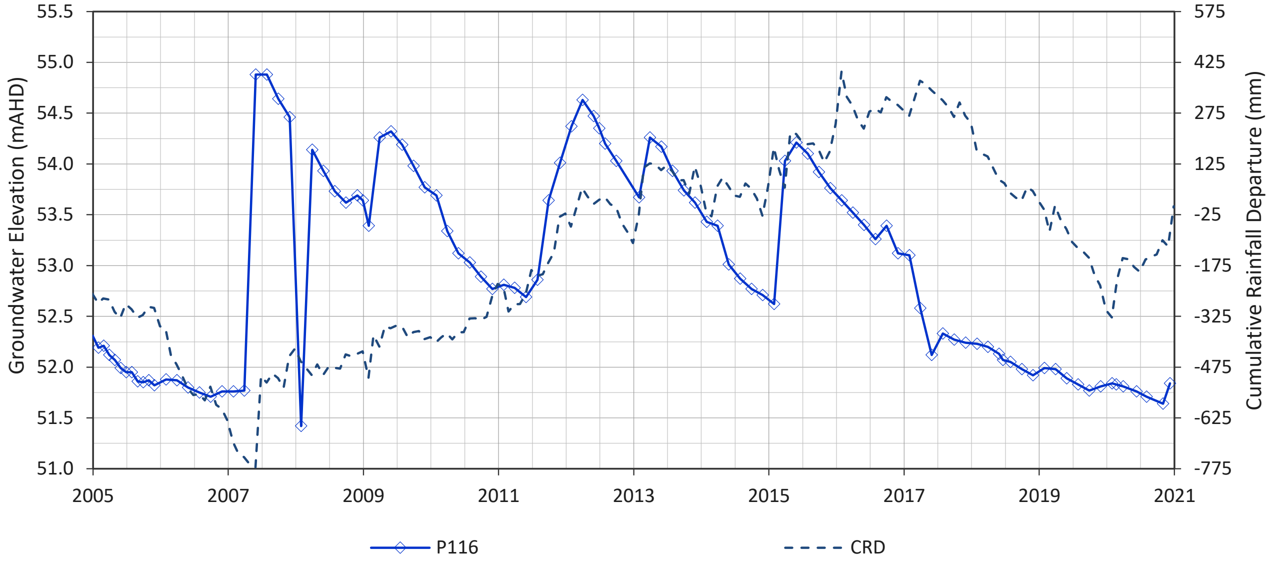


Field pH (pH unit)
Cumulative Rainfall Departure (mm)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P114
CRD

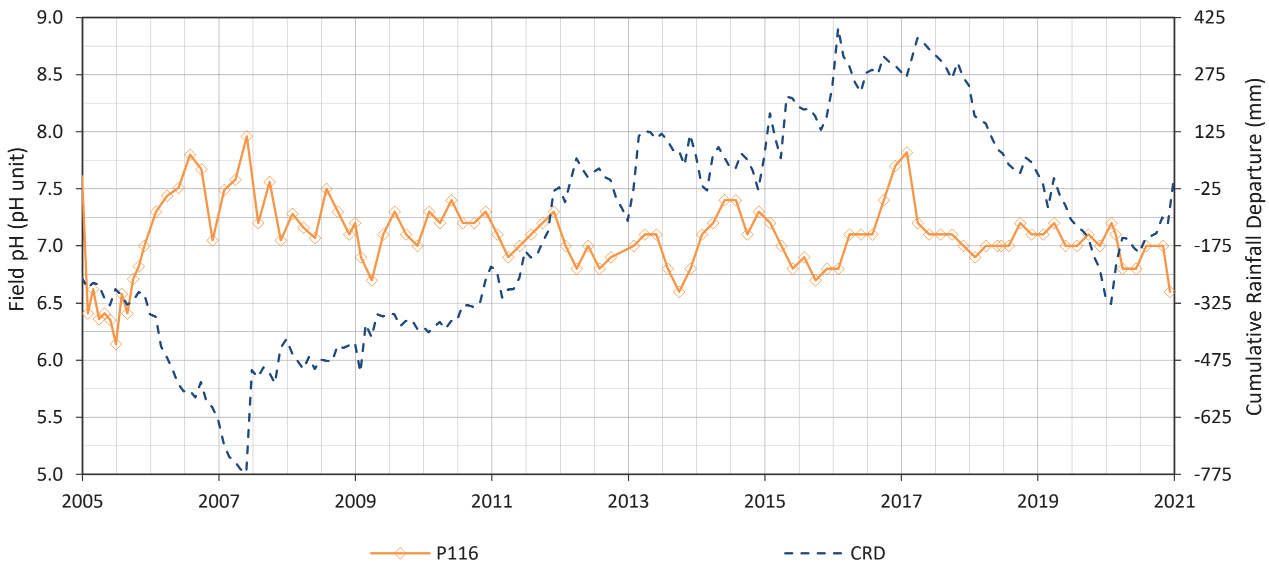


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
12000
10000
8000
6000
4000
2000
0
425
225
25
-175
-375
-575
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P114
CRD

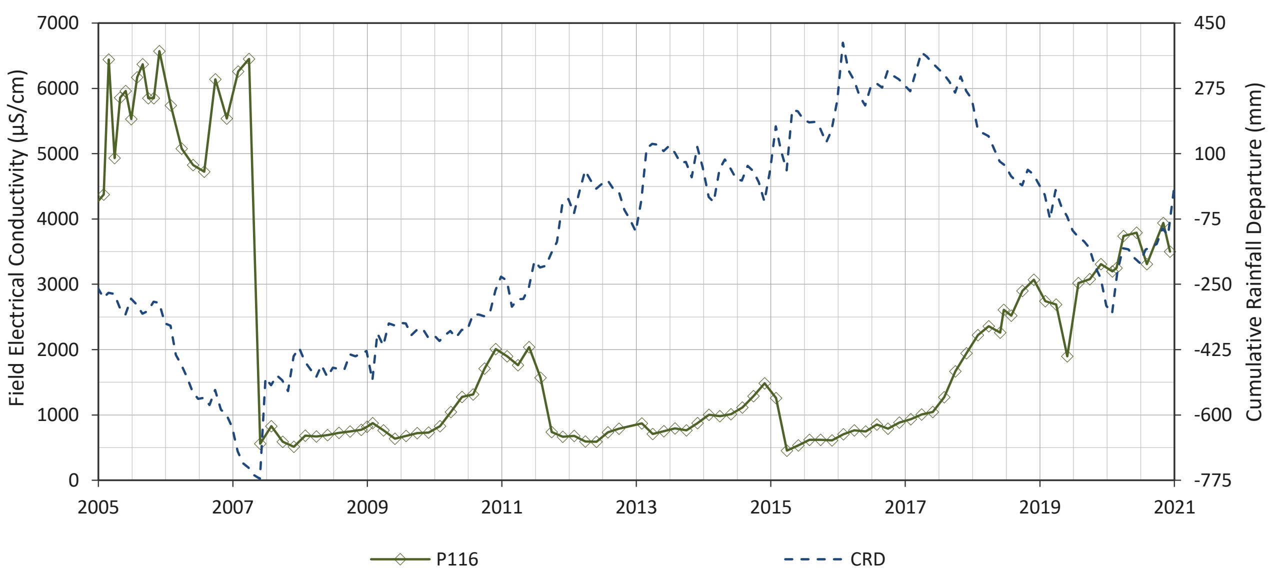
P116



Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
55.5
55.0
54.5
54.0
53.5
53.0
52.5
52.0
51.5
51.0
575
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P116
CRD



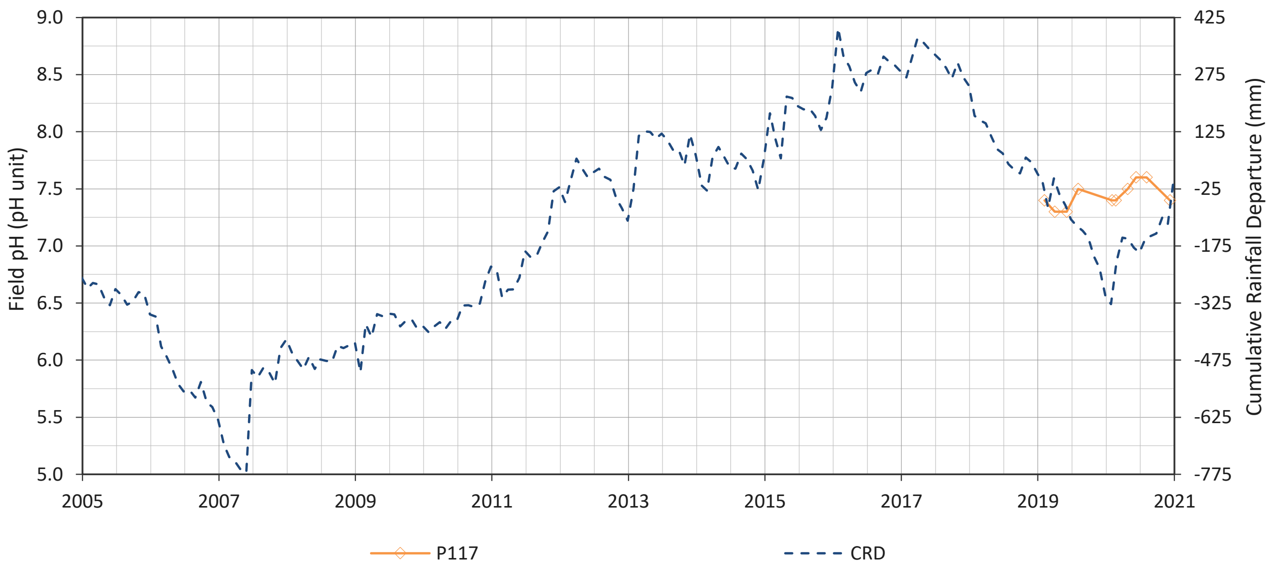
Field pH (pH unit)
Cumulative Rainfall Departure (mm)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P116
CRD

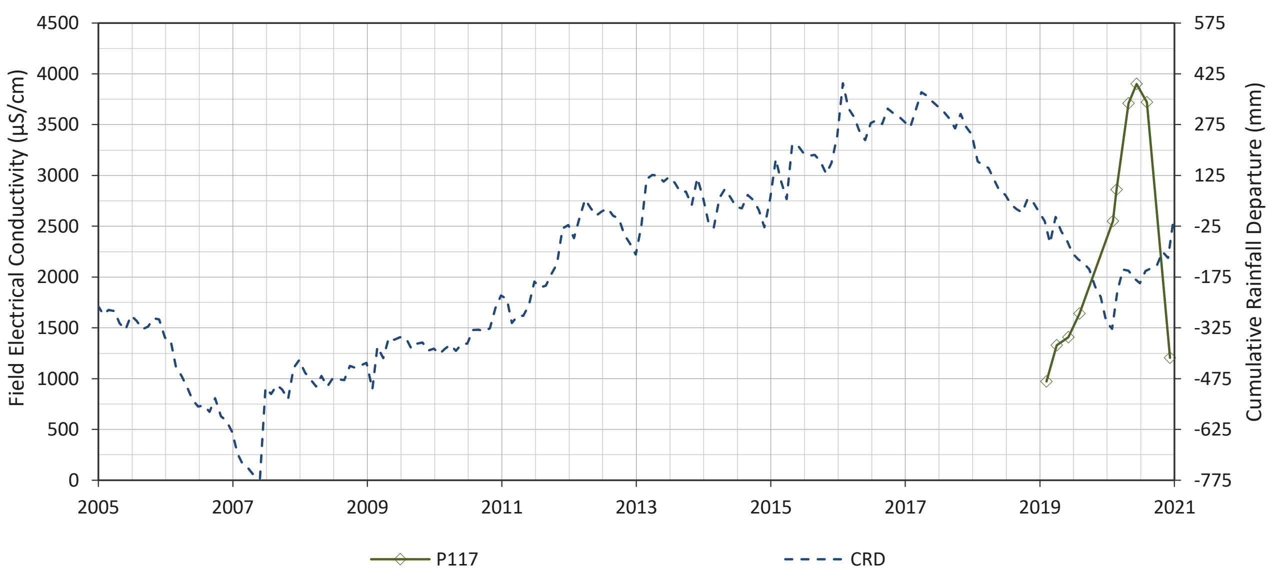


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
7000
6000
5000
4000
3000
2000
1000
0
450
275
100
-75
-250
-425
-600
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P116
CRD

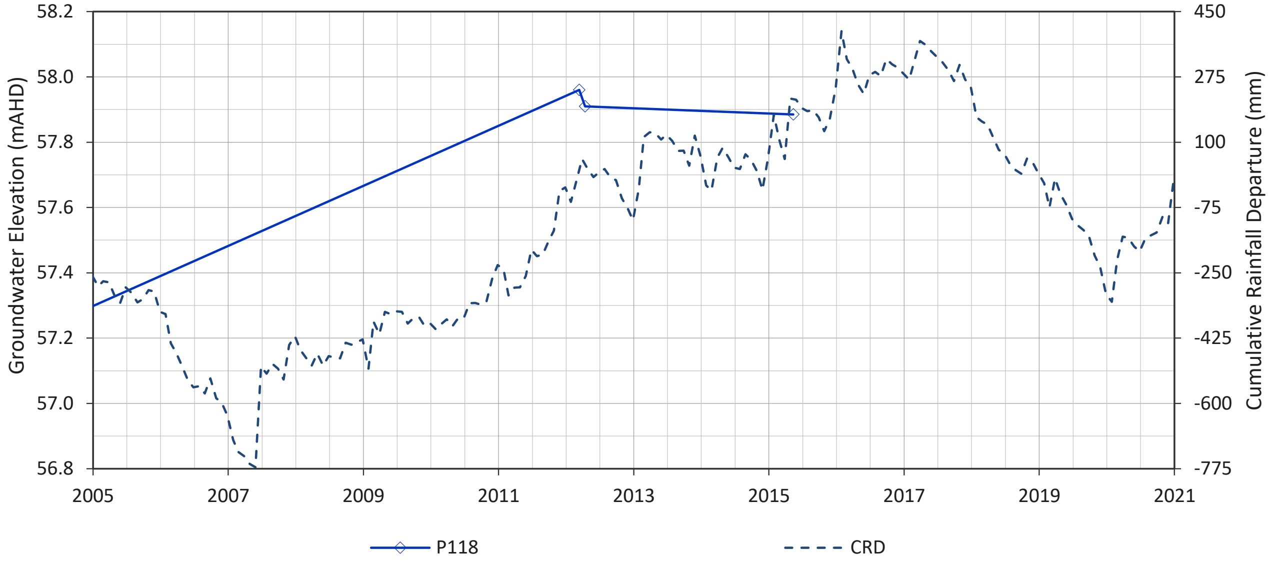
P117


Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
P117
CRD

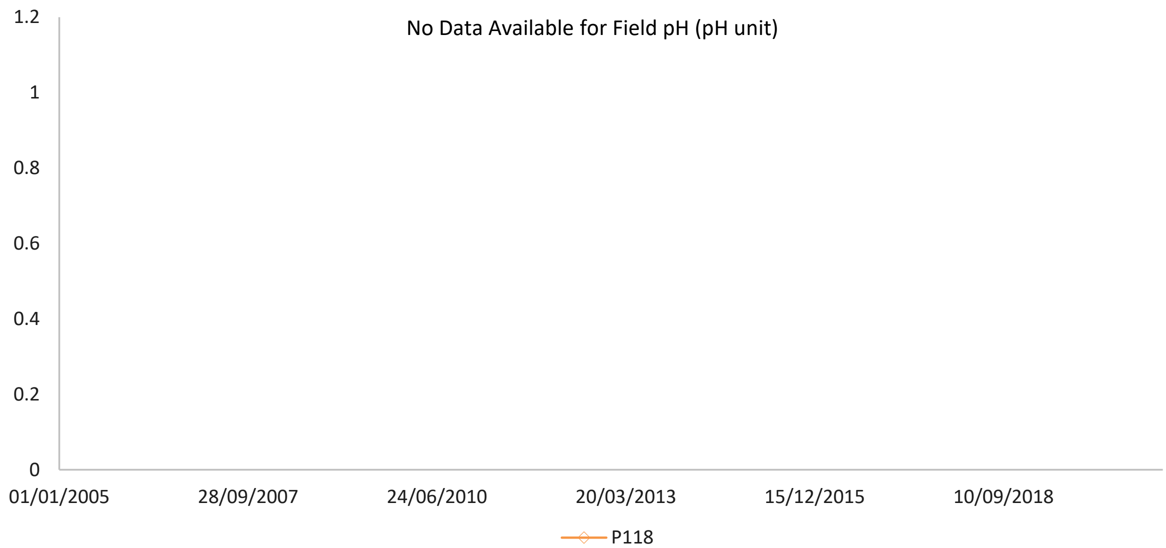

Field pH (pH unit)
Cumulative Rainfall Departure (mm)
P117
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
P117
CRD

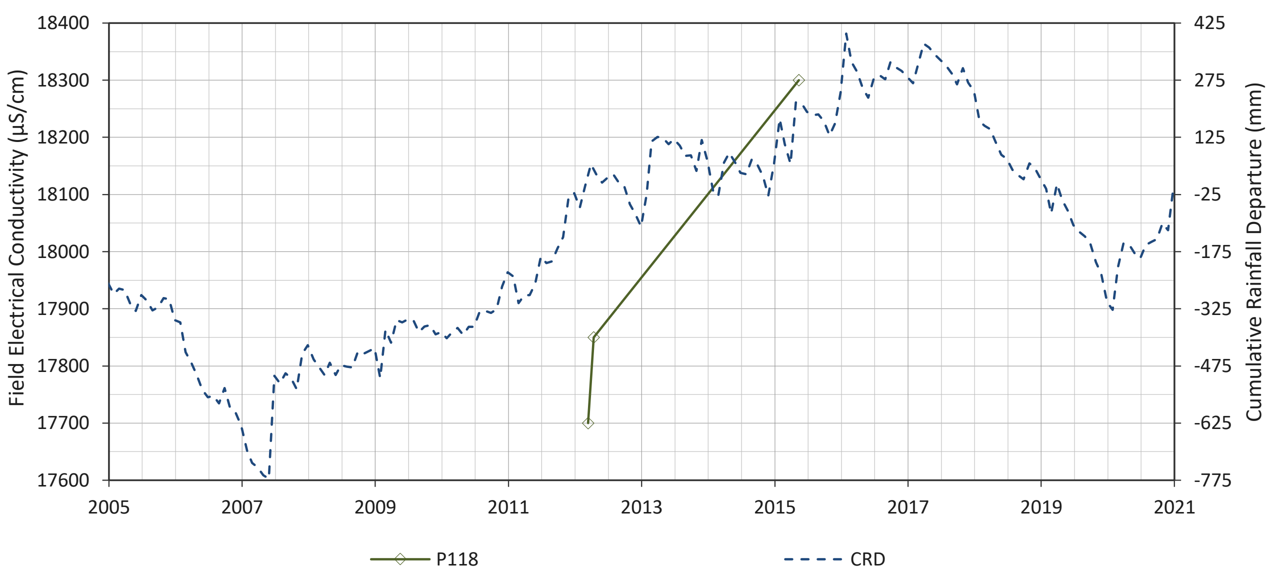
P118



Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
58.2
58.0
57.8
57.6
57.4
57.2
57.0
56.8
450
275
100
-75
-250
-425
-600
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P118
CRD

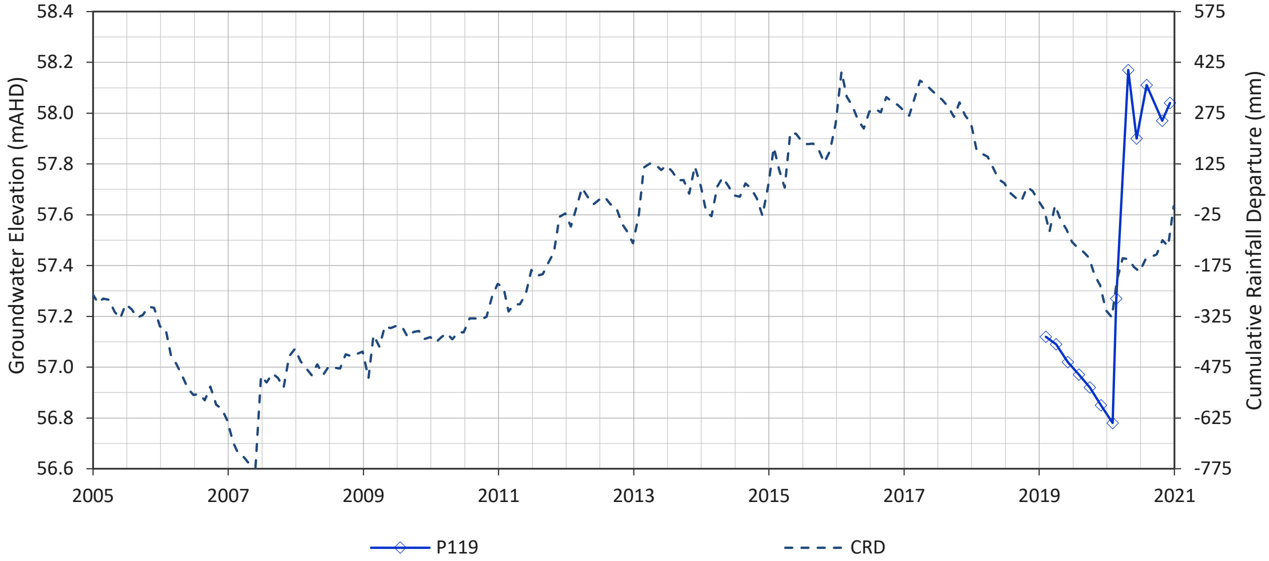


No Data Available for Field pH (pH unit)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
P118

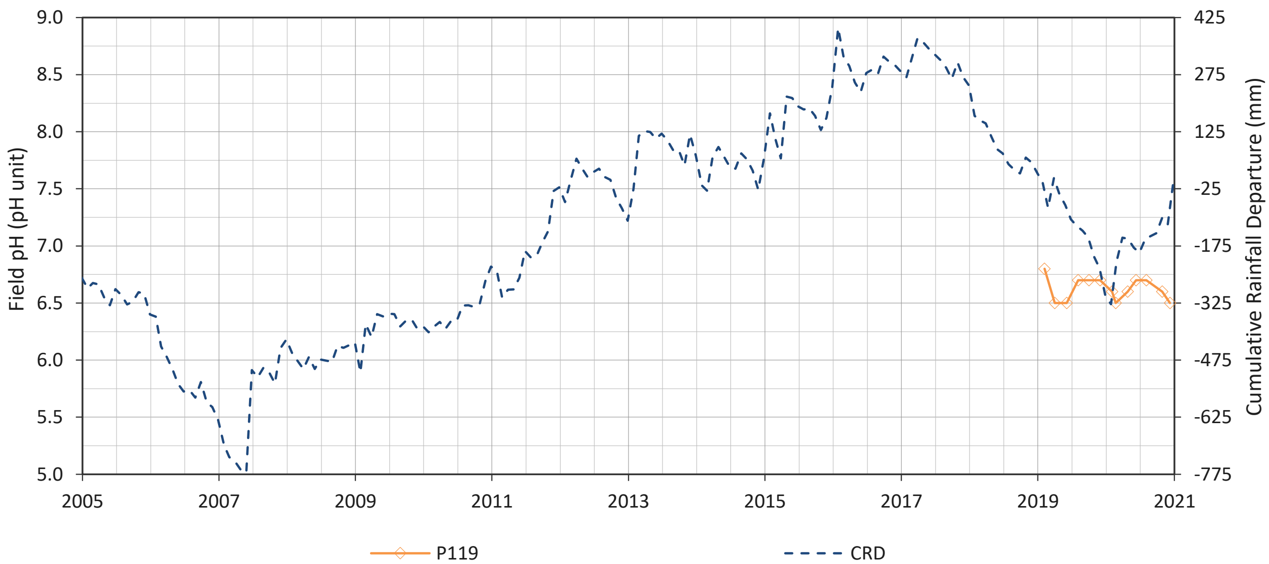


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
18400
18300
18200
18100
18000
17900
17800
17700
17600
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P118
CRD

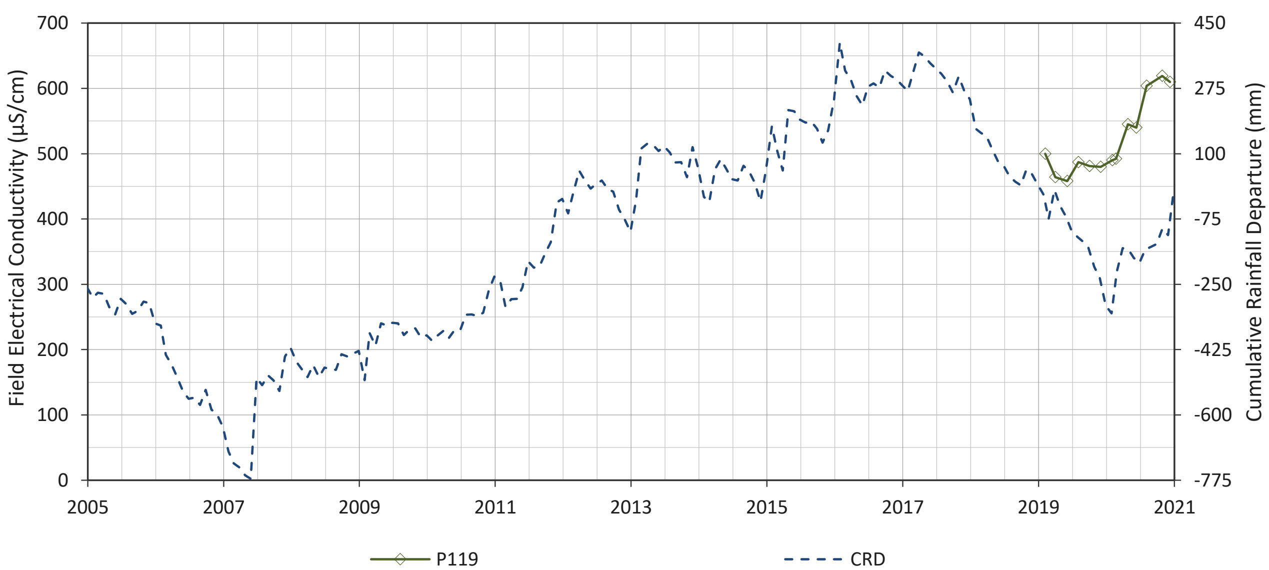
P119



Groundwater Elevation (mAHD)
58.4
58.2
58.0
57.8
57.6
57.4
57.2
57.0
56.8
56.6
Cumulative Rainfall Departure (mm)
575
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P119
CRD

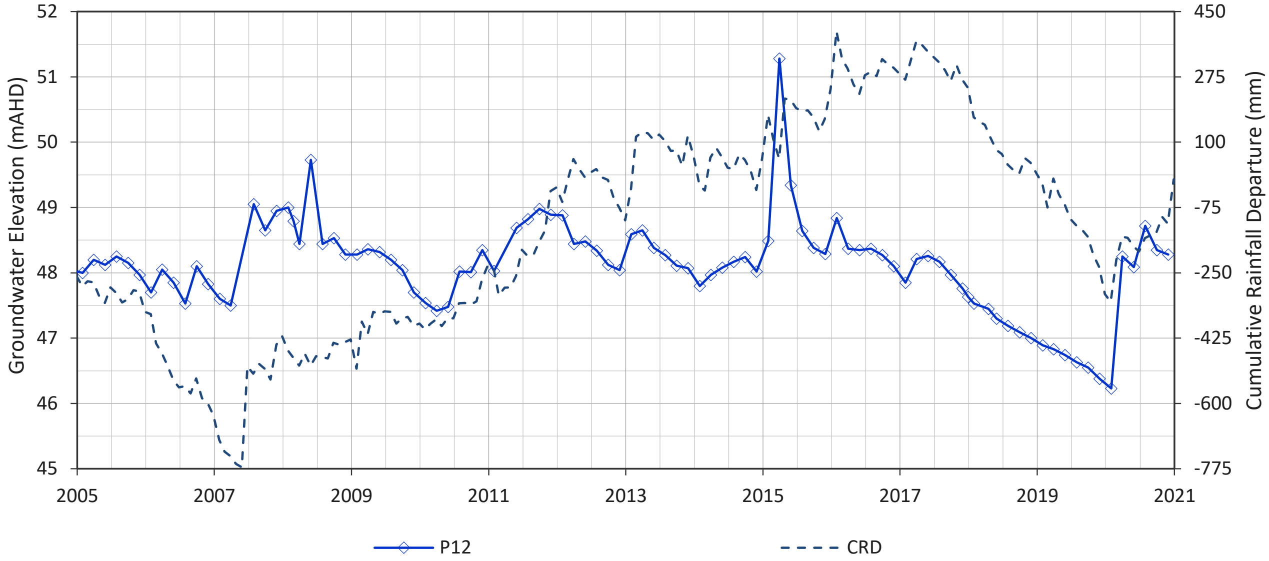


Field pH (pH unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
Cumulative Rainfall Departure (mm)
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P119
CRD

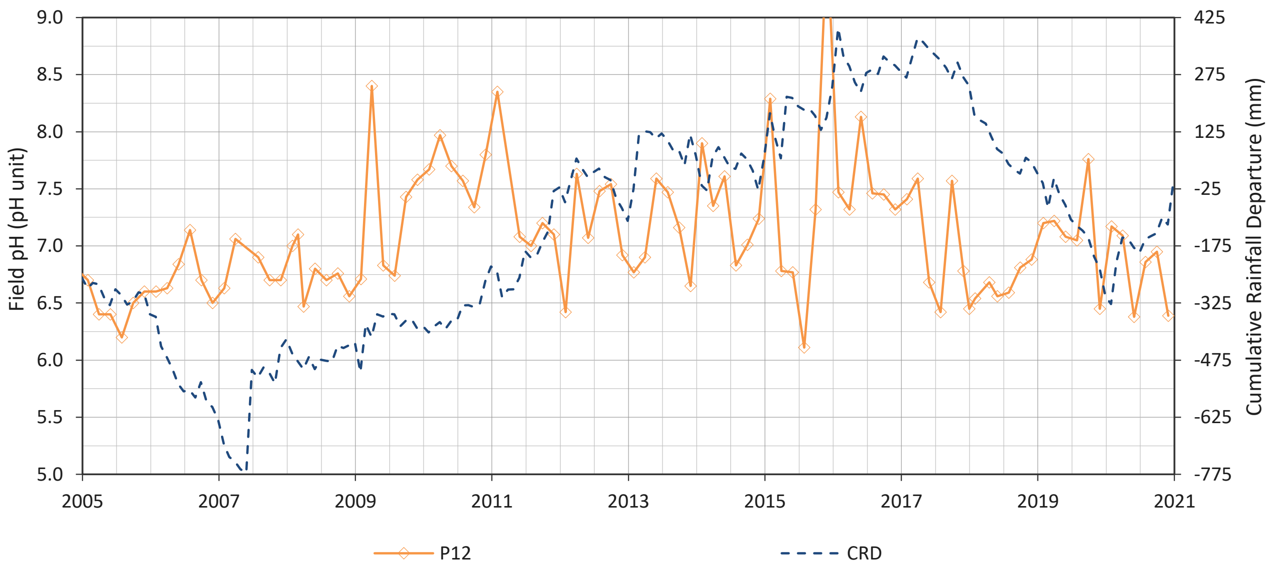


Field Electrical Conductivity (µS/cm)
700
600
500
400
300
200
100
0
Cumulative Rainfall Departure (mm)
450
275
100
-75
-250
-425
-600
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P119
CRD

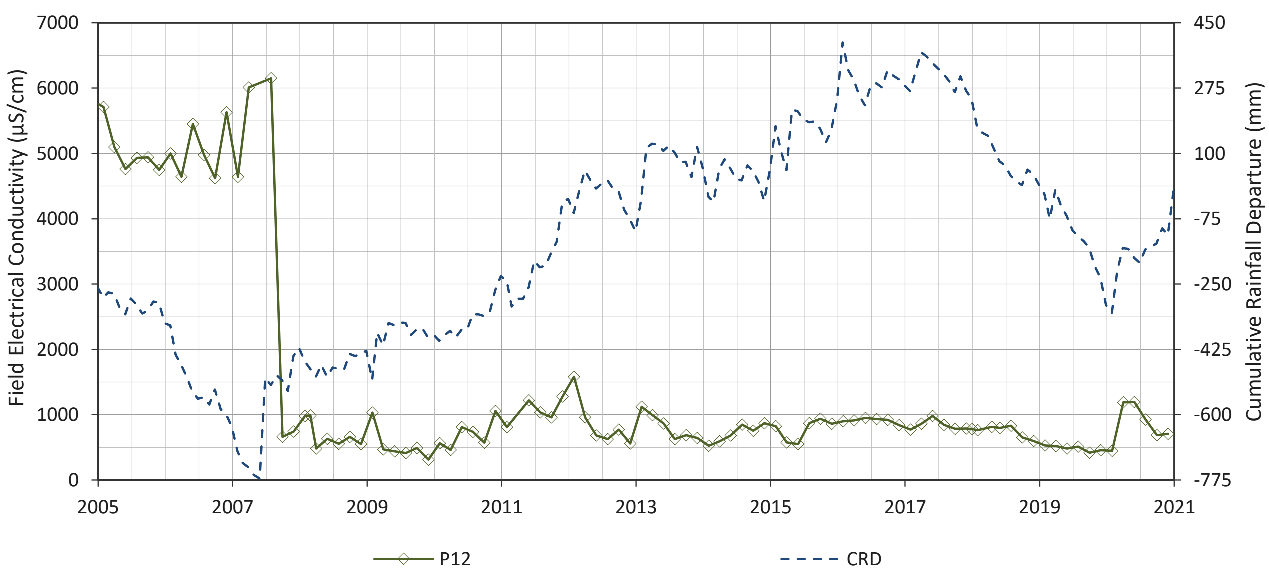
P12



Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
52
51
50
49
48
47
46
45
450
275
100
-75
-250
-425
-600
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P12
CRD

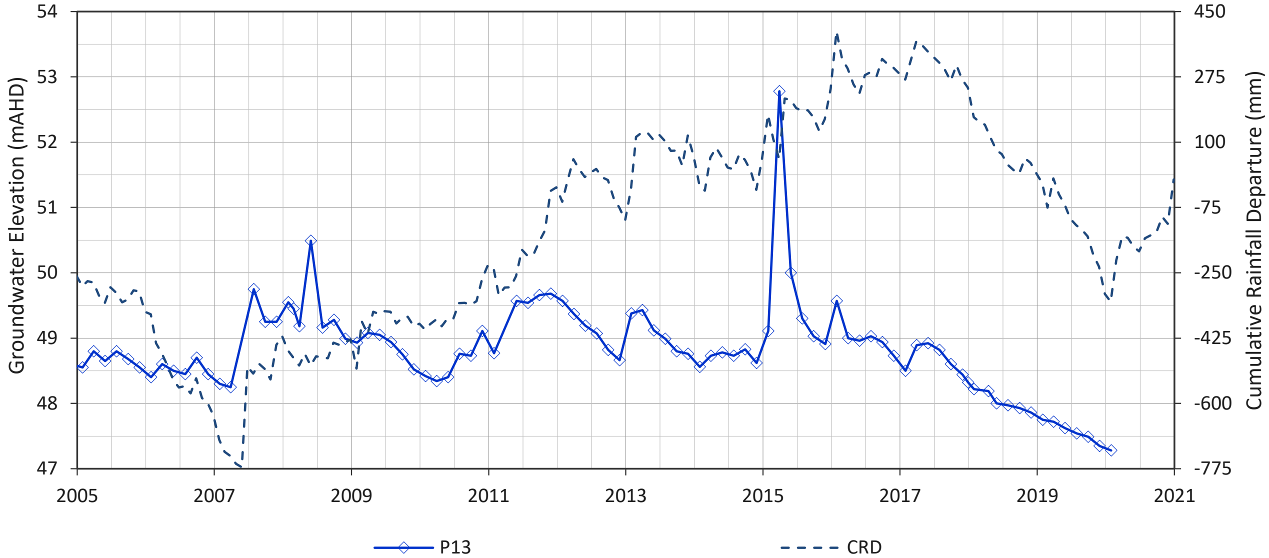


Field pH (pH unit)
Cumulative Rainfall Departure (mm)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P12
CRD

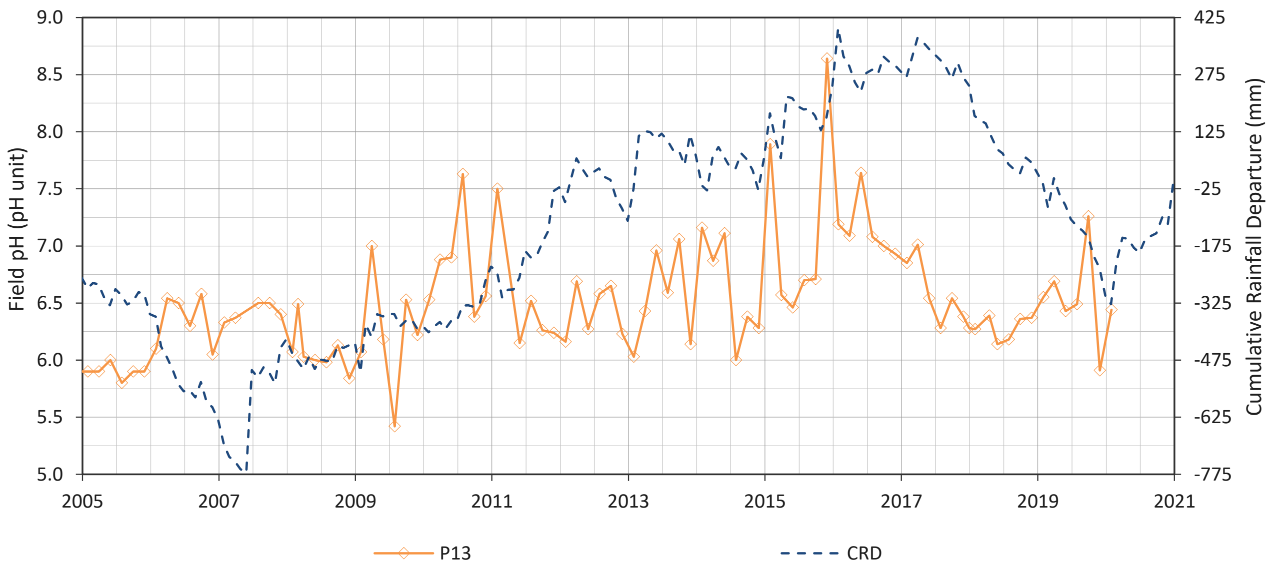


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
7000
6000
5000
4000
3000
2000
1000
0
450
275
100
-75
-250
-425
-600
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P12
CRD

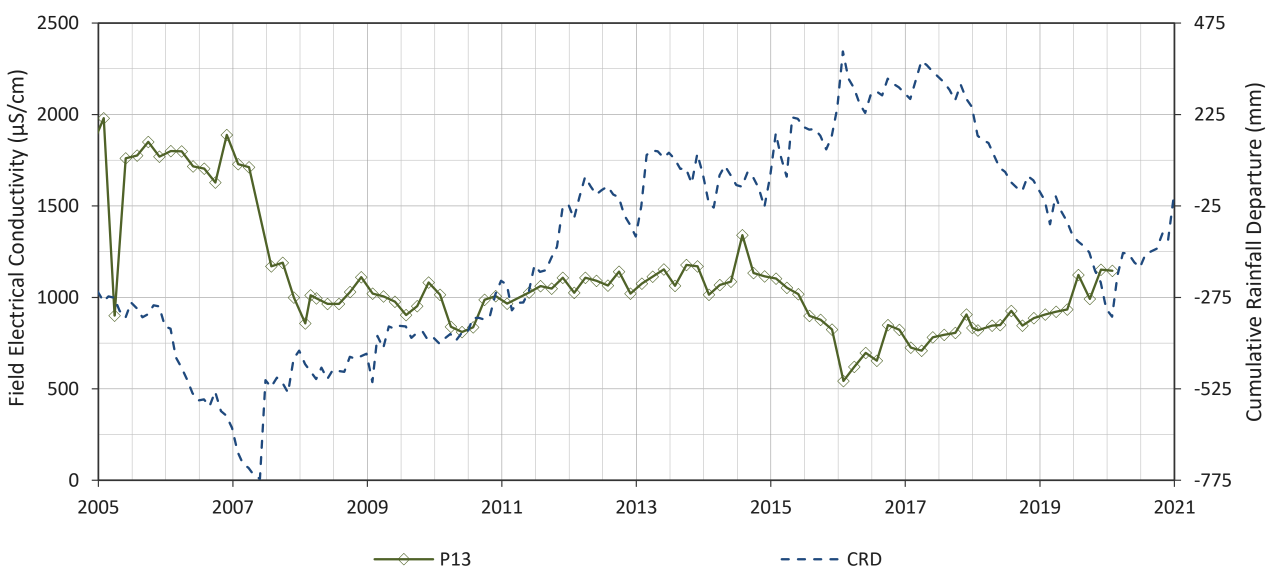
P13



Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
54
53
52
51
50
49
48
47
450
275
100
-75
-250
-425
-600
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P13
CRD

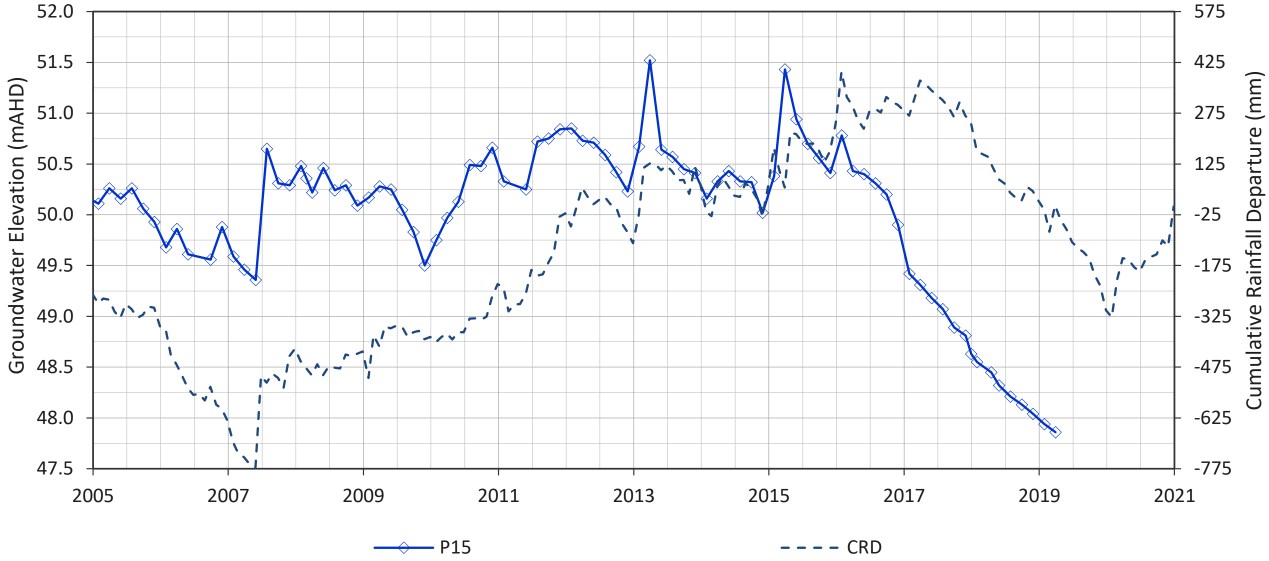


Field pH (pH unit)
Cumulative Rainfall Departure (mm)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P13
CRD

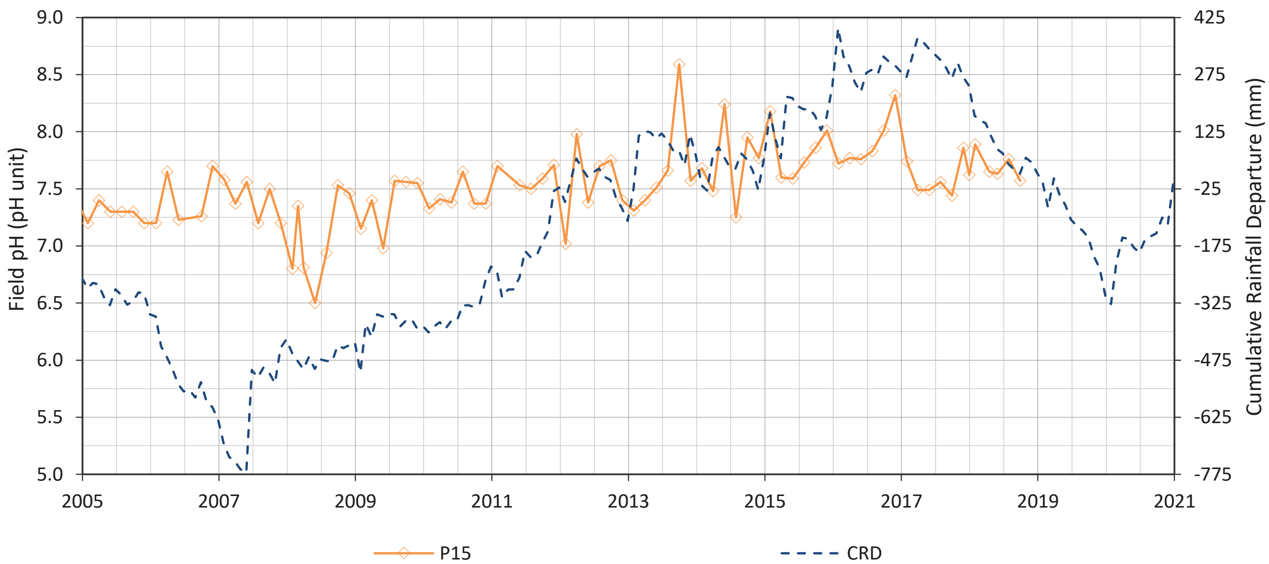


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
2500
2000
1500
1000
500
0
475
225
-25
-275
-525
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P13
CRD

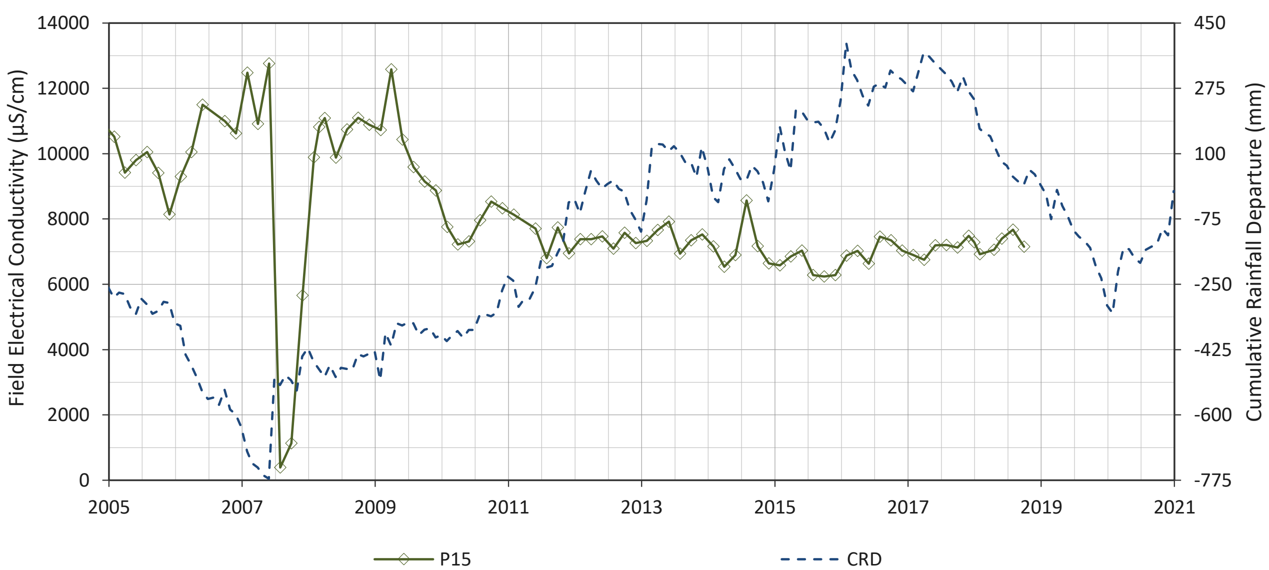
P15



Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
52.0
51.5
51.0
50.5
50.0
49.5
49.0
48.5
48.0
47.5
575
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P15
CRD

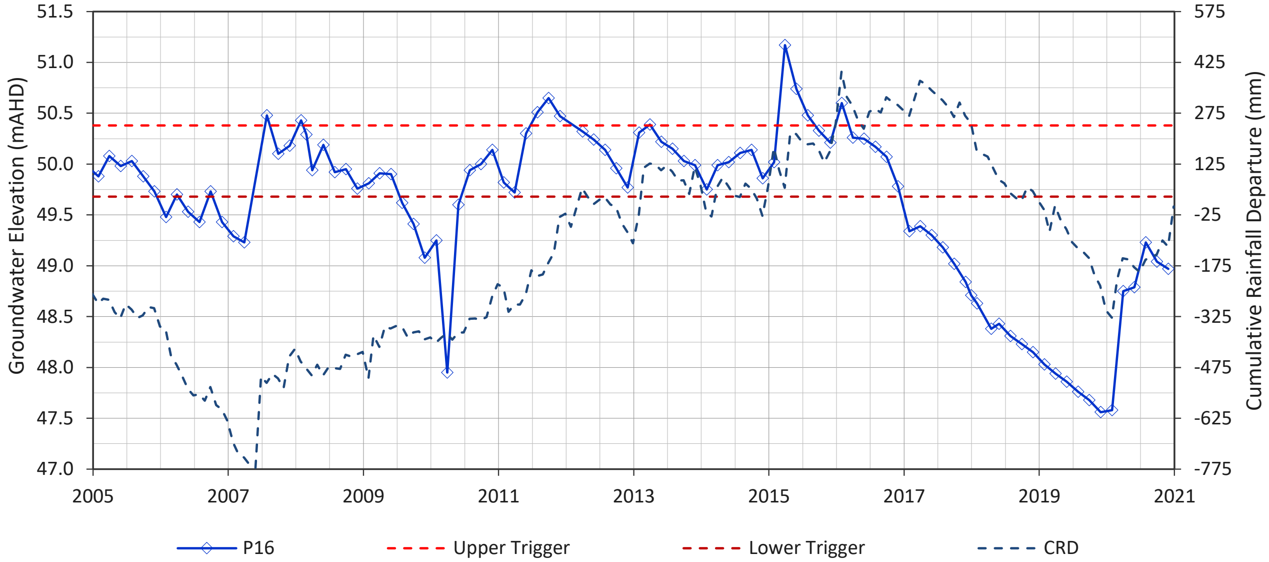


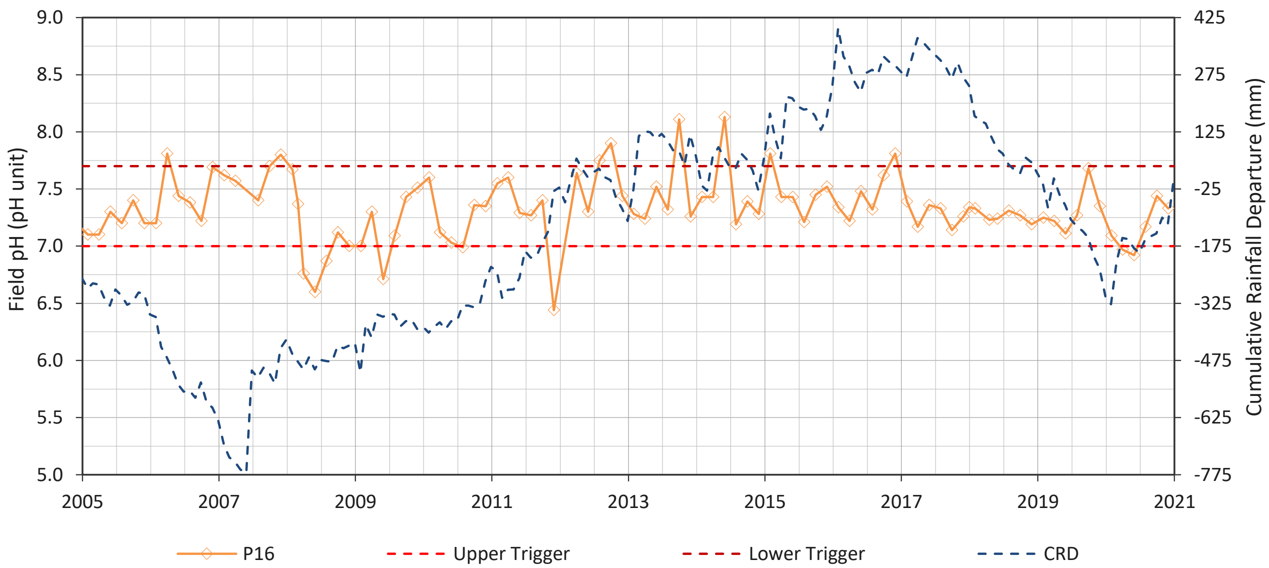
Field pH (pH unit)
Cumulative Rainfall Departure (mm)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P15
CRD

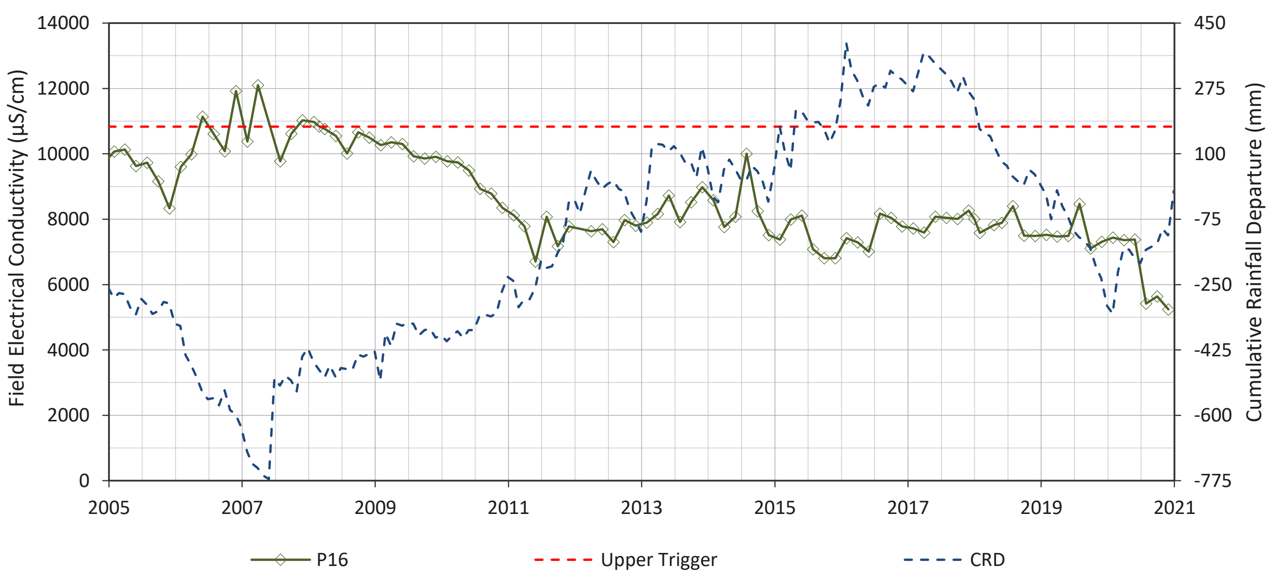


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
14000
12000
10000
8000
6000
4000
2000
0
450
275
100
-75
-250
-425
-600
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P15
CRD

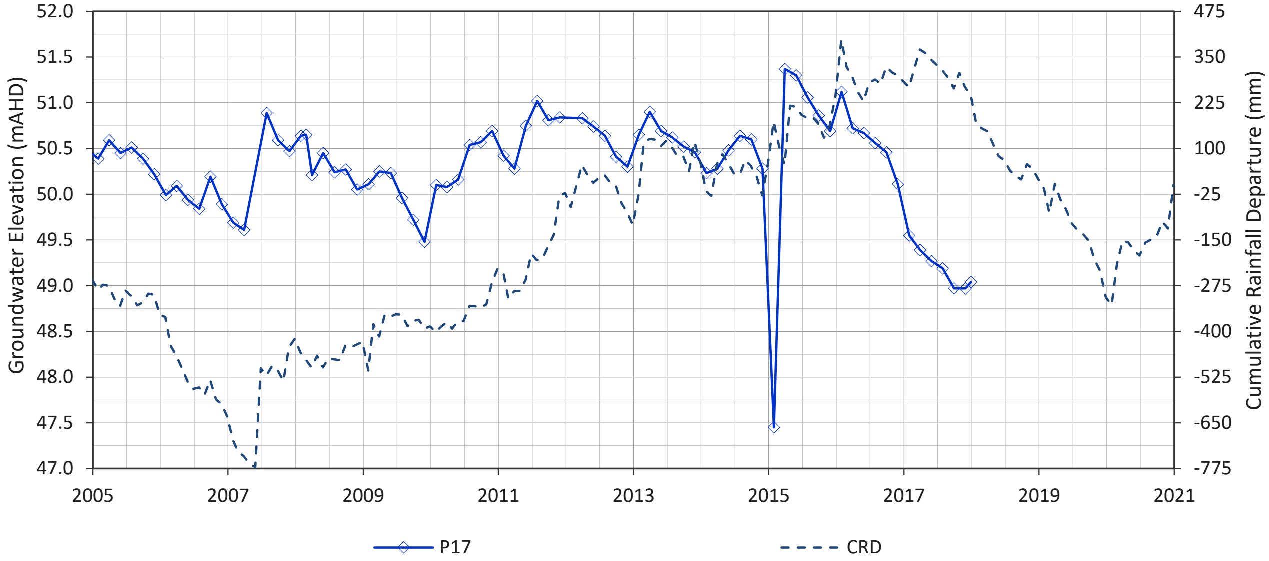
P16


Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
P16
Upper Trigger
Lower Trigger
CRD

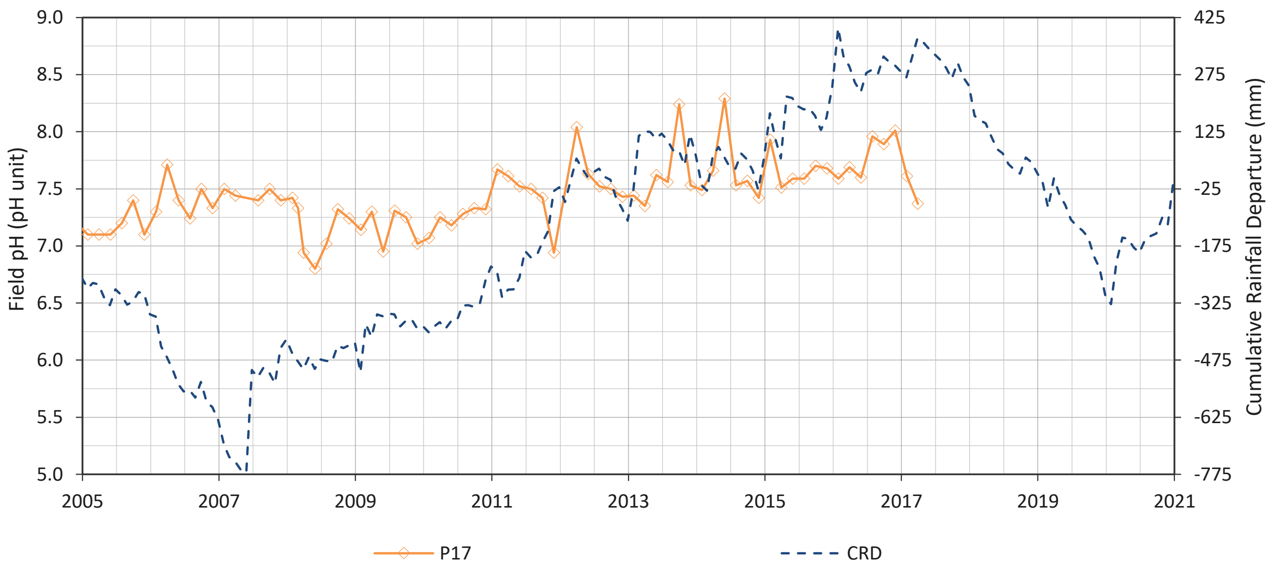

Field pH (pH unit)
Cumulative Rainfall Departure (mm)
P16
Upper Trigger
Lower Trigger
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
P16
Upper Trigger
CRD

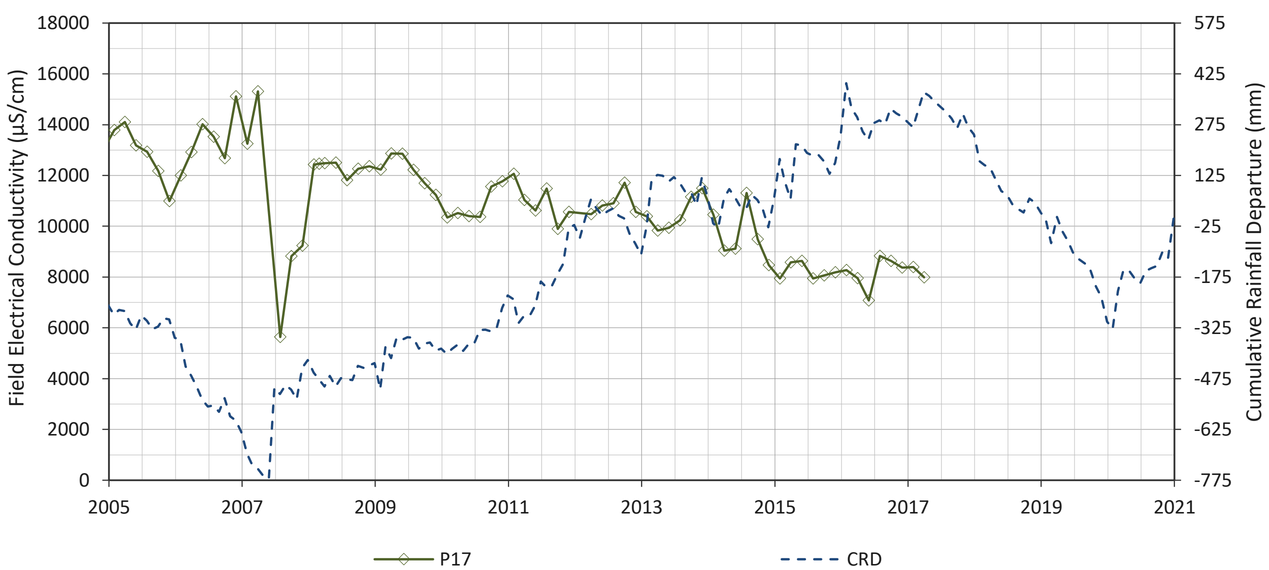
P17



52.0
51.5
51.0
50.5
50.0
49.5
49.0
48.5
48.0
47.5
47.0
Groundwater Elevation (mAHD)
475
350
225
100
-25
-150
-275
-400
-525
-650
-775
Cumulative Rainfall Departure (mm)
2005
2007
2009
2011
2013
2015
2017
2019
2021
P17
CRD

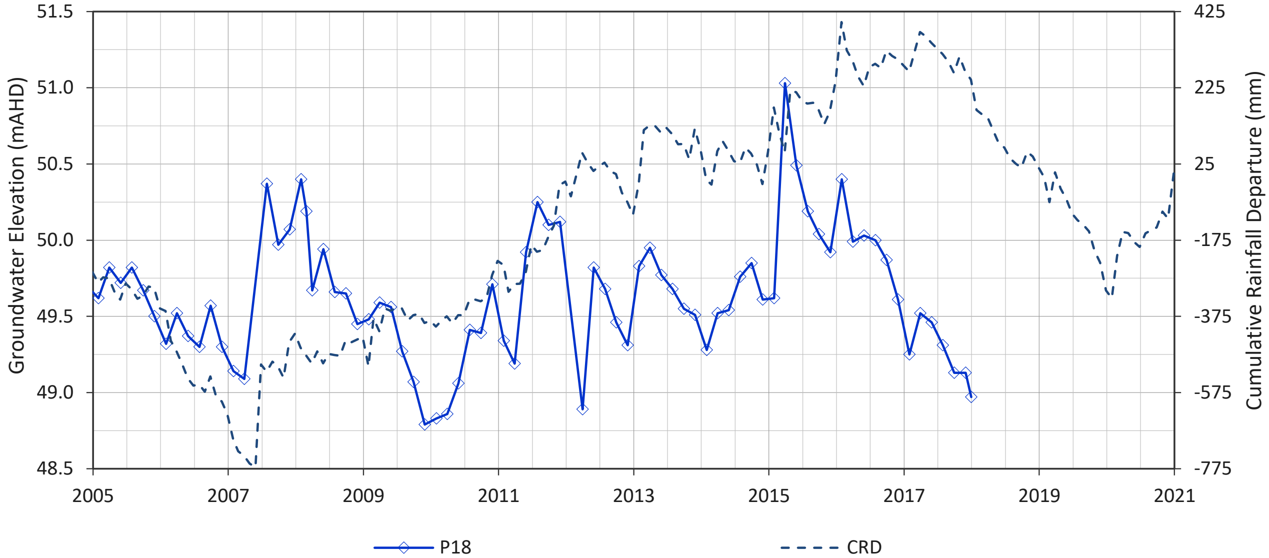


9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
Field pH (pH unit)
425
275
125
-25
-175
-325
-475
-625
-775
Cumulative Rainfall Departure (mm)
2005
2007
2009
2011
2013
2015
2017
2019
2021
P17
CRD

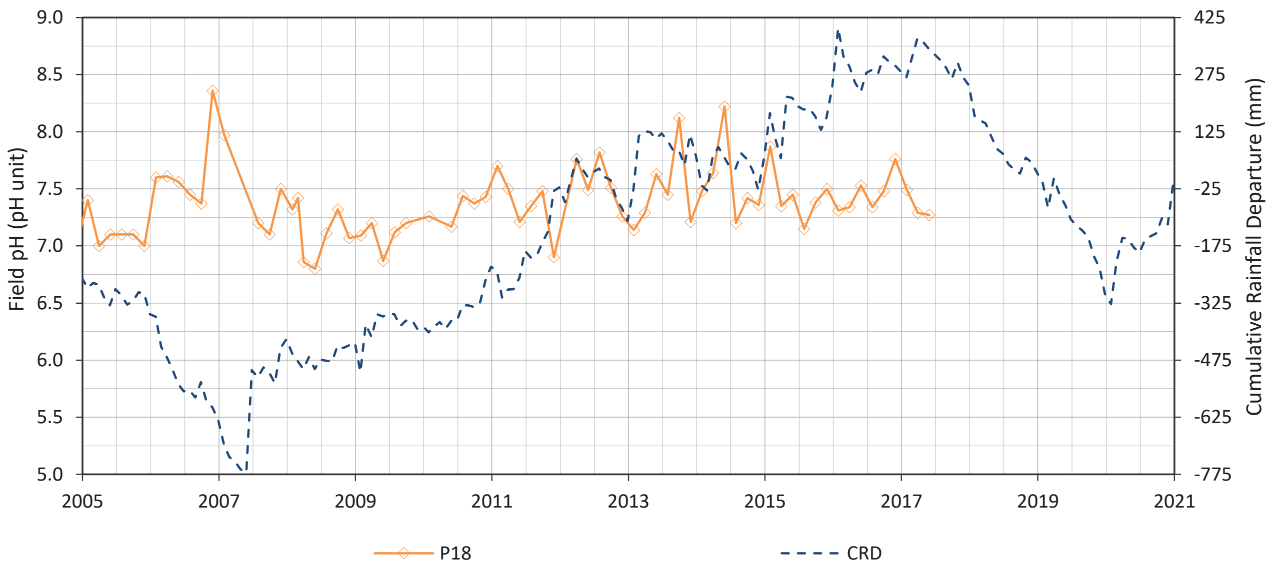


18000
16000
14000
12000
10000
8000
6000
4000
2000
0
Field Electrical Conductivity (µS/cm)
575
425
275
125
-25
-175
-325
-475
-625
-775
Cumulative Rainfall Departure (mm)
2005
2007
2009
2011
2013
2015
2017
2019
2021
P17
CRD

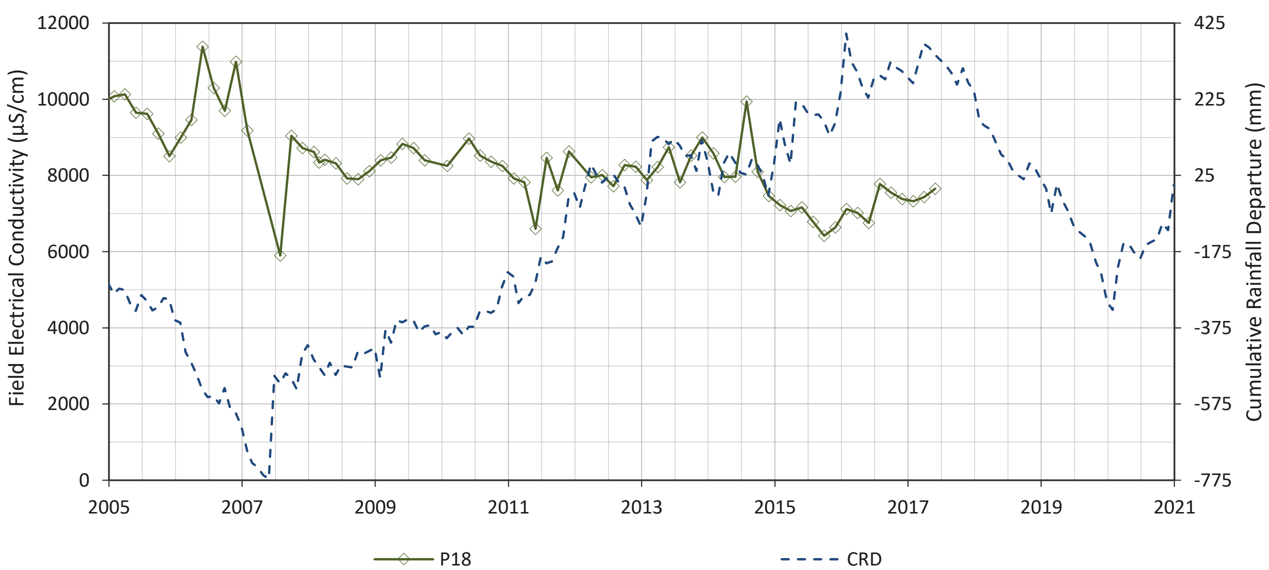
P18



Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
51.5
51.0
50.5
50.0
49.5
49.0
48.5
425
225
25
-175
-375
-575
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P18
CRD

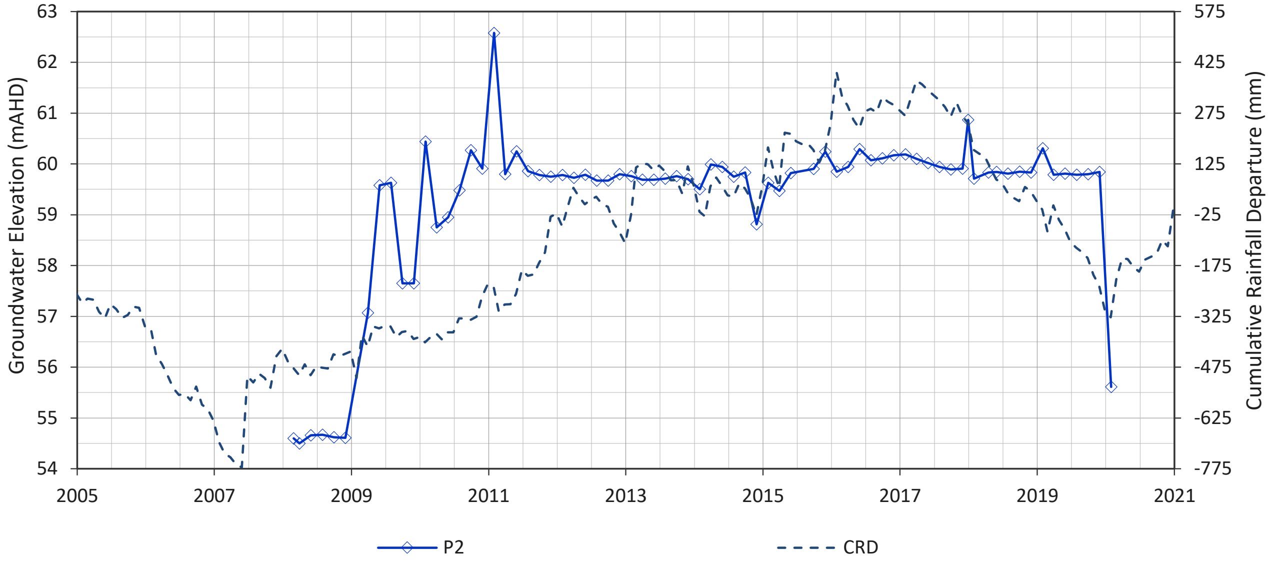


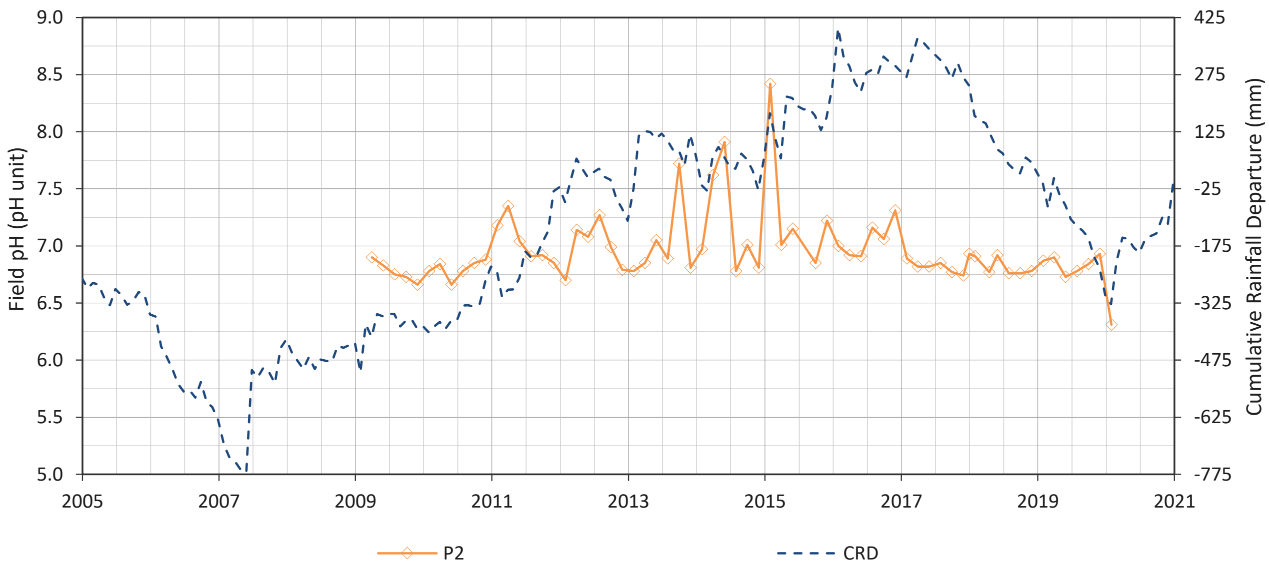
Field pH (pH unit)
Cumulative Rainfall Departure (mm)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P18
CRD

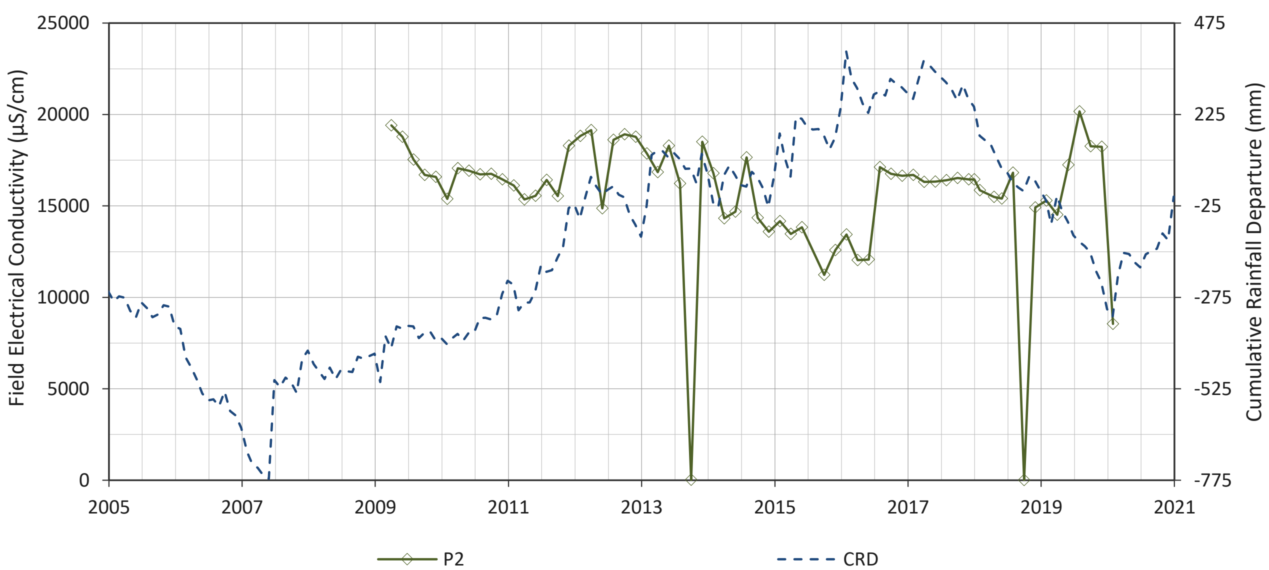


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
12000
10000
8000
6000
4000
2000
0
425
225
25
-175
-375
-575
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P18
CRD

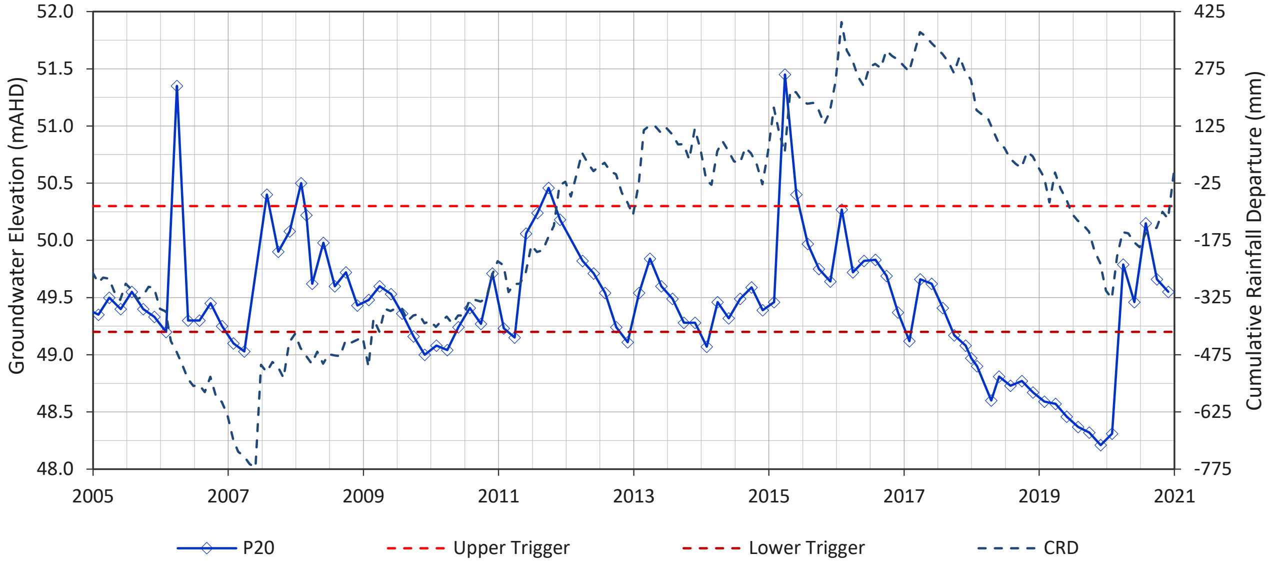
P2


Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
63
62
61
60
59
58
57
56
55
54
575
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P2
CRD

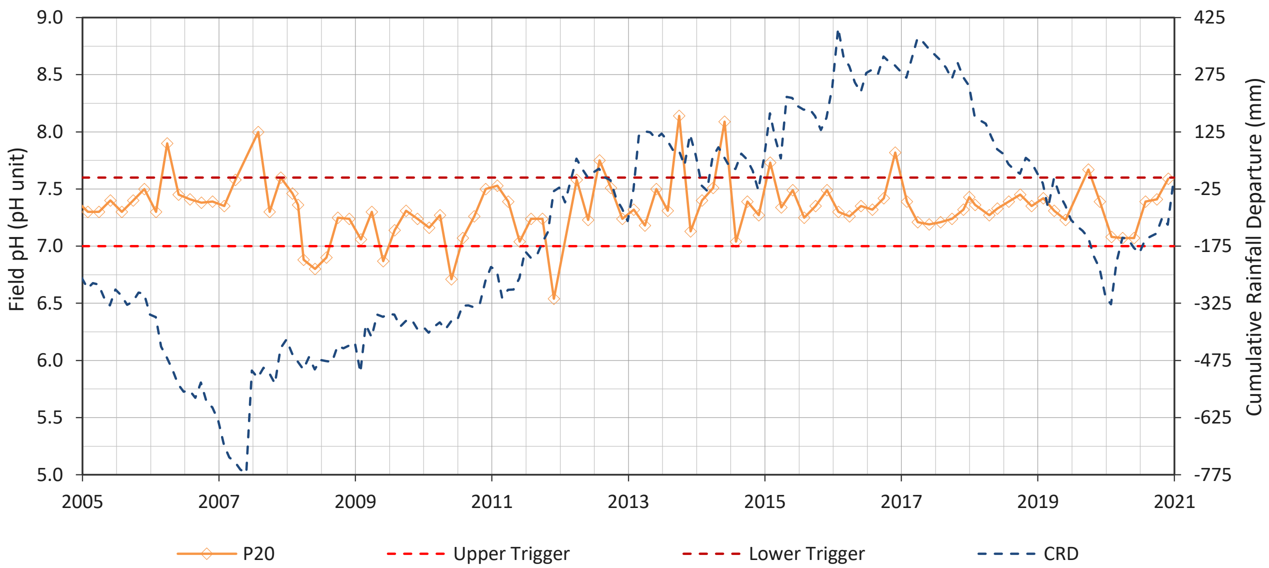

Field pH (pH unit)
Cumulative Rainfall Departure (mm)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P2
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
25000
20000
15000
10000
5000
0
475
225
-25
-275
-525
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P2
CRD

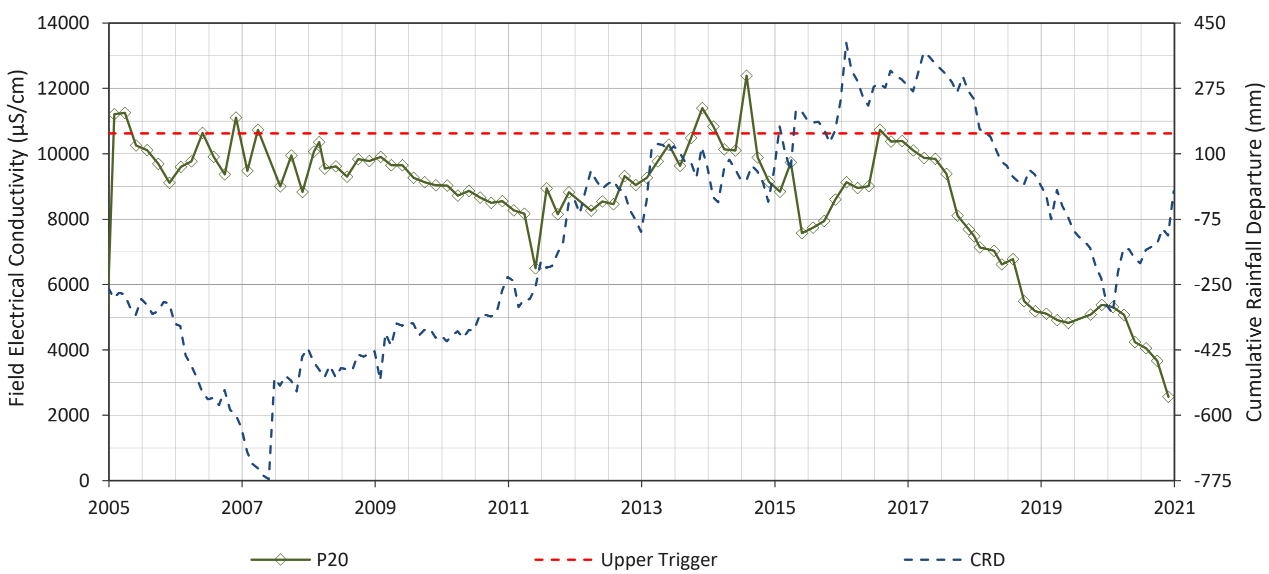
P20



Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
52.0
51.5
51.0
50.5
50.0
49.5
49.0
48.5
48.0
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P20
Upper Trigger
Lower Trigger
CRD

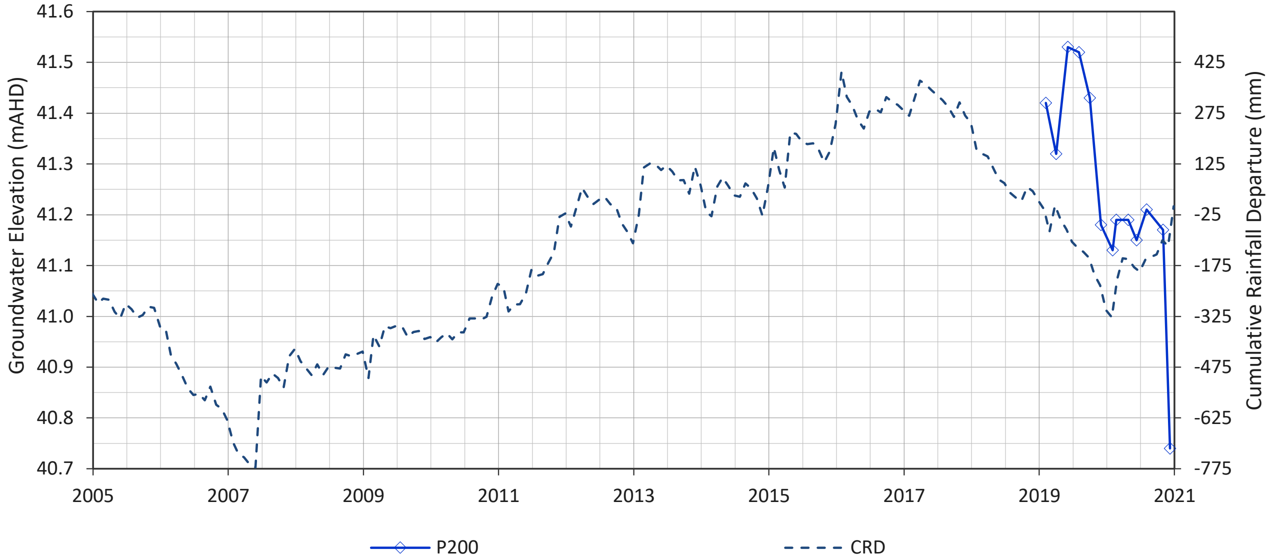


Field pH (pH unit)
Cumulative Rainfall Departure (mm)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P20
Upper Trigger
Lower Trigger
CRD

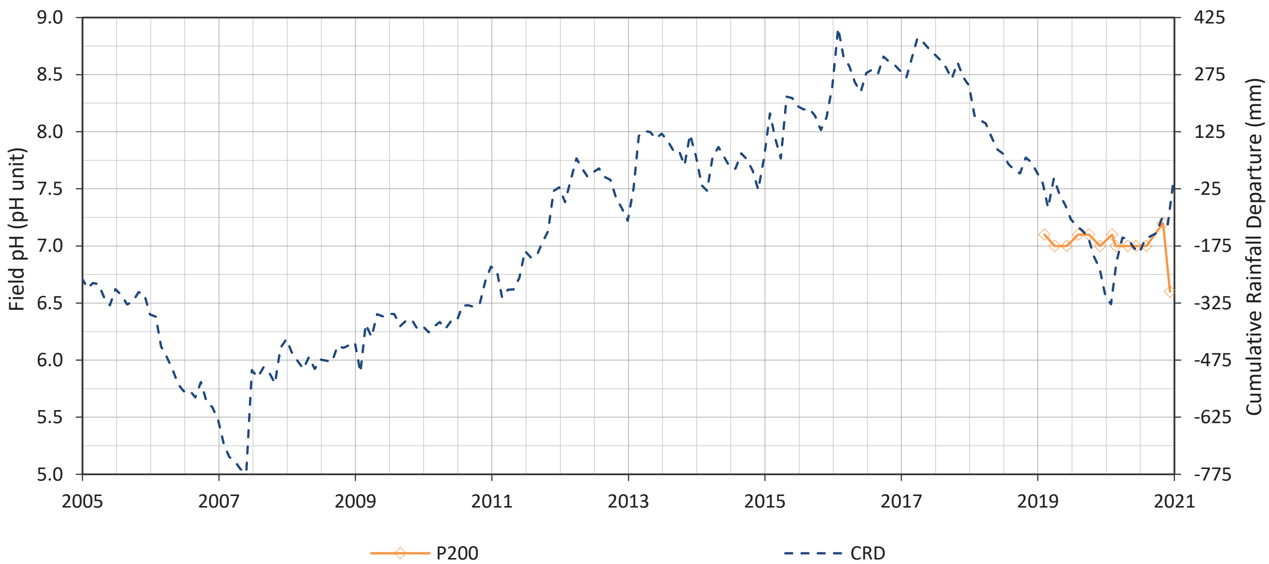


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
14000
12000
10000
8000
6000
4000
2000
0
450
275
100
-75
-250
-425
-600
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P20
Upper Trigger
CRD

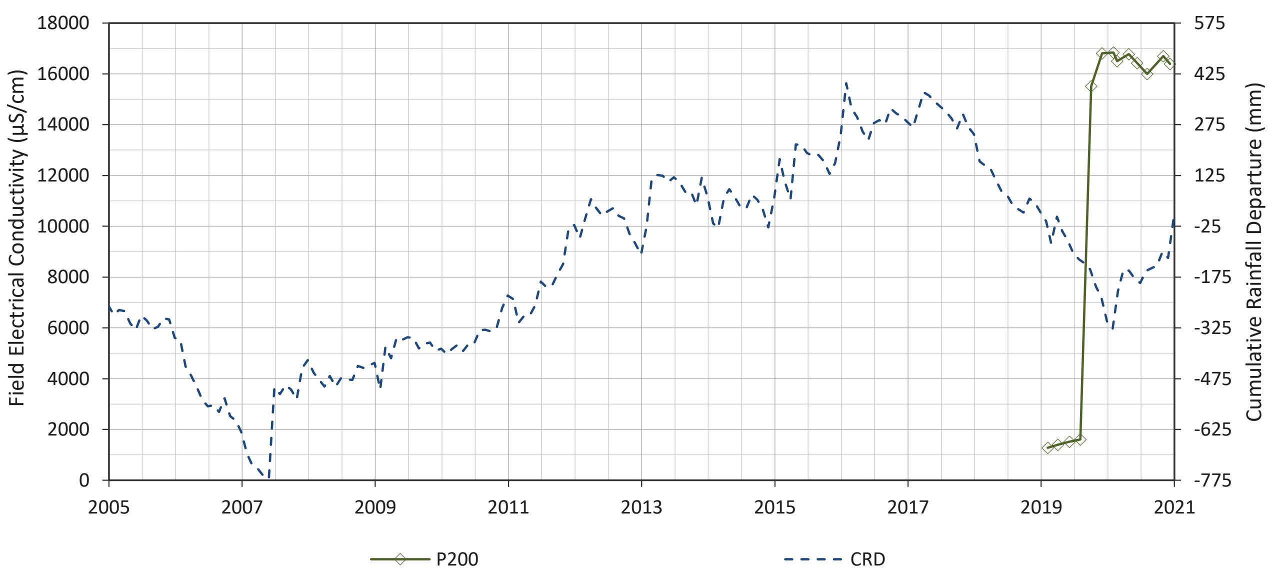
P200



Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
41.6
41.5
41.4
41.3
41.2
41.1
41.0
40.9
40.8
40.7
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P200
CRD

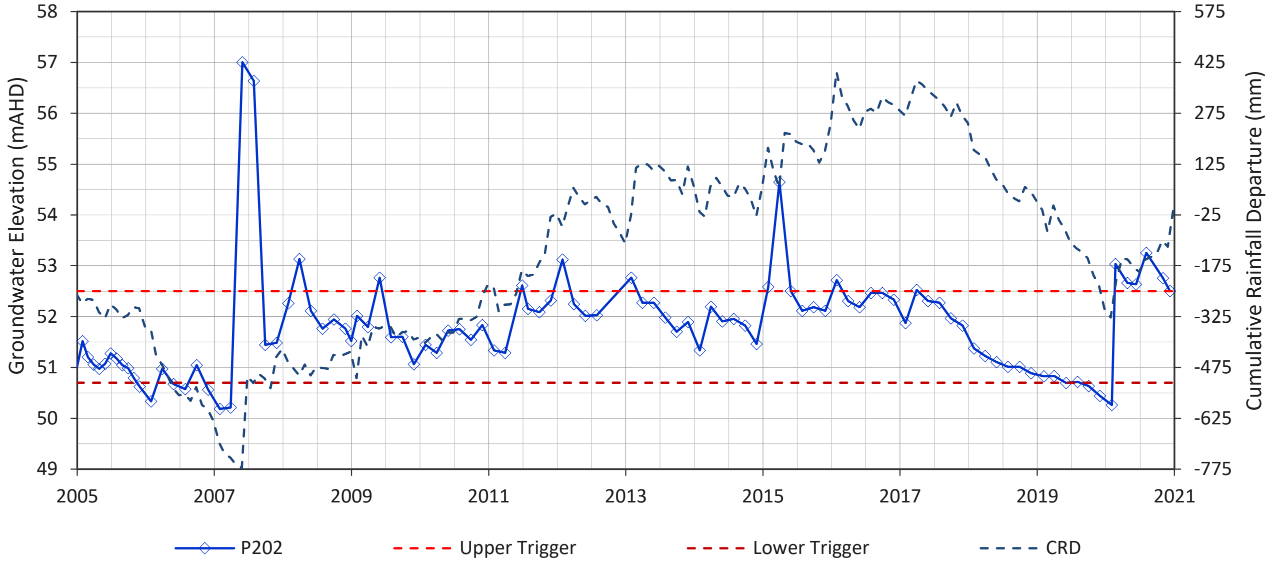


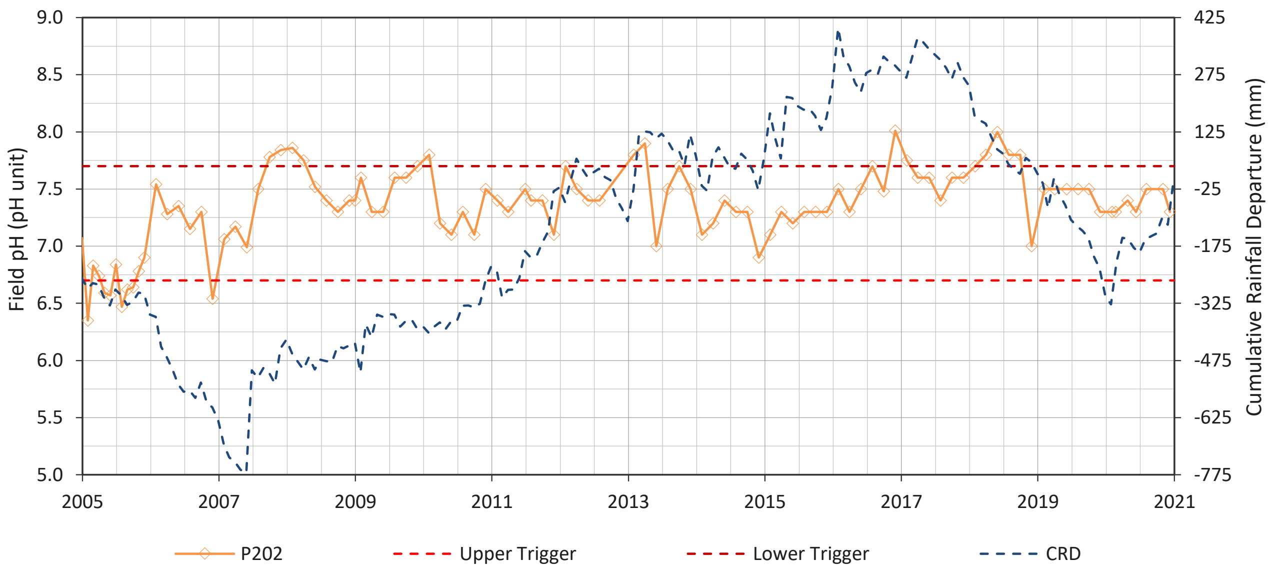
Field pH (pH unit)
Cumulative Rainfall Departure (mm)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P200
CRD

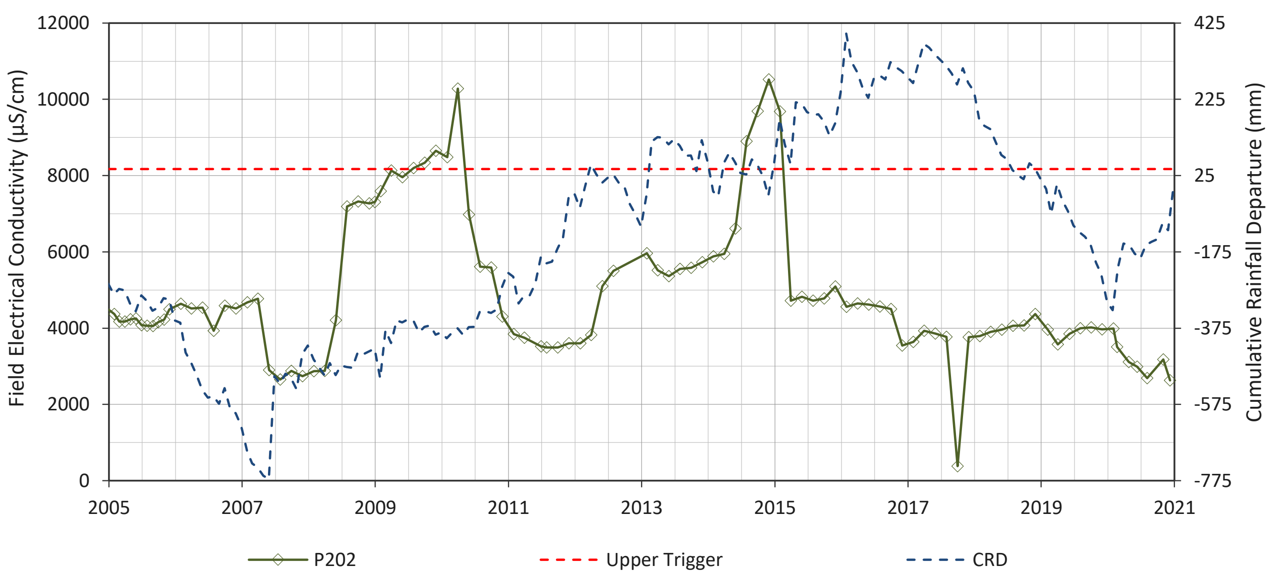


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
575
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P200
CRD

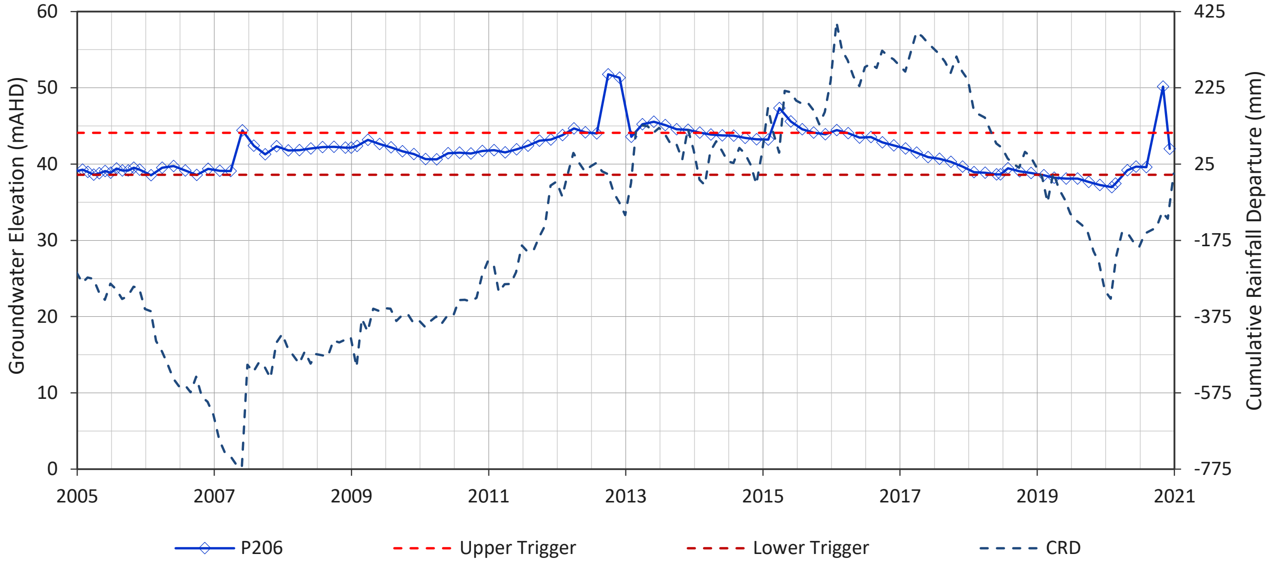
P202


Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
P202
Upper Trigger
Lower Trigger
CRD

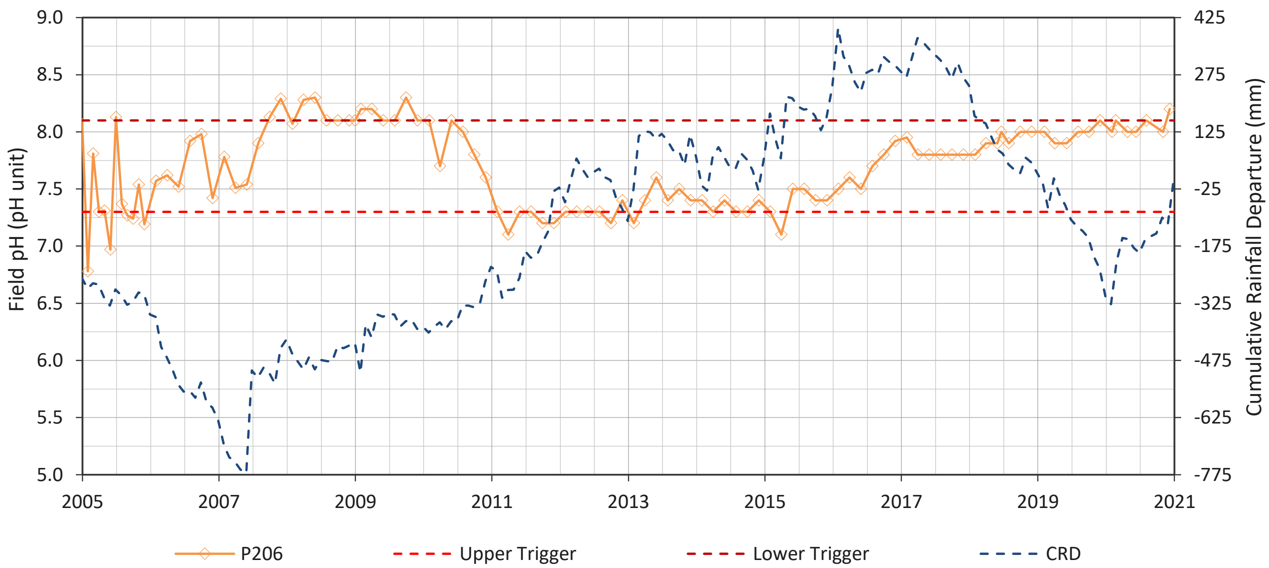

Field pH (pH unit)
Cumulative Rainfall Departure (mm)
P202
Upper Trigger
Lower Trigger
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
P202
Upper Trigger
CRD

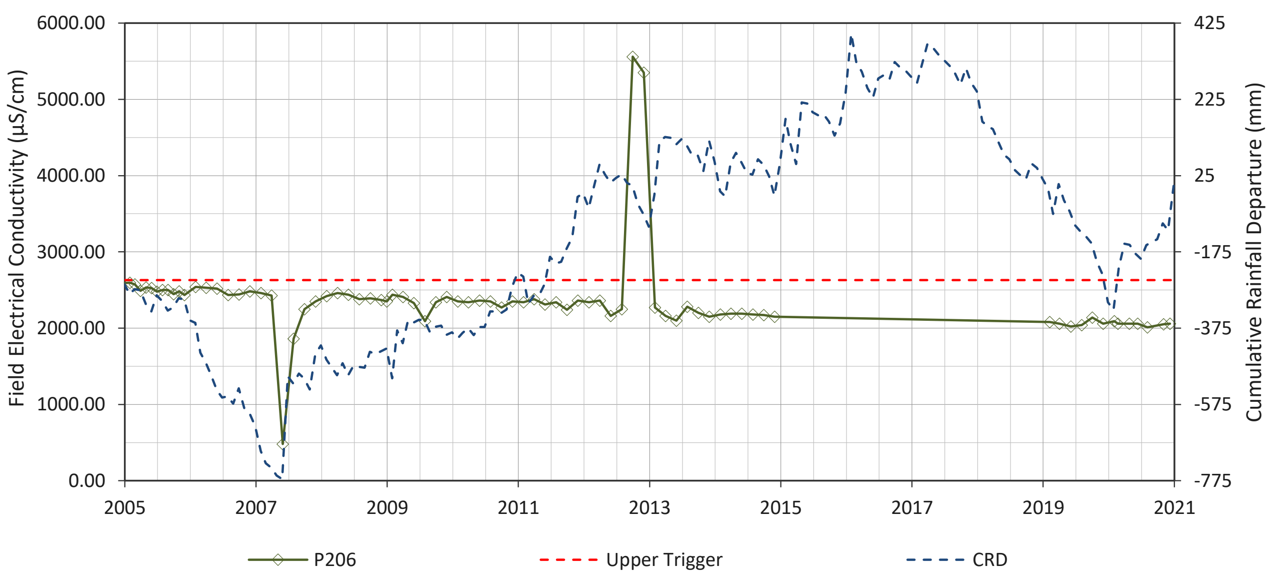
P206



Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
P206
Upper Trigger
Lower Trigger
CRD



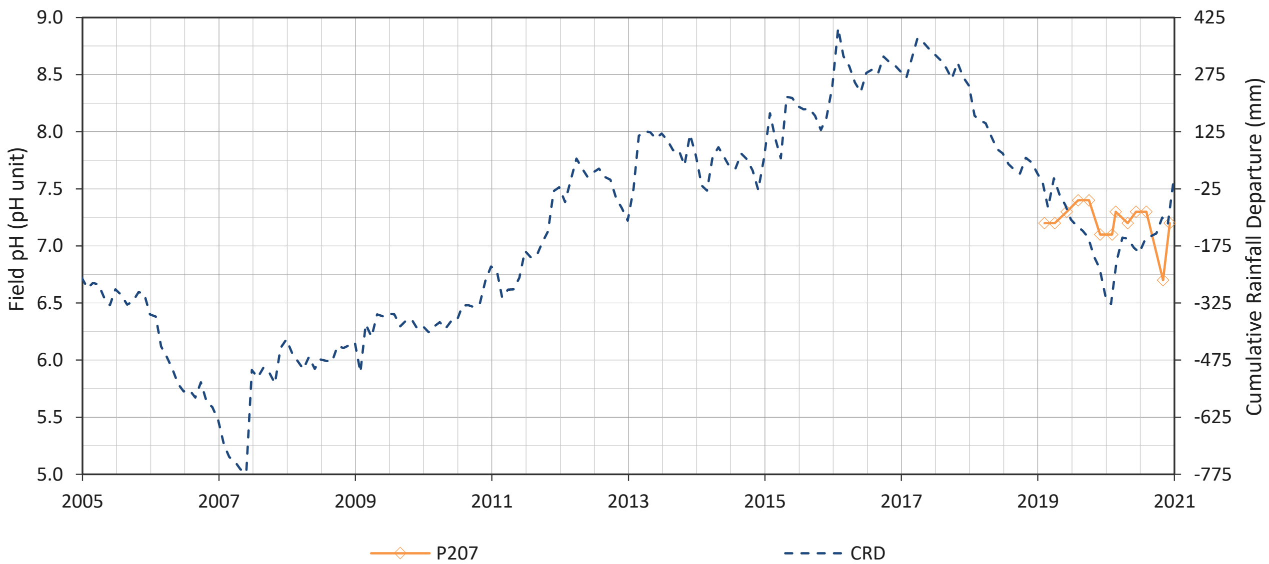
Field pH (pH unit)
Cumulative Rainfall Departure (mm)
P206
Upper Trigger
Lower Trigger
CRD

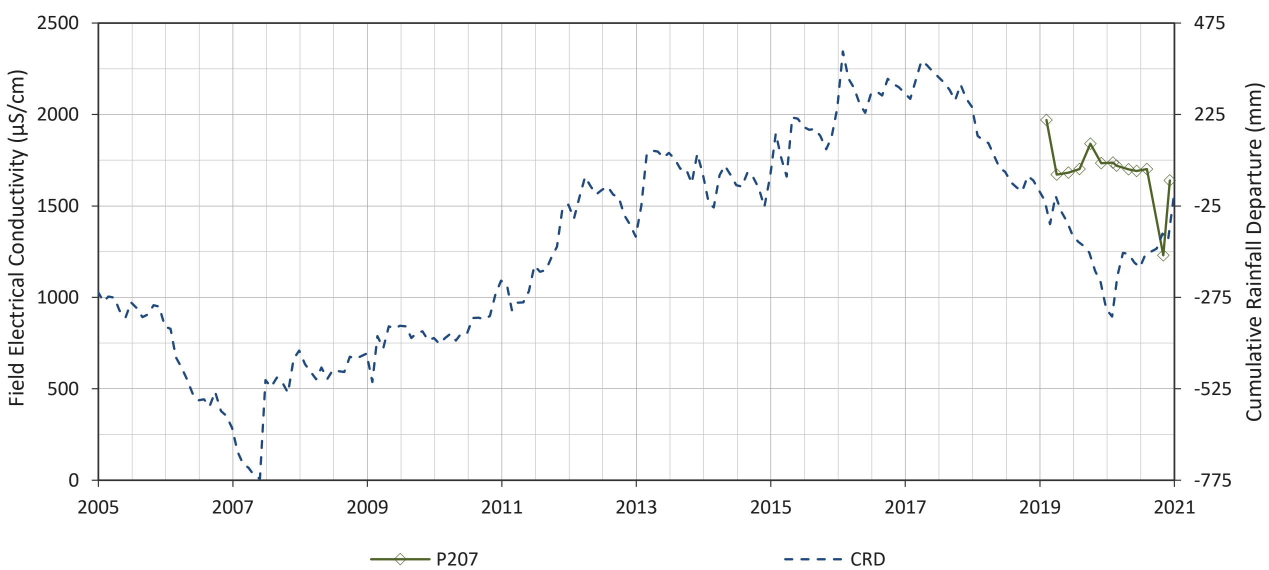


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
P206
Upper Trigger
CRD

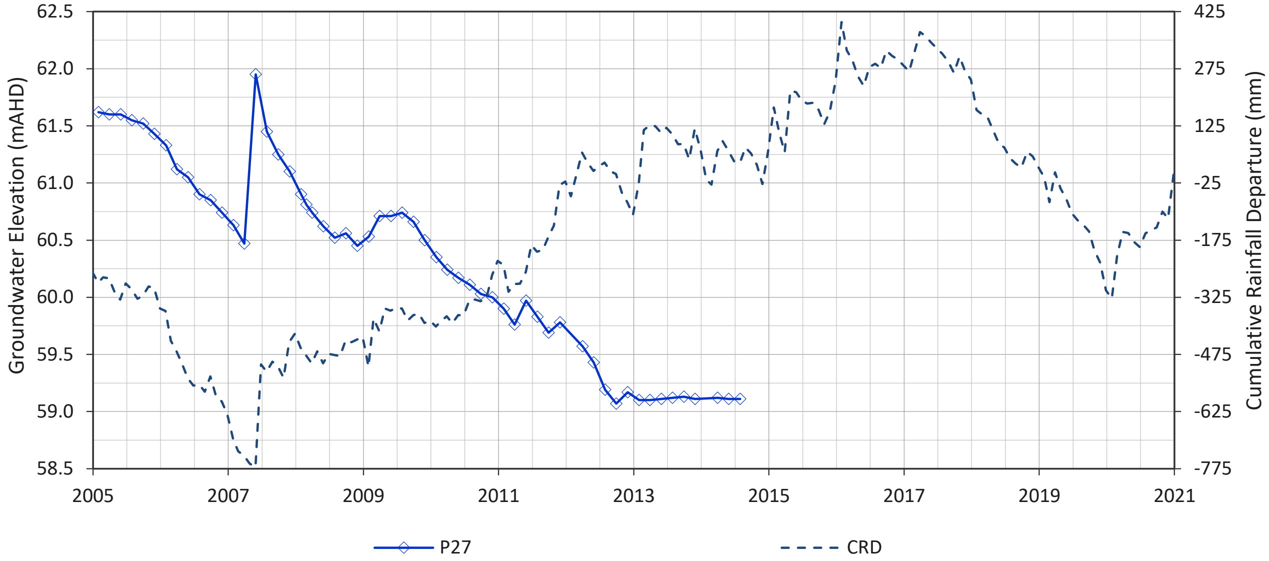
P207


Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
53.5
53.0
52.5
52.0
51.5
51.0
50.5
425
225
25
-175
-375
-575
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P207
CRD

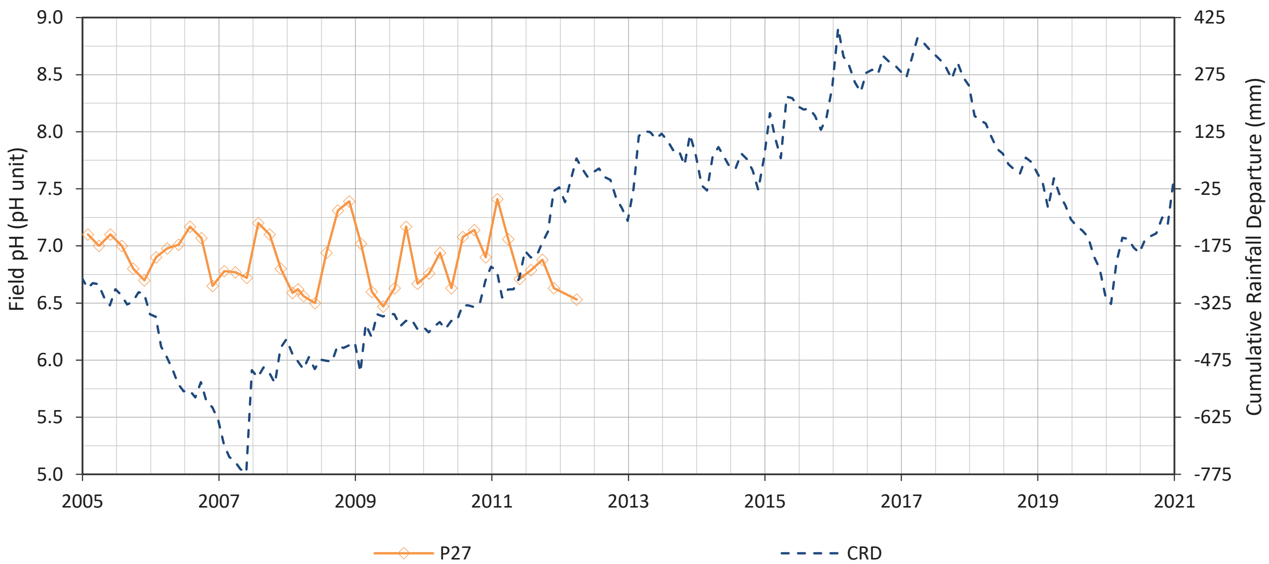

Field pH (pH unit)
Cumulative Rainfall Departure (mm)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P207
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
2500
2000
1500
1000
500
0
475
225
-25
-275
-525
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P207
CRD

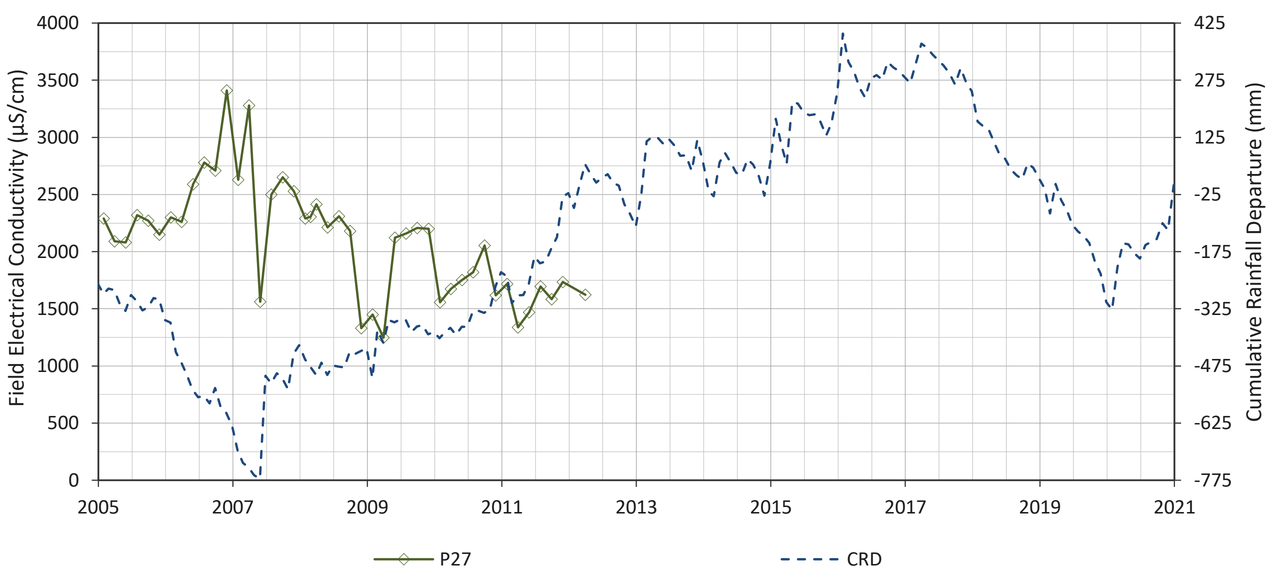
P27



Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
62.5
62.0
61.5
61.0
60.5
60.0
59.5
59.0
58.5
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P27
CRD

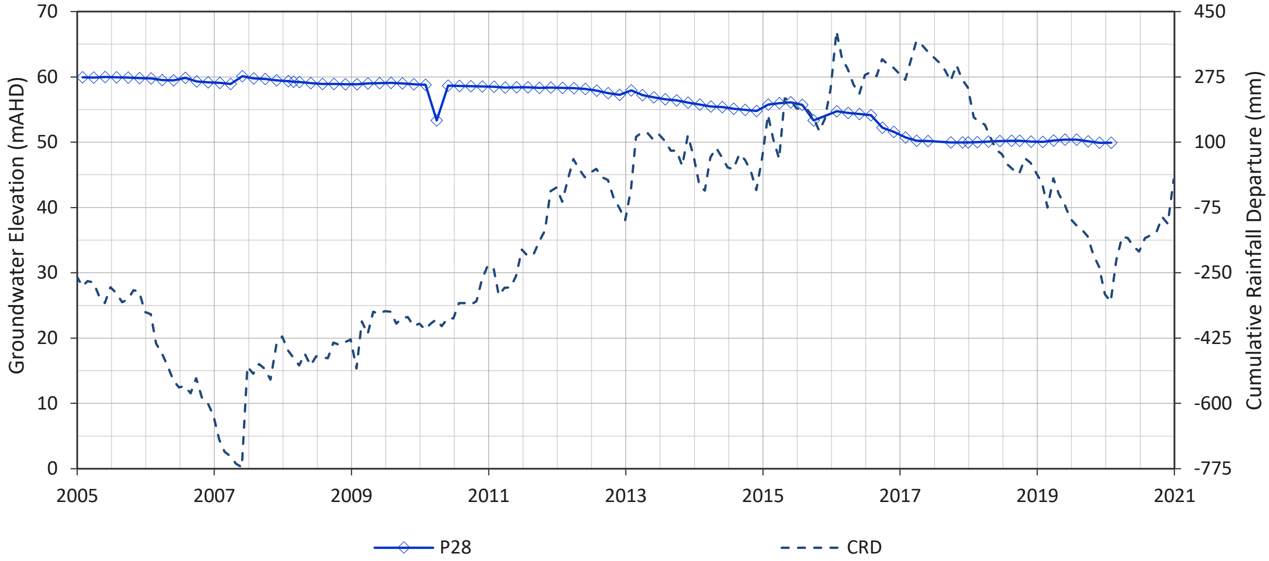


Field pH (pH unit)
Cumulative Rainfall Departure (mm)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P27
CRD

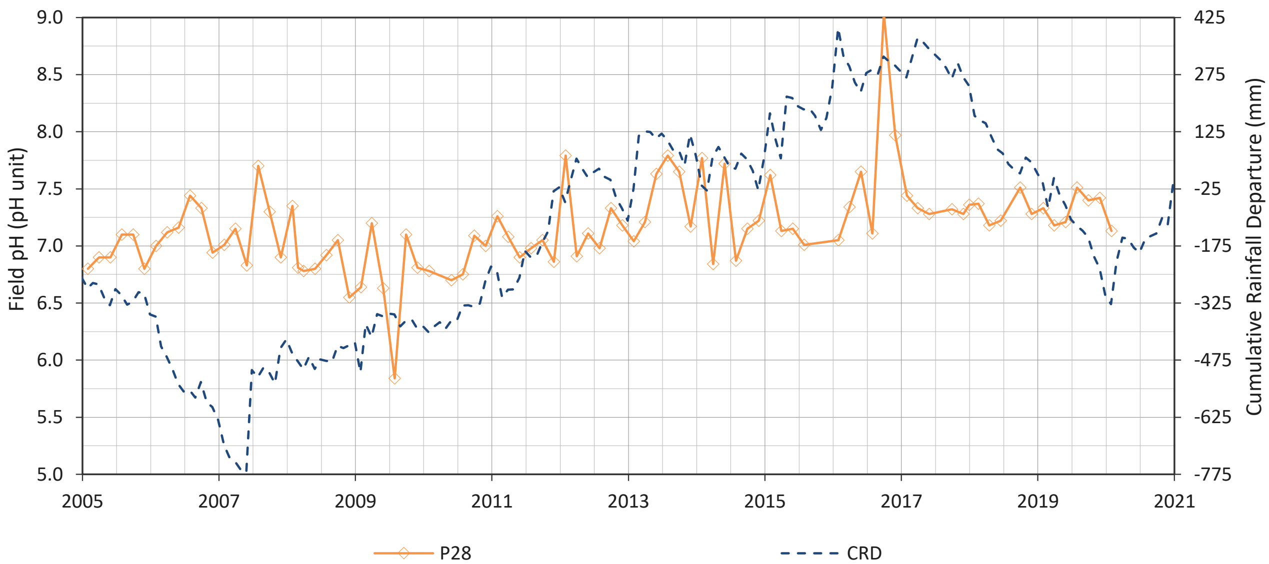


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
4000
3500
3000
2500
2000
1500
1000
500
0
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P27
CRD

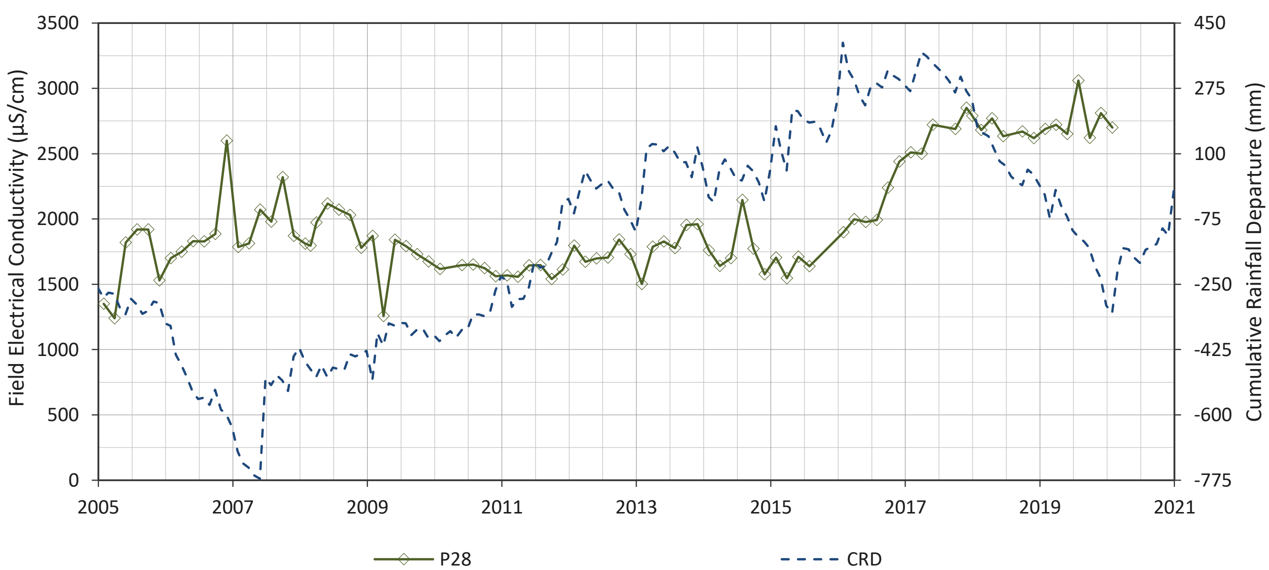
P28



Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
P28
CRD

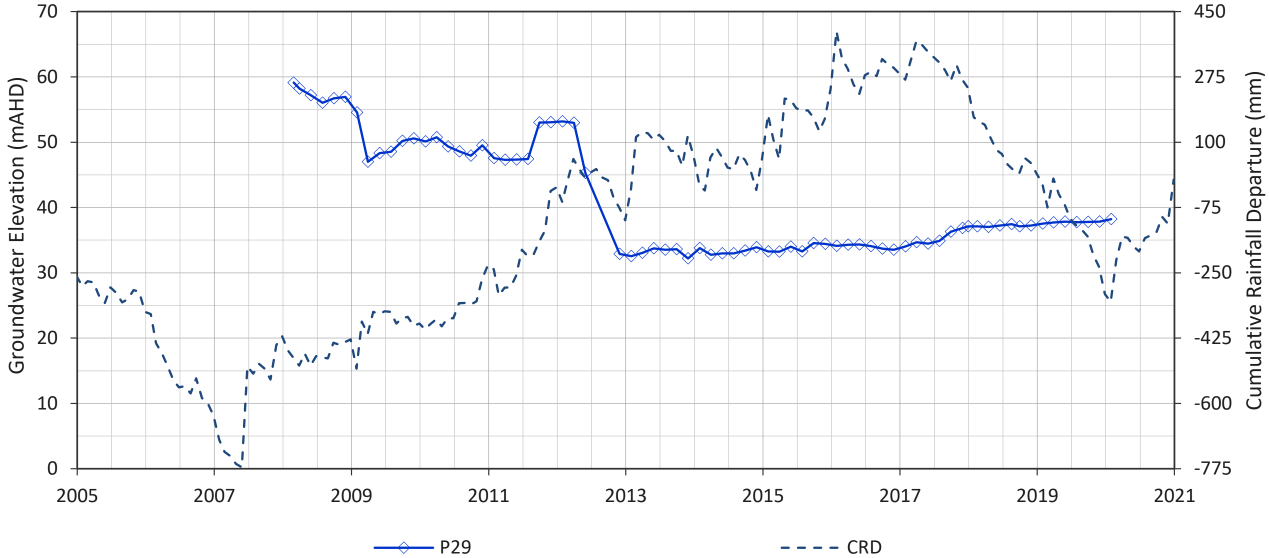


Field pH (pH unit)
Cumulative Rainfall Departure (mm)
P28
CRD

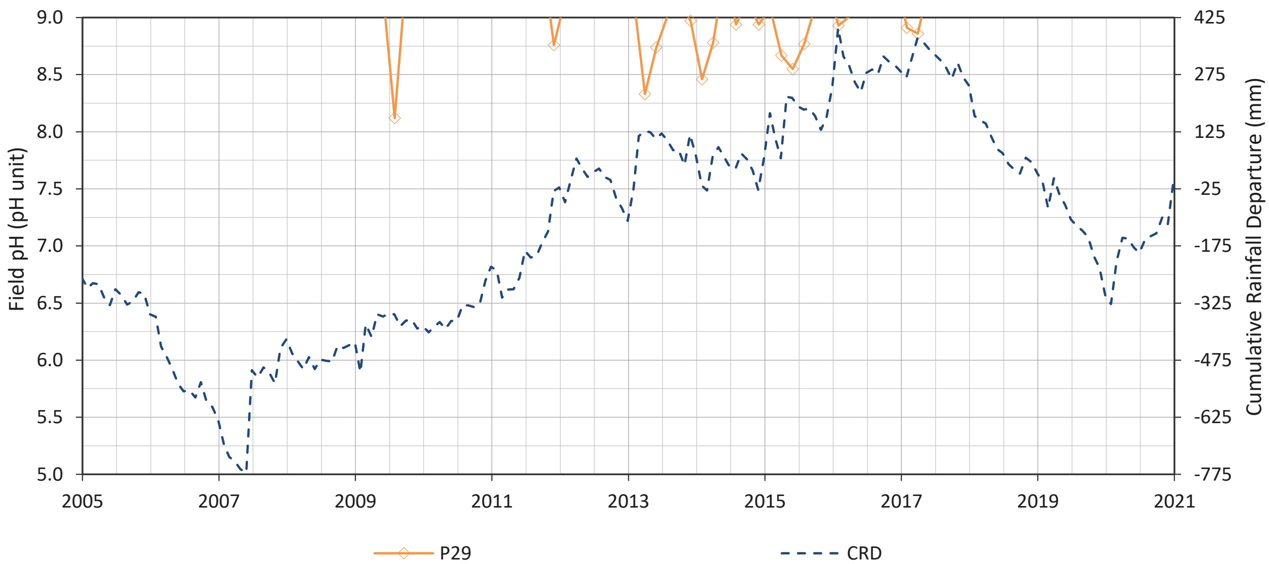


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
P28
CRD

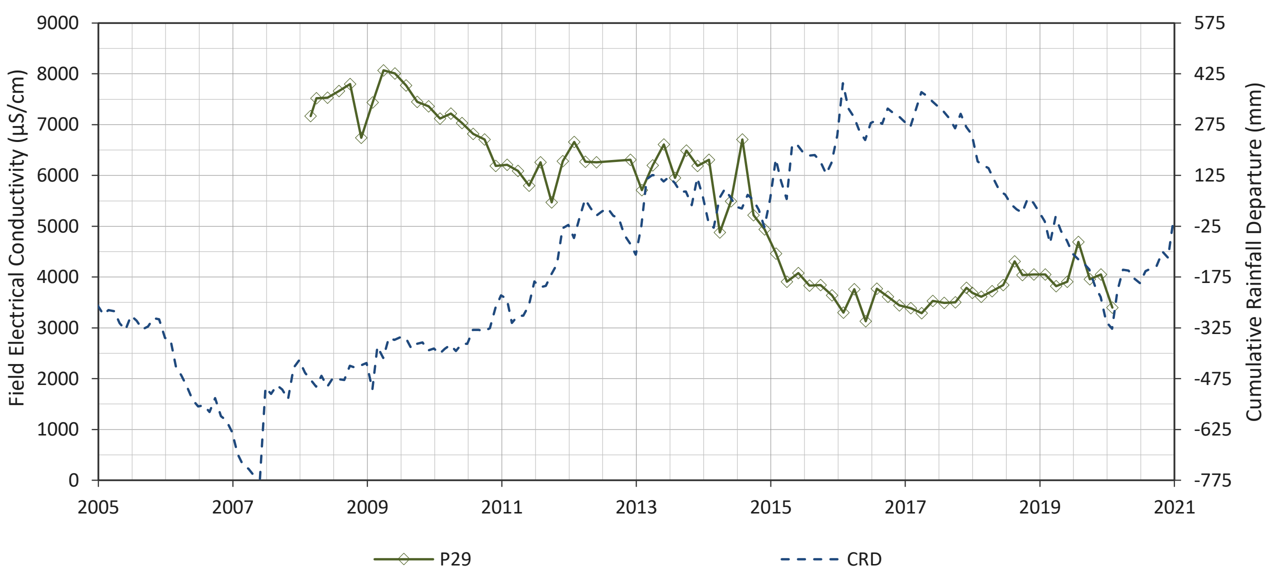
P29



Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
70 60 50 40 30 20 10 0
450 275 100 -75 -250 -425 -600 -775
2005 2007 2009 2011 2013 2015 2017 2019 2021
P29
CRD

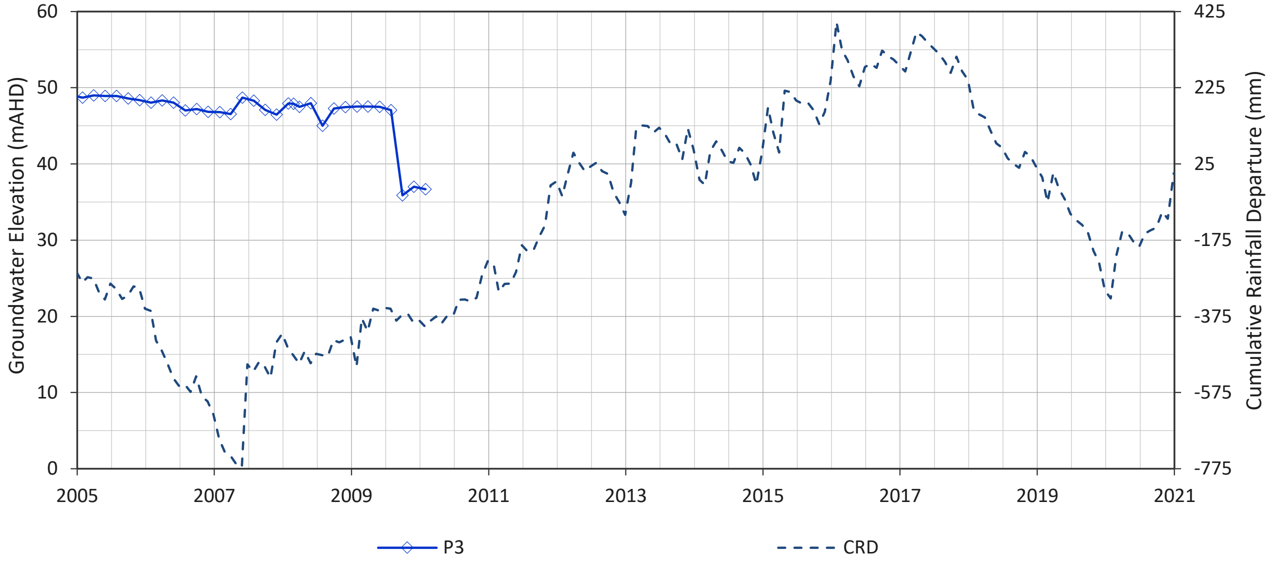


Field pH (pH unit)
Cumulative Rainfall Departure (mm)
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0
425 275 125 -25 -175 -325 -475 -625 -775
2005 2007 2009 2011 2013 2015 2017 2019 2021
P29
CRD

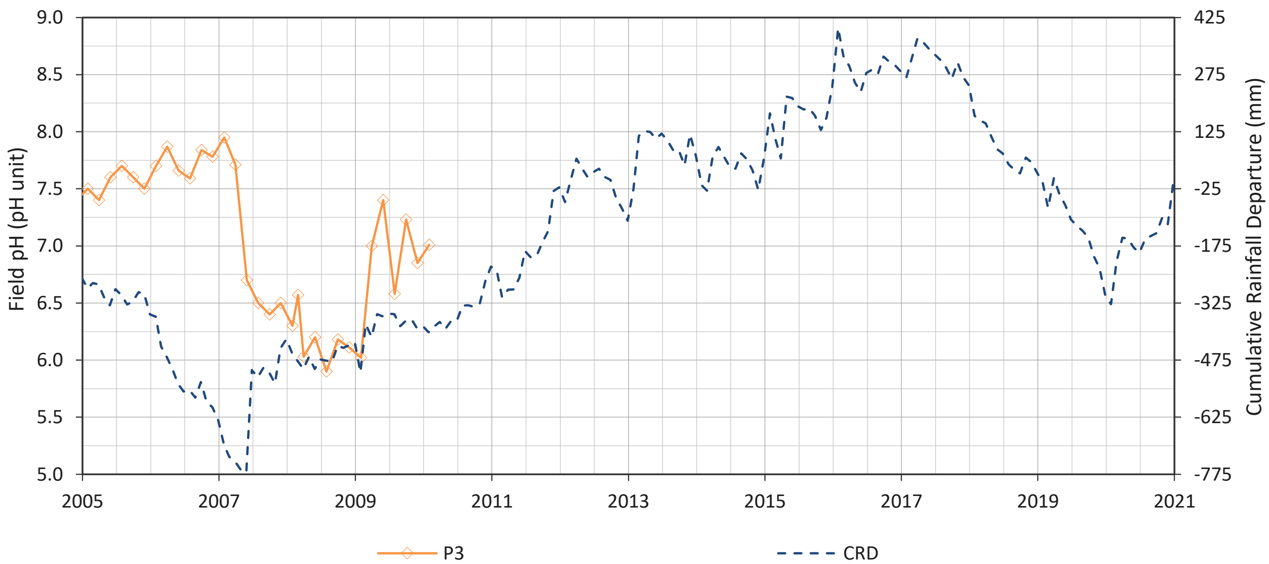


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
9000 8000 7000 6000 5000 4000 3000 2000 1000 0
575 425 275 125 -25 -175 -325 -475 -625 -775
2005 2007 2009 2011 2013 2015 2017 2019 2021
P29
CRD

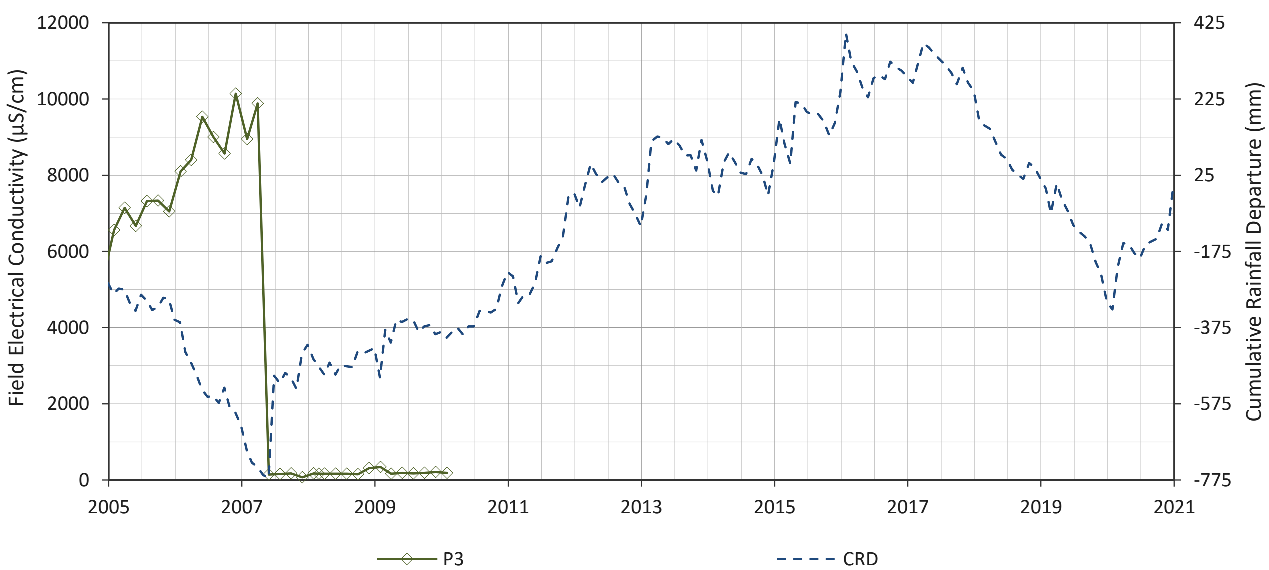
P3



Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
60
50
40
30
20
10
0
425
225
25
-175
-375
-575
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P3
CRD

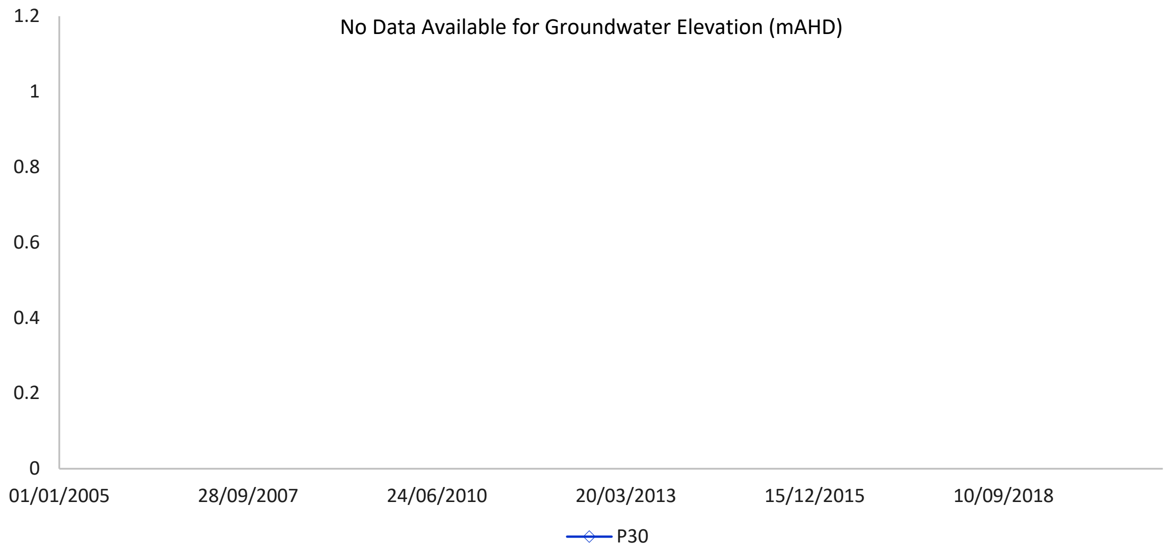


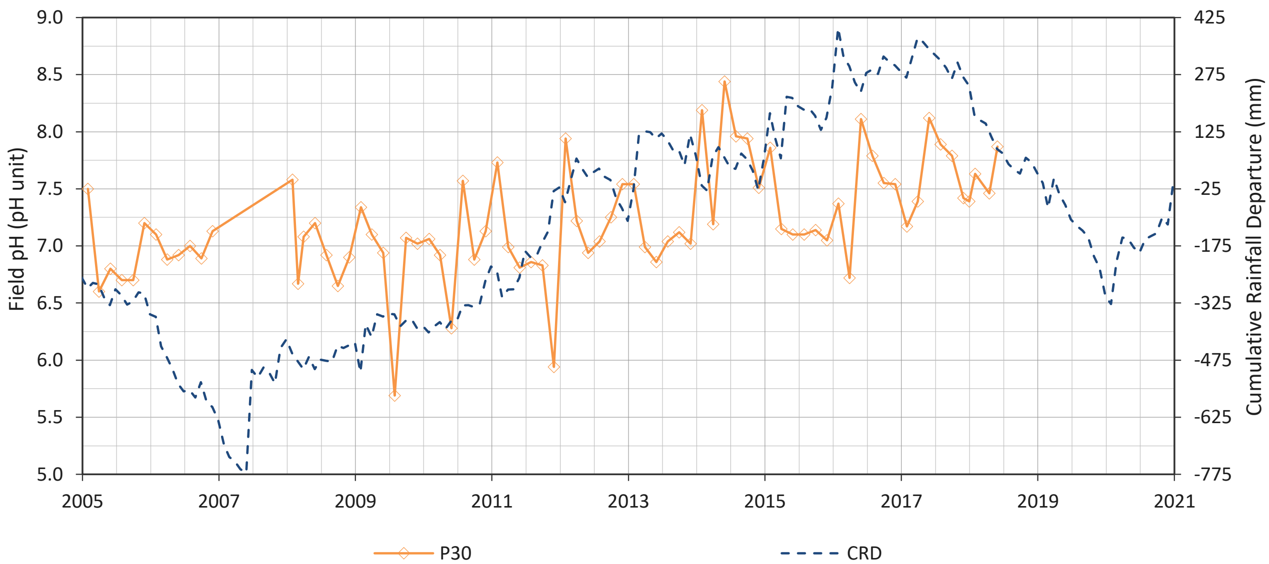
Field pH (pH unit)
Cumulative Rainfall Departure (mm)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P3
CRD

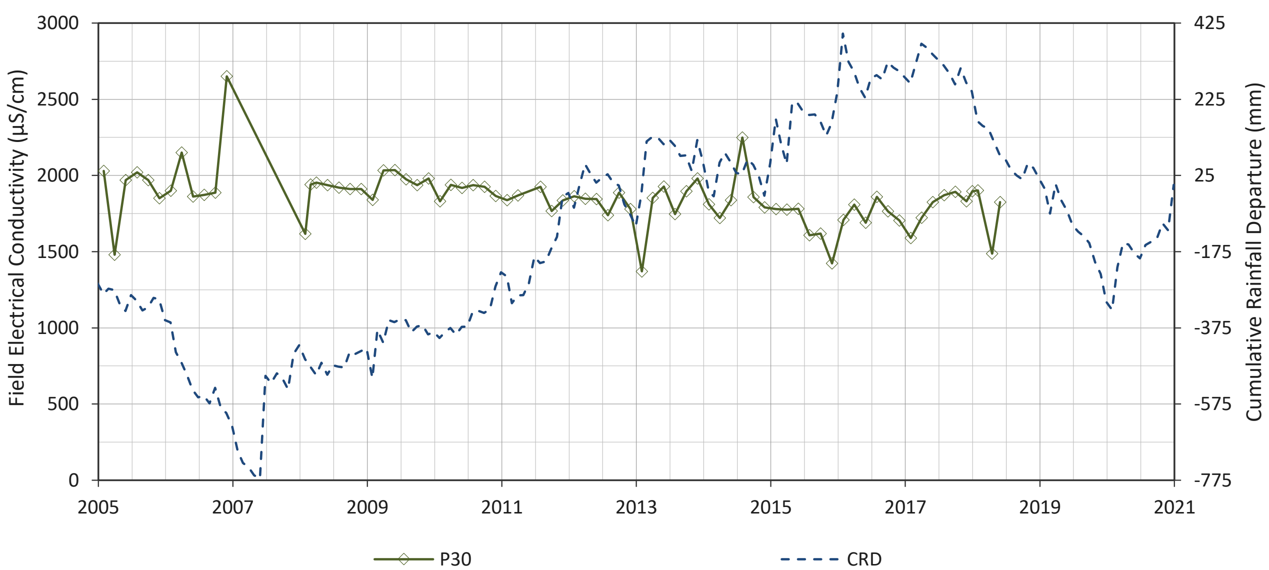


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
12000
10000
8000
6000
4000
2000
0
425
225
25
-175
-375
-575
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P3
CRD

P30


No Data Available for Groundwater Elevation (mAHD)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
P30


Field pH (pH unit)
Cumulative Rainfall Departure (mm)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P30
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
3000
2500
2000
1500
1000
500
0
425
225
25
-175
-375
-575
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P30
CRD

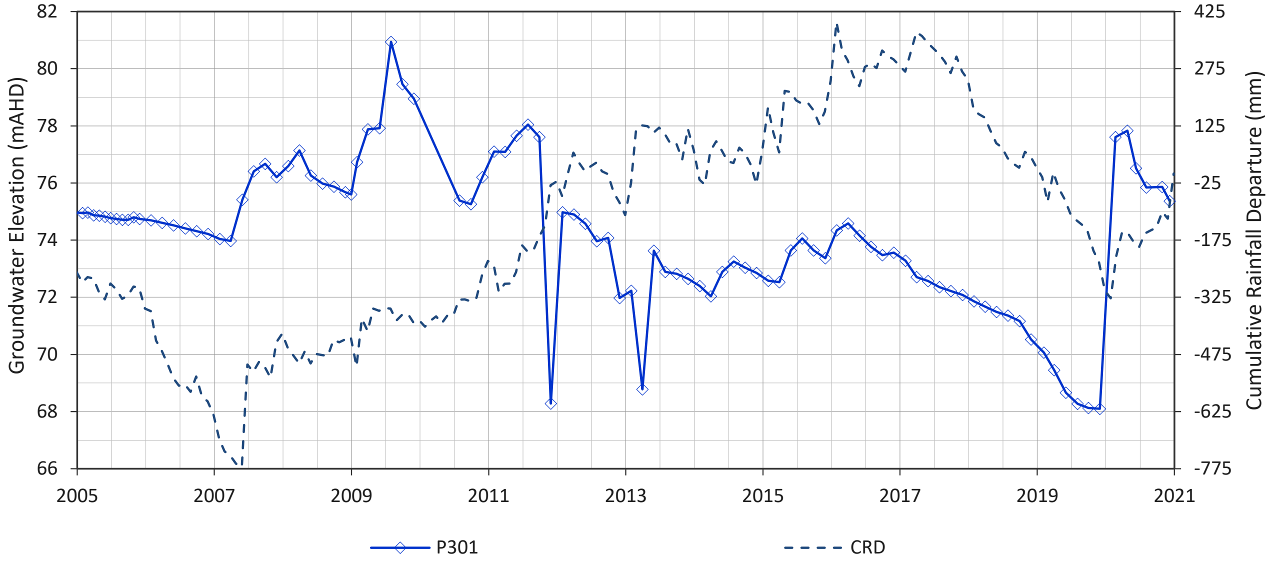
P30

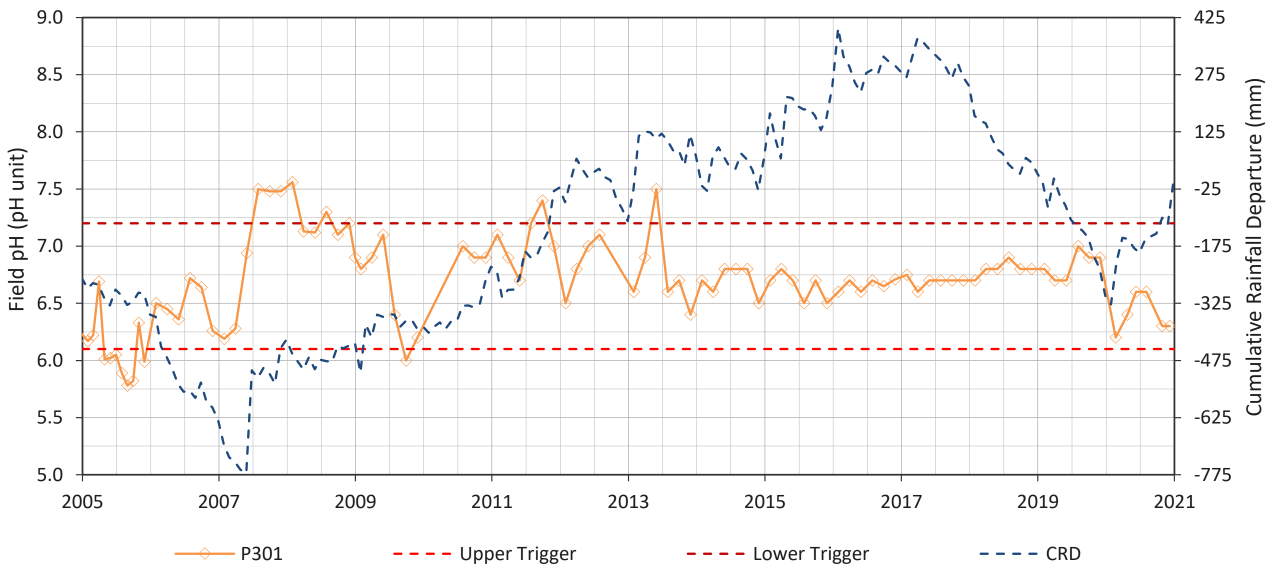
No Data Available for Groundwater Elevation (mAHD)

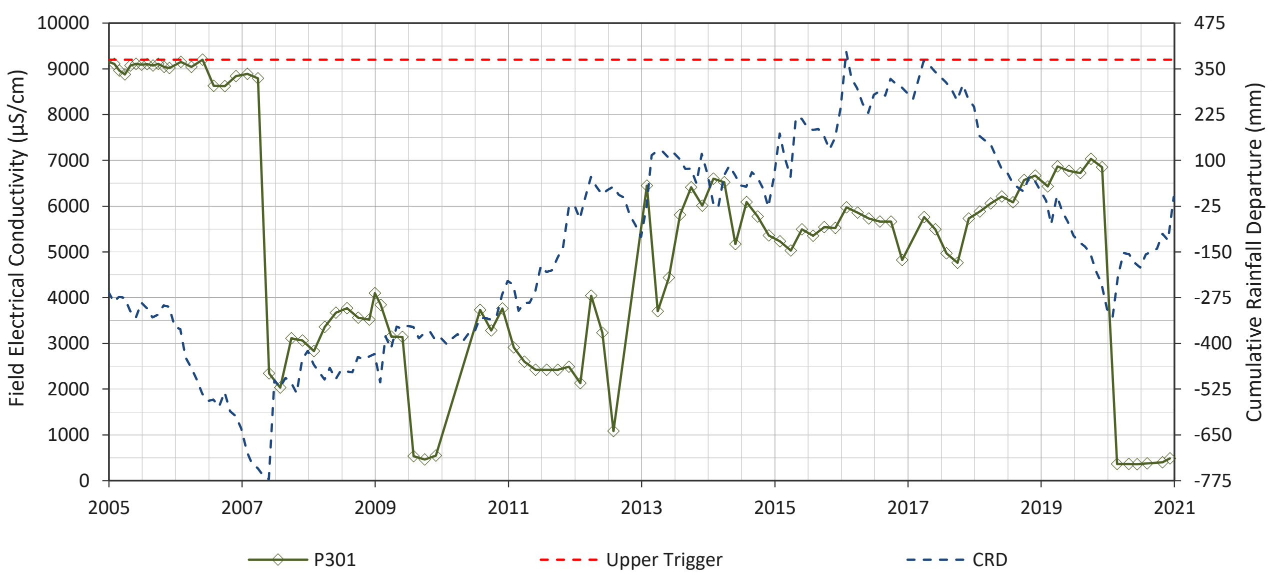
No Data Available for Field pH (pH unit)

No Data Available for Field Electrical Conductivity (µS/cm)

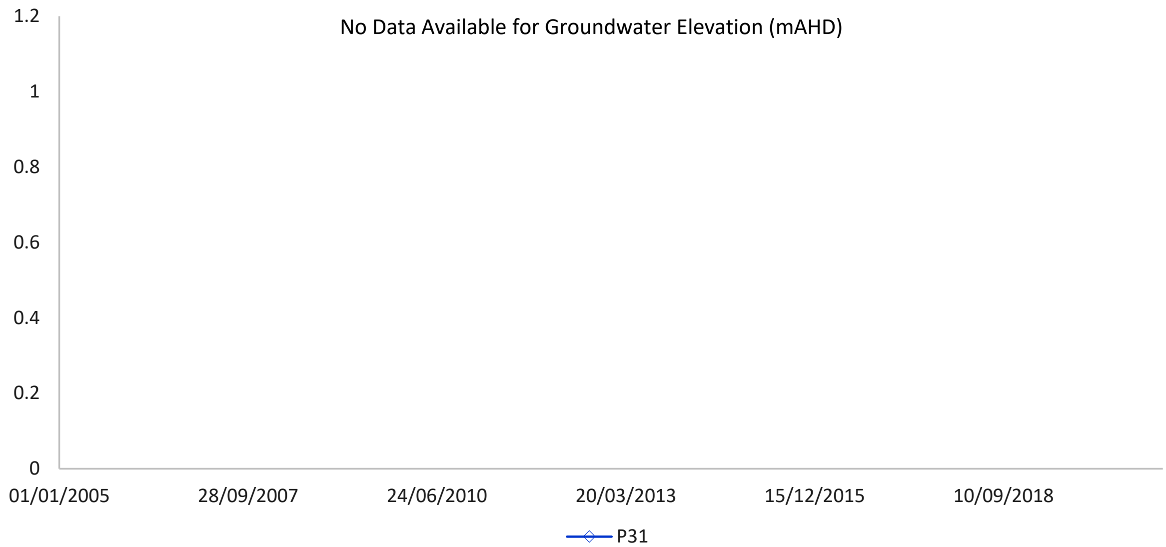
P301


Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
82
80
78
76
74
72
70
68
66
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P301
CRD

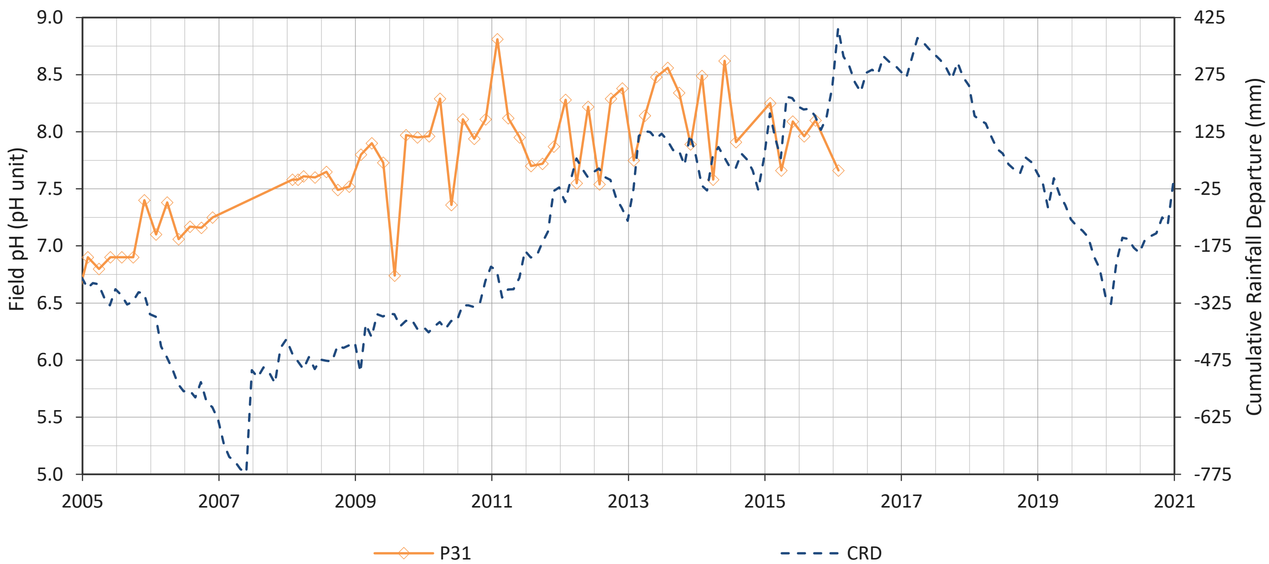

Field pH (pH unit)
Cumulative Rainfall Departure (mm)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P301
Upper Trigger
Lower Trigger
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
475
350
225
100
-25
-150
-275
-400
-525
-650
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P301
Upper Trigger
CRD

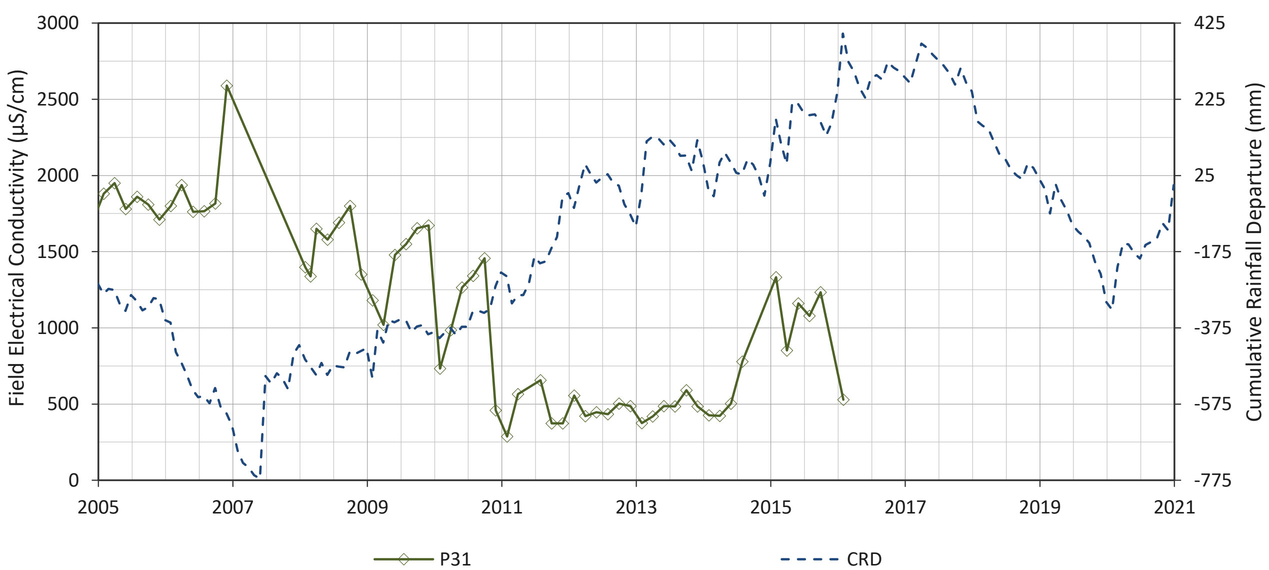
P31



No Data Available for Groundwater Elevation (mAHD)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
P31

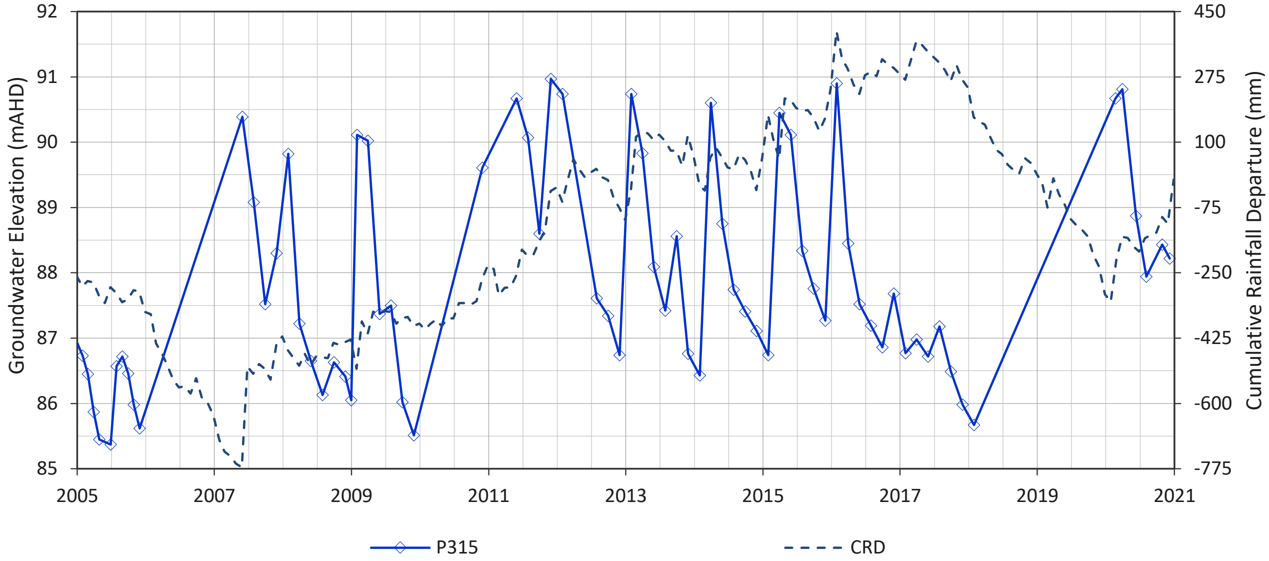


Field pH (pH unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
Cumulative Rainfall Departure (mm)
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P31
CRD

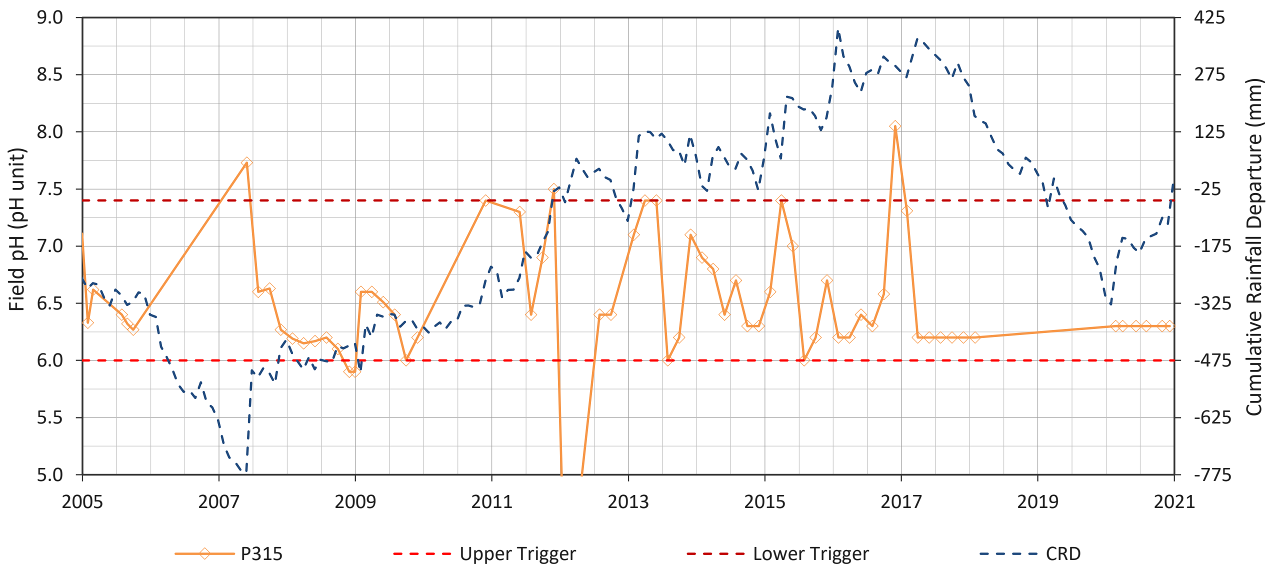


Field Electrical Conductivity (µS/cm)
3000
2500
2000
1500
1000
500
0
Cumulative Rainfall Departure (mm)
425
225
25
-175
-375
-575
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P31
CRD

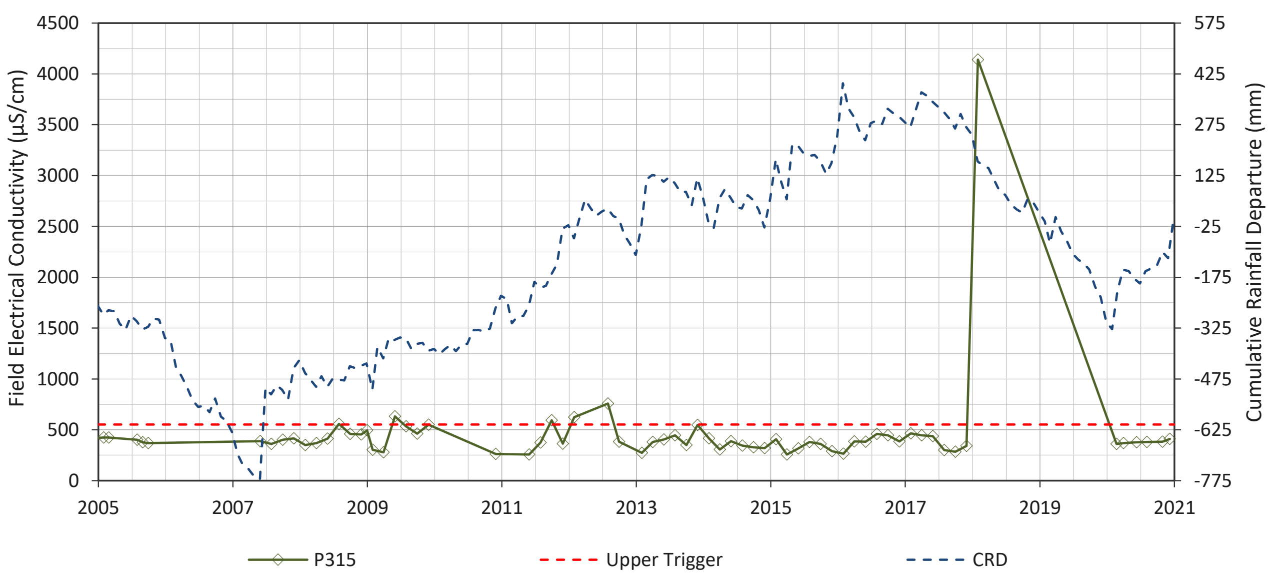
P315



Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
92
91
90
89
88
87
86
85
450
275
100
-75
-250
-425
-600
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P315
CRD

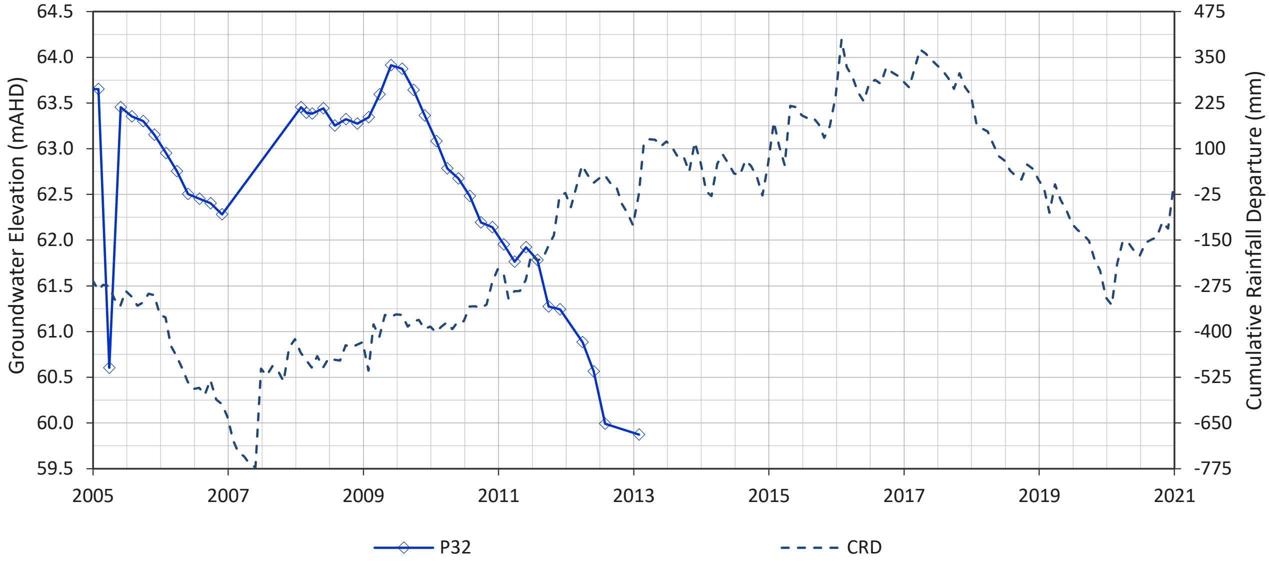


Field pH (pH unit)
Cumulative Rainfall Departure (mm)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P315
Upper Trigger
Lower Trigger
CRD

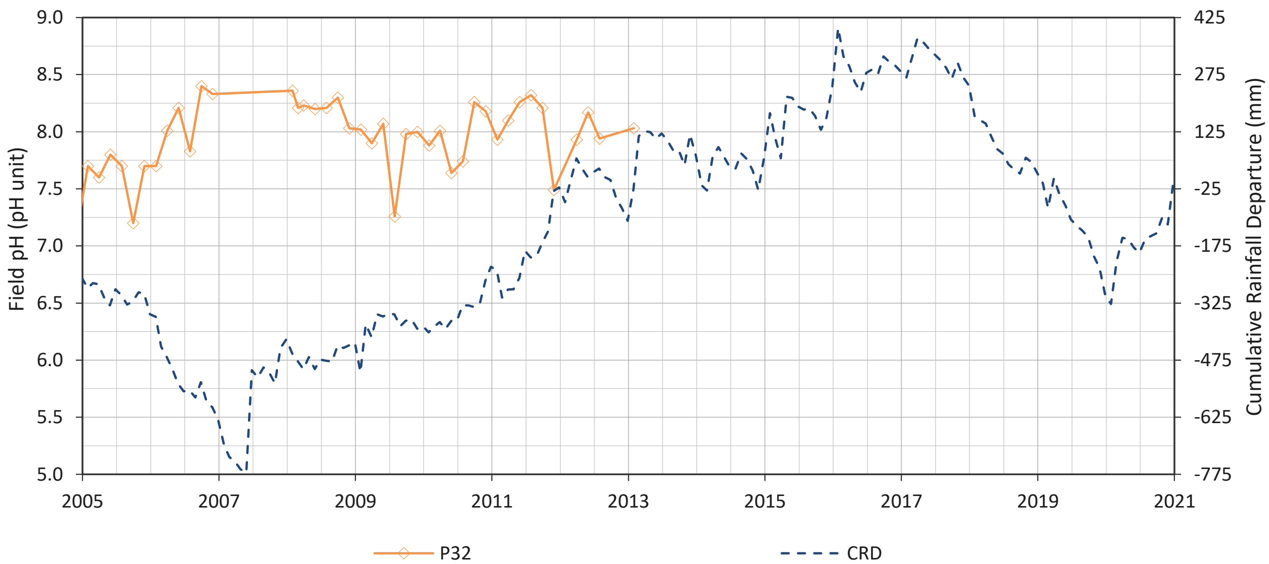


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
4500
4000
3500
3000
2500
2000
1500
1000
500
0
575
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P315
Upper Trigger
CRD

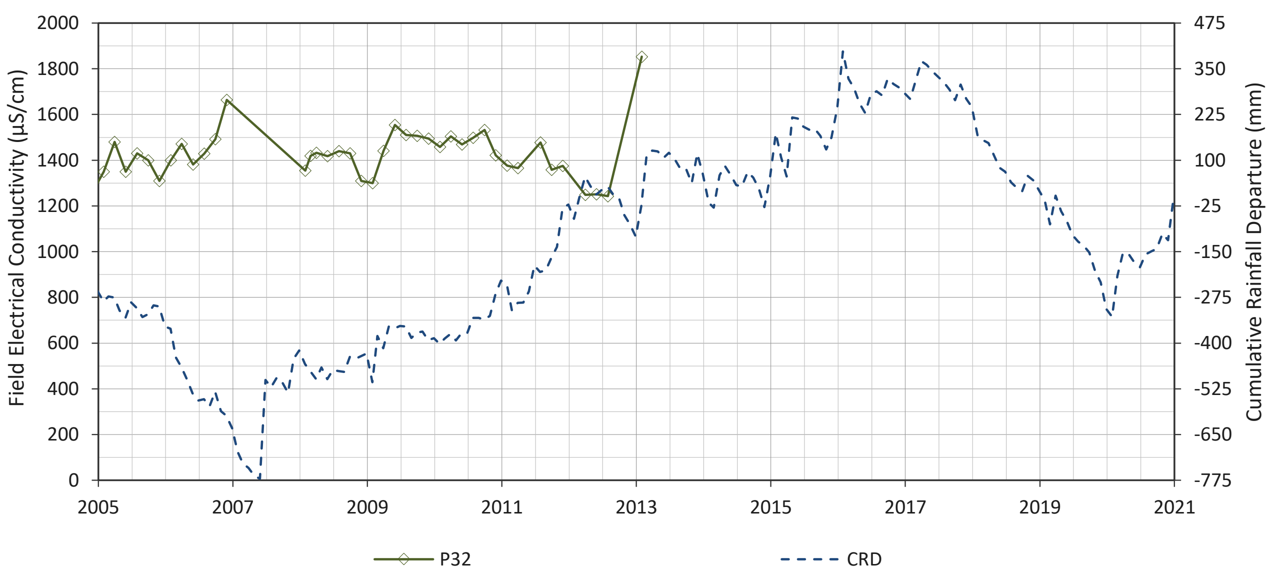
P32



Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
64.5
64.0
63.5
63.0
62.5
62.0
61.5
61.0
60.5
60.0
59.5
475
350
225
100
-25
-150
-275
-400
-525
-650
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P32
CRD

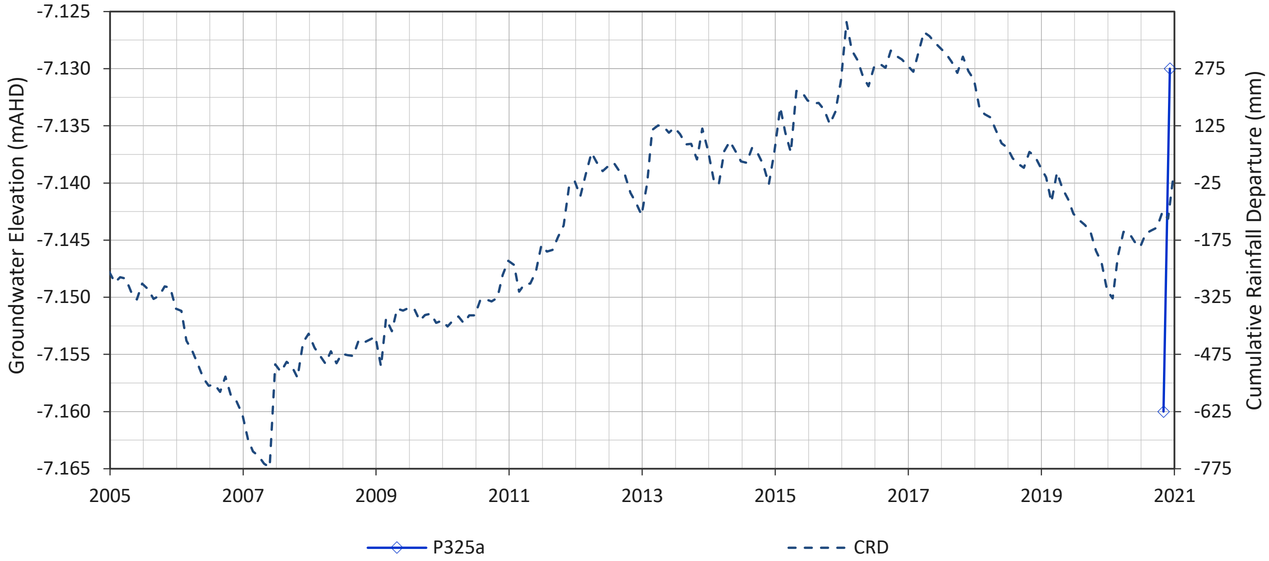


Field pH (pH unit)
Cumulative Rainfall Departure (mm)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P32
CRD

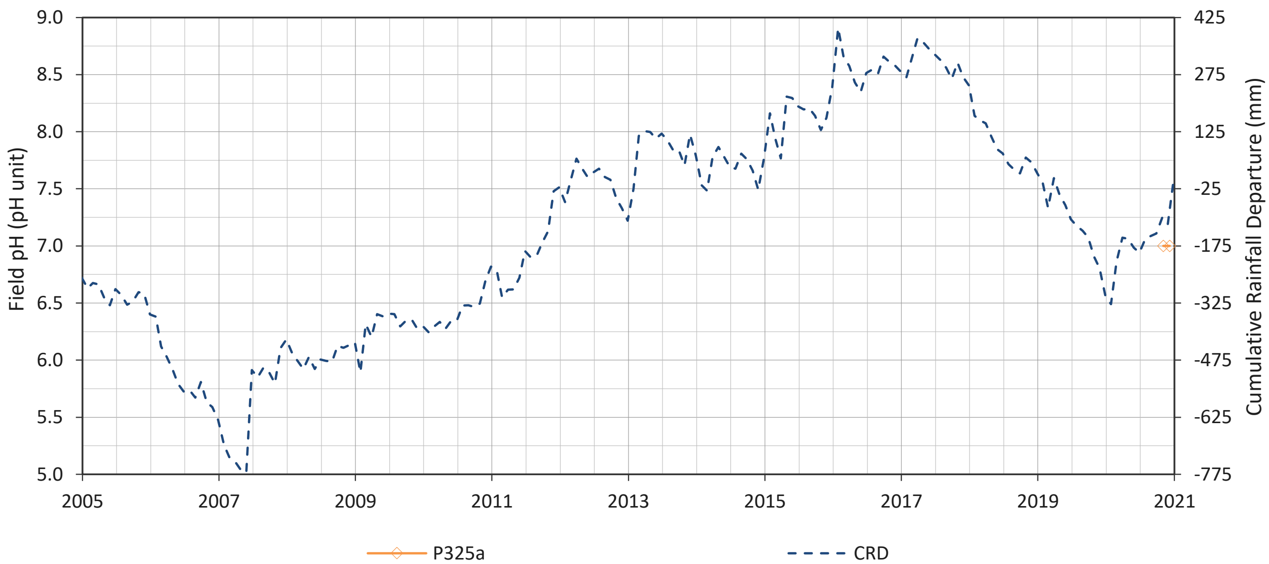


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
475
350
225
100
-25
-150
-275
-400
-525
-650
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P32
CRD

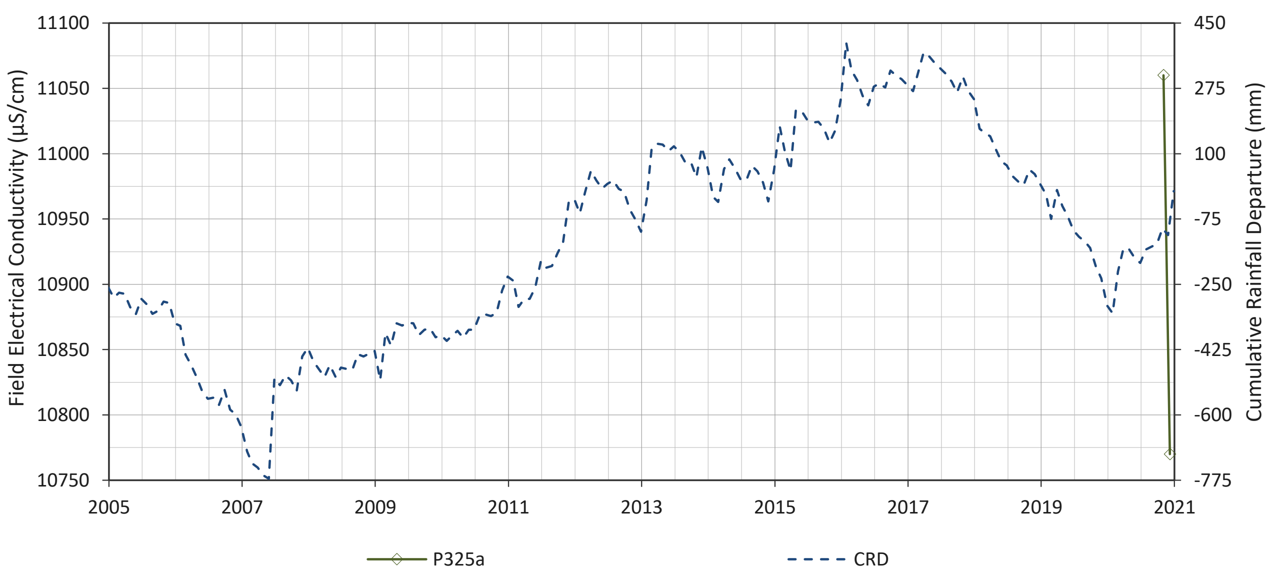
P325a



Groundwater Elevation (mAHD)
-7.125
-7.130
-7.135
-7.140
-7.145
-7.150
-7.155
-7.160
-7.165
Cumulative Rainfall Departure (mm)
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P325a
CRD

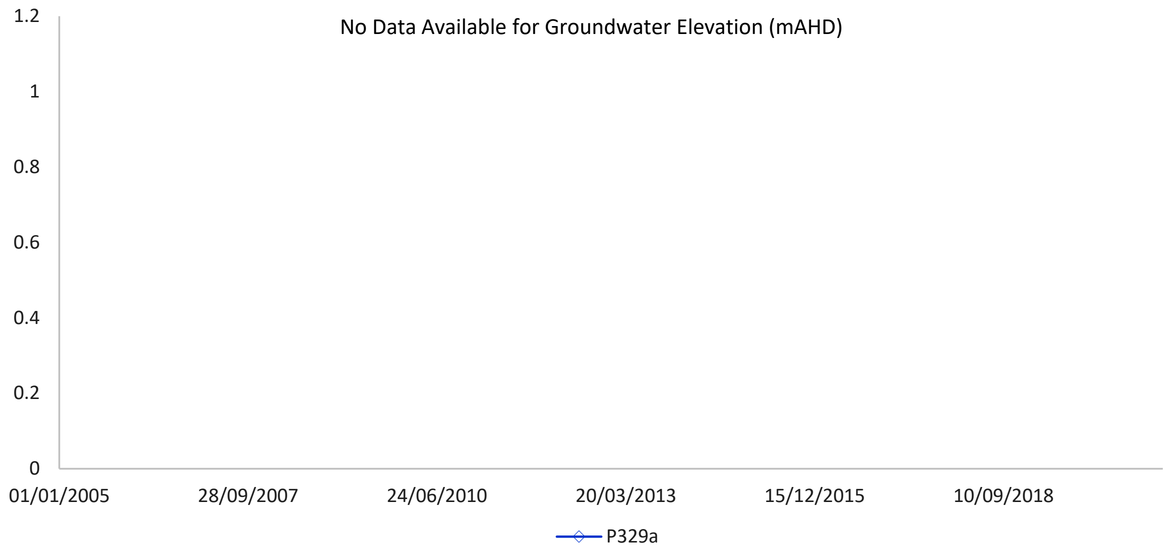


Field pH (pH unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
Cumulative Rainfall Departure (mm)
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P325a
CRD

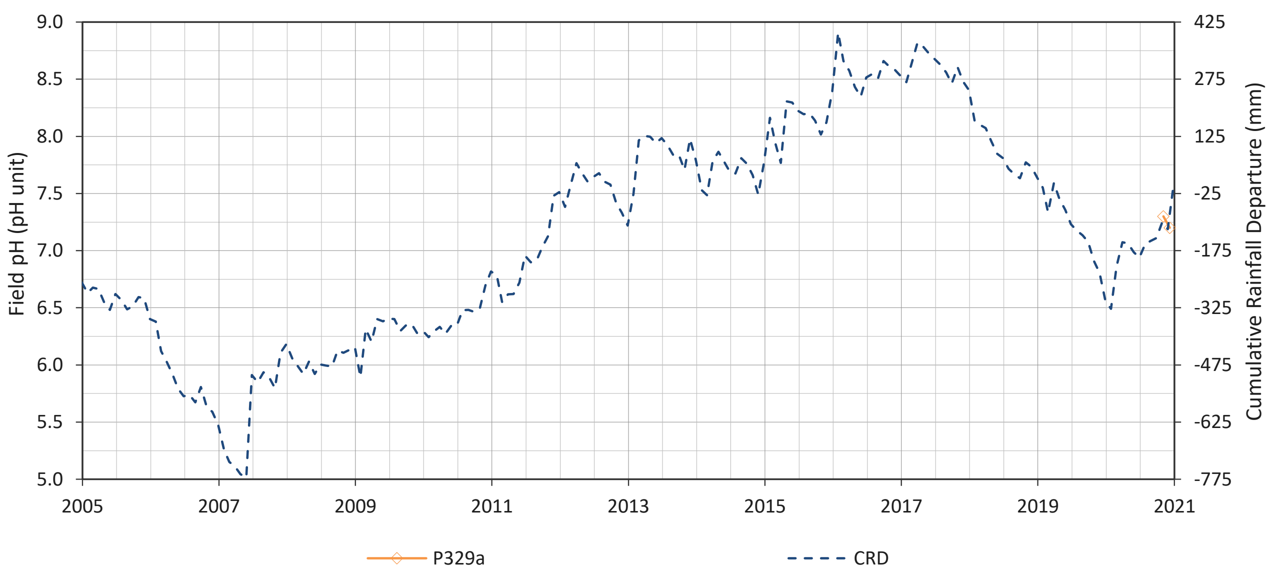


Field Electrical Conductivity (µS/cm)
11100
11050
11000
10950
10900
10850
10800
10750
Cumulative Rainfall Departure (mm)
450
275
100
-75
-250
-425
-600
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P325a
CRD

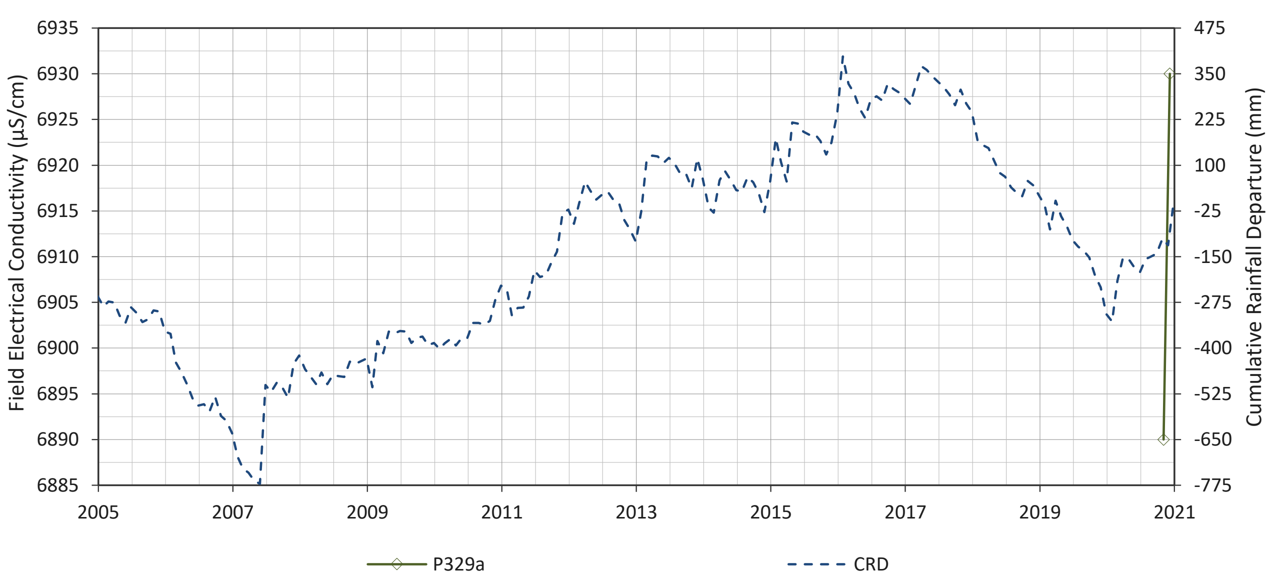
P329a



1.2
1
0.8
0.6
0.4
0.2
0
No Data Available for Groundwater Elevation (mAHD)
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
P329a

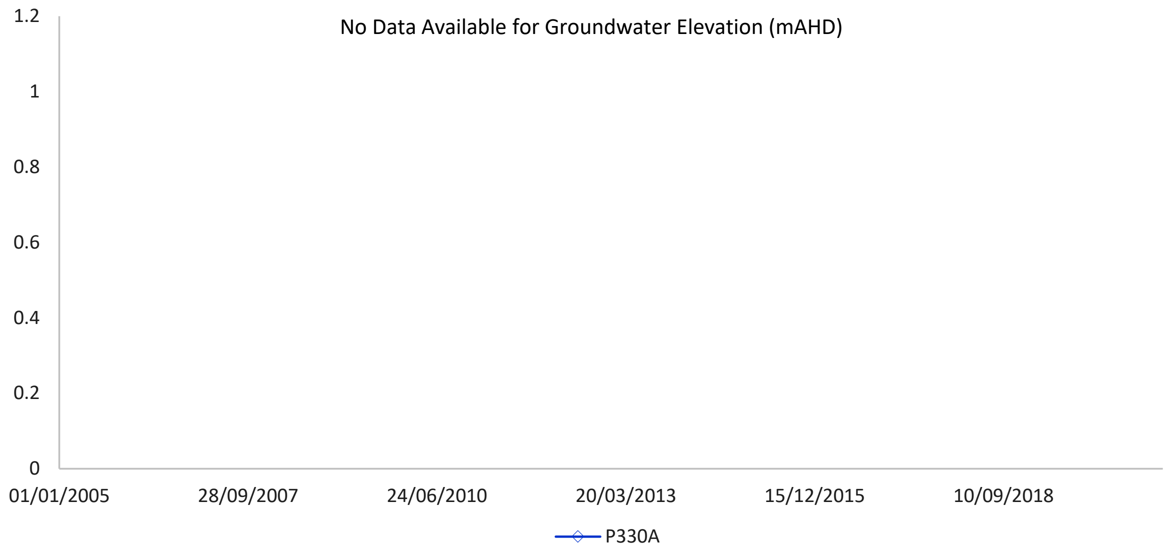


Field pH (pH unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
Cumulative Rainfall Departure (mm)
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P329a
CRD

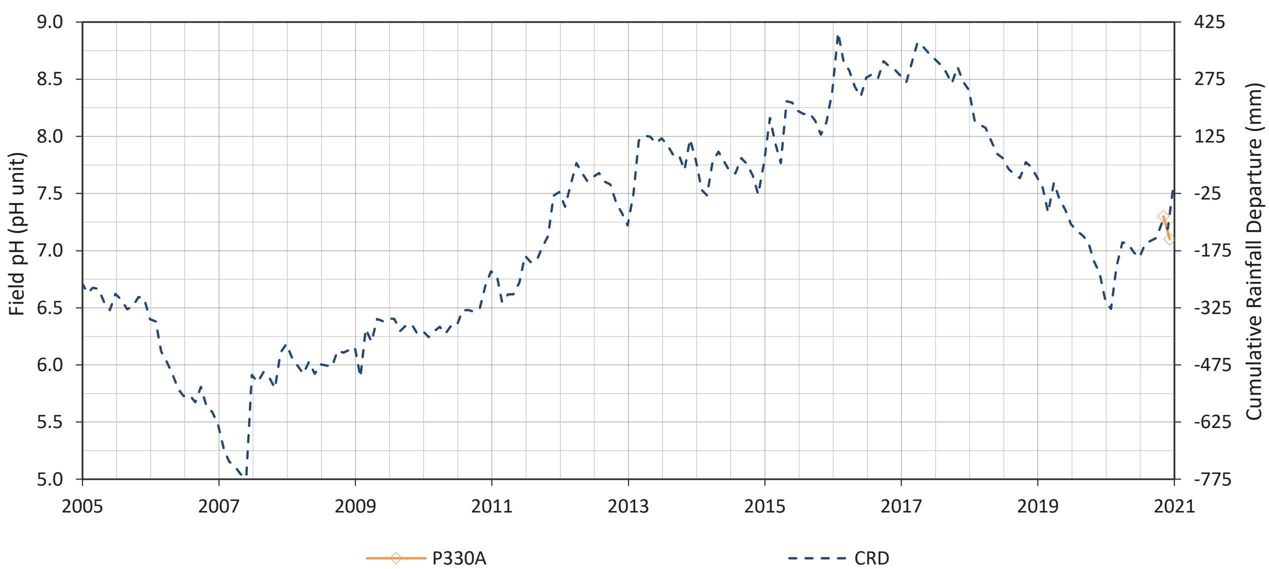


Field Electrical Conductivity (µS/cm)
6935
6930
6925
6920
6915
6910
6905
6900
6895
6890
6885
Cumulative Rainfall Departure (mm)
475
350
225
100
-25
-150
-275
-400
-525
-650
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P329a
CRD

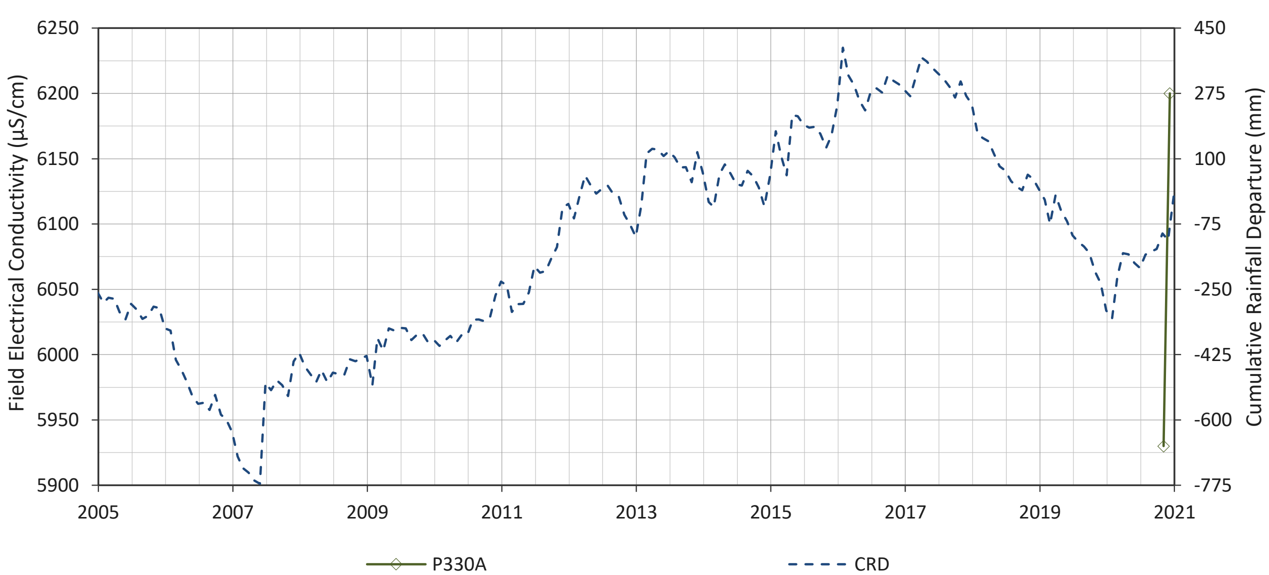
P330A



No Data Available for Groundwater Elevation (mAHD)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
P330A

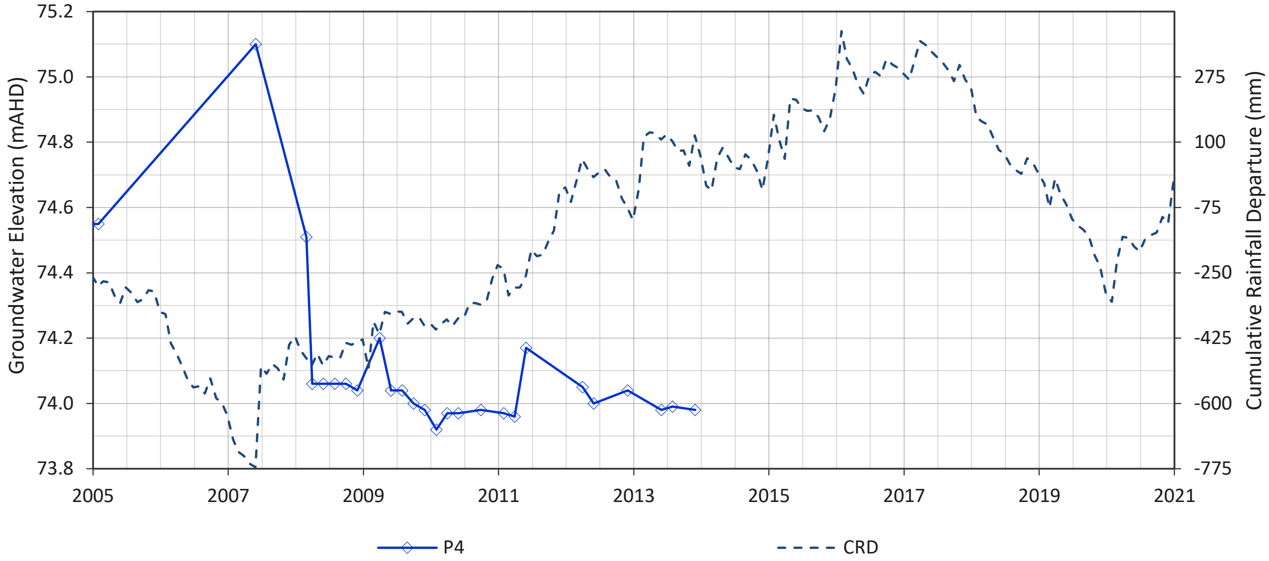


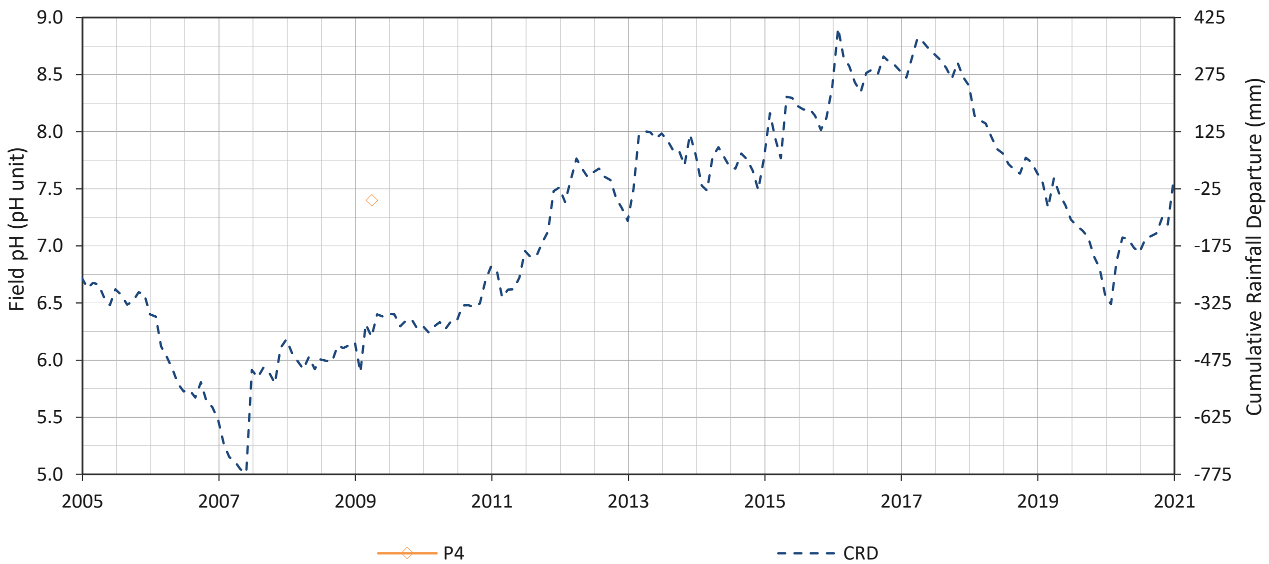
Field pH (pH unit)
Cumulative Rainfall Departure (mm)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P330A
CRD

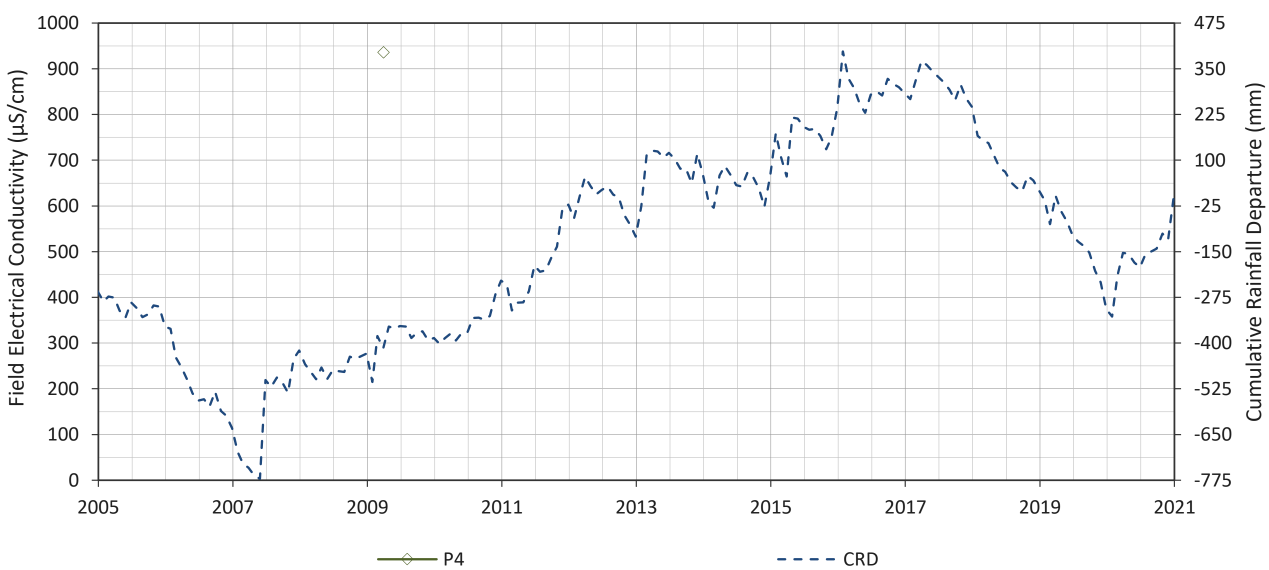


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
6250
6200
6150
6100
6050
6000
5950
5900
450
275
100
-75
-250
-425
-600
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P330A
CRD

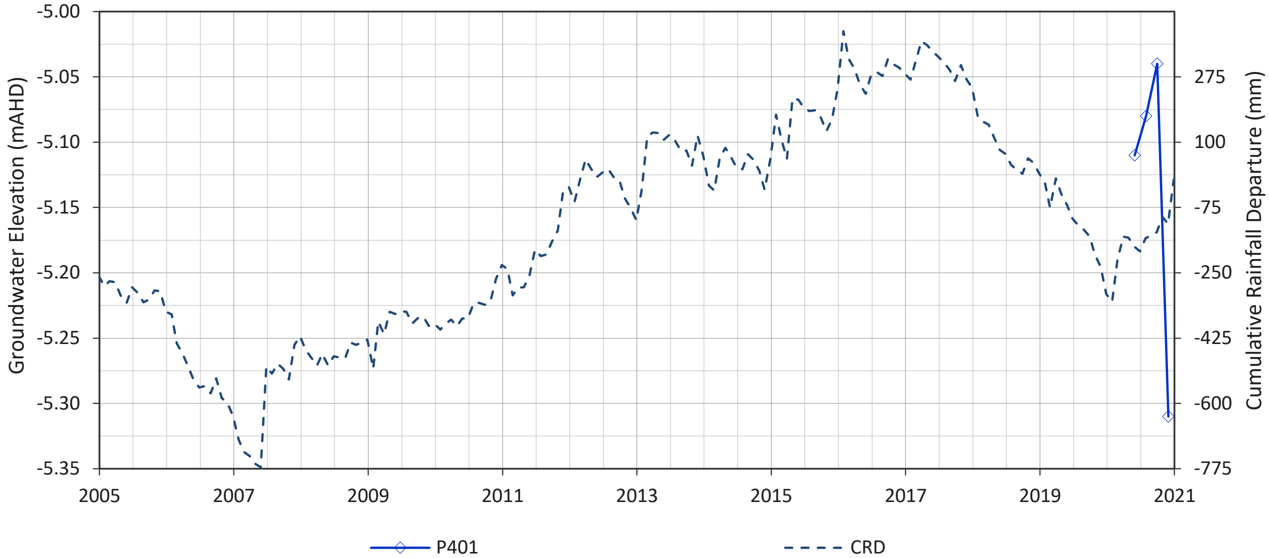
P4


75.2
75.0
74.8
74.6
74.4
74.2
74.0
73.8
Groundwater Elevation (mAHD)
275
100
-75
-250
-425
-600
-775
Cumulative Rainfall Departure (mm)
2005
2007
2009
2011
2013
2015
2017
2019
2021
P4
CRD

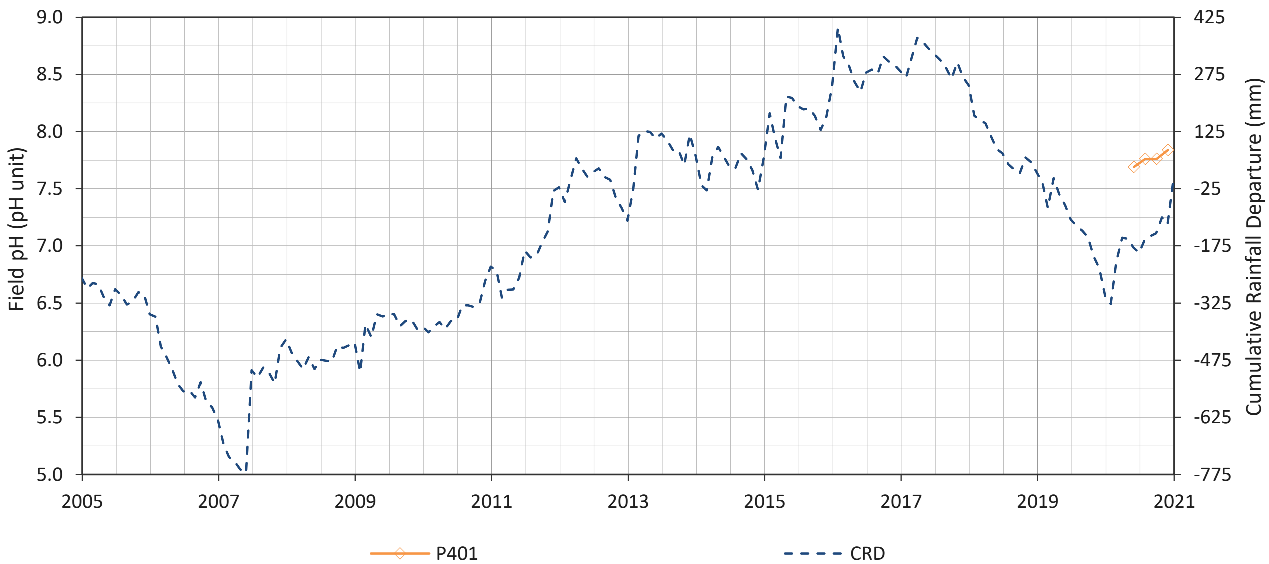

9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
Field pH (pH unit)
425
275
125
-25
-175
-325
-475
-625
-775
Cumulative Rainfall Departure (mm)
2005
2007
2009
2011
2013
2015
2017
2019
2021
P4
CRD


1000
900
800
700
600
500
400
300
200
100
0
Field Electrical Conductivity (µS/cm)
475
350
225
100
-25
-150
-275
-400
-525
-650
-775
Cumulative Rainfall Departure (mm)
2005
2007
2009
2011
2013
2015
2017
2019
2021
P4
CRD

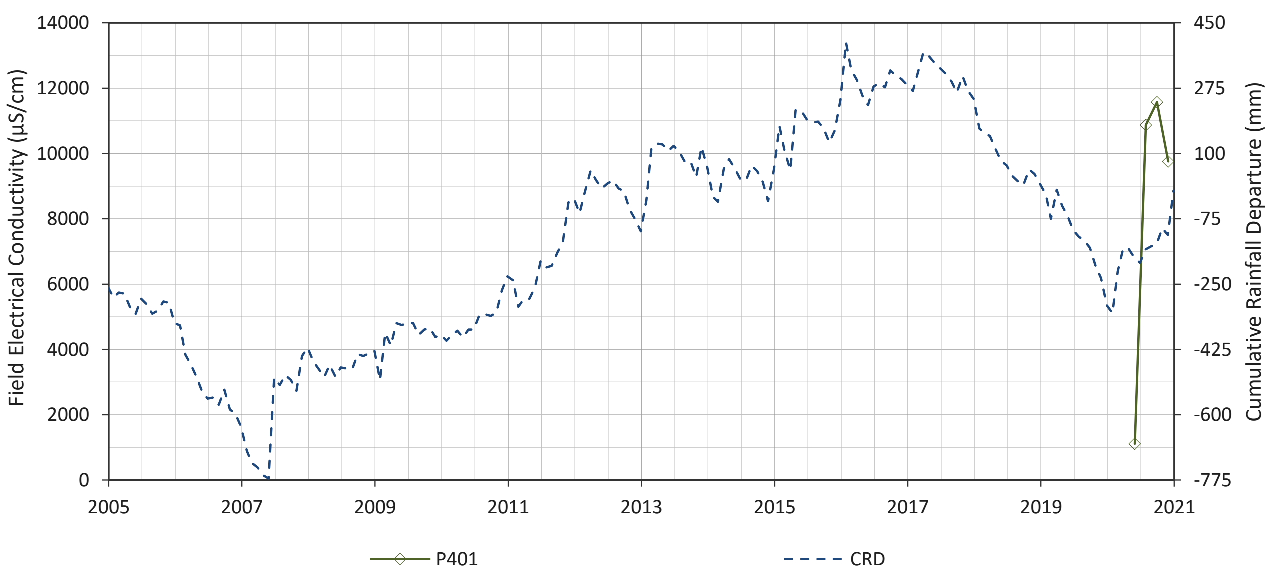
P401



Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
-5.00
-5.05
-5.10
-5.15
-5.20
-5.25
-5.30
-5.35
275
100
-75
-250
-425
-600
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P401
CRD

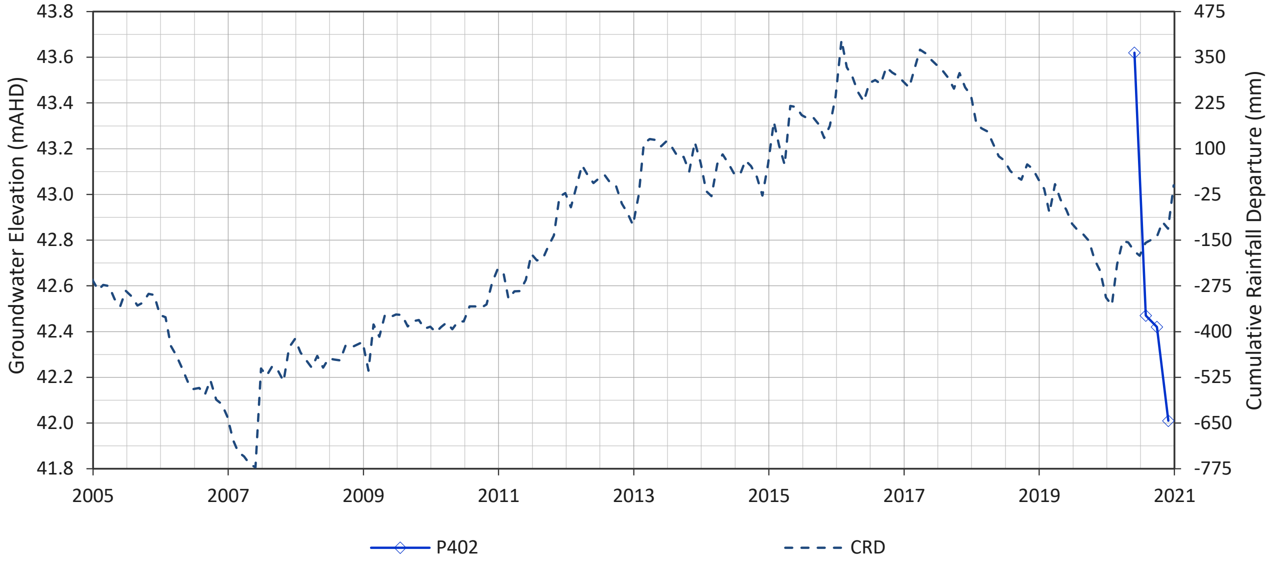


Field pH (pH unit)
Cumulative Rainfall Departure (mm)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P401
CRD

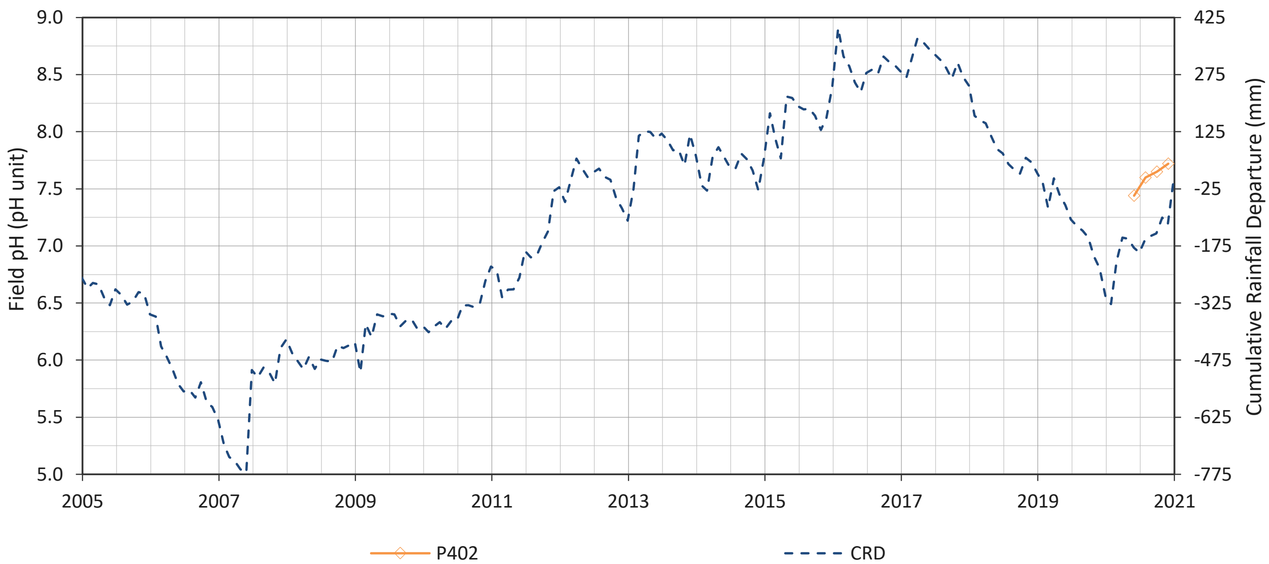


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
14000
12000
10000
8000
6000
4000
2000
0
450
275
100
-75
-250
-425
-600
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P401
CRD

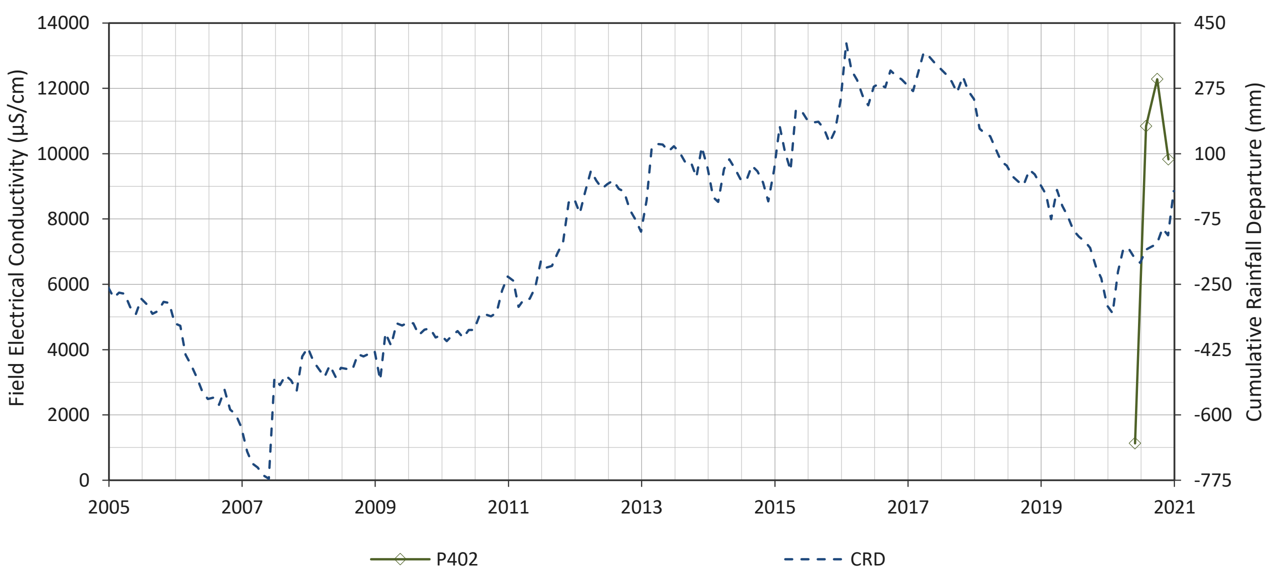
P402



Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
43.8
43.6
43.4
43.2
43.0
42.8
42.6
42.4
42.2
42.0
41.8
475
350
225
100
-25
-150
-275
-400
-525
-650
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P402
CRD

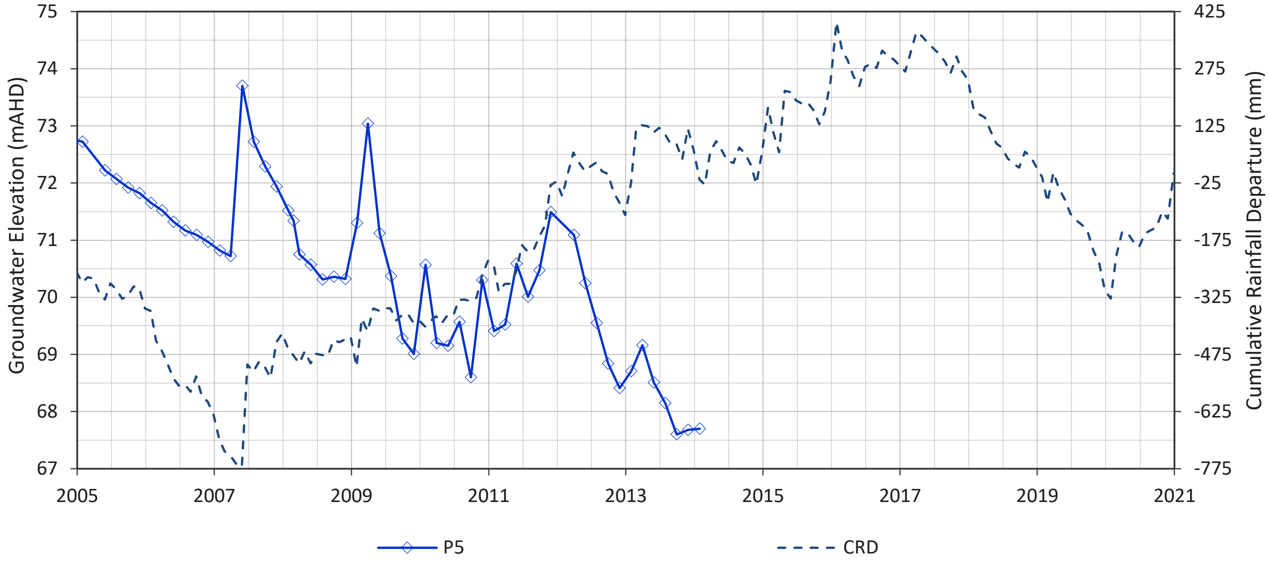


Field pH (pH unit)
Cumulative Rainfall Departure (mm)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P402
CRD

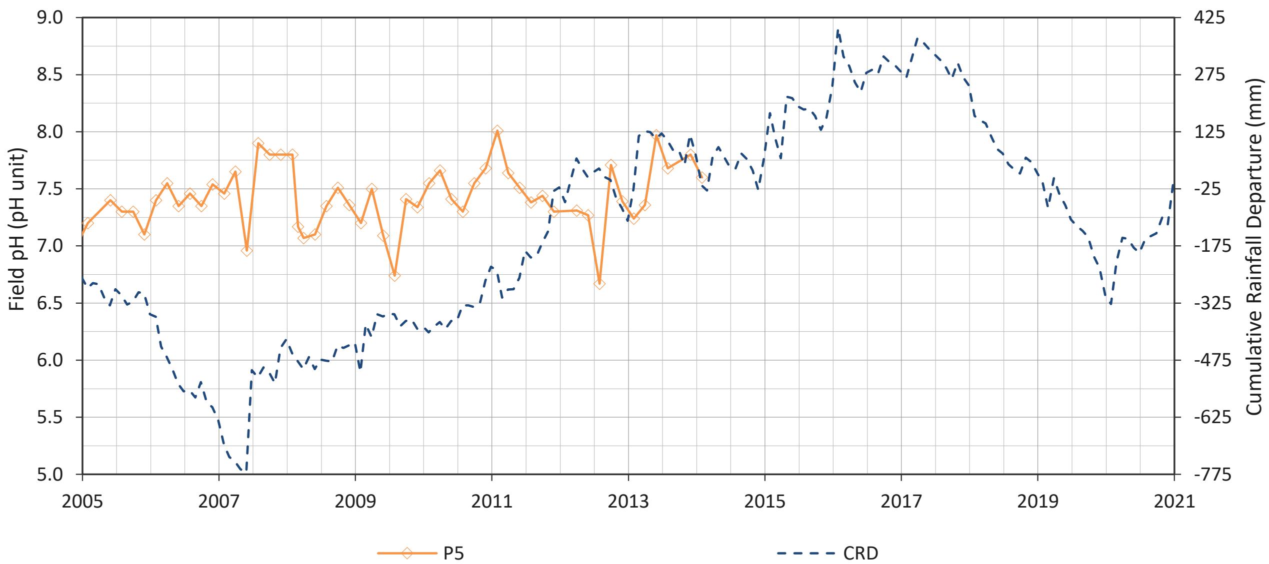


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
14000
12000
10000
8000
6000
4000
2000
0
450
275
100
-75
-250
-425
-600
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P402
CRD

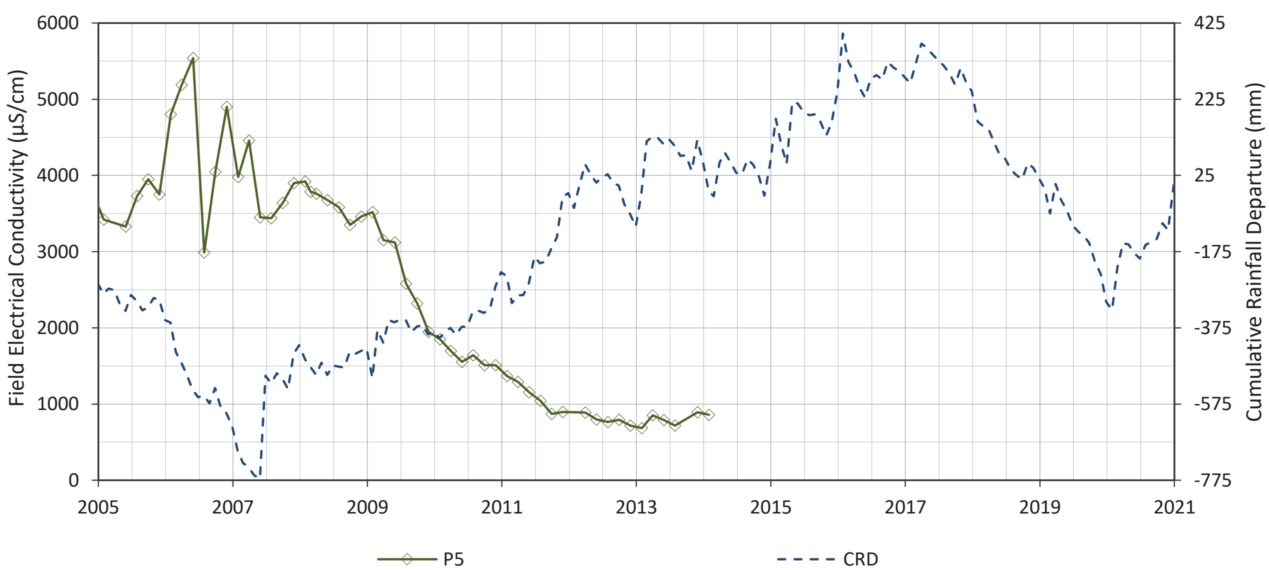
P5



Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
75
74
73
72
71
70
69
68
67
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P5
CRD

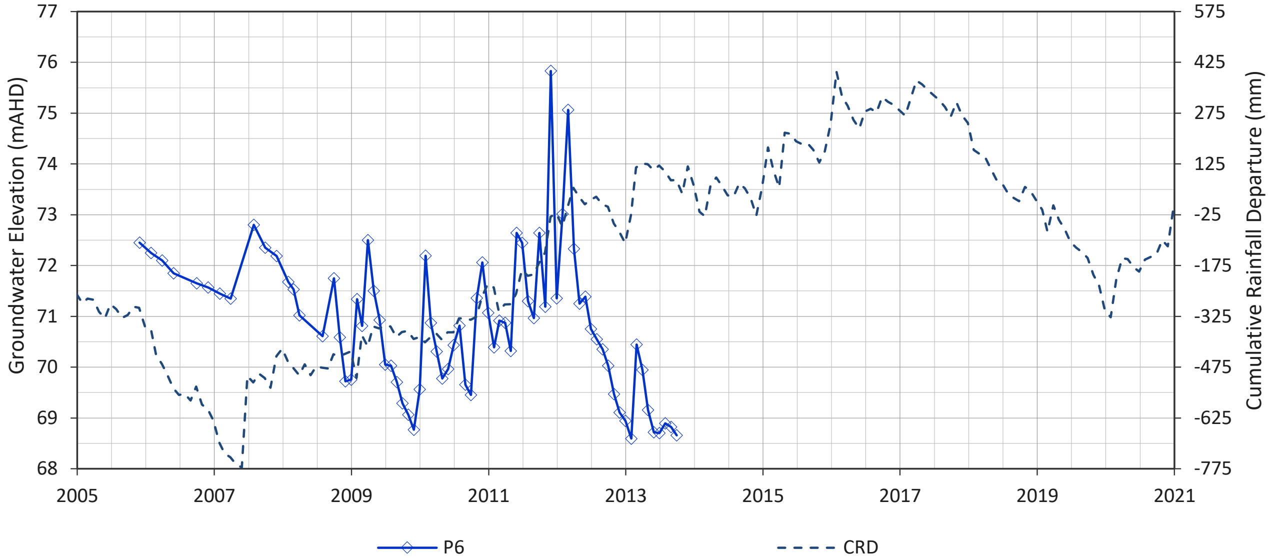


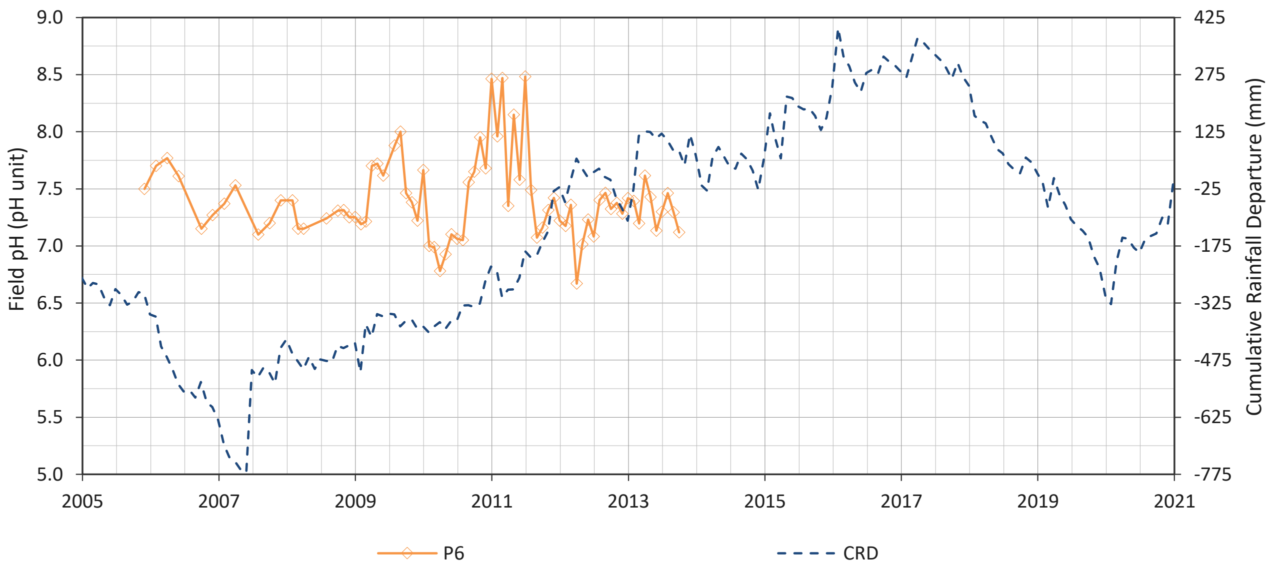
Field pH (pH unit)
Cumulative Rainfall Departure (mm)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P5
CRD

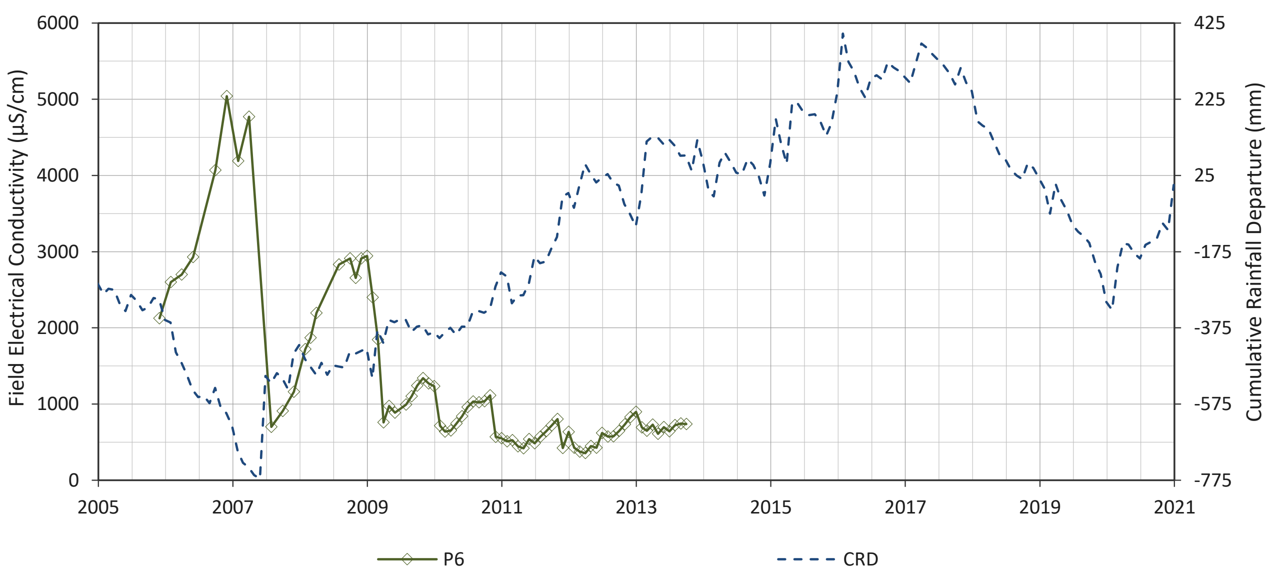


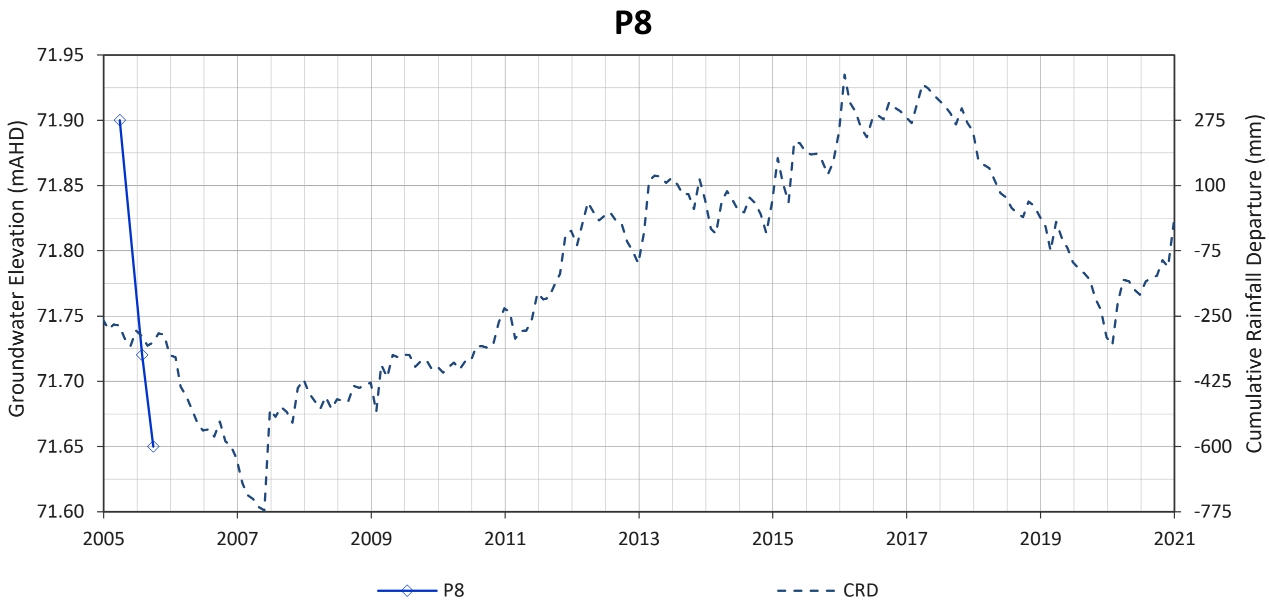
Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
6000
5000
4000
3000
2000
1000
0
425
225
25
-175
-375
-575
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P5
CRD

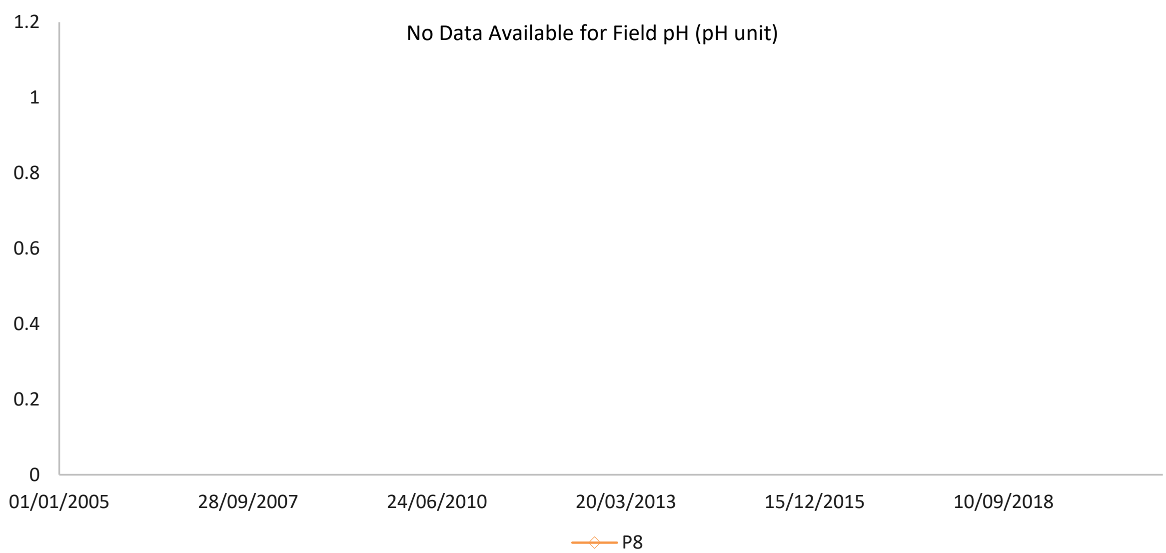
P6

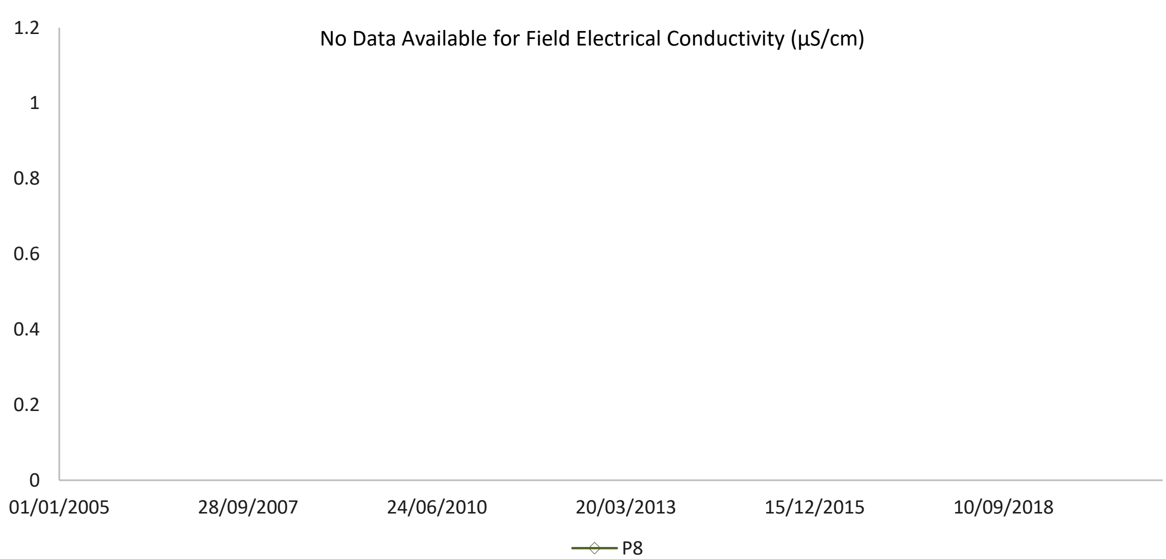

Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
77
76
75
74
73
72
71
70
69
68
575
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P6
CRD


Field pH (pH unit)
Cumulative Rainfall Departure (mm)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P6
CRD

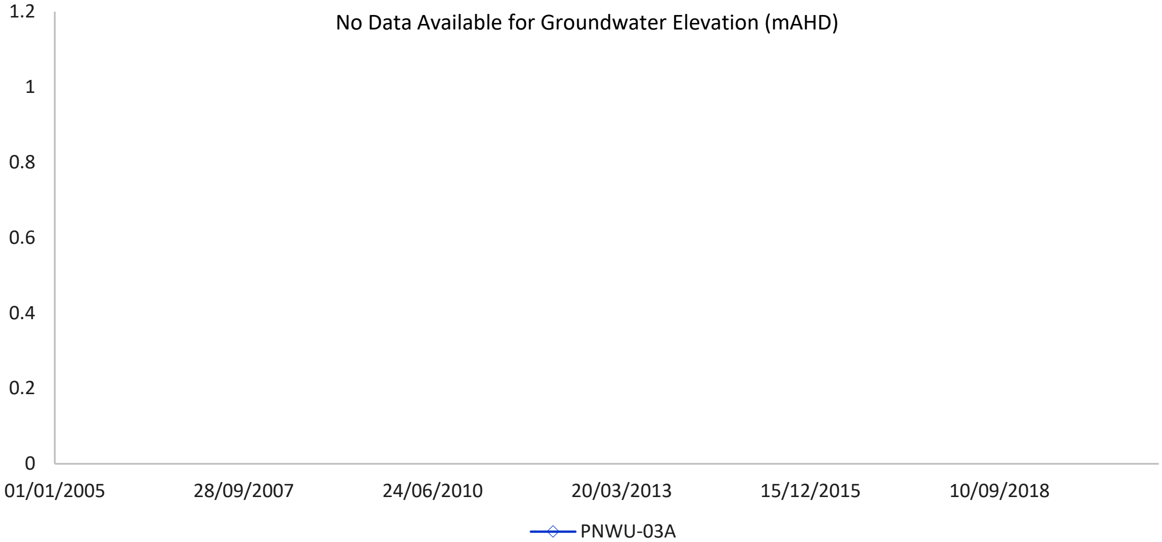

Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
6000
5000
4000
3000
2000
1000
0
425
225
25
-175
-375
-575
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P6
CRD


P8
Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
71.95
71.90
71.85
71.80
71.75
71.70
71.65
71.60
275
100
-75
-250
-425
-600
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
P8
CRD

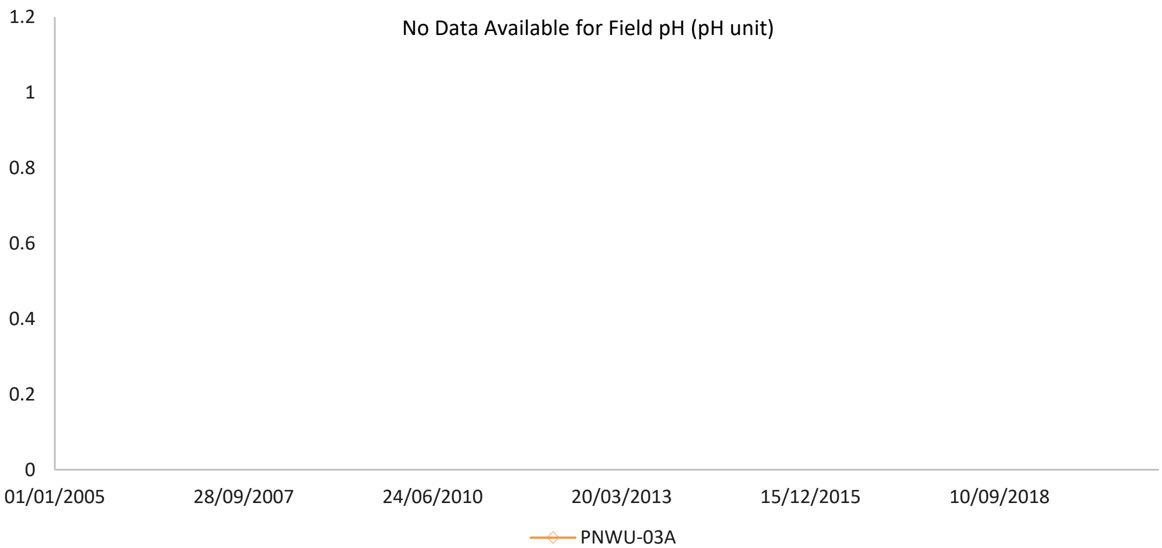

No Data Available for Field pH (pH unit)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
P8


No Data Available for Field Electrical Conductivity (µS/cm)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
P8

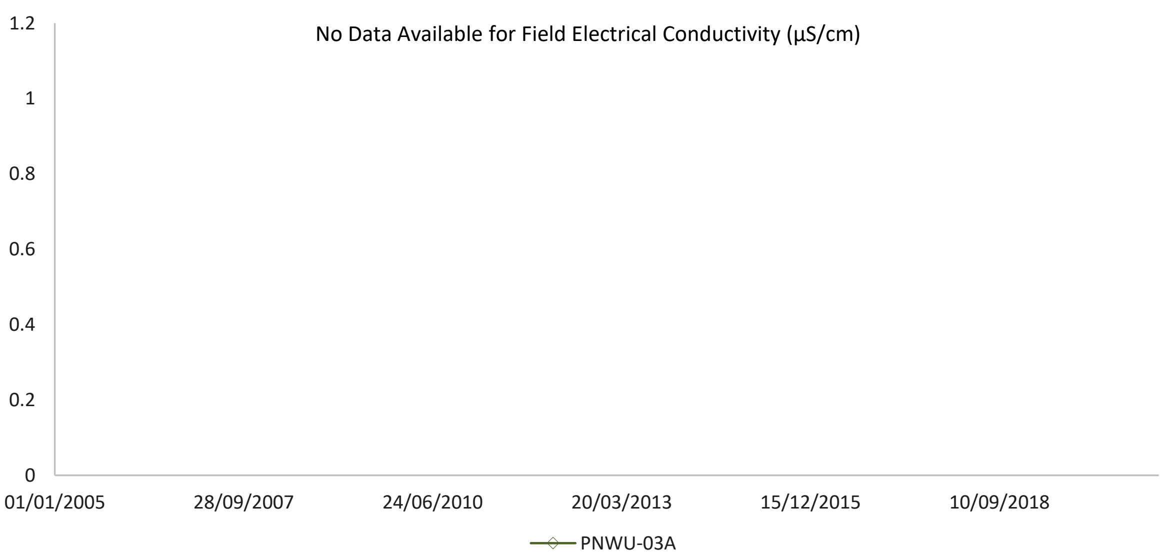
PNWU-03A



No Data Available for Groundwater Elevation (mAHD)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
PNWU-03A

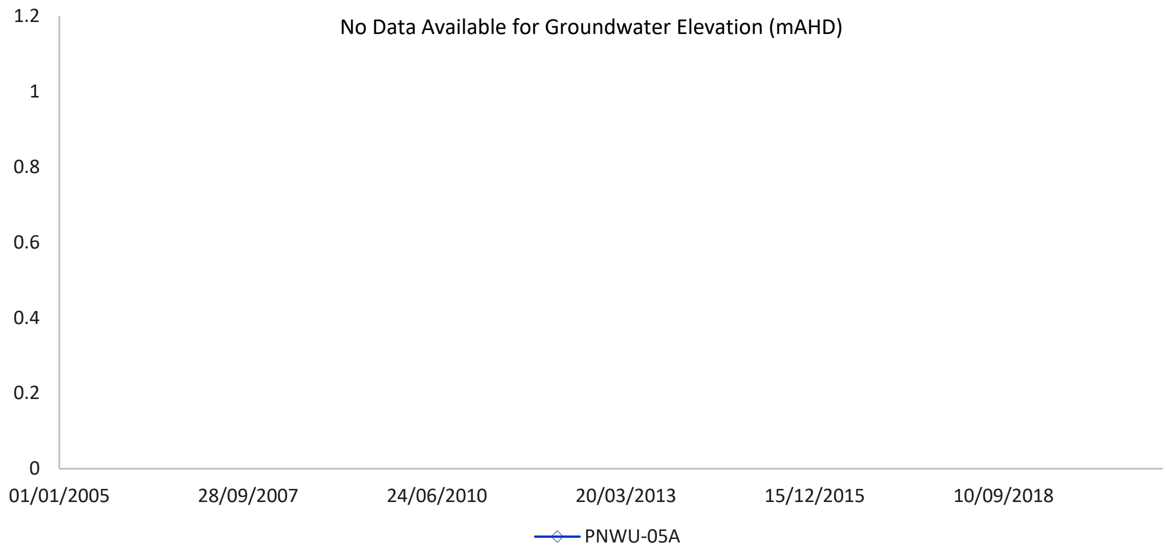


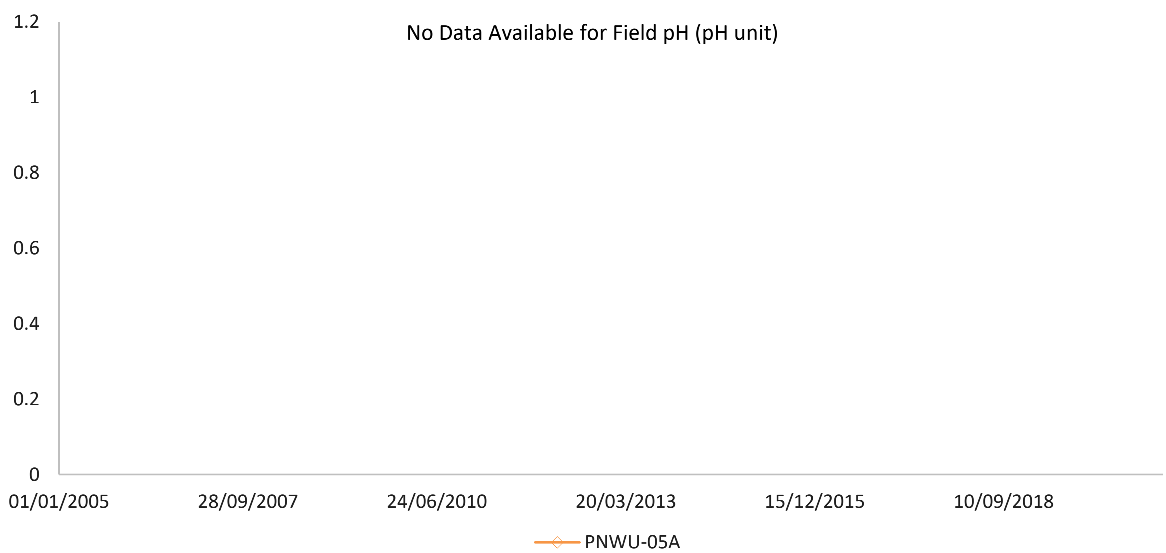
No Data Available for Field pH (pH unit)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
PNWU-03A

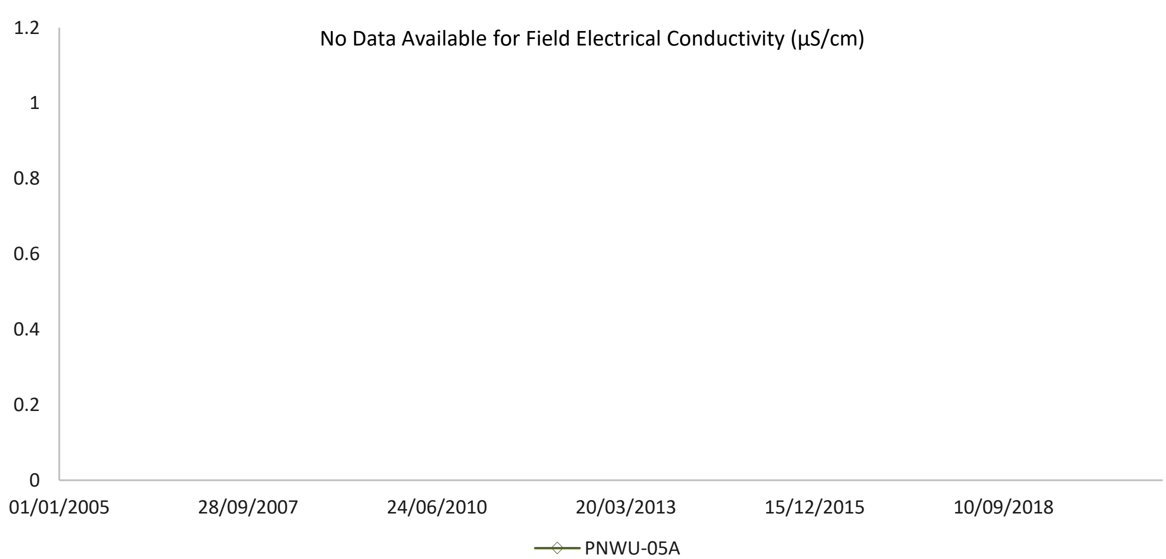


No Data Available for Field Electrical Conductivity (µS/cm)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
PNWU-03A

PNWU-05A

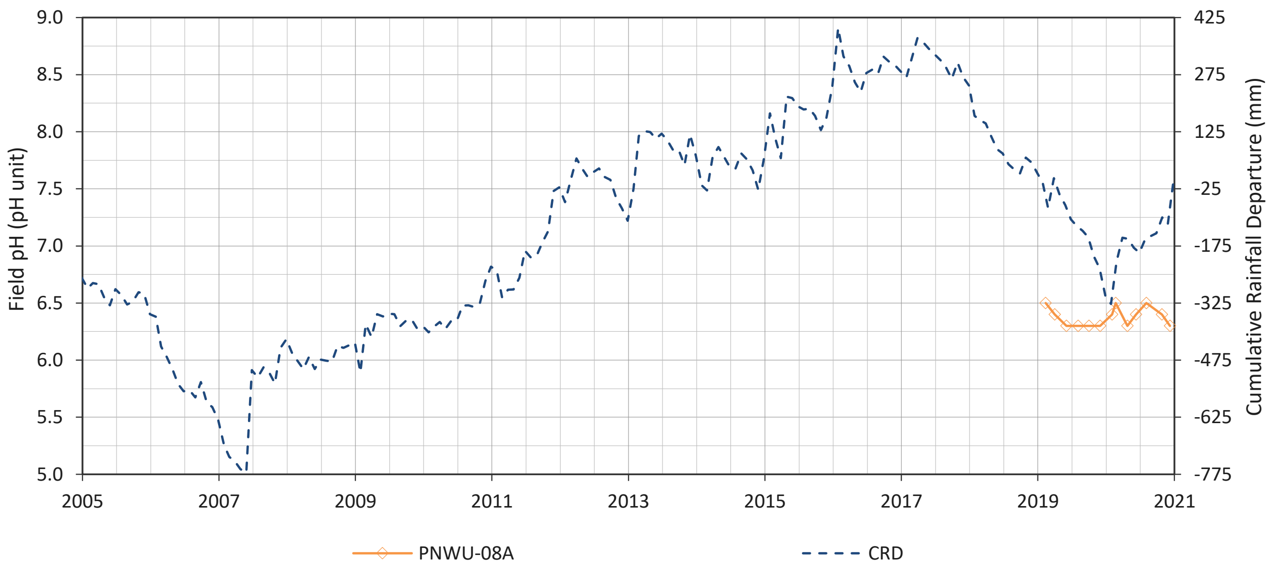

No Data Available for Groundwater Elevation (mAHD)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
PNWU-05A

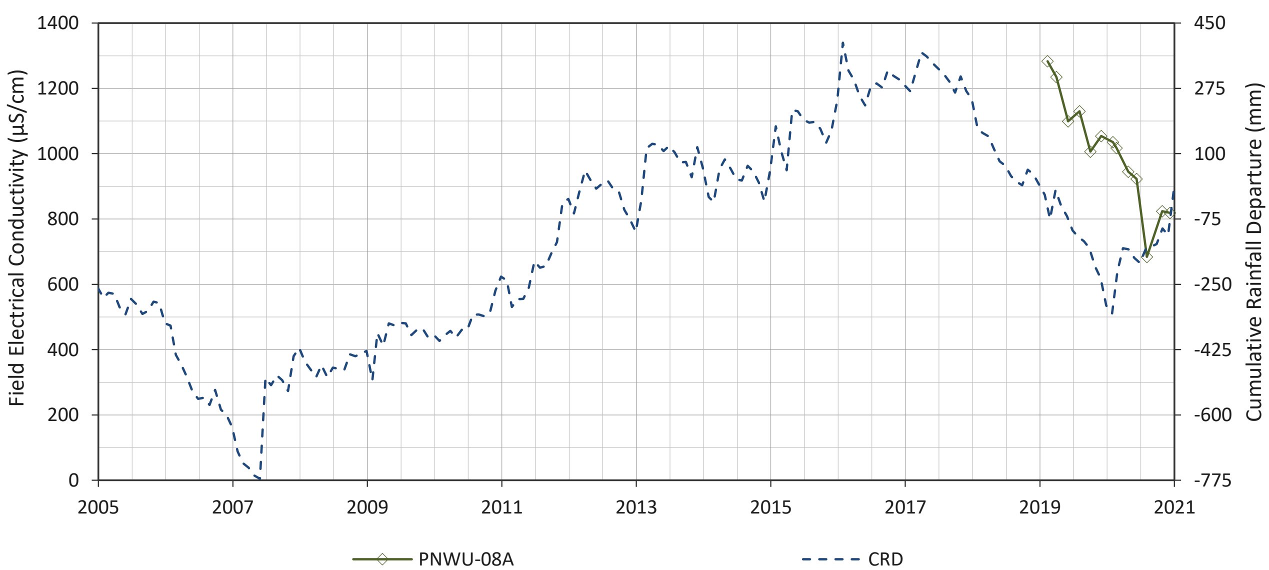

No Data Available for Field pH (pH unit)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
PNWU-05A


No Data Available for Field Electrical Conductivity (µS/cm)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
PNWU-05A

PNWU-08A

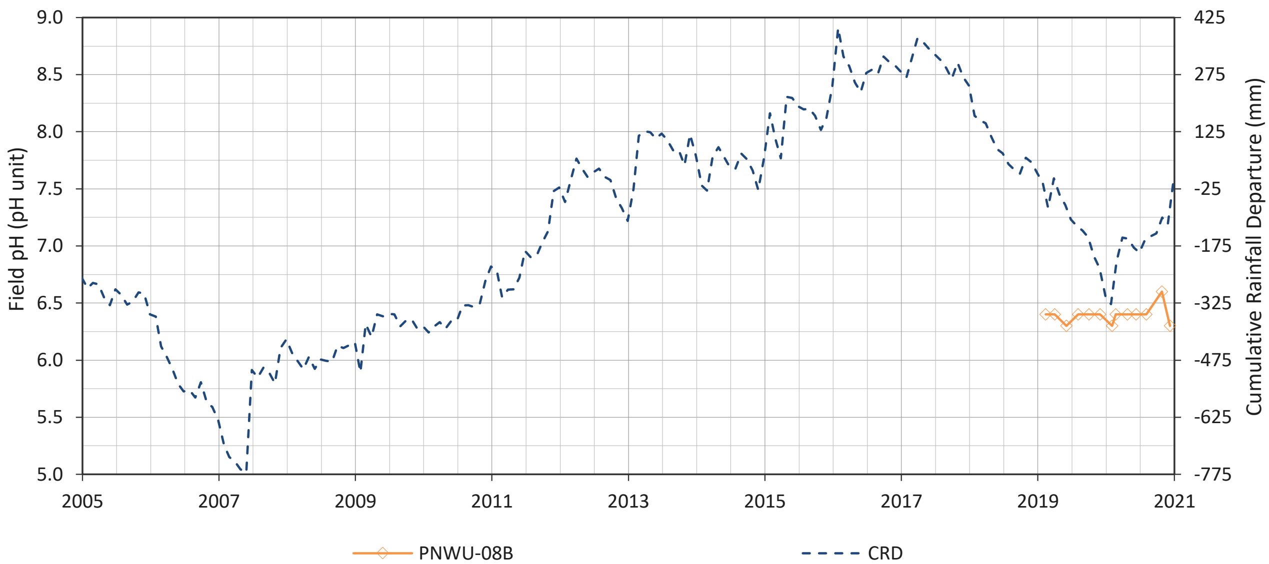

Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
62.5
62.0
61.5
61.0
60.5
60.0
59.5
425
225
25
-175
-375
-575
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
PNWU-08A
CRD


Field pH (pH unit)
Cumulative Rainfall Departure (mm)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
PNWU-08A
CRD

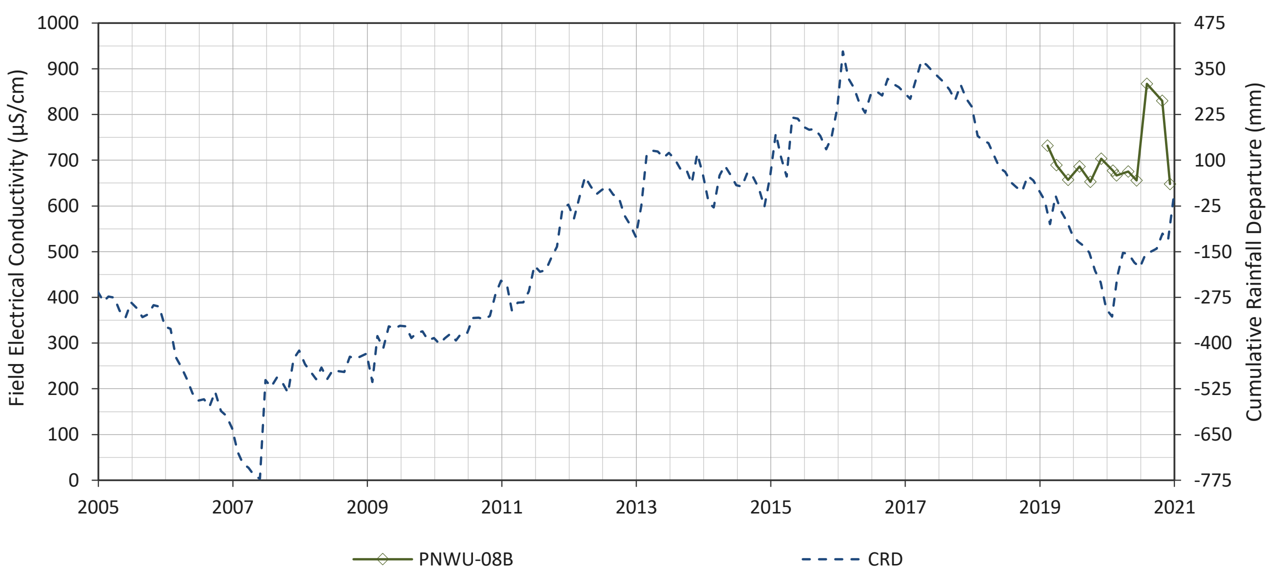

Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
1400
1200
1000
800
600
400
200
0
450
275
100
-75
-250
-425
-600
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
PNWU-08A
CRD

PNWU-08B

Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
60.4
60.2
60.0
59.8
59.6
59.4
59.2
59.0
58.8
58.6
58.4
475
350
225
100
-25
-150
-275
-400
-525
-650
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
PNWU-08B
CRD

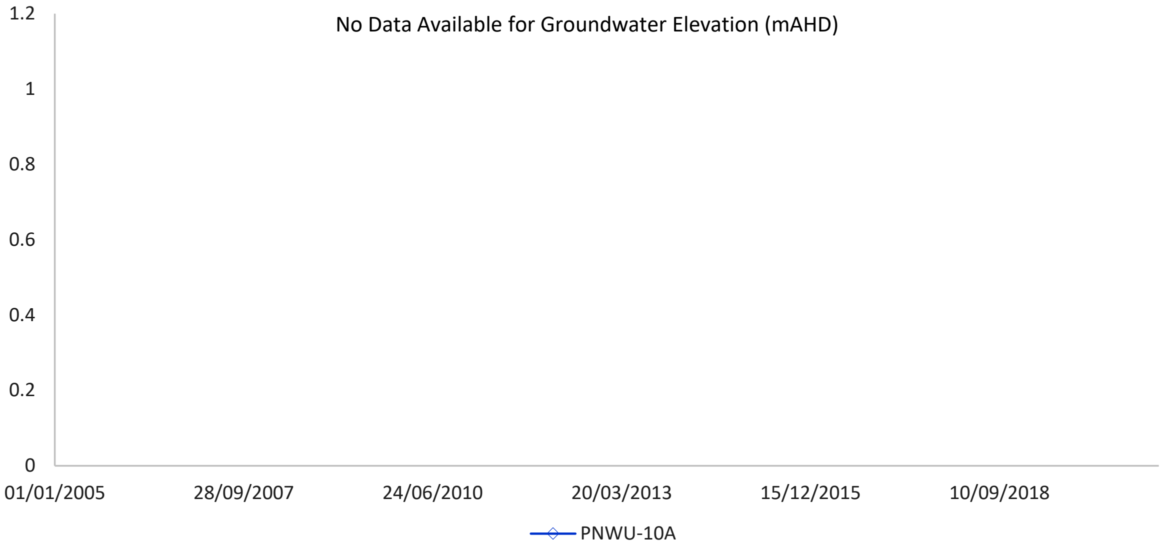


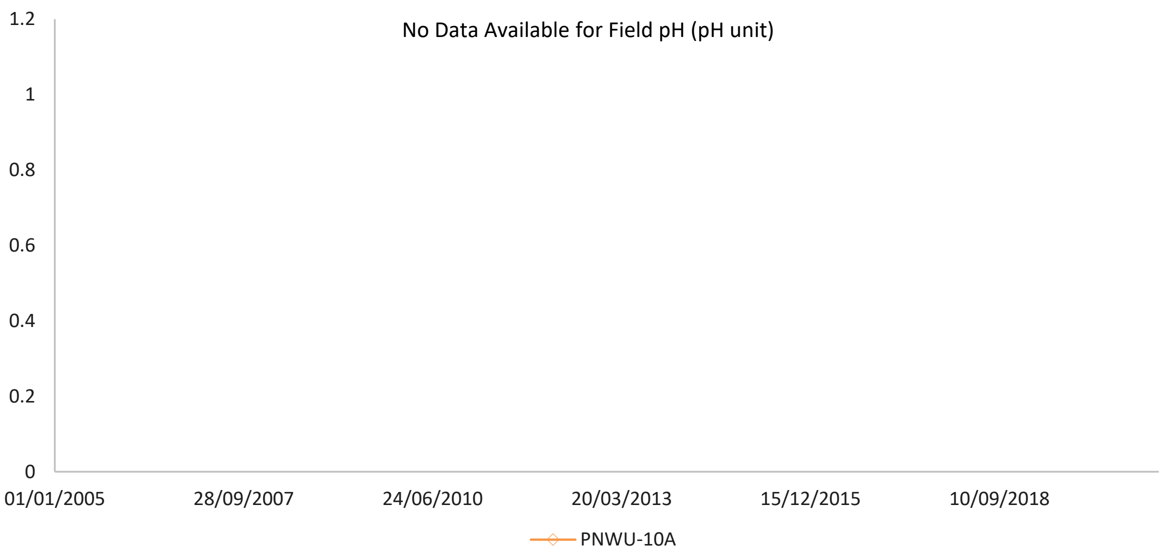
Field pH (pH unit)
Cumulative Rainfall Departure (mm)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
PNWU-08B
CRD

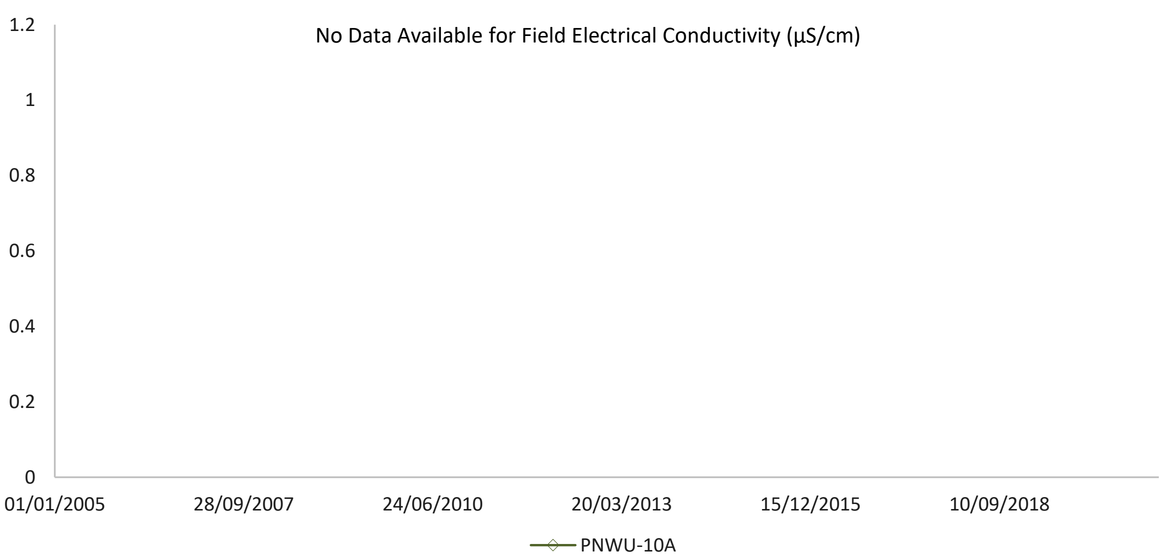


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
1000
900
800
700
600
500
400
300
200
100
0
475
350
225
100
-25
-150
-275
-400
-525
-650
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
PNWU-08B
CRD

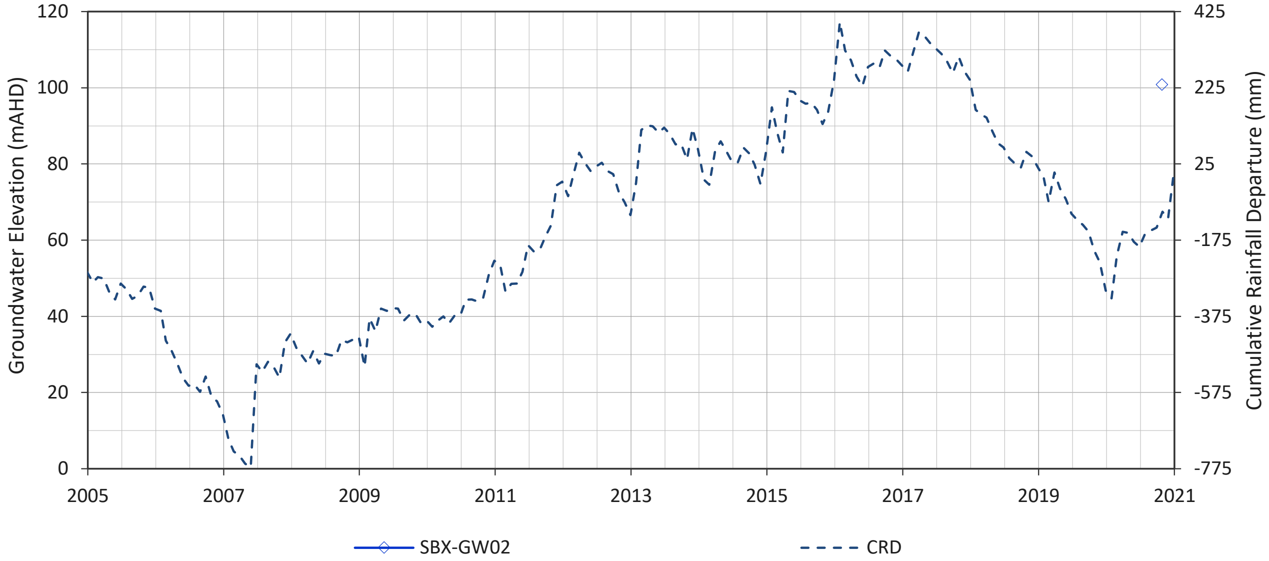
PNWU-10A


No Data Available for Groundwater Elevation (mAHD)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
PNWU-10A

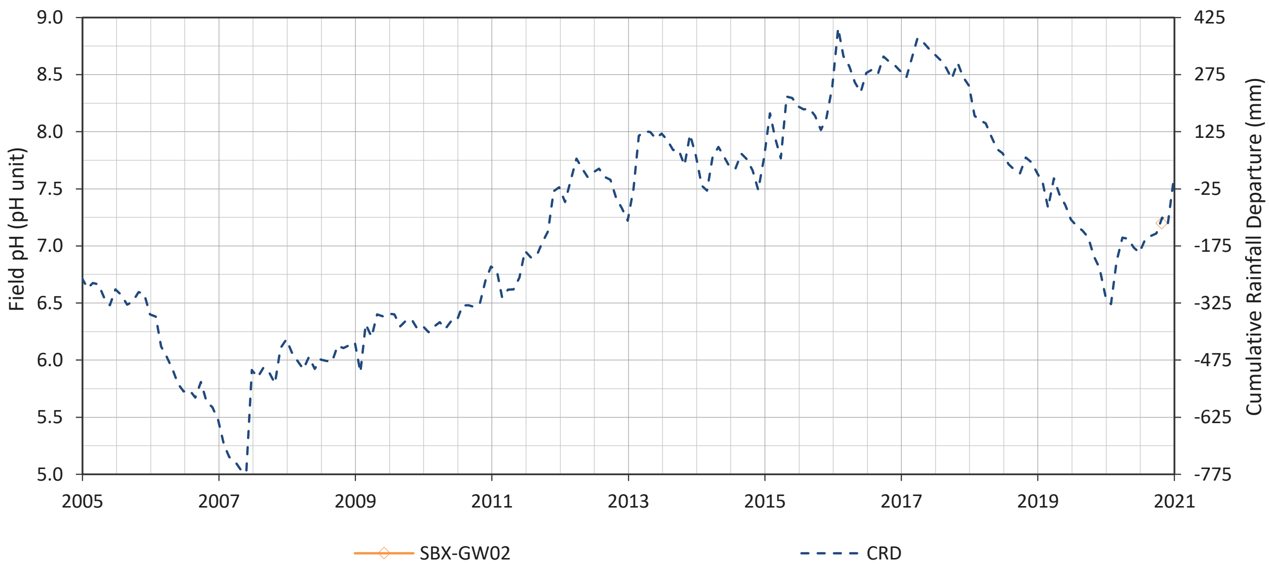

No Data Available for Field pH (pH unit)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
PNWU-10A


No Data Available for Field Electrical Conductivity (µS/cm)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
PNWU-10A

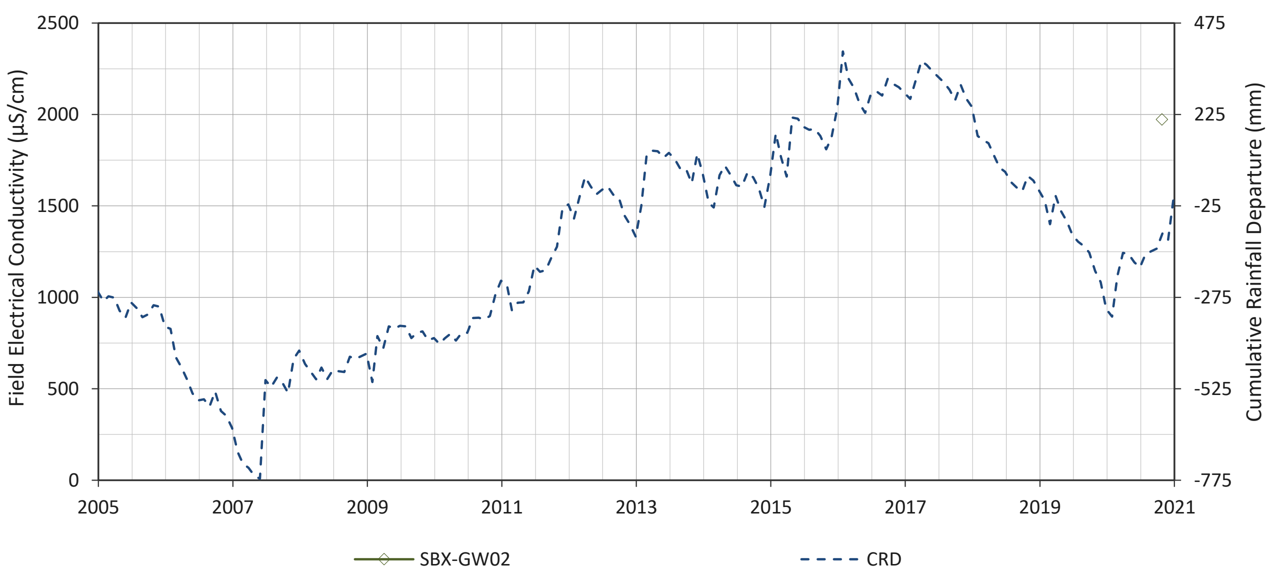
SBX-GW02



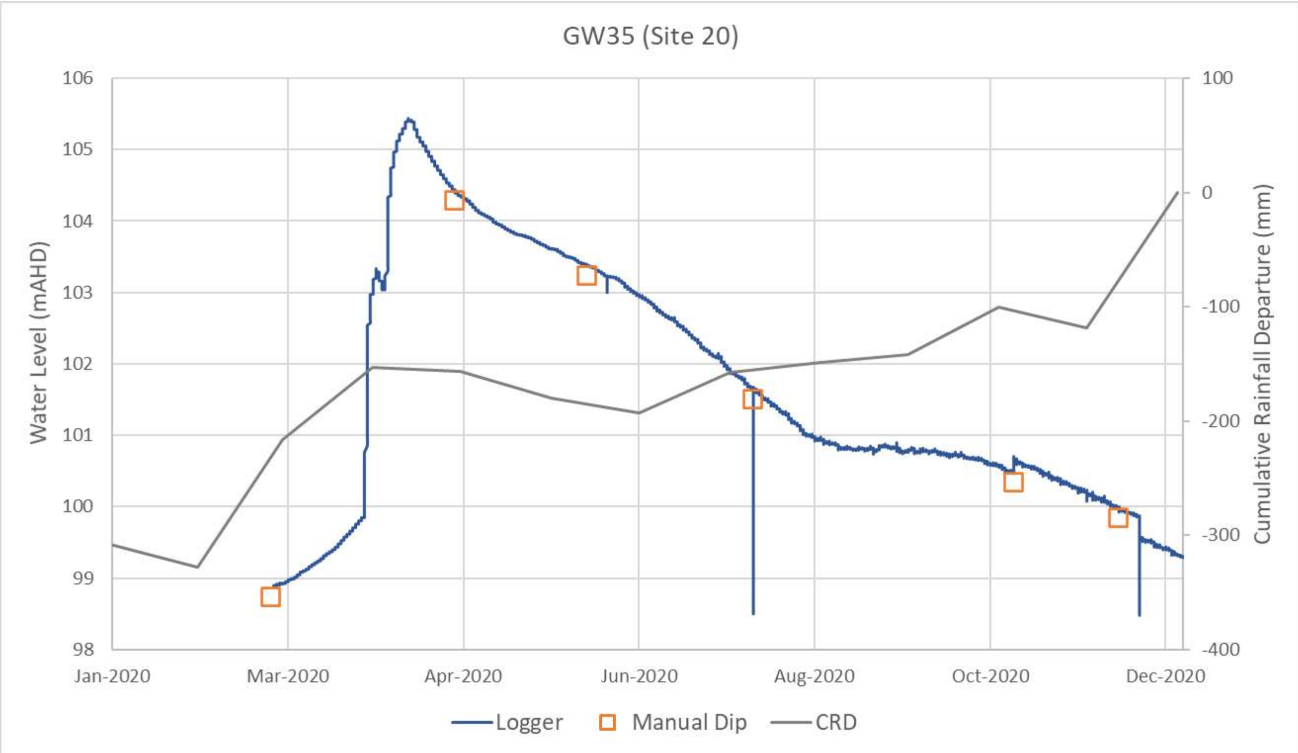
Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
120
100
80
60
40
20
0
425
225
25
-175
-375
-575
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
SBX-GW02
CRD



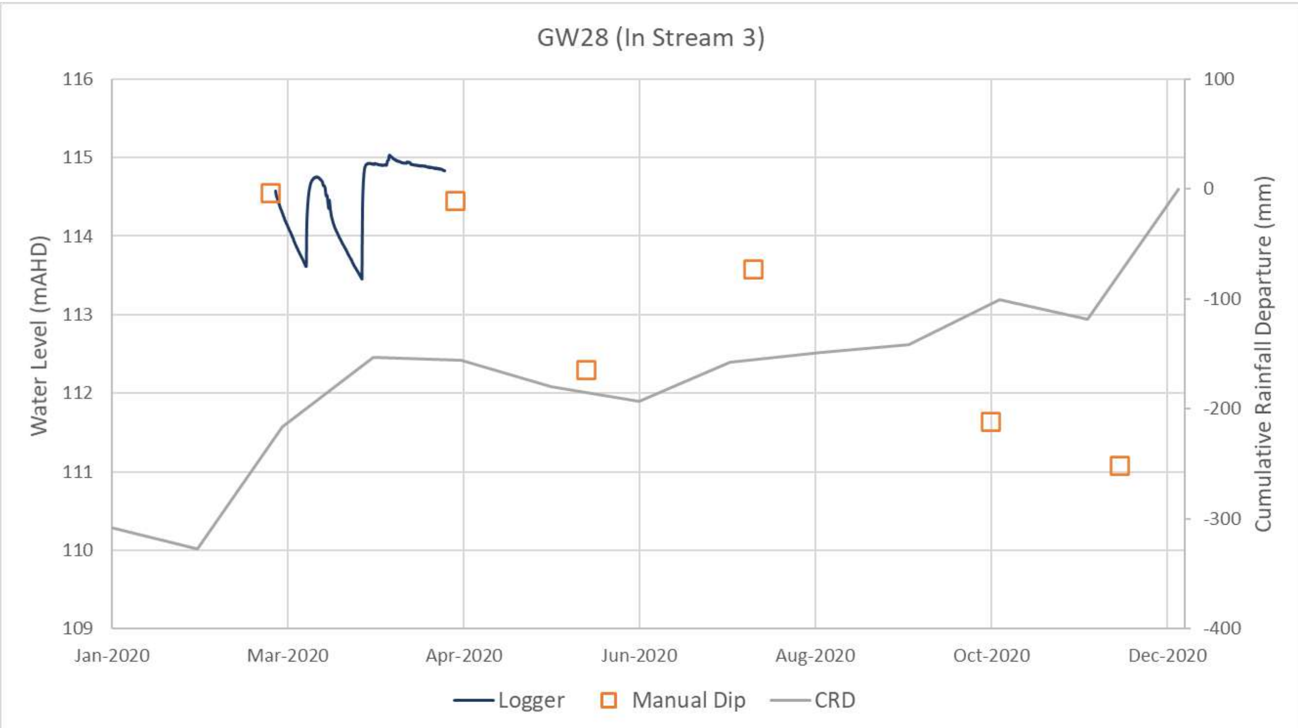
Field pH (pH unit)
Cumulative Rainfall Departure (mm)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
SBX-GW02
CRD



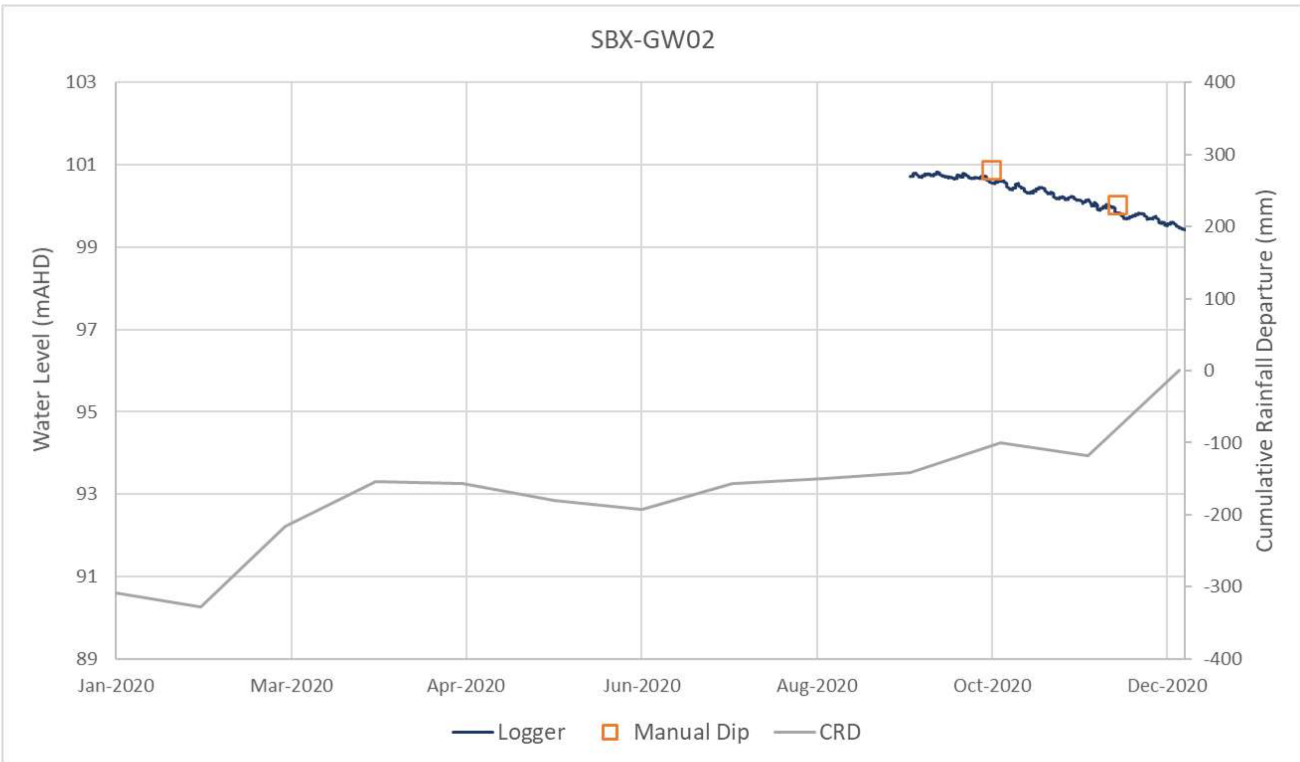
Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
2500
2000
1500
1000
500
0
475
225
-25
-275
-525
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
SBX-GW02
CRD

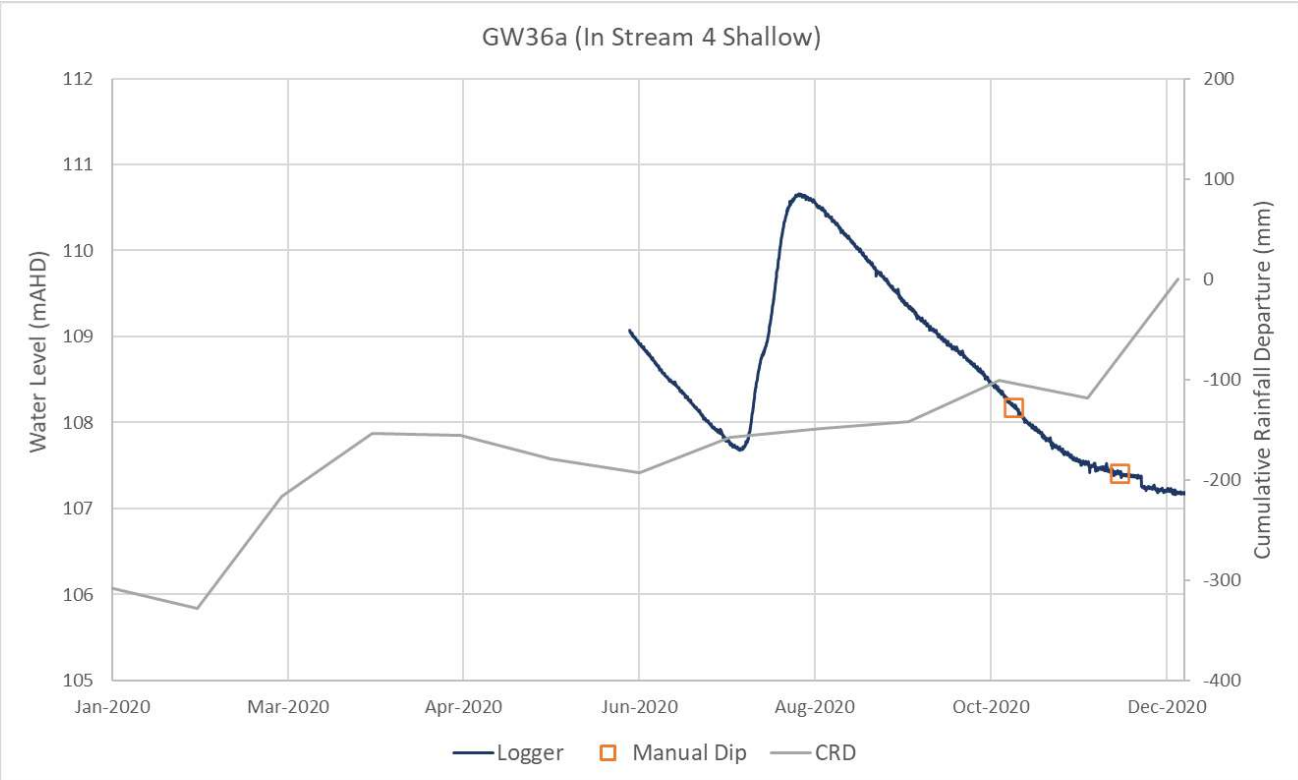


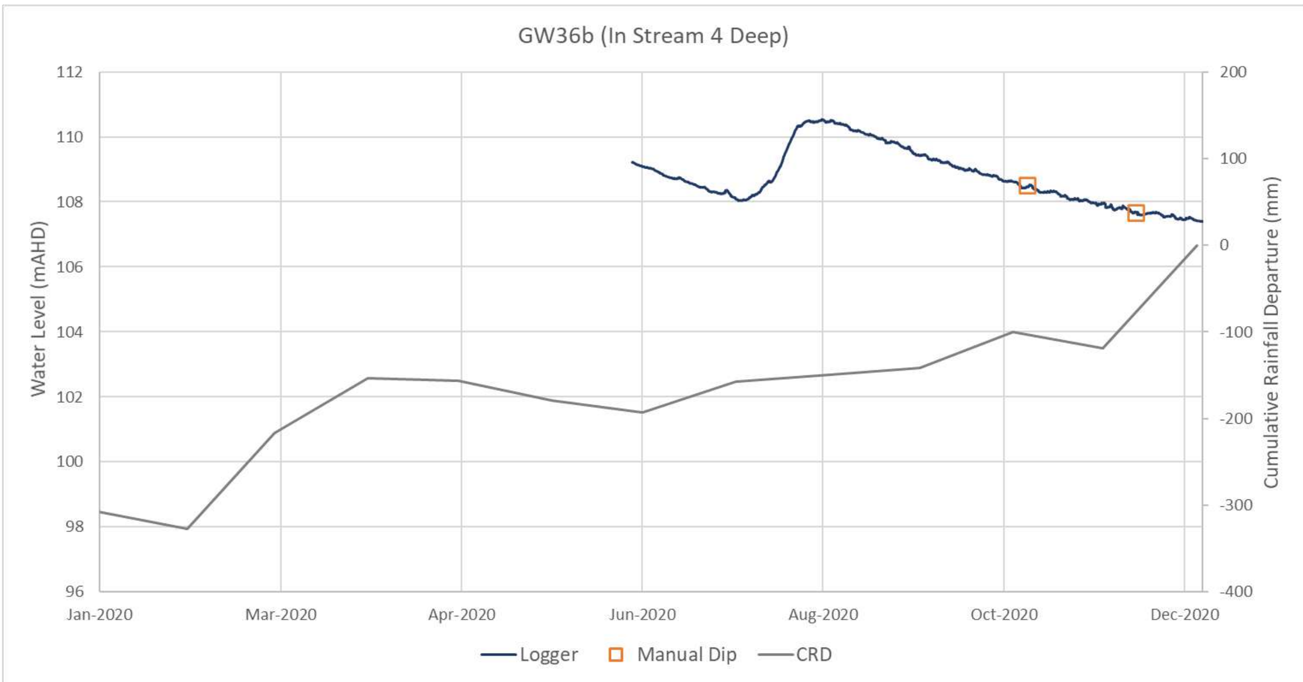
GW35 (Site 20)
Water Level (mAHD)
Cumulative Rainfall Departure (mm)
106
105
104
103
102
101
100
99
98
100
0
-100
-200
-300
-400
Jan-2020
Mar-2020
Apr-2020
Jun-2020
Aug-2020
Oct-2020
Dec-2020
Logger
Manual Dip
CRD



GW28 (In Stream 3)
Water Level (mAHD)
Cumulative Rainfall Departure (mm)
116
115
114
113
112
111
110
109
100
0
-100
-200
-300
-400
Jan-2020
Mar-2020
Apr-2020
Jun-2020
Aug-2020
Oct-2020
Dec-2020
Logger
Manual Dip
CRD


SBX-GW02
Water Level (mAHD)
Cumulative Rainfall Departure (mm)
103
101
99
97
95
93
91
89
400
300
200
100
0
-100
-200
-300
-400
Jan-2020
Mar-2020
Apr-2020
Jun-2020
Aug-2020
Oct-2020
Dec-2020
Logger
Manual Dip
CRD


GW36a (In Stream 4 Shallow)
Water Level (mAHD)
Cumulative Rainfall Departure (mm)
112
111
110
109
108
107
106
105
200
100
0
-100
-200
-300
-400
Jan-2020
Mar-2020
Apr-2020
Jun-2020
Aug-2020
Oct-2020
Dec-2020
Logger
Manual Dip
CRD


GW36b (In Stream 4 Deep)
Water Level (mAHD)
Cumulative Rainfall Departure (mm)
112
110
108
106
104
102
100
98
96
200
100
0
-100
-200
-300
-400
Jan-2020
Mar-2020
Apr-2020
Jun-2020
Aug-2020
Oct-2020
Dec-2020
Logger
Manual Dip
CRD

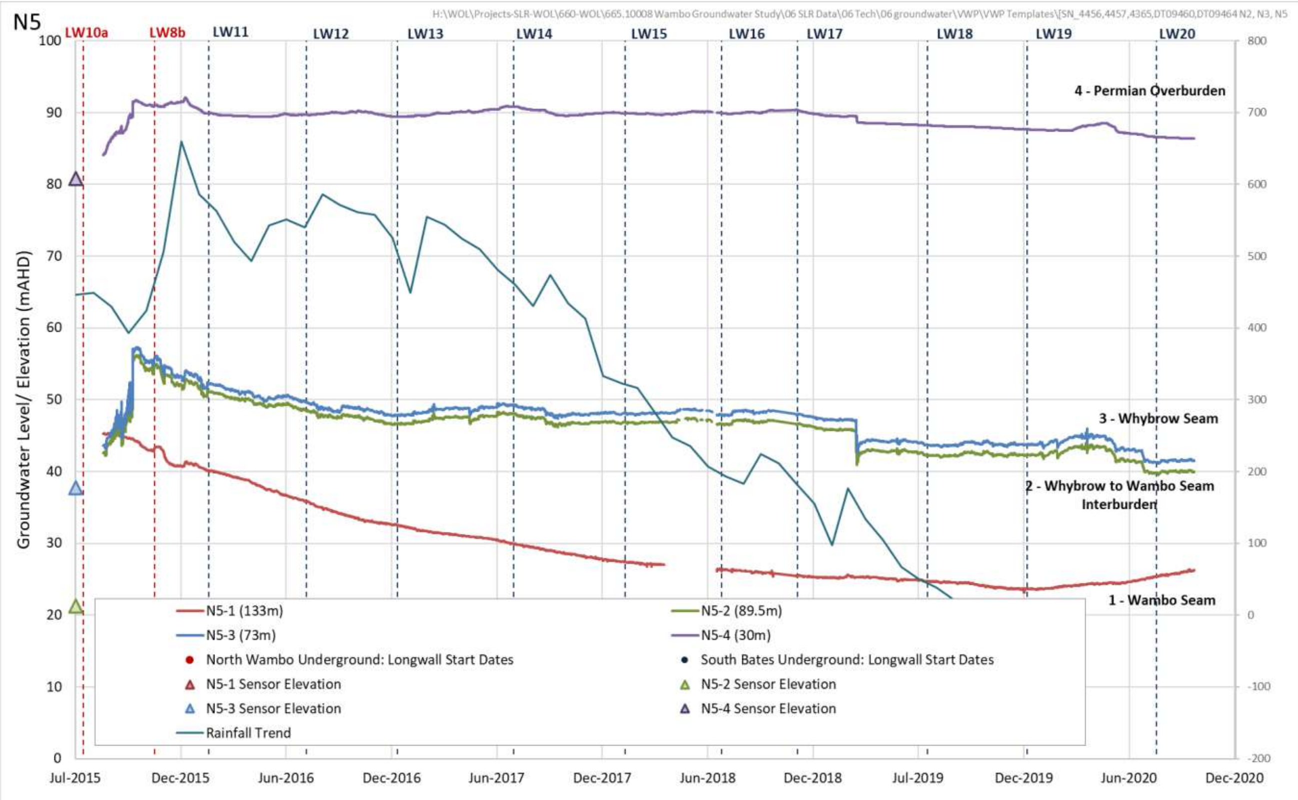


Figure 2 N5 VWP hydrograph

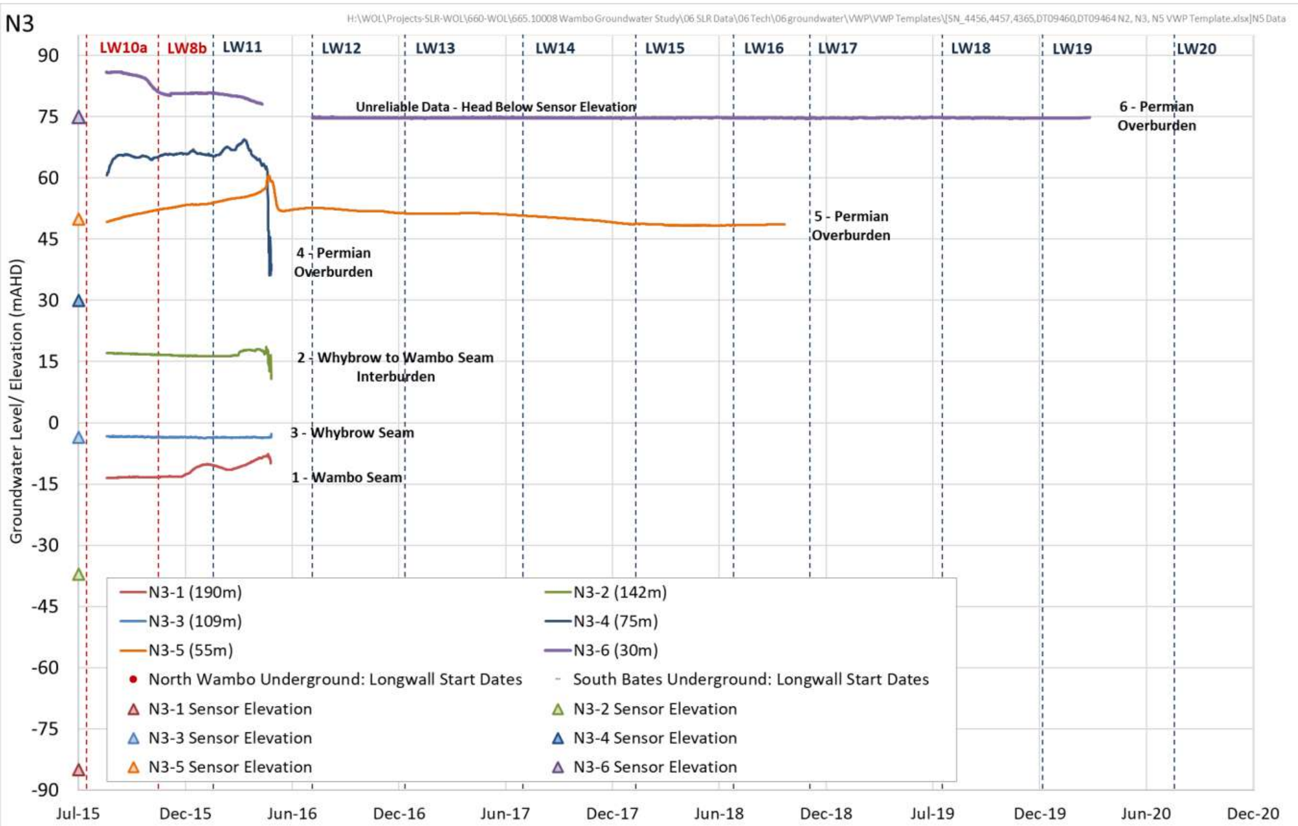


Figure 3 N3 VWP hydrograph

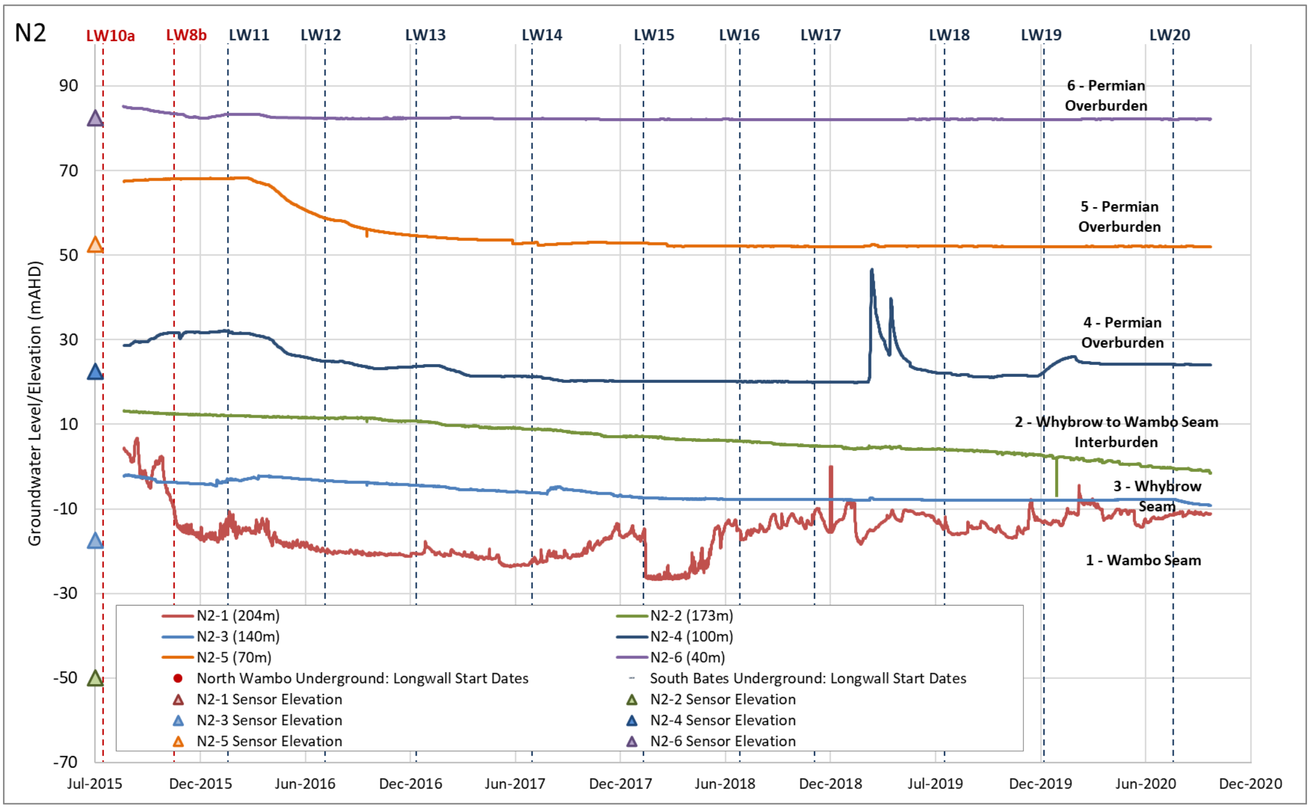


Figure 4 N2 VWP hydrograph

APPENDIX B

Calibration Hydrographs

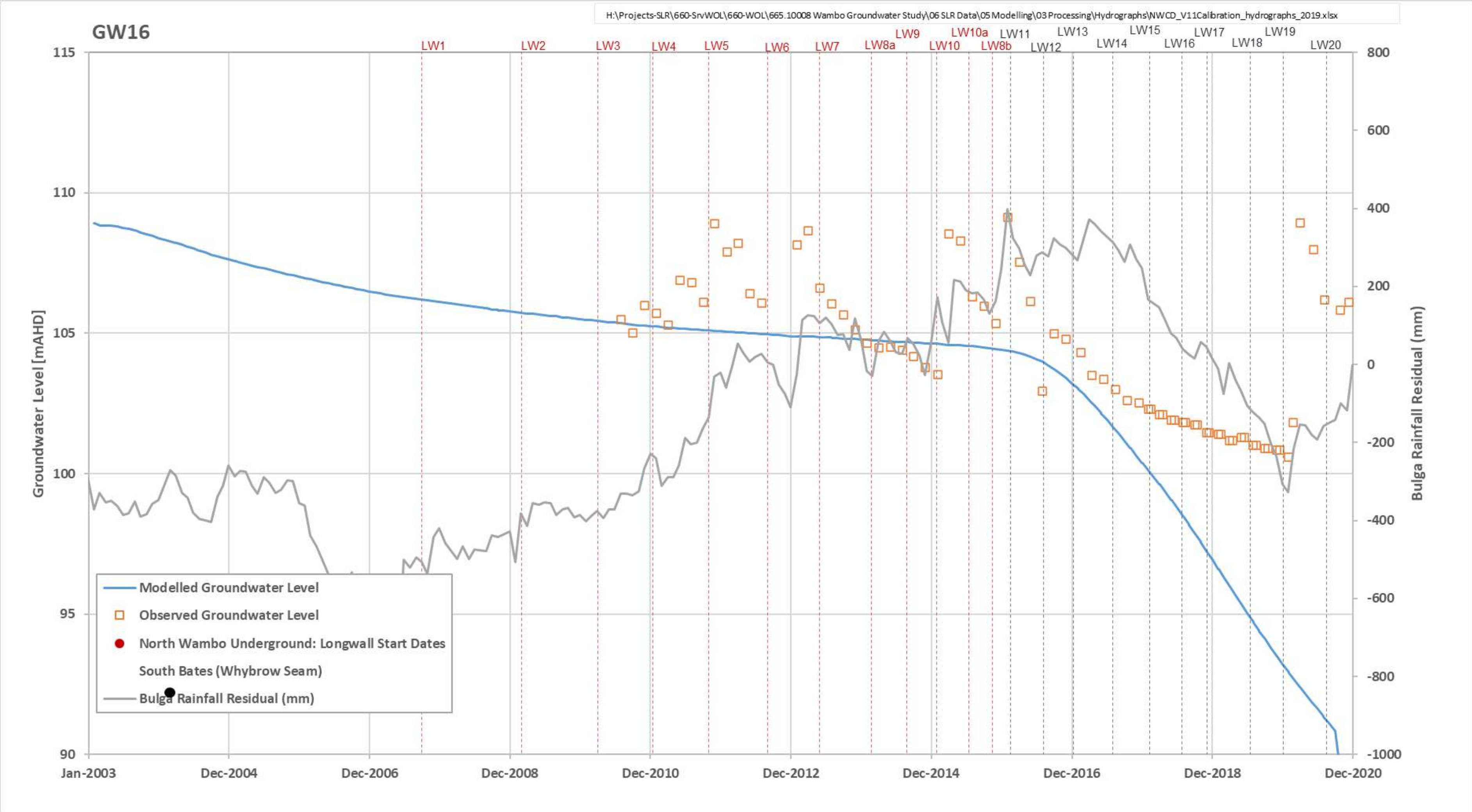


Figure 5 GW16 Calibration Hydrographs

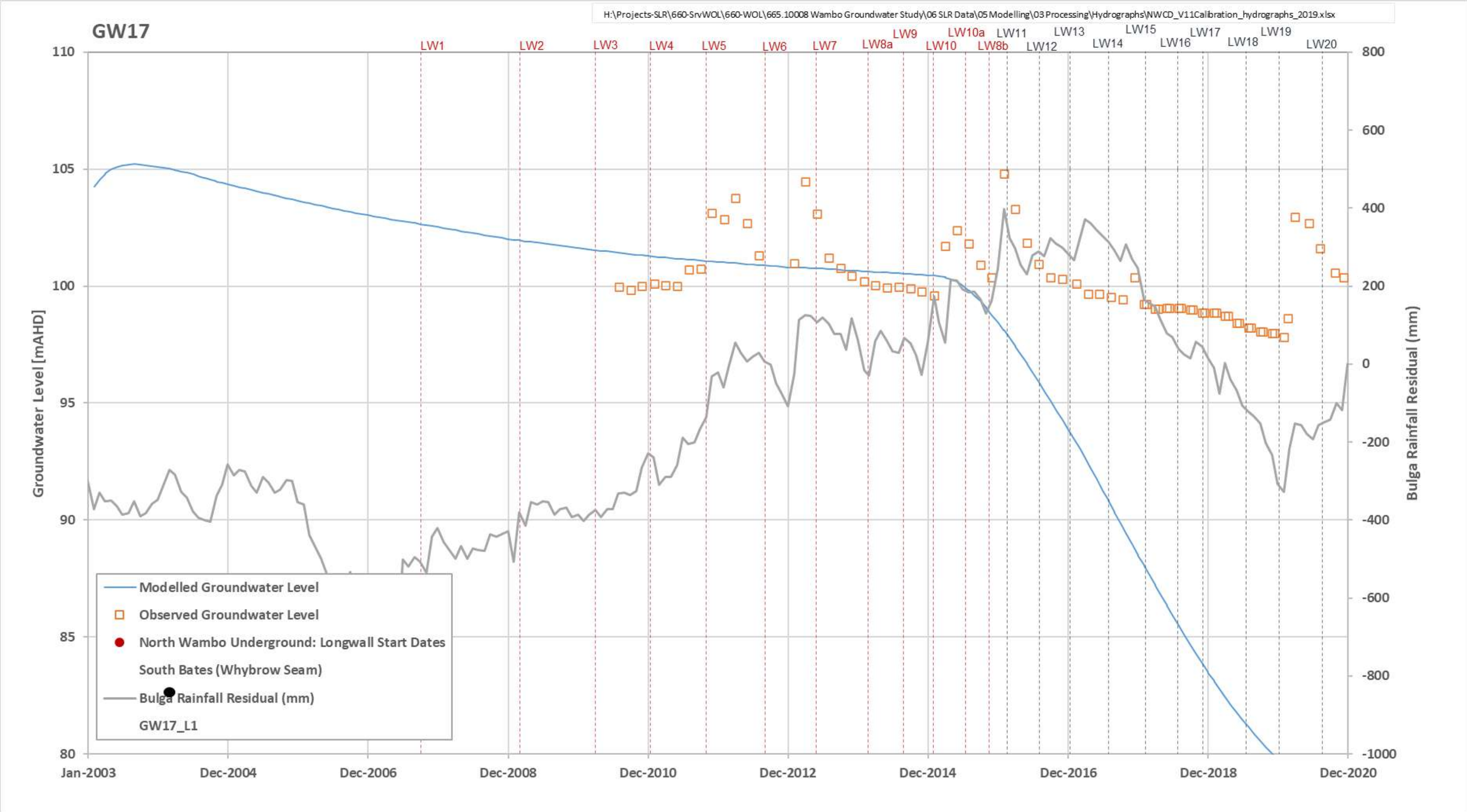


Figure 6 GW17 Calibration Hydrographs

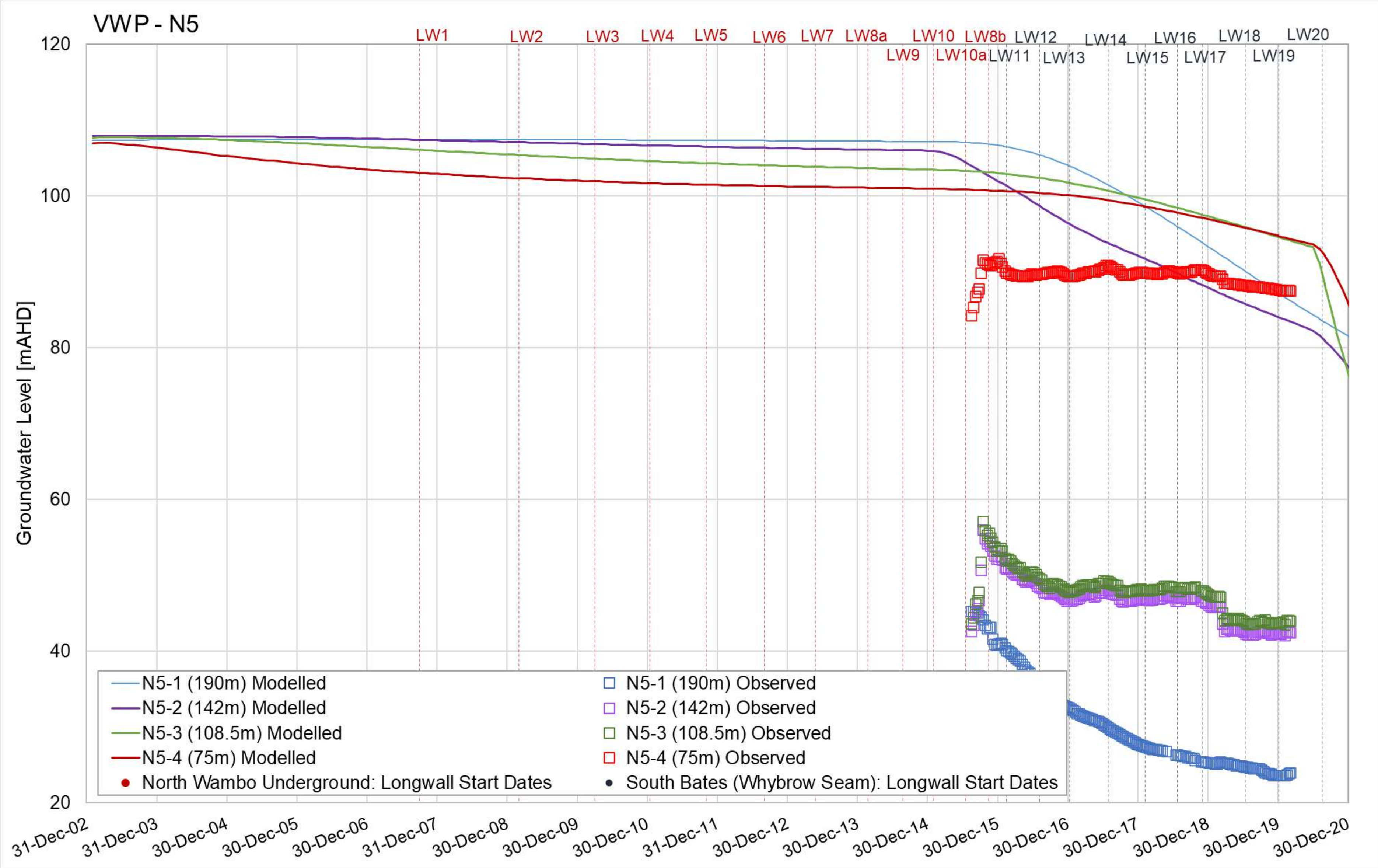


Figure 7 N5 Calibration Hydrographs

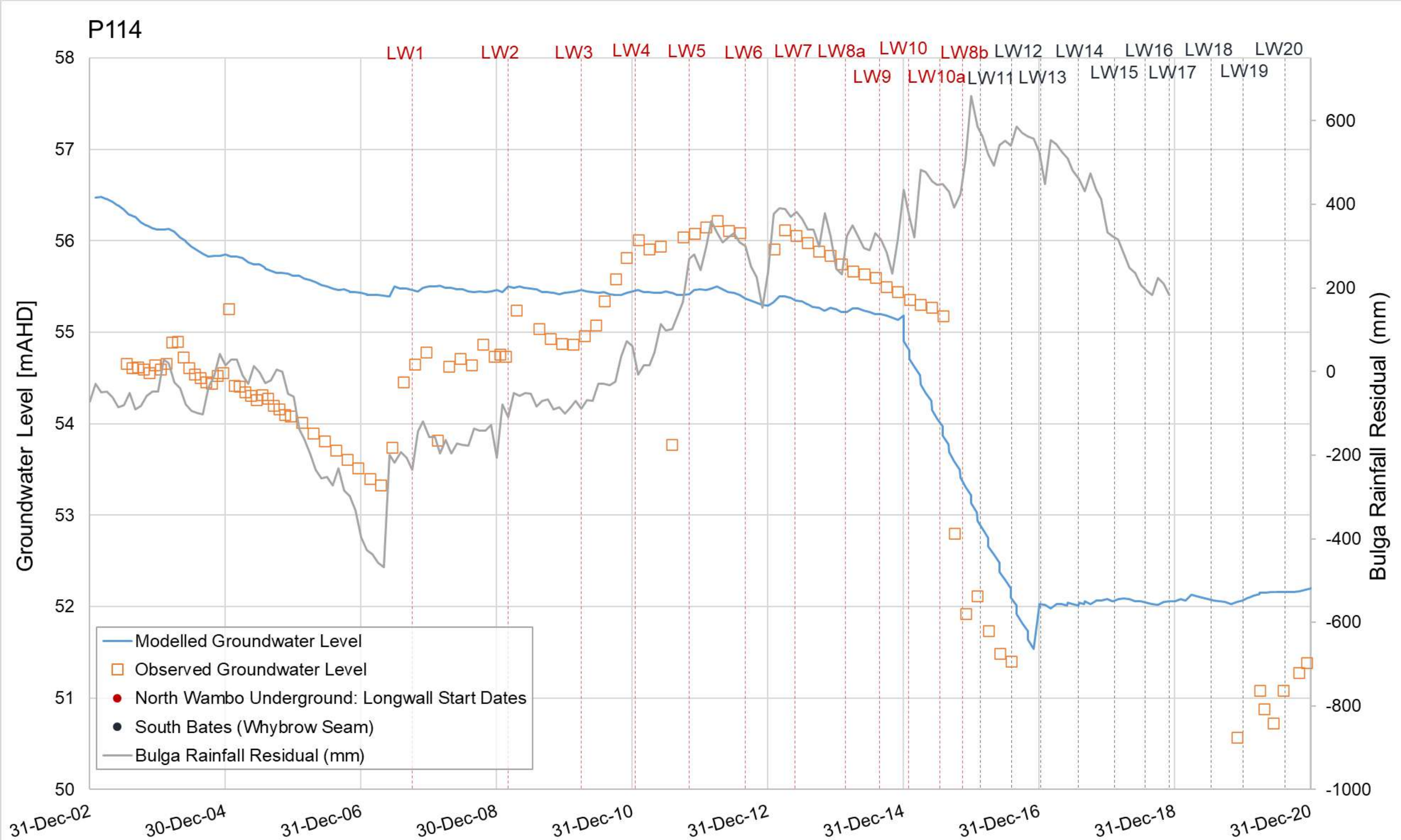


Figure 8 P114 Calibration Hydrographs

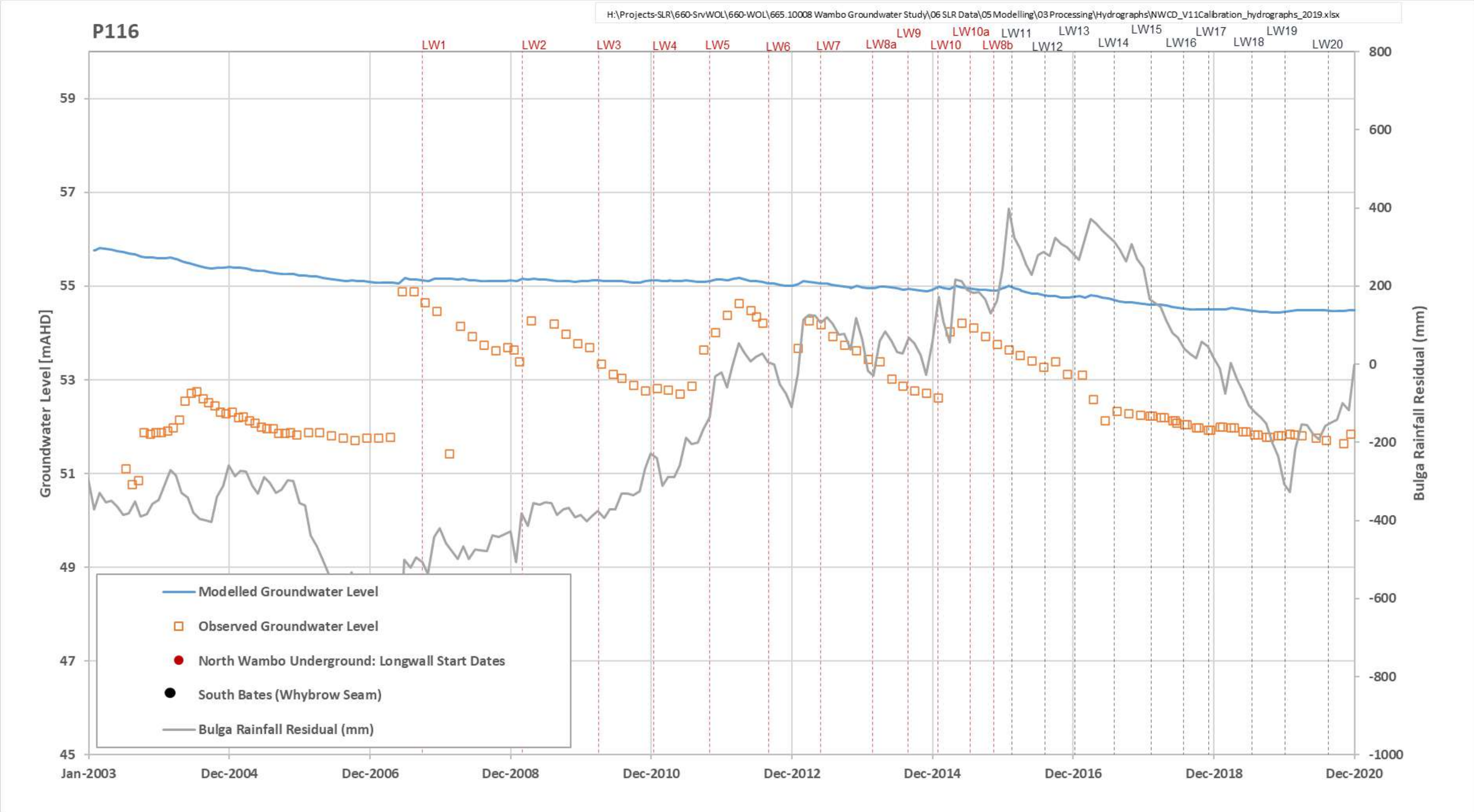


Figure 9 P116 Calibration Hydrographs

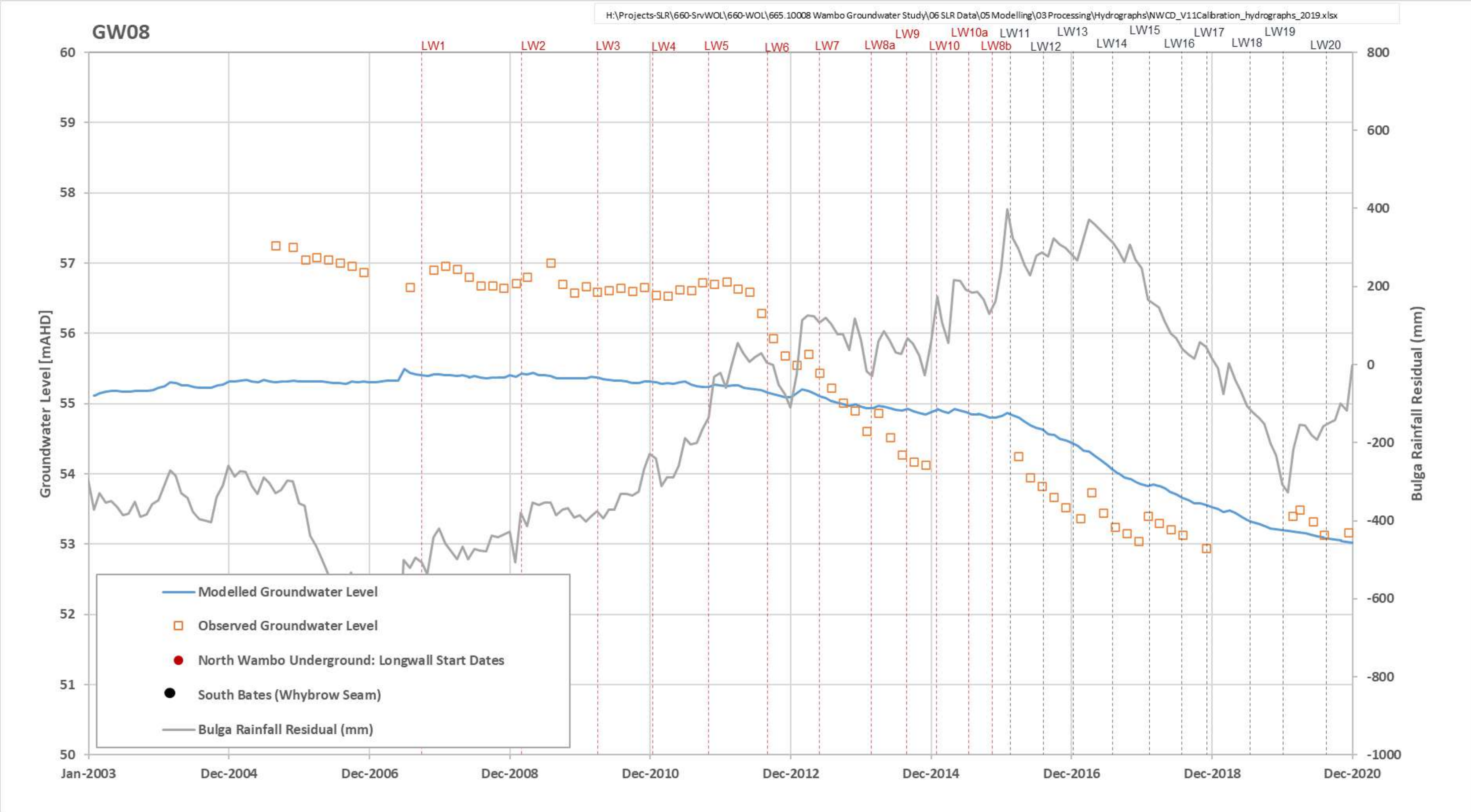


Figure 10 GW08 Calibration Hydrographs

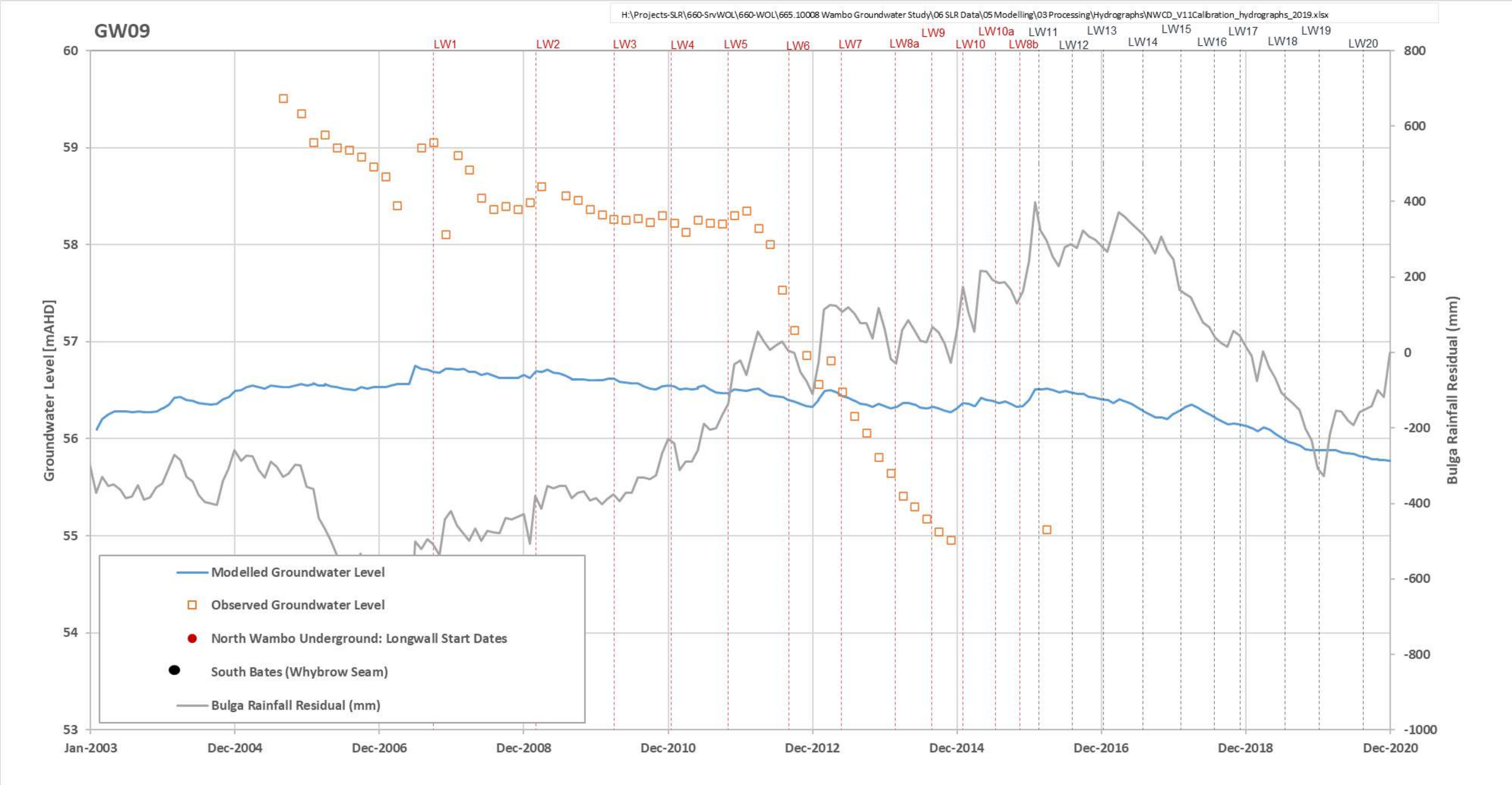


Figure 11 GW09 Calibration Hydrographs

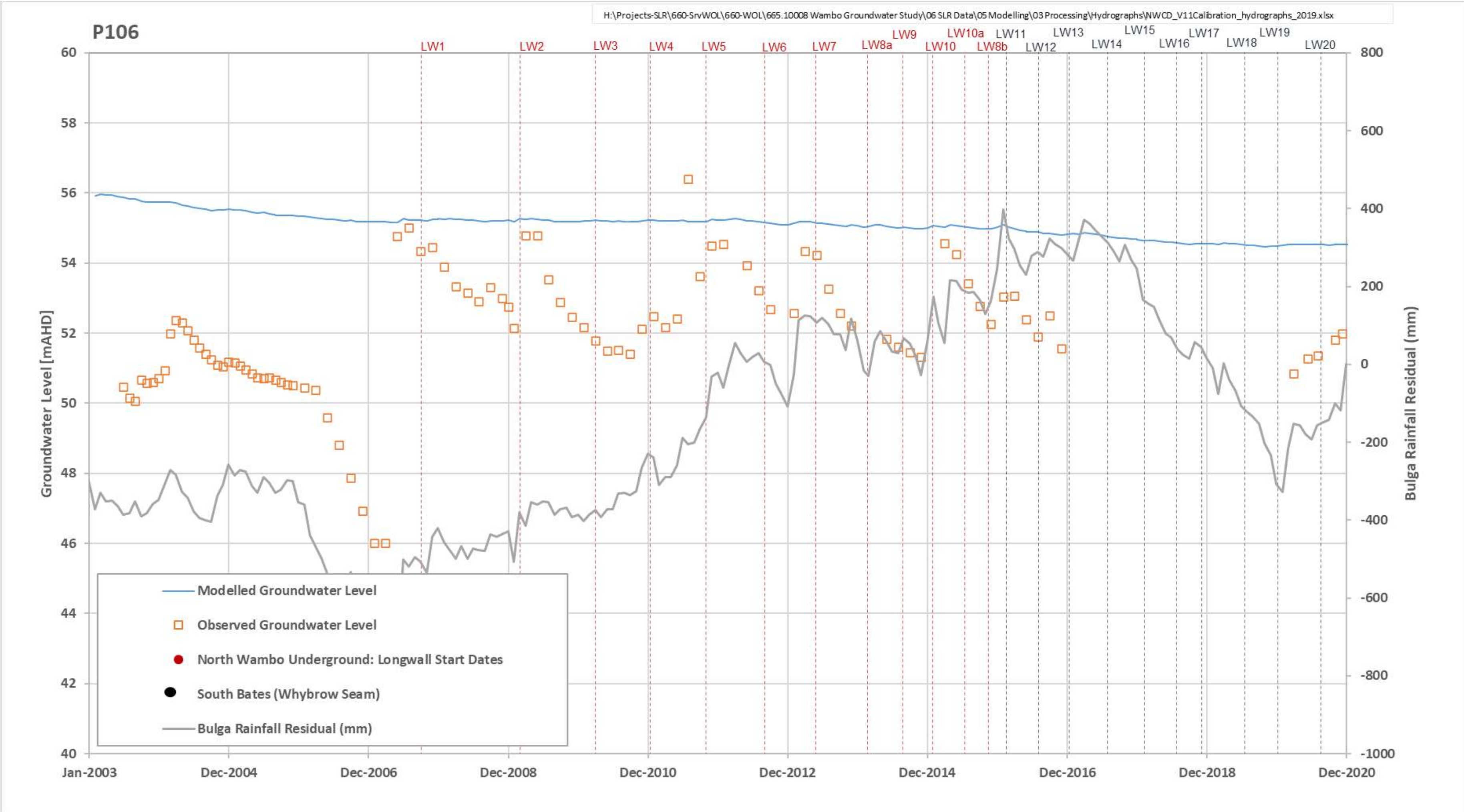


Figure 12 P106 Calibration Hydrographs

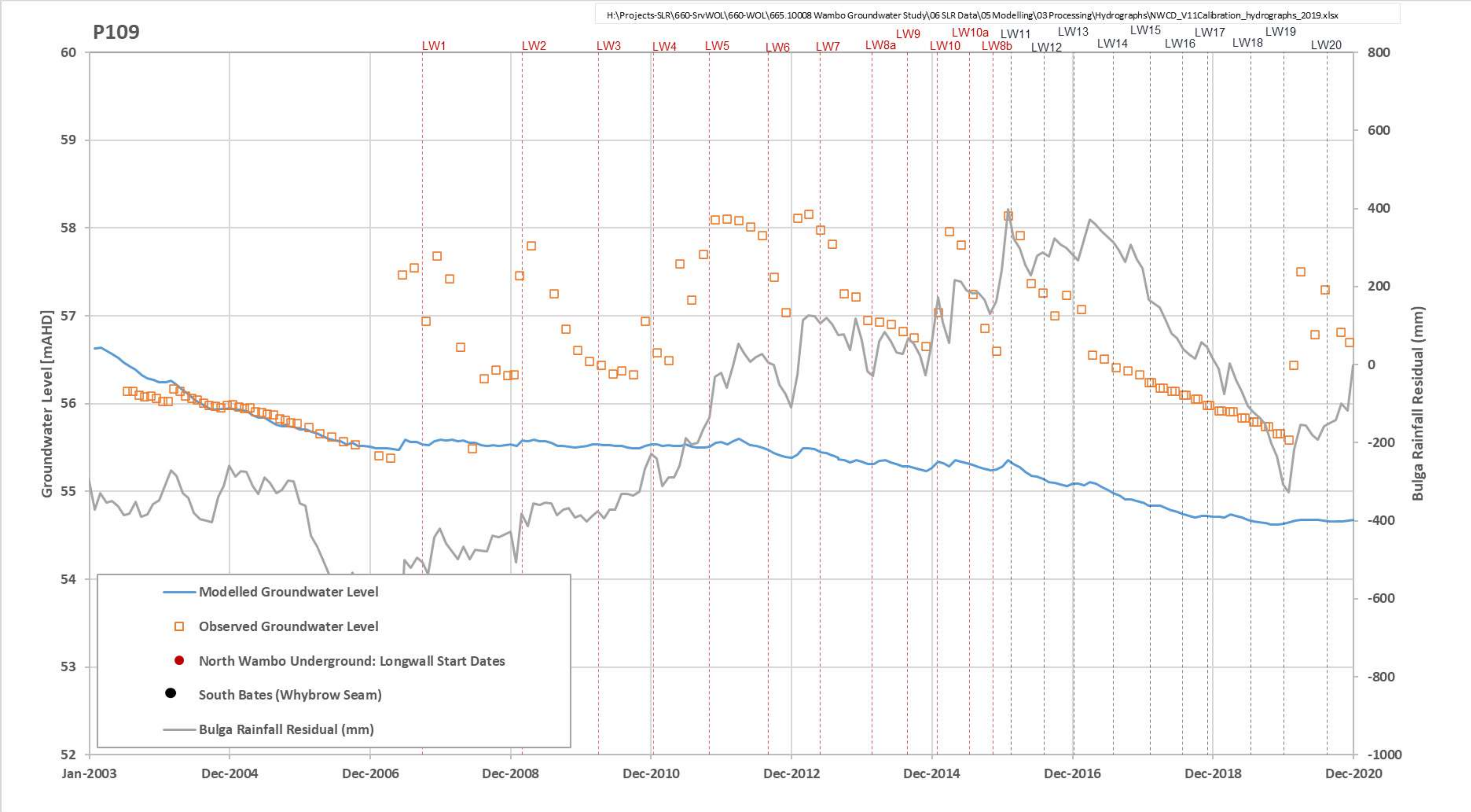


Figure 13 P109 Calibration Hydrographs

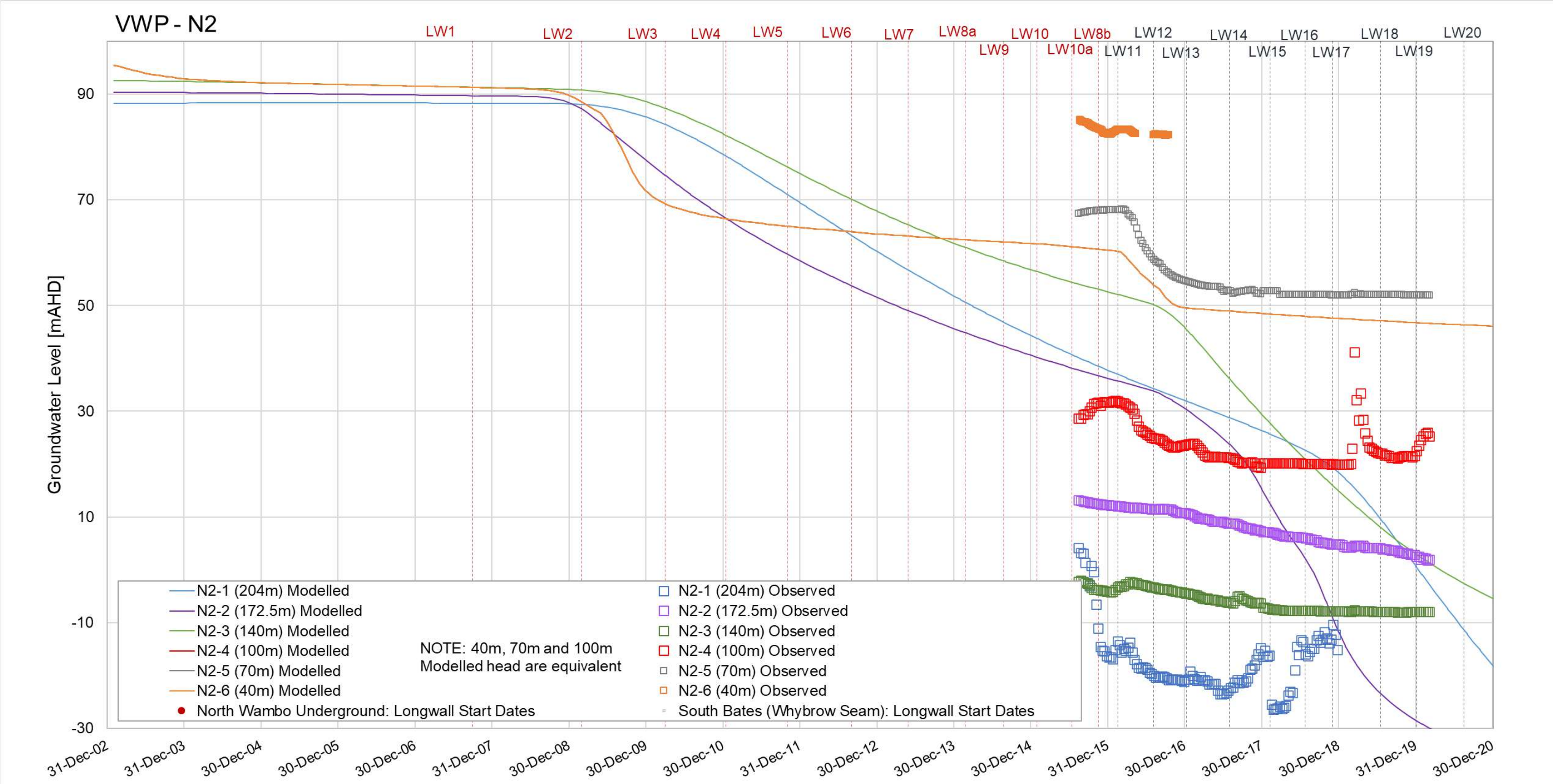


Figure 14 N2 Calibration Hydrographs

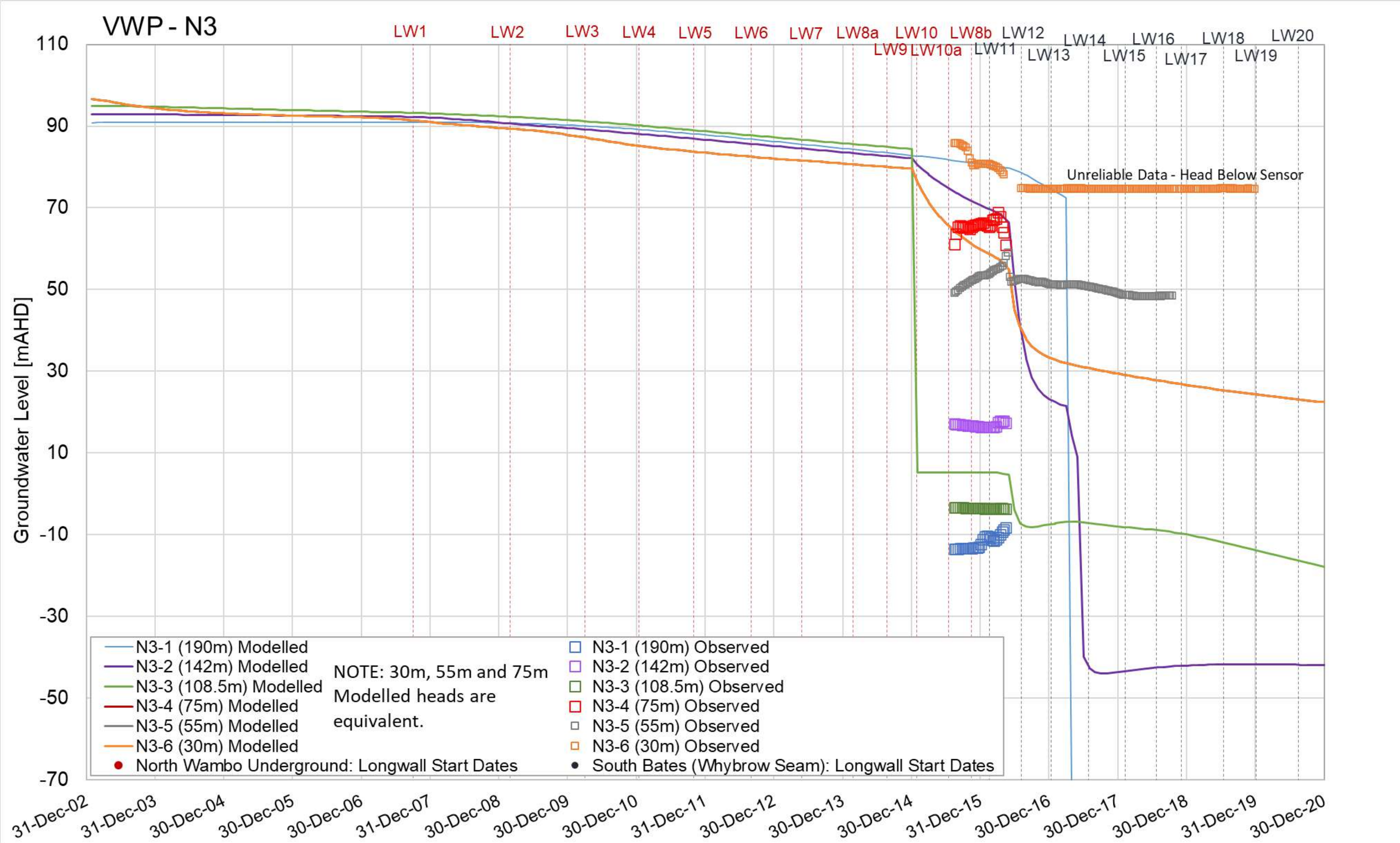


Figure 15 N3 Calibration Hydrographs

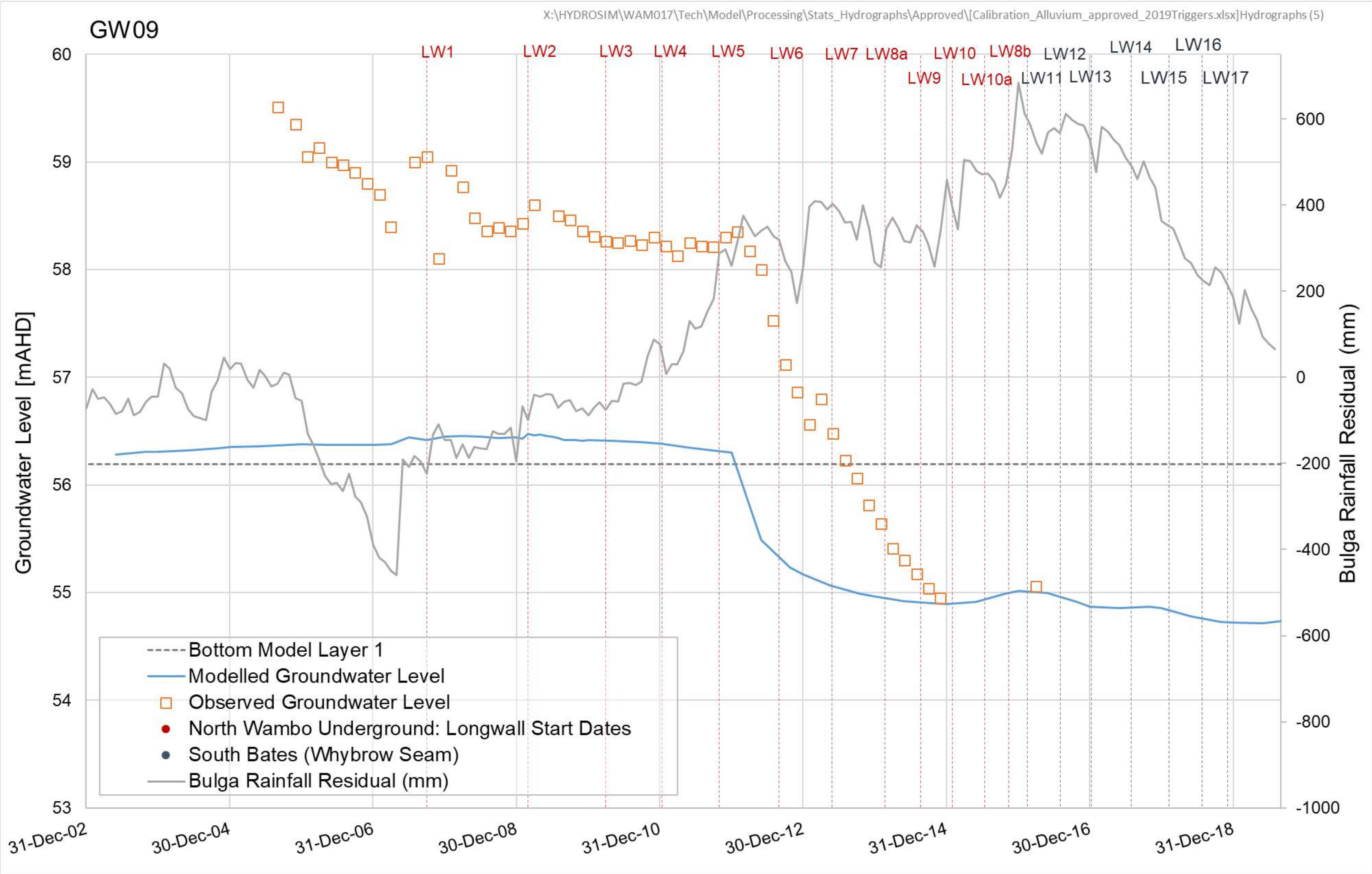


Figure 16 Simulated vs observed groundwater level at GW09 from previous model (Hydrosimulations, 2019b)

APPENDIX C

Vibrating Wire Piezometer – Data Quality Assessment

Install ID	Wambo ID	Easting	Northing	Ground Elevation (mAHD)	Sensor Depth (mBGL)	Sensor Elevation (mAHD)	Target Geology	Sensor Quality Assessment
EX06	P321	307999	6399498	110.39	31.8	78.6	Arrowfield Seam	ok
					72.1	38.3	Warkworth Seam	ok
					161.2	-50.8	Vaux Seam	ok
					187.8	-77.4	Bayswater Seam	ok
SW64	P319	311121	6391412	64.4	11.0	53.4	Regolith	Sensor dry - all obs
					74.9	-10.5	Whybrow Seam	Sensor dry - all obs
					161.3	-96.9	Wambo Seam	ok
					265.3	-200.9	Interburden Sandstone	ok
SW30	P325	312068	6390138	65.2	10.5	54.7	Regolith	ok
					32.5	32.7	Permian Overburden	poor data from 21/7/2020
					82.0	-16.8	Whybrow Seam	poor data from 27/7/2018
					159.5	-94.3	Wambo Seam	poor data from 27/7/2018
					203.0	-137.8	Whynot Seam	ok
					251.5	-186.3	Woodlands Hill Seam	ok
					336.5	-271.3	Arrowfield Seam	ok
P408	P408	307000	6399500	74.62	138.8	-64.1	Vaux Seam	poor data from 8/6/2019
					187.0	-112.4	Bayswater Seam	ok
					223.8	-149.1	Pikes Gully Seam	ok

Install ID	Wambo ID	Easting	Northing	Ground Elevation (mAHD)	Sensor Depth (mBGL)	Sensor Elevation (mAHD)	Target Geology	Sensor Quality Assessment
WJ175	P320	307573	6398890	85.86	344.0	-258.1	Warkworth Seam	ok
					305.0	-219.1	Vaux Seam	ok
					263.0	-177.1	Bayswater Seam	ok
					217.5	-131.6	Pikes Gully Seam	ok
					191.0	-105.1	Lower Arties Seam	ok
					92.0	-6.1	Middle Barret Seam	ok
SW65	P324	310471	6391983	74.44	11.5	62.9	Regolith	sensor near-dry
					95.8	-21.3	Whybrow Seam	sensor near-dry
					157.0	-82.6	Wambo Seam	sensor near-dry
					269.8	-195.3	Woodlands Hill Seam	ok
					304.5	-230.1	Interburden	ok
SW62	P326	310087	6392874	75.48	43.0	32.5	Overburden	Sensor dry - all obs
					113.5	-38.0	Wambo Seam	ok
					234.0	-158.5	Woodlands Hill Seam	ok
					294.5	-219.0	Arrowfield Seam	ok
SW28	P318	312599	6388922	71.05	11.0	60.1	Regolith	Sensor dry
					150.8	-79.7	Whybrow Seam	ok
					205.3	-134.2	Wambo Seam	ok

Install ID	Wambo ID	Easting	Northing	Ground Elevation (mAHD)	Sensor Depth (mBGL)	Sensor Elevation (mAHD)	Target Geology	Sensor Quality Assessment
					314.3	-243.2	Woodlands Hill Seam	ok
					357.0	-286.0	Arrowfield Seam	ok
SW12	P323	309798	6393429	76.64	23.0	53.6	Overburden siltstone	WL below sensor - all obs
					33.0	43.6	Whybrow Seam	WL below sensor - all obs
					85.5	-8.9	Wambo Seam	ok
					224.5	-147.9	Woodlands Hill Seam	ok
					273.5	-196.9	Arrowfield Seam	ok
ELA3	P307	302941	6399995	141.25	65.3	76.0	Overburden sandstone	ok
					228.3	-87.0	Whybrow Seam	ok
					301.1	-159.8	Wambo Seam	ok
					332.5	-191.2	Whynot Seam	ok
P114_116	P316	311252	6391128	60.39	10.0	50.5	Alluvium	WL below sensor - all obs
					25.0	35.5	Regolith	ok
					50.6	9.8	Regolith-overburden	WL below sensor - all obs
					71.0	-10.6	Whybrow Seam	WL below sensor - all obs
Hunter 1		307454	6400351	72.42	67.6	4.8	Vaux Seam	ok
					87.4	-15.0	Vaux Seam	ok
					117.5	-45.1	Bayswater Seam	ok

Install ID	Wambo ID	Easting	Northing	Ground Elevation (mAHD)	Sensor Depth (mBGL)	Sensor Elevation (mAHD)	Target Geology	Sensor Quality Assessment
					150.5	-78.1	Pikes Gully Seam	ok
Hunter 2		306533	6400050	73.62	67.0	6.6	Vaux Seam	ok
					137.3	-63.6	Vaux Seam	ok
					201.5	-127.9	Pikes Gully Seam	ok
P317	P317	307115	6394439	155.41	248.5	-93.1	Wambo Seam	poor quality data from 2/9/2019
					213.0	-57.6	Wambo Rider Seam	poor quality data from 2/9/2019
					174.0	-18.6	Whybrow Seam	poor quality data from 7/8/2019
					100.0	55.4	Overburden	WL below sensor 20/9/2019
					35.0	120.4	Regolith	WL below sensor all obs
ELA5		303160	6398870	131.89	43.0	88.9	Overburden	ok
					275.0	-143.1	Whybrow Seam	Poor quality data from sensors - all obs
					350.0	-218.1	Wambo Seam	ok
					388.0	-256.1	Whynot Seam	ok
SW06	P322	312572	6395026	110.13	56.0	54.1	Regolith	ok
					65.0	45.1	Whynot Seam	ok
					128.0	-17.9	Whynot – Woodlands Hill Interburden	ok
N5	N5	306753	6395960	110.78	133.0	-22.2	Permian Overburden	ok
					89.5	21.3	Whybrow Seam	ok

Install ID	Wambo ID	Easting	Northing	Ground Elevation (mAHD)	Sensor Depth (mBGL)	Sensor Elevation (mAHD)	Target Geology	Sensor Quality Assessment
					73.0	37.8	Interburden	ok
					30.0	80.8	Wambo Seam	ok
N3	N3	308313	6394574	104.968	190.0	-85.0	Permian Overburden	no data from most recent download for all sensors, returns "nan"
					142.0	-37.0	Permian Overburden	
					108.5	-3.5	Permian Overburden	
					75.0	30.0	Whybrow Seam	
					55.0	50.0	Interburden	
					30.0	75.0	Wambo Seam	
N2	N2	308633	6393372	122.52	204.0	-81.5	Permian Overburden	ok
					172.5	-50.0	Permian Overburden	ok
					140.0	-17.5	Permian Overburden	ok
					100.0	22.5	Whybrow Seam	WL below sensor from Apr 2017
					70.0	52.5	Interburden	WL below sensor from Sept 2016
					40.0	82.5	Wambo Seam	WL below sensor from mid-2015
SBX_20 GW01	SBX_GW01	307009	6395884	107.9	43	65.0		Yet to be downloaded
SBX_20 GW01	SBX_GW02	306909	6395939	108.9	65.8	43.1		Yet to be downloaded
					61.7	47.2		
					53.7	55.2		

Install ID	Wambo ID	Easting	Northing	Ground Elevation (mAHD)	Sensor Depth (mBGL)	Sensor Elevation (mAHD)	Target Geology	Sensor Quality Assessment
MG08-01 (Unlabelled)	MG08-01	311054	6392670	65.35	9.0	56.4	Alluvium	
					37.0	28.4	Permian	
					46.0	19.4	Whybrow Seam	
					60.0	5.4	Interburden	
					77.3	-12.0	Redbank Seam	
					90.0	-24.7	Interburden	
					101.0	-35.7	Wambo Seam	
MG08-01 (Incorrect)	MG08-01	311618	6392876	66				4 sensors at site – installation data unavailable. Naming incorrect – not consistent with MG08 install report
MG09-01	MG09-01	310539	6391186	69.75	9.0	60.8	Alluvium	pressure below sensor for all obs sensors failed Oct 2014
					30.0	39.8	Permian Upper	
					60.0	9.8	Permian Lower	
					103.0	-33.3	Whybrow Seam	
					130.0	-60.3	Interburden	
					153.0	-83.3	Redbank Seam	
					170.0	-100.3	Interburden	
					192.0	-122.3	Wambo Seam	

Install ID	Wambo ID	Easting	Northing	Ground Elevation (mAHD)	Sensor Depth (mBGL)	Sensor Elevation (mAHD)	Target Geology	Sensor Quality Assessment
Unknown Fenwick	U/ Fenwick	310636	6390994	70				5 Sensors No data collected from sensors "Nan"
GW20	GW20	309075	6393949	91.31	9.3	82.0	Base of Colluvium/ Alluvium	data not collected, suggest check/ test download next time, installation report incomplete original template sheet only has data to 2011
					61.5	29.8	Whybrow Seam	
					93.0	-1.7	Redbank Seam	
					129.5	-38.2	Wambo Seam	
"Unknown 1"	MG06-01	310862	6392901	71.62	67.5	4.1	Wambo Seam	Data to June 2011 - none collected since then.
					69.5	2.1	Wambo Seam	
					71.0	0.6	Wambo Seam	
					74.0	-2.4	Interburden	

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APPENDIX H

STREAM FLOW MONITORING REPORT

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25 March 2021

Commercial-in-Confidence

Nicole Dobbins
Environmental Advisor
Wambo Coal Pty Ltd.
ABN: 13 000 668 057
PMB 1
Singleton NSW 2330

Dear Nicole,

Report on stream flow events along North Wambo, South Wambo and Stoney Creeks for the period 1 January to 31 December 2020.

Please find contained within this report a summary of probable flow events which occurred along North Wambo, South Wambo and Stony Creeks from and inclusive of 1 January to 31 December 2020.

1.0 Locations, Configurations and Observations

The flow monitoring network now comprises of eleven flow monitoring stations. These flow monitoring stations are distributed along the following creeks: -

- North Wambo Creek has five flow monitoring stations;
- South Wambo Creek has three flow monitoring stations, and;
- Stony Creek has two monitoring stations with an additional flow monitoring station located on a major tributary to Stony Creek.

Details of the location (**Table 1, Table 2, Figure 1** and **Figure 2**), configuration (**Table 3**) and observations (**Table 4**) for each flow monitoring station are provided below.

Table 1 Flow Station Locations

Station ID	Location	Easting	Northing
FM1	North Wambo Creek adjacent to the mine	307014	6396139
USFM1	North Wambo Creek upstream of mine	305257	6395201
FM2	Midway along old North Wambo Creek diversion	308217	6395056
FM3	Midway along new North Wambo Creek diversion	309226	6393663
FM4	North Wambo Creek upstream of the confluence of Wollombi Brook	311906	6392160
FM15	South Wambo Creek upstream of the confluence of Wollombi Brook	311814	6391224
FM16	South Wambo Creek upstream of washout of Wambo Mine Road	311279	6390673
FM9	South Wambo Creek downstream	308666	6389176
FM12	Stony Creek upstream of proposed area to be mined	307711	6392744
FM14	Major tributary of Stony Creek upstream of proposed area to be mined	307723	6392242
FM13	Stony Creek downstream of proposed area to be mined	309537	6391090

Table 2 Atmospheric Pressure Correcting Station Locations

Station ID	Location	Easting	Northing
PM2	Midway along old North Wambo Creek diversion at Flow Station FM2 data logging housing	308196	6395042
PM6	South Wambo Creek upstream of washout of Wambo Mine Road inside the data logger housing for old Flow Station FM6	311253	6390711
PM8	Stony Creek upstream on the old Flow Station FM8 infrastructure	307996	6392278
PM7	Stony Creek downstream on the old Flow Station FM7 infrastructure	309400	6391443

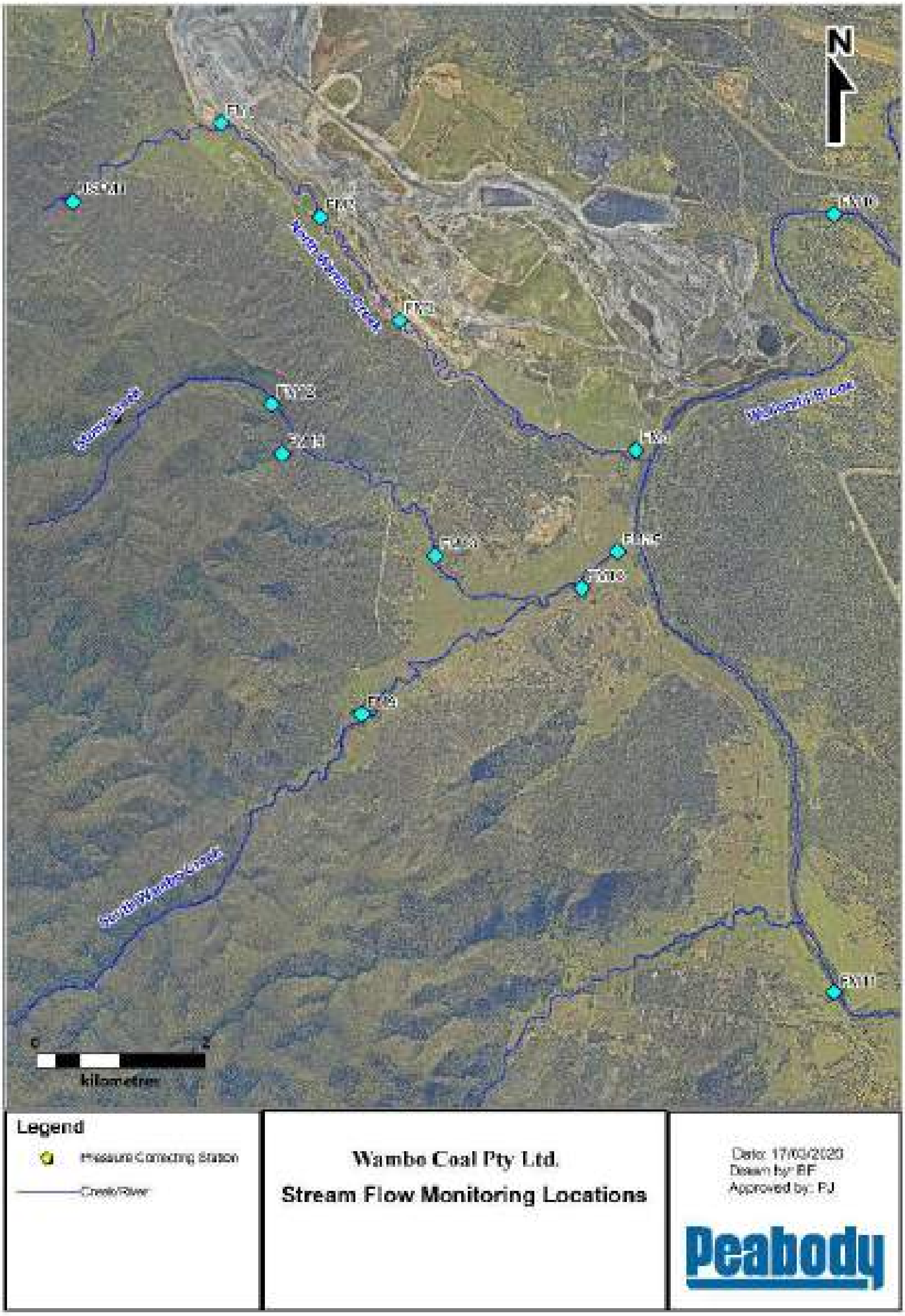

Figure 1 Stream Flow Locations

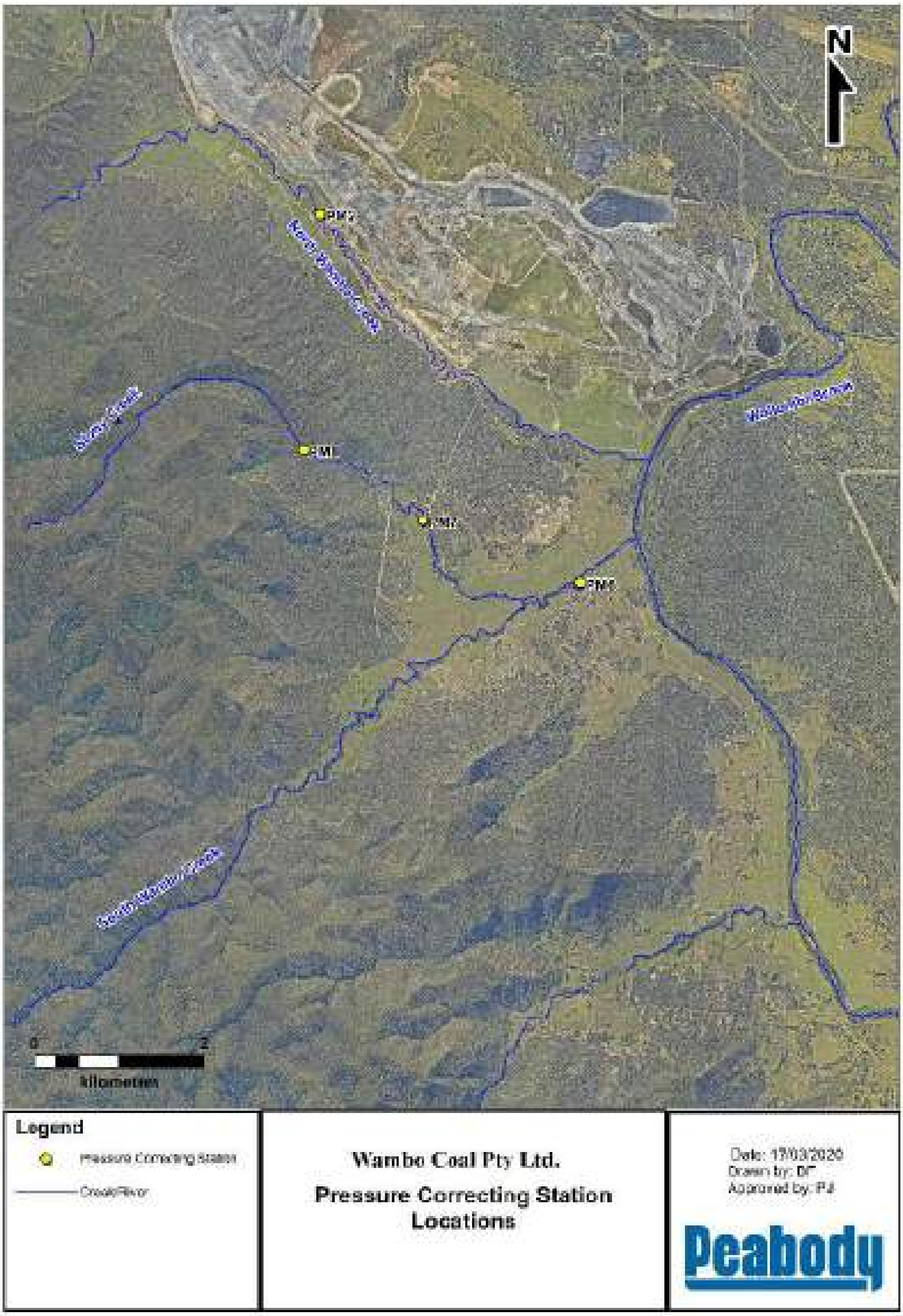

Figure 2 Pressure Correcting Station Locations

Table 3 Monitoring Location Equipment Configurations

Station ID	Equipment	Corresponding Correction Station
FM1	Campbell Scientific (CSA) CS451 SDI-12 pressure transducer connected to a CSA CR800 series data logger, powered by a 12-volt lead acid battery with solar charging. Data is logged hourly. A backup Insitu Rugged TROLL 100 absolute pressure sensor logging data at 10-minute intervals is also installed.	**PM2**
USFM1	Insitu Rugged TROLL 100 absolute pressure sensor. Data is logged at 10-minute intervals	**PM2**
FM2	CSA CS450 SDI 12 pressure transducer connected to a CSA CR200X series data logger, powered by a 12-volt lead acid battery with solar charging. Data is logged at 10-minute intervals. A backup Insitu Rugged TROLL 100 absolute pressure sensor logging data at 10-minute intervals is also installed.	**PM2**
FM3	CSA CS450 SDI 12 pressure transducer connected to a CSA CR200X series data logger, powered by a 12-volt lead acid battery with solar charging. Data is logged at 10-minute intervals. A backup Insitu Rugged TROLL 100 absolute pressure sensor logging data at 10-minute intervals is also installed.	**PM2**
FM4	CSA CS450 SDI 12 pressure transducer connected to a CSA CR200X series data logger, powered by a 12-volt lead acid battery with solar charging. Data is logged at 10-minute intervals. A backup Insitu Rugged TROLL 100 absolute pressure sensor logging data at 10-minute intervals is also installed.	**PM2**
FM15	Insitu Rugged TROLL100 absolute pressure sensor which has been configured to record data at 10-minute intervals.	**PM6**
FM16	Insitu Rugged TROLL100 absolute pressure sensor which has been configured to record data at 10-minute intervals.	**PM6**
FM9	Insitu Rugged TROLL100 absolute pressure sensor which has been configured to record data at 10-minute intervals.	**PM6**
FM12	Insitu Rugged TROLL100 absolute pressure sensor which has been configured to record data at 10-minute intervals	**PM8**
FM14	Insitu Rugged TROLL100 absolute pressure sensor which has been configured to record data at 10-minute intervals	**PM8**
FM13	Insitu Rugged TROLL100 absolute pressure sensor which has been configured to record data at 10-minute intervals	**PM7**
PM2	Insitu Rugged BaroTROLL. Data is logged at 10-minute intervals	N/A
PM6	Insitu Rugged BaroTROLL. Data is logged at 10-minute intervals	N/A
PM8	Insitu Rugged BaroTROLL. Data is logged at 10-minute intervals	N/A
PM7	Insitu Rugged BaroTROLL. Data is logged at 10-minute intervals	N/A

Table 4 Monitoring Location General Observations

Station ID	Observations
FM1	Originally located at the top of North Wambo Creek upstream of surface water monitoring site SW04; re-located approximately 300 to 400m further downstream in December 2017 – downstream of surface water monitoring site SW04
USFM1	New station installed on North Wambo Creek during December 2017; located approximately 1 kilometre upstream of the original site of FM1
FM2	Located downstream from relocated Flow Station FM1 approximately midway along the old North Wambo Creek diversion. A backup pressure sensor was installed at this location in August 2020.
FM3	Originally located on North Wambo Creek between the old Wambo Underground Surface Infrastructure and the Open Cut Overburden: relocated in May 2013 to approximately midway along the new diversion of North Wambo Creek downstream of Flow Station FM2. A backup pressure sensor was installed at this location in August 2020.
FM4	Located at the Wambo Mine Road culvert which crosses North Wambo Creek upstream of the confluence of North Wambo Creek and Wollombi Brook
FM15	Located on South Wambo Creek just upstream of the confluence of South Wambo Creek and Wollombi Brook; relocated to approximately 100 to 200m downstream in December 2016
FM16	Located on South Wambo Creek approximately 200 to 300 metres up stream of the washout on Wambo Mine Road
FM 9	Located approximately 2 kilometres upstream from its original location following a recommendation from Environmental Instrument Solutions' hydrographer
FM12	Re-located during September 2018 approximately 50 metres downstream from its original location following a recommendation from Environmental Instrument Solutions' hydrographer
FM14	Installed in December 2015
FM13	Re-located during September 2018 approximately 50 metres upstream from its original location following a recommendation from Environmental Instrument Solutions' hydrographer.
PM2	In November 2018 data collection it was identified that this BaroTROLL failed during October 2018. A replacement sensor was installed on 24 January 2019
PM6	N/A
PM8	N/A
PM7	N/A

2.0 Methodology

The results represent a theoretical flow and have been calculated using polynomial equations derived from theoretical flow rating curves. These theoretical flow curves were constructed from data received by AECOM from Wambo Coal and Environmental Instrument Solutions with the exception of the relocated Stony Creek flow monitoring station and the new monitoring station FM9 on South Wambo Creek. Theoretical flow curves generated by AECOM were utilised to calculate theoretical flow along Stony Creek and its tributary when probable flow events occurred.

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 data collected from each Flow Station was presented as a pressure reading in kPa. This pressure was converted to a stream height in metres using the following equation: -

Stream Height (m) = Stream Height (kPa) X 0.101972 (m/kPa)

The calculated stream height was then compared to the cease to flow point at each site. The cease to flow point was identified in conjunction with the long section surveys and represents a point in the reach/stream which the height of the stream must attain before it starts to flow.

The relative level of the cease to flow point was compared to the relative level of the sensor at each station. The difference in height between the cease to flow point and the sensor was calculated. This difference was used to screen the data collected from each station for probable flow events.

Once a flow event had been recognised at a flow monitoring station the resultant stream height was applied to the polynomial equation derived from theoretical flow rating curve, for that flow station, to give a theoretical stream flow rate for the identified flow event at the station. In some instances, more than one polynomial equation was required; see flow rating curves in **Appendix B**.

3.0 Results

Probable flow events for the period 1 January to 31 December 2020 for each flow station (including backup sensors) are presented in the following tables. All results displayed in respect to stream flow are theoretical and should be treated as such.

- Upper North Wambo Creek – Flow Monitoring Station USFM1 (**Table 5)**;
- North Wambo Creek adjacent to the mine – Flow Monitoring Station FM1BU (**Table 6)** – note that probable flow events were detected by the backup sensor only;
- North Wambo Creek midway along old diversion – Flow Monitoring Stations FM2 (**Table 7**) and FM2BU (**Table 8**) – note that the backup sensor was installed on 4 August 2020;
- North Wambo Creek midway along new diversion – Flow Monitoring Stations FM3 (**Table 9**) and FM3BU (**Table 10**) – note that the backup sensor was installed on 4 August 2020;
- North Wambo Creek upstream of Wollombi Brook – Flow Monitoring Stations FM4 (**Table 11**) and FM4BU (**Table 12**);
- South Wambo Creek upstream of Wollombi Brook – Flow Monitoring Station FM15 (**Table 13**);
- South Wambo Creek upstream of washout of Wambo Mine Road – Flow Monitoring Station FM16 (**Table 14**);
- South Wambo Creek downstream – Flow Monitoring Station FM9 (**Table 15**);
- Stony Creek upstream of proposed area to be mined – Flow Monitoring Station FM12 (**Table 16**);
- Major tributary of Stony Creek upstream of proposed area to be mined – Flow Monitoring Station FM14 **(Table 17**); and
- Stony Creek downstream of proposed area to be mined – Flow Monitoring Station FM13 (**Table 18**);

Table 5 Flow Monitoring Station – USFM1 Upper North Wambo Creek – Summary of Results – 1 January to 31 December 2020.

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	9/02/2020 8:22	18/07/2020 13:22	160	0.119	0.683	0.0632	5.46	3.26	282
2	26/07/2020 7:02	15/10/2020 12:32	81.2	0.117	0.195	0.0288	2.48	0.126	10.9
3	11/12/2020 4:02	11/12/2020 14:22	0.43	0.0106	0.0212	0.00171	0.148	0.0028	0.242
4	12/12/2020 4:02	12/12/2020 11:02	0.29	0.00946	0.0193	0.00158	0.137	0.00267	0.230
5	15/12/2020 2:42	16/12/2020 18:52	1.67	0.0421	0.0758	0.00359	0.31	0.00658	0.568
6	16/12/2020 21:42	17/12/2020 16:42	0.79	0.035	0.0625	0.0032	0.277	0.00474	0.410
7	17/12/2020 20:12	28/01/2021 10:02	41.6	0.159	0.663	0.135	11.7	3.06	264

Table 6 Flow Monitoring Station – FM1BU North Wambo Creek – Summary of Results – 1 January to 31 December 2020.

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	9/02/2020 11:09	11/02/2020 19:09	2.33	0.130	0.225	0.207	17.9	0.522	45.1
2	3/04/2020 21:19	12/04/2020 7:49	8.44	0.0719	0.157	0.0719	6.21	0.262	22.7

Table 7 Flow Monitoring Station FM2 North Wambo Creek Mid Old Diversion – Summary of Results – 1 January to 31 December 2020.

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	20/01/2020 1:10	20/01/2020 1:50	0.03	0.0151	0.0398	0.00569	0.492	0.0176	1.52
2	8/02/2020 17:00	12/02/2020 15:00	3.92	0.171	0.547	0.340	29.4	1.77	153
3	13/02/2020 11:00	14/02/2020 14:50	1.16	0.0123	0.0584	0.00452	0.39	0.0318	2.74
4	17/02/2020 6:40	18/02/2020 14:20	1.32	0.0116	0.0351	0.00367	0.317	0.0146	1.26
5	15/02/2020 15:30	16/02/2020 17:40	1.09	0.0133	0.0362	0.00455	0.393	0.0153	1.32
6	19/02/2020 1:20	19/02/2020 14:20	0.54	0.0178	0.0546	0.00678	0.586	0.0285	2.47
7	5/03/2020 14:50	6/03/2020 9:30	0.78	0.00812	0.0241	0.00231	0.199	0.00853	0.737
8	6/03/2020 20:30	7/03/2020 15:50	0.81	0.00756	0.0338	0.00217	0.188	0.0138	1.19
9	25/03/2020 12:10	25/03/2020 16:40	0.19	0.00925	0.0446	0.00294	0.254	0.0208	1.80
10	26/03/2020 3:30	29/03/2020 1:40	2.92	0.0186	0.195	0.0108	0.935	0.253	21.9
11	30/03/2020 10:00	31/03/2020 5:30	0.81	0.00633	0.0132	0.00171	0.148	0.0039	0.337
12	3/04/2020 15:20	8/04/2020 19:50	5.19	0.082	0.228	0.0883	7.63	0.338	29.2
13	10/04/2020 12:50	11/04/2020 13:50	1.04	0.00797	0.0113	0.00217	0.187	0.00323	0.279
14	26/07/2020 16:10	1/08/2020 0:20	5.34	0.0195	0.0926	0.00778	0.672	0.0678	5.86
15	10/08/2020 5:40	16/08/2020 11:30	6.24	0.0132	0.143	0.00526	0.454	0.145	12.5
16	24/10/2020 14:40	2/11/2020 9:30	8.78	0.0243	0.120	0.0103	0.889	0.106	9.16
17	13/11/2020 14:40	14/11/2020 17:20	1.11	0.0234	0.092	0.0103	0.893	0.0671	5.80
18	21/12/2020 17:50	24/12/2020 19:20	3.06	0.0253	0.154	0.0131	1.13	0.166	14.3
19	28/12/2020 18:50	11/01/2021 5:40	13.4	0.100	0.532	0.176	15.2	1.67	145

Table 8 Flow Monitoring Station FM2BU North Wambo Creek Mid Old Diversion – Summary of Results – 4 August to 31 December 2020.

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	10/08/2020 5:07	16/08/2020 18:37	6.56	0.0194	0.157	0.00788	0.681	0.171	14.8
2	24/10/2020 14:17	2/11/2020 17:47	9.15	0.0274	0.124	0.0120	1.03	0.112	9.69
3	13/11/2020 15:07	14/11/2020 22:17	1.30	0.0254	0.103	0.0115	0.994	0.0806	6.97
4	21/12/2020 18:17	24/12/2020 20:57	3.11	0.0257	0.159	0.0135	1.16	0.174	15.0
5	28/12/2020 19:17	11/01/2021 5:27	13.4	0.0999	0.55	0.177	15.3	1.79	154

Table 9 Flow Monitoring Station FM3 North Wambo Creek Mid New Diversion – Summary of Results – 1 January to 31 December 2020.

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	20/01/2020 1:20	20/01/2020 2:00	0.03	0.0252	0.0490	0.0138	1.20	0.0292	2.52
2	7/02/2020 7:50	7/02/2020 8:30	0.03	0.00731	0.00991	0.0032	0.277	0.00441	0.381
3	8/02/2020 17:40	8/02/2020 18:20	0.03	0.00627	0.00942	0.00273	0.236	0.00417	0.361
4	8/02/2020 20:20	8/02/2020 22:20	0.08	0.0251	0.0668	0.0146	1.26	0.0453	3.91
5	9/02/2020 2:40	9/02/2020 3:10	0.02	0.0016	0.00269	0.000671	0.0579	0.00114	0.0981
6	9/02/2020 4:50	11/02/2020 6:30	2.07	0.180	0.424	0.347	30.0	1.46	126
7	15/02/2020 15:40	15/02/2020 16:30	0.03	0.0371	0.0926	0.0249	2.15	0.0748	6.47
8	10/08/2020 9:00	10/08/2020 10:40	0.07	0.0245	0.0429	0.0129	1.12	0.0244	2.11
9	12/08/2020 19:30	12/08/2020 20:00	0.02	0.0128	0.0232	0.00611	0.528	0.0114	0.988
10	24/10/2020 13:30	24/10/2020 15:50	0.10	0.0114	0.0208	0.00523	0.452	0.0101	0.868
11	24/10/2020 18:50	24/10/2020 19:40	0.03	0.0157	0.0259	0.00752	0.65	0.013	1.12
12	25/10/2020 16:10	25/10/2020 17:10	0.04	0.0142	0.0243	0.00675	0.583	0.0121	1.04
13	28/10/2020 8:50	28/10/2020 9:20	0.02	0.00123	0.00197	0.000514	0.0444	0.000824	0.0712
14	28/10/2020 11:10	28/10/2020 12:10	0.04	0.0112	0.0182	0.00513	0.443	0.00861	0.744
15	29/10/2020 15:30	29/10/2020 16:20	0.03	0.0113	0.0229	0.00531	0.458	0.0112	0.971
16	13/11/2020 15:00	13/11/2020 16:40	0.07	0.0414	0.0855	0.0268	2.31	0.066	5.7
17	17/12/2020 19:50	17/12/2020 20:20	0.02	0.00292	0.00512	0.00124	0.108	0.0022	0.19
18	18/12/2020 21:30	18/12/2020 22:30	0.04	0.00897	0.0155	0.00407	0.352	0.00718	0.62
19	21/12/2020 21:40	22/12/2020 2:00	0.18	0.0301	0.0495	0.0168	1.45	0.0296	2.56
20	28/12/2020 19:00	29/12/2020 1:00	0.25	0.0398	0.149	0.0291	2.52	0.17	14.7

Table 10 Flow Monitoring Station FM3BU North Wambo Creek Mid New Diversion – Summary of Results – 4 August to 31 December 2020.

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	10/08/2020 5:19	10/08/2020 6:39	0.06	0.0136	0.0296	0.00644	0.556	0.0153	1.32
2	10/08/2020 7:59	10/08/2020 11:39	0.15	0.0331	0.0743	0.020	1.73	0.0531	4.58
3	12/08/2020 18:39	12/08/2020 20:19	0.07	0.021	0.0476	0.0112	0.967	0.0281	2.43
4	24/10/2020 13:19	24/10/2020 17:09	0.16	0.0263	0.0489	0.014	1.21	0.0291	2.52
5	24/10/2020 18:39	24/10/2020 21:19	0.11	0.0245	0.0561	0.0134	1.15	0.0353	3.05
6	25/10/2020 16:19	25/10/2020 18:19	0.08	0.0231	0.0468	0.0122	1.06	0.0274	2.37
7	26/10/2020 9:09	26/10/2020 10:19	0.05	0.00707	0.0113	0.00311	0.269	0.00507	0.438
8	28/10/2020 8:49	28/10/2020 13:49	0.21	0.0165	0.04	0.00815	0.704	0.0223	1.93
9	29/10/2020 15:39	29/10/2020 17:19	0.07	0.0219	0.0541	0.0118	1.02	0.0335	2.89
10	13/11/2020 15:09	13/11/2020 18:19	0.13	0.0512	0.117	0.0372	3.21	0.111	9.55
11	15/12/2020 9:59	15/12/2020 20:09	0.42	0.0273	0.0634	0.0149	1.29	0.0419	3.62
12	16/12/2020 8:59	16/12/2020 16:59	0.33	0.0266	0.0563	0.0142	1.23	0.0354	3.06
13	17/12/2020 11:59	17/12/2020 13:39	0.07	0.0172	0.0263	0.00823	0.711	0.0132	1.14
14	17/12/2020 14:59	17/12/2020 15:49	0.03	0.0148	0.0301	0.00707	0.61	0.0156	1.35
15	17/12/2020 19:39	17/12/2020 21:19	0.07	0.0222	0.0361	0.0112	0.967	0.0195	1.69
16	18/12/2020 21:39	18/12/2020 23:29	0.08	0.0237	0.0425	0.0124	1.07	0.0241	2.09
17	21/12/2020 18:19	22/12/2020 4:29	0.42	0.0332	0.0804	0.0201	1.74	0.0599	5.18
18	28/12/2020 19:19	29/12/2020 17:39	0.93	0.0712	0.193	0.0617	5.33	0.280	24.2
19	30/12/2020 11:39	30/12/2020 14:59	0.14	0.0508	0.0776	0.033	2.85	0.0567	4.90

Table 11 Flow Monitoring Station FM4 North Wambo Creek upstream of the confluence of Wollombi Brook – Summary of Results – 1 January to 31 December 2020.

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	9/02/2020 10:50	11/02/2020 12:40	2.08	0.165	0.42	0.614	53.1	1.84	159

Table 12 Flow Monitoring Station FM4BU North Wambo Creek upstream of the confluence of Wollombi Brook – Summary of Results – 1 January to 31 December 2020.

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	9/02/2020 10:25	11/02/2020 20:49	2.43	0.157	0.423	0.577	49.9	1.86	160

Table 13 Flow Monitoring Station FM15 South Wambo Creek upstream of the confluence of Wollombi Brook – Summary of Results – 1 January to 31 December 2020.

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	9/02/2020 10:00	14/02/2020 17:10	5.30	0.243	0.855	7.40	639	65.2	5640
2	18/02/2020 2:00	19/02/2020 4:10	1.09	0.0594	0.139	0.156	13.5	0.970	83.8
3	19/02/2020 19:10	20/02/2020 1:00	0.24	0.0138	0.0263	0.00113	0.0977	0.00394	0.340
4	20/02/2020 2:20	21/02/2020 5:40	1.14	0.169	0.332	2.77	239	8.64	747
5	26/03/2020 10:30	14/04/2020 13:10	19.1	0.0859	0.319	0.616	53.2	7.71	666
6	28/07/2020 3:10	3/08/2020 12:00	6.37	0.611	1.32	49.6	4280	155	13400
7	10/08/2020 11:20	10/08/2020 12:50	0.06	0.0064	0.0139	0.00013	0.0112	0.000603	0.0521
8	11/08/2020 15:20	16/08/2020 15:50	5.02	0.111	0.214	0.981	84.7	3.03	261
9	28/12/2020 23:30	29/12/2020 1:50	0.10	0.00640	0.0140	0.000123	0.0107	0.000617	0.0533
10	31/12/2020 1:50	1/01/2021 18:40	1.70	0.0201	0.0464	0.00429	0.371	0.0289	2.50

Table 14 Flow Monitoring Station FM16 South Wambo Creek upstream of the washout of Wambo Mine Road – Summary of Results – 1 January to 31 December 2020.

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	9/02/2020 12:14	15/02/2020 11:34	5.97	0.184	0.857	10.1	874	248	21400
2	15/02/2020 15:54	16/02/2020 8:24	0.69	0.00471	0.0122	0.00441	0.381	0.01	0.864
3	16/02/2020 17:44	16/02/2020 19:04	0.06	0.00248	0.00371	0.00249	0.215	0.00365	0.315
4	16/02/2020 20:14	16/02/2020 22:24	0.09	0.00152	0.0033	0.00156	0.135	0.00328	0.283
5	17/02/2020 7:14	17/02/2020 12:24	0.22	0.00315	0.00758	0.00306	0.264	0.00688	0.594
6	19/02/2020 1:44	19/02/2020 4:14	0.10	0.00525	0.015	0.00476	0.411	0.0116	1
7	8/03/2020 12:44	14/03/2020 7:04	5.76	0.0389	0.0773	0.0179	1.54	0.0351	3.04
8	14/03/2020 14:54	14/03/2020 16:44	0.08	0.00255	0.00462	0.00255	0.220	0.00447	0.386
9	14/03/2020 18:24	15/03/2020 0:14	0.24	0.00415	0.0125	0.00384	0.331	0.0102	0.880
10	15/03/2020 13:54	16/03/2020 6:14	0.68	0.00547	0.0214	0.00472	0.408	0.0143	1.24
11	16/03/2020 9:44	16/03/2020 22:34	0.53	0.00686	0.0254	0.00561	0.485	0.0156	1.35
12	17/03/2020 11:54	18/03/2020 21:54	1.42	0.010	0.034	0.0077	0.665	0.0175	1.52
13	19/03/2020 15:44	20/03/2020 5:34	0.58	0.0073	0.019	0.00628	0.543	0.0134	1.16
14	20/03/2020 12:14	20/03/2020 16:34	0.18	0.00695	0.0225	0.00577	0.499	0.0147	1.27
15	20/03/2020 18:14	20/03/2020 19:34	0.06	0.00187	0.00462	0.00187	0.161	0.00447	0.386
16	21/03/2020 14:14	21/03/2020 16:04	0.08	0.0082	0.0285	0.00634	0.547	0.0164	1.42
17	21/03/2020 19:24	21/03/2020 21:54	0.10	0.00156	0.00534	0.00157	0.136	0.00508	0.439
18	22/03/2020 14:44	12/05/2020 1:44	50.5	0.0956	0.389	0.428	37.0	12.6	1090
19	12/05/2020 8:34	2/06/2020 3:44	20.8	0.0111	0.0288	0.00904	0.781	0.0165	1.43
20	2/06/2020 8:54	2/06/2020 17:54	0.38	0.00309	0.00942	0.00299	0.258	0.00821	0.710
21	2/06/2020 18:54	2/06/2020 19:54	0.04	0.00507	0.0105	0.00463	0.400	0.00897	0.775
22	31/07/2020 13:04	17/09/2020 10:04	47.9	0.0375	0.0975	0.0183	1.58	0.0681	5.89
23	17/09/2020 16:34	19/09/2020 10:04	1.73	0.00605	0.0159	0.0055	0.475	0.0121	1.04
24	19/09/2020 15:24	21/09/2020 11:24	1.83	0.00722	0.0181	0.00636	0.549	0.0131	1.13

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
25	21/09/2020 15:14	22/09/2020 9:54	0.78	0.00544	0.0137	0.00496	0.429	0.0109	0.940
26	22/09/2020 17:14	23/09/2020 10:04	0.70	0.00384	0.0156	0.00355	0.307	0.0119	1.03
27	23/09/2020 17:34	24/09/2020 0:44	0.30	0.00249	0.00768	0.00244	0.211	0.00695	0.601
28	24/09/2020 18:14	24/09/2020 22:04	0.16	0.00251	0.00799	0.00247	0.213	0.00718	0.621
29	25/09/2020 17:04	26/09/2020 2:04	0.38	0.00313	0.00779	0.00303	0.261	0.00703	0.608
30	26/09/2020 17:24	26/09/2020 23:54	0.27	0.00212	0.00513	0.00213	0.184	0.00491	0.424
31	27/09/2020 17:54	28/09/2020 2:04	0.34	0.00225	0.00605	0.00224	0.193	0.00567	0.490
32	28/09/2020 17:44	28/09/2020 22:24	0.19	0.00260	0.00728	0.00256	0.221	0.00664	0.574
33	28/09/2020 22:54	28/09/2020 23:54	0.04	0.00223	0.00411	0.00224	0.193	0.00402	0.347
34	29/09/2020 0:44	29/09/2020 2:04	0.06	0.00245	0.00585	0.00241	0.209	0.0055	0.476
35	29/09/2020 18:44	30/09/2020 0:54	0.26	0.00187	0.00564	0.00187	0.162	0.00534	0.461
36	30/09/2020 16:14	1/10/2020 5:54	0.57	0.00218	0.00605	0.00218	0.188	0.00567	0.490
37	1/10/2020 18:24	2/10/2020 0:54	0.27	0.00282	0.00748	0.00277	0.239	0.0068	0.588
38	2/10/2020 16:44	3/10/2020 0:24	0.32	0.00314	0.00921	0.00305	0.263	0.00807	0.697
39	3/10/2020 18:14	4/10/2020 9:24	0.63	0.00460	0.0192	0.00416	0.360	0.0135	1.17
40	4/10/2020 19:44	5/10/2020 8:14	0.52	0.00398	0.0141	0.00371	0.320	0.0111	0.960
41	5/10/2020 21:04	6/10/2020 4:34	0.31	0.00349	0.0104	0.00336	0.290	0.0089	0.769
42	6/10/2020 19:24	6/10/2020 22:44	0.14	0.00277	0.00809	0.00271	0.234	0.00726	0.627
43	24/10/2020 21:54	25/10/2020 13:44	0.66	0.0440	0.0841	0.0202	1.74	0.0433	3.74
44	25/10/2020 14:34	26/10/2020 13:44	0.97	0.0992	0.142	0.120	10.4	0.273	23.6
45	26/10/2020 17:34	27/10/2020 11:34	0.75	0.0809	0.151	0.0996	8.61	0.346	29.9
46	27/10/2020 21:34	28/10/2020 14:14	0.69	0.0657	0.131	0.0515	4.45	0.198	17.1
47	28/10/2020 20:44	29/10/2020 11:24	0.61	0.0523	0.104	0.0284	2.45	0.0839	7.25
48	29/10/2020 15:44	30/10/2020 8:14	0.69	0.0413	0.136	0.0374	3.23	0.231	20.0
49	30/10/2020 19:24	31/10/2020 10:34	0.63	0.0768	0.136	0.0781	6.75	0.231	20.0
50	31/10/2020 19:34	1/11/2020 12:44	0.72	0.103	0.191	0.265	22.9	0.867	74.9
51	1/11/2020 21:54	2/11/2020 10:24	0.52	0.0716	0.134	0.0656	5.67	0.219	18.9
52	2/11/2020 21:44	3/11/2020 11:34	0.58	0.0865	0.161	0.141	12.2	0.45	38.9
53	3/11/2020 21:14	4/11/2020 10:14	0.54	0.0614	0.114	0.0421	3.64	0.118	10.2
54	13/11/2020 16:24	13/11/2020 18:34	0.09	0.00259	0.00707	0.00253	0.219	0.00649	0.560
55	22/12/2020 4:04	23/12/2020 11:34	1.31	0.0308	0.0908	0.0171	1.48	0.0542	4.68
56	23/12/2020 17:24	24/12/2020 11:34	0.76	0.00819	0.0159	0.00708	0.611	0.0121	1.04
57	24/12/2020 20:14	25/12/2020 9:54	0.57	0.00524	0.0124	0.00485	0.419	0.0101	0.874
58	25/12/2020 16:04	26/12/2020 8:54	0.70	0.00554	0.0108	0.00511	0.442	0.00917	0.792
59	26/12/2020 18:04	27/12/2020 10:34	0.69	0.00759	0.0158	0.00668	0.577	0.012	1.04
60	27/12/2020 19:14	28/12/2020 12:14	0.71	0.00598	0.0127	0.00542	0.468	0.0103	0.890
61	28/12/2020 18:04	29/01/2021 14:14	31.8	0.154	1.17	8.74	755	857	74000

Table 15 Flow Monitoring Station FM9 South Wambo Creek downstream – Summary of Results – 1 January to 31 December 2020.

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	9/02/2020 10:01	29/01/2021 12:41	355	0.186	2.01	0.265	22.9	38.5	3330

Table 16 Flow Monitoring Station FM12 Stony Creek upstream of the proposed area to be mined – Summary of Results – 1 January to 31 December 2020.

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	9/02/2020 8:33	2/03/2020 9:53	22.06	0.0502	0.677	0.149	12.9	8.12	702
2	2/03/2020 16:33	4/03/2020 13:23	1.87	0.00412	0.0117	0.00513	0.443	0.0145	1.26
3	4/03/2020 15:33	6/03/2020 11:03	1.81	0.00524	0.0193	0.00652	0.563	0.0242	2.09
4	6/03/2020 14:53	18/03/2020 11:33	11.86	0.0151	0.0405	0.0189	1.63	0.0525	4.54
5	18/03/2020 15:33	19/03/2020 11:03	0.81	0.00475	0.00955	0.00591	0.511	0.0119	1.03
6	19/03/2020 16:43	20/03/2020 10:33	0.74	0.00448	0.0118	0.00558	0.482	0.0147	1.27
7	20/03/2020 18:43	21/03/2020 9:23	0.61	0.00399	0.0108	0.00496	0.429	0.0134	1.16
8	21/03/2020 19:13	21/03/2020 22:53	0.15	0.00218	0.00649	0.00271	0.234	0.00807	0.697
9	22/03/2020 2:33	22/03/2020 10:23	0.33	0.0019	0.00486	0.00236	0.204	0.00604	0.522
10	22/03/2020 17:53	22/03/2020 21:53	0.17	0.00236	0.00669	0.00294	0.254	0.00832	0.719
11	24/03/2020 0:33	24/03/2020 8:53	0.35	0.00163	0.00547	0.00203	0.175	0.0068	0.588
12	25/03/2020 0:23	25/03/2020 5:03	0.19	0.00175	0.00455	0.00219	0.189	0.00566	0.489
13	25/03/2020 12:33	25/03/2020 17:03	0.19	0.00381	0.0107	0.00474	0.409	0.0133	1.15
14	26/03/2020 2:53	23/04/2020 10:33	28.32	0.0533	0.312	0.0982	8.49	1.52	131
15	23/04/2020 14:23	24/04/2020 10:23	0.83	0.00378	0.00945	0.0047	0.406	0.0117	1.01
16	24/04/2020 15:43	25/04/2020 9:13	0.73	0.00286	0.00843	0.00356	0.308	0.0105	0.905
17	25/04/2020 16:53	26/04/2020 9:13	0.68	0.00286	0.007	0.00356	0.307	0.0087	0.752
18	26/04/2020 16:43	27/04/2020 3:23	0.44	0.00181	0.00598	0.00226	0.195	0.00744	0.643
19	28/04/2020 17:43	29/04/2020 8:43	0.63	0.00198	0.0073	0.00247	0.214	0.00908	0.785
20	29/04/2020 18:23	30/04/2020 5:13	0.45	0.00234	0.00537	0.00292	0.252	0.00668	0.577
21	30/04/2020 8:33	30/04/2020 19:23	0.45	0.00281	0.00822	0.0035	0.303	0.0102	0.883
22	10/08/2020 8:33	10/08/2020 11:13	0.11	0.00295	0.00883	0.00368	0.318	0.011	0.949
23	12/08/2020 18:53	12/08/2020 20:33	0.07	0.00185	0.00445	0.00231	0.199	0.00554	0.478
24	13/08/2020 2:13	20/08/2020 8:23	7.26	0.00655	0.0171	0.00815	0.704	0.0213	1.84
25	20/08/2020 14:43	21/08/2020 5:33	0.62	0.00236	0.00771	0.00294	0.254	0.00959	0.829
26	21/08/2020 18:43	21/08/2020 21:03	0.10	0.00253	0.00465	0.00315	0.272	0.00579	0.5
27	30/10/2020 14:23	3/11/2020 9:43	3.81	0.00938	0.0248	0.0117	1.01	0.0312	2.7
28	3/11/2020 15:03	4/11/2020 8:43	0.74	0.00324	0.0152	0.00404	0.349	0.0189	1.63
29	4/11/2020 19:33	6/11/2020 16:33	1.88	0.00351	0.0149	0.00437	0.378	0.0185	1.6
30	12/11/2020 0:33	12/11/2020 2:03	0.06	0.0031	0.00761	0.00386	0.333	0.00946	0.818
31	13/11/2020 1:33	13/11/2020 3:33	0.08	0.00199	0.00271	0.00248	0.214	0.00338	0.292
32	13/11/2020 14:33	14/11/2020 0:53	0.43	0.00594	0.018	0.00739	0.638	0.0225	1.94
33	16/11/2020 22:23	17/11/2020 8:23	0.42	0.00244	0.00659	0.00303	0.262	0.0082	0.708
34	17/11/2020 17:53	18/11/2020 9:33	0.65	0.00253	0.0073	0.00315	0.272	0.00908	0.785

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
35	18/11/2020 19:13	19/11/2020 8:43	0.56	0.00273	0.00751	0.00341	0.294	0.00934	0.807
36	19/11/2020 22:33	20/11/2020 7:03	0.35	0.00221	0.00506	0.00275	0.237	0.0063	0.544
37	21/11/2020 1:03	21/11/2020 7:13	0.26	0.00225	0.00547	0.0028	0.242	0.0068	0.588
38	21/11/2020 21:53	22/11/2020 2:53	0.21	0.00207	0.00496	0.00258	0.223	0.00617	0.533
39	22/11/2020 18:23	23/11/2020 4:03	0.40	0.00199	0.00404	0.00248	0.214	0.00503	0.435
40	1/12/2020 21:03	2/12/2020 0:03	0.13	0.00216	0.00792	0.00269	0.233	0.00985	0.851
41	2/12/2020 2:53	2/12/2020 7:13	0.18	0.00193	0.00506	0.0024	0.207	0.0063	0.544
42	5/12/2020 22:33	6/12/2020 0:13	0.07	0.00284	0.00639	0.00354	0.305	0.00794	0.686
43	21/12/2020 21:53	22/12/2020 7:43	0.41	0.00515	0.0139	0.00641	0.554	0.0173	1.5
44	22/12/2020 16:33	25/12/2020 13:03	2.85	0.0113	0.0321	0.0141	1.22	0.0409	3.53
45	25/12/2020 15:43	25/12/2020 18:03	0.10	0.00225	0.00822	0.0028	0.242	0.0102	0.883
46	25/12/2020 19:13	26/12/2020 1:53	0.28	0.00237	0.00547	0.00295	0.255	0.0068	0.588
47	26/12/2020 3:33	26/12/2020 7:43	0.17	0.00122	0.00363	0.00152	0.131	0.00452	0.391
48	26/12/2020 20:23	27/12/2020 1:33	0.22	0.00263	0.00649	0.00328	0.283	0.00807	0.697
49	28/12/2020 19:23	17/01/2021 11:03	19.65	0.0818	1.08	0.364	31.4	19.7	1700

Table 17 Flow Monitoring Station FM14 Major tributary of Stony Creek upstream of the proposed area to be mined – Summary of Results – 1 January to 31 December 2020.

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	9/02/2020 9:58	29/02/2020 15:58	20.25	0.0606	0.259	0.00684	0.591	0.281	24.3
2	29/02/2020 18:08	1/03/2020 9:08	0.63	0.00414	0.00983	0.0000321	0.00277	0.0000552	0.00477
3	1/03/2020 18:28	1/03/2020 23:18	0.20	0.00225	0.00698	0.0000198	0.00171	0.0000476	0.00411
4	2/03/2020 2:28	2/03/2020 7:18	0.20	0.00272	0.00657	0.0000233	0.00201	0.000046	0.00398
5	5/03/2020 14:58	6/03/2020 2:48	0.49	0.00698	0.0174	0.0000434	0.00375	0.0000652	0.00563
6	6/03/2020 20:48	7/03/2020 7:58	0.47	0.0029	0.00942	0.0000236	0.00204	0.0000543	0.0047
7	9/03/2020 0:18	21/03/2020 12:58	12.53	0.0277	0.0493	0.000208	0.018	0.00088	0.0761
8	21/03/2020 18:58	22/03/2020 8:48	0.58	0.00261	0.00728	0.0000225	0.00194	0.0000486	0.0042
9	26/03/2020 3:38	23/04/2020 11:18	28.32	0.0625	0.261	0.00702	0.606	0.288	24.9
10	23/04/2020 13:48	24/04/2020 10:18	0.85	0.00445	0.0106	0.0000332	0.00287	0.0000566	0.00489
11	24/04/2020 18:38	25/04/2020 1:58	0.31	0.00229	0.00524	0.0000205	0.00177	0.0000403	0.00348
12	25/04/2020 3:08	25/04/2020 4:48	0.07	0.0016	0.00432	0.0000149	0.00128	0.0000354	0.00306

Table 18 Flow Monitoring Station FM13 Stony Creek downstream of the proposed area to be mined – Summary of Results – 1 January to 31 December 2020.

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	9/02/2020 12:07	12/02/2020 10:27	2.93	0.0906	0.289	0.117	10.1	1.2	103
2	26/03/2020 3:37	22/04/2020 17:07	27.56	0.0383	0.185	0.0453	3.91	0.274	23.6
3	22/04/2020 19:17	23/04/2020 11:57	0.69	0.00852	0.0197	0.0219	1.89	0.0423	3.65
4	23/04/2020 13:27	23/04/2020 16:47	0.14	0.007	0.0155	0.0188	1.62	0.0362	3.13
5	23/04/2020 17:47	24/04/2020 10:07	0.68	0.00848	0.019	0.0219	1.89	0.0413	3.57
6	24/04/2020 13:17	25/04/2020 12:17	0.96	0.00669	0.0219	0.0174	1.5	0.045	3.89
7	25/04/2020 15:27	27/04/2020 1:47	1.43	0.00858	0.0216	0.0217	1.87	0.0447	3.86
8	27/04/2020 2:47	27/04/2020 8:17	0.23	0.00668	0.0141	0.018	1.55	0.0338	2.92
9	27/04/2020 9:37	28/04/2020 7:57	0.93	0.00736	0.0197	0.0192	1.66	0.0423	3.65
10	28/04/2020 9:27	28/04/2020 12:07	0.11	0.00338	0.00968	0.00955	0.825	0.0253	2.19
11	28/04/2020 13:27	8/05/2020 9:47	9.85	0.00885	0.0324	0.0223	1.93	0.0535	4.63
12	8/05/2020 12:17	9/05/2020 9:57	0.90	0.00726	0.0182	0.019	1.64	0.0402	3.47
13	9/05/2020 12:27	10/05/2020 17:07	1.19	0.00898	0.0215	0.0228	1.97	0.0445	3.85
14	10/05/2020 19:37	11/05/2020 2:57	0.31	0.00818	0.0219	0.0204	1.76	0.045	3.89
15	11/05/2020 7:57	11/05/2020 17:37	0.40	0.00863	0.0226	0.0217	1.88	0.0458	3.96
16	11/05/2020 21:27	12/05/2020 17:07	0.82	0.00639	0.0195	0.0169	1.46	0.042	3.63
17	12/05/2020 20:37	22/05/2020 10:57	9.60	0.00862	0.0273	0.0219	1.9	0.0502	4.34
18	22/05/2020 12:27	23/05/2020 6:57	0.77	0.00591	0.0179	0.016	1.38	0.0399	3.45
19	23/05/2020 8:57	24/05/2020 23:07	1.59	0.0075	0.0261	0.0194	1.68	0.0492	4.25
20	25/05/2020 0:07	25/05/2020 2:17	0.09	0.00509	0.011	0.0141	1.22	0.0281	2.42
21	25/05/2020 3:17	25/05/2020 5:47	0.10	0.00475	0.0123	0.0133	1.15	0.0306	2.65
22	25/05/2020 6:57	26/05/2020 8:57	1.08	0.00573	0.0157	0.0155	1.34	0.0365	3.16
23	26/05/2020 14:57	27/05/2020 10:57	0.83	0.00596	0.0189	0.016	1.38	0.0412	3.56
24	27/05/2020 12:57	28/05/2020 11:07	0.92	0.00675	0.0204	0.0177	1.53	0.0432	3.73
25	28/05/2020 13:17	29/05/2020 6:17	0.71	0.00618	0.0196	0.0165	1.43	0.0421	3.64
26	29/05/2020 7:57	1/06/2020 9:57	3.08	0.00709	0.0255	0.0184	1.59	0.0487	4.2
27	1/06/2020 12:47	1/06/2020 20:57	0.34	0.00595	0.0156	0.0161	1.39	0.0364	3.14
28	2/06/2020 8:07	2/06/2020 18:47	0.44	0.00737	0.0152	0.0195	1.68	0.0357	3.08
29	3/06/2020 7:47	3/06/2020 12:57	0.22	0.00428	0.0177	0.0116	1	0.0396	3.42
30	3/06/2020 14:27	3/06/2020 16:47	0.10	0.00663	0.0187	0.0171	1.48	0.0409	3.54
31	4/06/2020 2:37	4/06/2020 3:57	0.06	0.00596	0.00907	0.0163	1.41	0.024	2.07
32	4/06/2020 5:27	4/06/2020 8:37	0.13	0.00378	0.00744	0.0108	0.934	0.0203	1.75
33	4/06/2020 11:47	4/06/2020 13:37	0.08	0.00283	0.00469	0.00838	0.724	0.0135	1.16
34	5/06/2020 3:47	5/06/2020 4:47	0.04	0.00266	0.00438	0.0079	0.682	0.0127	1.09
35	5/06/2020 10:57	5/06/2020 16:37	0.24	0.0045	0.0119	0.0125	1.08	0.0299	2.58
36	5/06/2020 22:57	6/06/2020 1:07	0.09	0.00505	0.0111	0.014	1.21	0.0283	2.44
37	6/06/2020 8:27	6/06/2020 16:27	0.33	0.00377	0.00999	0.0108	0.931	0.026	2.24
38	6/06/2020 21:17	7/06/2020 1:57	0.19	0.00374	0.00846	0.0106	0.917	0.0226	1.96
39	7/06/2020 8:17	7/06/2020 18:07	0.41	0.0062	0.0235	0.0162	1.4	0.0467	4.03
40	9/06/2020 19:37	9/06/2020 21:47	0.09	0.00525	0.0108	0.0146	1.26	0.0277	2.39
41	10/06/2020 14:07	11/06/2020 1:47	0.49	0.00481	0.0153	0.0132	1.14	0.0359	3.1
42	11/06/2020 4:47	11/06/2020 5:47	0.04	0.00292	0.00754	0.00835	0.722	0.0205	1.78

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
43	11/06/2020 14:47	11/06/2020 18:37	0.16	0.0044	0.0137	0.0123	1.06	0.0331	2.86
44	11/06/2020 20:07	11/06/2020 22:57	0.12	0.00311	0.0104	0.00883	0.763	0.0268	2.32
45	12/06/2020 15:27	12/06/2020 17:07	0.07	0.00313	0.00642	0.0091	0.787	0.0179	1.54

A summary of total monthly rain fall data presented in **Table 19** below was derived from the Wambo Coal's Meteorological Station located next to the helicopter pad near the Mine Infrastructure Area.

Table 19 Monthly Total Rain Fall Data – 1 January to 31 December 2020.

Month	Wambo Coal's Meteorological Station Total Rain Fall (mm)	Number of Days Rain Fell in the Month
January	45.4	11
February	179.4	16
March	110.0	15
April	58.0	6
May	10.4	9
June	40.2	11
July	71.6	11
August	43.6	10
September	40.6	11
October	102.0	12
November	56.4	10
December	209.0	18

The daily rain fall data was used to cross reference the raw data collected from the Flow Monitoring Stations to help identify periods where a flow event may have occurred.

Appendix C contains, where theoretical flow events were recognised, annual graphical depictions of stream height and theoretical flow in conjunction with daily and cumulative rainfall.

The results presented in the above tables should be read with the following qualifying statements in mind: -

- All flow events represent a theoretical flow and have been derived from stream height data. The stream height data was then applied to polynomial equations derived from theoretical flow rating curves to give a theoretical flow. These theoretical flow rating curves were generated using cross and long section surveys in conjunction with the Manning's equation. These theoretical flow rating curves were constructed by AECOM in 2019 on data provided by Environmental Instrument Solutions;
- North Wambo, South Wambo and Stony Creeks are ephemeral and as such only flow after significant rainfall events, therefore the theoretical flow rating curves in **Appendix B** have not been calibrated/checked against actual physical measurements of flow using a current meter;
- Some flow events may have been overlooked due to, but not limited to, poor data quality, data missing, inconsistent data, sensor failure or loss, logger failure, power supply problems and changes to stream bed characteristics, and;

- The three flow monitoring stations installed on Stony Creek and its associated tributary have been positioned such as to be outside a proposed underground mine area and designed to monitor stream flow and any associated effect of underground mining on stream flow. These stations were installed by AECOM on 7 December 2016 and replace flow monitoring stations 7 and 8.

4.0 Recommendations

During the period 1 January to 31 December 2020 no issues were encountered with the stream monitoring network.

Due to the failure of the Barometric correction sensor associated the absolute pressure sensor along North Wambo Creek resulting in unusable data from October 2018 to 24 January 2020 AECOM recommends that the percentage battery used in the remaining Insitu sensors at the flow stations along Stony and South Wambo Creek be closely monitored. Once the percentage battery used is great than 50% and as delivery lead times are unpredictable (estimated 4 to 6 weeks) consideration should be given to obtaining replacement loggers.

If you have any questions or require any clarification of aspects in this report, please contact us in the Singleton office.

Yours faithfully

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encl: Appendix A - Flow Station Field Sheets and Station Data Logger Status Sheets.
Appendix B - Theoretical Flow Rating Curves.
Appendix C - Stream Height, Theoretical Flow, Daily and Cumulative Rainfall Charts.

Addendum: Comparison of Flow Monitoring Data with the Surface Water Monitoring Plan (SWMPV2)

SWMPV2 states:

"Flow impact assessment criteria for the local mine site ephemeral creeks are based on the unexpected absence of flow in climatic situations when flows would be expected. The impact assessment criteria would be met if there was no flow recorded at the flow monitoring site either on the day or the day after the recorded rainfall was equal to or greater than the nominated amount. The resulting runoff generating rainfall values are given in Table 14" of the SWMPV2 which has been reproduced as **Table 20** below.

Table 20 Surface Water Flow Impact Assessment Condition

Watercourse and flow monitoring site	Daily rainfall when flow commenced on 80% of recorded occasions
North Wambo Creek – FM4*	20mm
North Wambo Creek – FM1*	100mm
South Wambo Creek – FM15	20mm
Stony Creek – FM13	20mm

*Revised Wambo SWMP V2 (approved 20 November 2020) removed North Wambo Creek performance indicator of 20mm at location FM4 replacing with performance indicator of 100mm at location FM1 effective 21 November 2020.

Table 21 below lists the dates from 1 January to 31 December 2020 when 20mm or greater of rainfall was recorded at the Wambo Coal's Meteorological Station located next to the helicopter pad near the Mine Infrastructure Area and corresponding flow events, if any, at flow monitoring sites FM4, FM15 and FM13. In regard to site FM1, there were no events of accumulated rainfall greater than 100mm from 20 November to 31 December 2020. The maximum continuous rainfall events after 20 November 2020 were 83mm from 14 to 19 December and 60mm from 26 to 31 December.

Table 21 Dates of Rainfall Greater than 20mm and Corresponding Flow Events

<table>
<tr><th>Date</th><th>24 hour Rainfall (mm)</th><th>Site FM4</th><th>Site FM15</th><th>Site FM13</th></tr>
<tr><td>6/02/2020</td><td>21.4</td><td>No flow event</td><td>No flow event</td><td>No flow event</td></tr>
<tr><td>8/02/2020</td><td>33.0</td><td>No flow event</td><td>No flow event</td><td>No flow event</td></tr>
<tr><td>9/02/2020</td><td>57.6</td><td>Flow event 9/02/2020 10:50 to 11/02/2020 12:40</td><td>Flow event 9/02/2020 12:07 to 12/02/2020 10:27</td><td>Flow event 9/02/2020 10:00 to 14/02/2020 4:10</td></tr>
<tr><td>5/03/2020</td><td>31.0</td><td>No flow event</td><td>No flow event</td><td>No flow event</td></tr>
<tr><td>26/03/2020</td><td>26.6</td><td>No flow event</td><td rowspan="2">Flow event 26/03/2020 3:37 to 22/04/2020 17:07</td><td rowspan="2">Flow event 26/03/2020 10:30 to 14/04/2020 13:10</td></tr>
<tr><td>3/04/2020</td><td>20.0</td><td>No flow event</td></tr>
<tr><td>26/07/2020</td><td>37.6</td><td>No flow event</td><td>No flow event</td><td>No flow event</td></tr>
<tr><td>10/08/2020</td><td>20.2</td><td>No flow event</td><td>No flow event</td><td>Flow event 10/08/2020 11:20 to 10/08/2020 12:50</td></tr>
<tr><td>24/10/2020</td><td>45.6</td><td>No flow event</td><td>No flow event</td><td>No flow event</td></tr>
<tr><td>13/11/2020</td><td>42.6</td><td>No flow event</td><td>No flow event</td><td>No flow event</td></tr>
<tr><td>15/12/2020</td><td>28.8</td><td>*</td><td>No flow event</td><td>No flow event</td></tr>
<tr><td>17/12/2020</td><td>27.4</td><td>*</td><td>No flow event</td><td>No flow event</td></tr>
<tr><td>21/12/2020</td><td>34.6</td><td>*</td><td>No flow event</td><td>No flow event</td></tr>
<tr><td>28/12/2020</td><td>36.4</td><td>*</td><td>No flow event</td><td>Flow event 28/12/2020 23:30 to 29/12/2020 1:50</td></tr>
</table>

*Not applicable from 21 November 2020

Appendix A

Flow Station Field Sheets & Data Logger Status Sheets

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27/7/2020 810 North Wambo Creek Only Required ✓.

60245356 - Wambo Coal - Quarterly Flow Station Field Sheet

Flow Station No	Location (Creek)	Date	Time	Logger Type	Solar Panel Output (V)	Battery (V)	Solar Panel Cleaned	Battery Replaced	Memory Used (%)	Battery Used (%)	Data Collected	Sensor Operating	Logger Operating	Stream Observations	Height of Water Above Sensor (mm)	Comments
Upstream old FM1	North Wambo	27/7/20	948	RuggedTroll	-	-	-	-	98%	17%	Y	Y	Y	Flow	0-5 230 mm	Data wrap on
Old FM1	North Wambo	27/7/20	1012	RuggedTroll	-	-	-	-	50	2	✓	✓	Y	Dry	0	Data wrap on New logger
FM1 New Location	North Wambo	27/7/20	1025	CS-CR800	NA	13.38	NO	No	-	-	Y	Y	Y	Dry	0	
FM1 New Location BU	North Wambo	27/7/20	1035	RuggedTroll	-	-	-	-	53	17	Y	Y	Y	Dry	0	Data wrap on New logger
FM2	North Wambo	27/7/20	1050	CS-CR200	NA	13.45	NO	No	-	-	Y	Y	Y	Wet	0	All sensor OK
BaroLogger NWC	North Wambo	27/7/20	1045	BaroTroll	-	-	-	-	50	9	Y	Y	Y	-	-	Data wrap on New barologger
FM3	North Wambo	27/7/20	911	CS-CR200	NA	13.45	NO	No	-	-	Y	Y	Y	Dry	0 ✓	Pool at level of sensor.
FM4	North Wambo	27/7/20	535	CS-CR200	NA	13.45	NO	No	-	-	Y	Y	Y	Dry	0	
FM4 BU	North Wambo	27/7/20	555	RuggedTroll	-	-	-	-	9	8	Y	Y	Y	Dry	0	Data wrap on New logger
FM12 SCUP	Stoney			RuggedTroll	-	-	-	-							0	Data wrap on
FM14 SCtrib	Stoney Ck Tributary			RuggedTroll	-	-	-	-							0	Data wrap on
Stoney Ck Up Barro	Stoney			BaroTroll	-	-	-	-						-	-	Data wrap on
FM13 SCDown	Stoney			RuggedTroll	-	-	-	-							0	Data wrap on
Stoney Ck Down Barro	Stoney			BaroTroll	-	-	-	-						-	-	Data wrap on
FM9 Bressi	South Wambo			RuggedTroll	-	-	-	-							0	Data wrap on
FM15 (FM6)	South Wambo			RuggedTroll	-	-	-	-							0	Data wrap on
FM16 (FM8)	South Wambo			RuggedTroll	-	-	-	-							0	Data wrap on
Barro Logger SWC	South Wambo			BaroTroll	-	-	-	-						-	-	Data wrap on
Upstream old FM1	North Wambo			RuggedTroll	-	-	-	-							0	Data wrap on
Old FM1	North Wambo			RuggedTroll	-	-	-	-							0	Data wrap on
FM1 New Location	North Wambo			CS-CR800					-	-					0	
FM1 New Location BU	North Wambo			RuggedTroll	-	-	-	-							0	Data wrap on
FM2	North Wambo			CS-CR200					-	-					0	
BaroLogger NWC	North Wambo			BaroTroll	-	-	-	-						-	-	Data wrap on
FM3	North Wambo			CS-CR200					-	-					0	
FM4	North Wambo			CS-CR200					-	-					0	
FM4 BU	North Wambo			RuggedTroll	-	-	-	-							0	Data wrap on
FM12 SCUP	Stoney			RuggedTroll	-	-	-	-							0	Data wrap on
FM14 SCtrib	Stoney Ck Tributary			RuggedTroll	-	-	-	-							0	Data wrap on
Stoney Ck Up Barro	Stoney			BaroTroll	-	-	-	-						-	-	Data wrap on
FM13 SCDown	Stoney			RuggedTroll	-	-	-	-							0	Data wrap on
Stoney Ck Down Barro	Stoney			BaroTroll	-	-	-	-						-	-	Data wrap on
FM9 Bressi	South Wambo			RuggedTroll	-	-	-	-							0	Data wrap on
FM15 (FM6)	South Wambo			RuggedTroll	-	-	-	-							0	Data wrap on
FM16 (FM8)	South Wambo			RuggedTroll	-	-	-	-							0	Data wrap on
Barro Logger SWC	South Wambo			BaroTroll	-	-	-	-						-	-	Data wrap on

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60245365 - Wambo Coal - Quarterly Flow Station Field Sheet

Flow Station No.	Location (Creek)	Date	Time	Logger Type	Solar Panel Output (V)	Battery (V)	Solar Panel Cleaned	Battery Replaced	Memory Used (%)	Battery Used (%)	Data Collected	Sensor Operating	Logger Operating	Stream Observations	Height of Water Above Sensor (mm)	Comments
Upstream old FM1	North Wambo	29-04-20	1310	RuggedTroll	-	-	-	-	100%	19%	Yes	Yes	Yes	Flowing	0.225	Data wrap on
Old FM1	North Wambo	29-04-20	1335	RuggedTroll	-	-	-	-	56%	10%	Yes	Yes	Yes	Pool	0.28[illegible]	Data wrap on New logger
FM1 New Location	North Wambo	29-04-20	1410	CS-CR800	20.40	9.89	Yes	No	-	-	Yes	Yes	Yes	DRY	0	Possible battery failure
FM1 New Location BU	North Wambo	29-04-20	1415	RuggedTroll	-	-	-	-	100%	19%	Yes	Yes	Yes	DRY	0	Data wrap on New logger
FM2	North Wambo	29-04-20	1425	CS-CR200	19.64	13.27	Yes	No	-	-	Yes	Yes	Yes	DRY	0	
BaroLogger NWC	North Wambo	29-04-20	1450	BaroTroll	-	-	-	-	56%	10%	Yes	Yes	Yes	-	-	Data wrap on New barologger
FM3	North Wambo	29-04-20	1215	CS-CR200	20.31	13.3	Yes	No	-	-	Yes	No	Yes	Dry	0	Sensor washed down creek, [illegible] 50m
FM4	North Wambo	29-04-20	0940	CS-CR200	15.40	13.41	Yes	No	-	-	Yes	Yes	Yes	Dry	0	
FM4 BU	North Wambo	29-04-20	0935	RuggedTroll	-	-	-	-	15%	10%	Yes	Yes	Yes	Dry	0	Data wrap on New logger
FM12 SCUP	Stoney	29-04-20	1030	RuggedTroll	-	-	-	-	100%	36%	Yes	Yes	Yes	Flowing	0.555	Data wrap on
FM14 SCtrib	Stoney Ck Tributary	29-04-20	0955	RuggedTroll	-	-	-	-	100%	38%	Yes	Yes	Yes	Flowing	0.172	Data wrap on
Stoney Ck Up Baro	Stoney	29-04-20	1105	BaroTroll	-	-	-	-	100%	36%	Yes	Yes	Yes	- Flowing	-	Data wrap on
FM13 SCDown	Stoney	29-04-20	1135	RuggedTroll	-	-	-	-	100%	36%	Yes	Yes	Yes	Flowing	0.213	Data wrap on
Stoney Ck Down Baro	Stoney	29-04-20	1150	BaroTroll	-	-	-	-	100%	36%	Yes	Yes	Yes	-	-	Data wrap on
FM9 Broad	South Wambo	30-04-20	0925	RuggedTroll	-	-	-	-	71%	15%	Yes	Yes	Yes	Flowing	0.33[illegible]	Data wrap on
FM15 (FM5)	South Wambo	30-04-20	1005	RuggedTroll	-	-	-	-	100%	27%	Yes	Yes	Yes	DRY	0	Data wrap on
FM16 (FM6)	South Wambo	30-04-20	1040	RuggedTroll	-	-	-	-	100%	27%	Yes	Yes	Yes	Flowing	0.230	Data wrap on
Barro Logger SWC	South Wambo	30-04-20	1015	BaroTroll	-	-	-	-	100%	27%	Yes	Yes	Yes	-	-	Data wrap on
Upstream old FM1	North Wambo	4/8/20	0950	RuggedTroll	-	-	-	-	100%	21%	Yes	Yes	Yes	Flowing	0 [illegible]	Data wrap on
Old FM1	North Wambo	04-08-20	1005	RuggedTroll	-	-	-	-	65%	12%	Yes	Yes	Yes	Dry	0	Data wrap on
FM1 New Location	North Wambo	04-08-20	1020	CS-CR800	0.0	14.13	Yes	No	-	-	Yes	Yes	Yes	Dry	0	Battery full charged = 0 [illegible] need [illegible]
FM1 New Location BU	North Wambo	04-08-20	1035	RuggedTroll	-	-	-	-	100%	21%	Yes	Yes	Yes	Dry	0	Data wrap on
FM2	North Wambo	04-08-20	1050	CS-CR200	22.09	13.97	Yes	No	-	-	Yes	Yes	Yes	Pool	0 [illegible]	
BaroLogger NWC	North Wambo	04-08-20	1105	BaroTroll	-	-	-	-	65%	12%	Yes	Yes	Yes	-	-	Data wrap on
FM3	North Wambo	04-08-20	0950	CS-CR200	21.19	13.64	Yes	No	-	-	Yes	Yes	Yes	Dry	0	
FM4	North Wambo	04-08-20	0915	CS-CR200	18.70V	13.66	Yes	No	-	-	Yes	Yes	Yes	Dry	0	
FM4 BU	North Wambo	04-08-20	0930	RuggedTroll	-	-	-	-	[illegible]%	12%	Yes	Yes	Yes	Dry	0	Data wrap on
FM12 SCUP	Stoney	24-07-20	0910	RuggedTroll	-	-	-	-	100%	38%	Yes	Yes	Yes	Flowing	0.335	Data wrap on
FM14 SCtrib	Stoney Ck Tributary	24-07-20	0940	RuggedTroll	-	-	-	-	100%	40%	Yes	Yes	Yes	DRY	0	Data wrap on Elv - 143m
Stoney Ck Up Baro	Stoney	24-07-20	09[illegible]	BaroTroll	-	-	-	-	100%	36%	Yes	Yes	Yes	-	-	Data wrap on Elv - 134m
FM13 SCDown	Stoney	24-07-20	1510	RuggedTroll	-	-	-	-	100%	46%	Yes	Yes	Yes	DRY	0	Data wrap on Elv - 94m
Stoney Ck Down Baro	Stoney	24-07-20	1000	BaroTroll	-	-	-	-	100%	35%	Yes	Yes	Yes	-	-	Data wrap on Elv - 95m
FM9 Broad	South Wambo	3/8/20	1500	RuggedTroll	-	-	-	-	98%	25%	Yes	Yes	Yes	Flowing	0 [illegible]	Data wrap on
FM15 (FM5)	South Wambo	3/8/20	1525	RuggedTroll	-	-	-	-	100%	39%	Yes	Yes	Yes	Pool	0 [illegible]	Data wrap on
FM16 (FM6)	South Wambo	3/8/20	1405	RuggedTroll	-	-	-	-	100%	29%	Yes	Yes	Yes	Flowing	0 [illegible]	Data wrap on
Barro Logger SWC	South Wambo	3/8/20	1415	BaroTroll	-	-	-	-	100%	29%	Yes	Yes	Yes	-	-	Data wrap on
FM3 BU	North Wambo	04-08-20	0900	Rugged Troll	-	-	-	-	6%	0%	Yes	Yes	Yes	Dry		
FM2 BU	North Wambo	04-08-20	1100	Rugged Troll	-	-	-	-	6%	0%	Yes	Yes	Yes	Pool	F2	

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60244356 - Wambo Coal - Quarterly Flow Station Field Sheet

Flow Station No.	Location (Creek)	Date	Time	Logger Type	Solar Panel Output (V)	Battery (V)	Solar Panel Cleaned	Battery Replaced	Memory Used (%)	Battery Used (%)	Data Collected	Sensor Operating	Logger Operating	Stream Observations	Height of Water Above Sensor (mm)	Comments
Upstream old FM1	North Wambo	15.10.20	1226	RuggedTroll	-	-	-	-	100%	22%	Y	Y	Y	Flowing	0.110	Data wrap on
Old FM1	North Wambo	15-10-20	1240	RuggedTroll	-	-	-	-	75%	15%	Y	Y	Y	Dry	0	Data wrap on New logger
FM1 New Location	North Wambo	15.10.20	1255	CS-CR800	Cycling	13.16	Y	N	-	-	Y	Y	Y	Dry	0	
FM1 New Location BU	North Wambo	15.10.20	1305	RuggedTroll	-	-	-	-	100%	22%	Y	Y	Y	Dry	0	Data wrap on New logger
FM2	North Wambo	15.10.20	1320	CS-CR200	21.20	13.16	Y	N	-	-	Y	Y	Y	Dry	0	
FM2 BU	North Wambo	15.10.20	1330	RuggedTroll	-	-	-	-	12%	1%	Y	Y	Y	Dry	0	
BarroLogger NWC	North Wambo	15.10.20	1335	BaroTroll	-	-	-	-	32%	15%	Y	Y	Y	-	-	Data wrap on New barrologger
FM3	North Wambo	15.10.20	1410	CS-CR200	24.41	13.33	Y	N	-	-	Y	Y	Y	Dry	0	
FM3 BU	North Wambo	15.10.20	1415	RuggedTroll	-	-	-	-	12%	1%	Y	Y	Y	Dry	0	
FM4	North Wambo	15.10.20	0835	CS-CR200	24.61	13.46	Y	N	-	-	Y	Y	Y	Dry	0	
FM4 BU	North Wambo	15.10.20	0845	RuggedTroll	-	-	-	-	34%	13%	Y	Y	Y	Dry	0	Data wrap on New logger
FM12 SCUP	Stoney	15.10.20	1000	RuggedTroll	-	-	-	-	100%	40%	Y	Y	Y	Flowing	0.340	Data wrap on
FM14 SCtrib	Stoney Ck Trubutary	15.10.20	0930	RuggedTroll	-	-	-	-	100%	41%	Y	Y	Y	Dry	0	Data wrap on
Stoney Ck Up Barro	Stoney	15.10.20	1030	BaroTroll	-	-	-	-	100%	40%	Y	Y	Y	-	-	Data wrap on
FM13 SCDown	Stoney	15.10.20	1100	RuggedTroll	-	-	-	-	100%	41%	Y	Y	Y	Dry	0	Data wrap on
Stoney Ck Down Barro	Stoney	15.10.20	1110	BaroTroll	-	-	-	-	100%	40%	Y	Y	Y	-	-	Data wrap on
FM8 Brosel	South Wambo	16.10.20	0855	RuggedTroll	-	-	-	-	100%	[illegible]	Y	Y	Y	Pool	0.535	Data wrap on
FM15 (FM6)	South Wambo	16.10.20	0925	RuggedTroll	-	-	-	-	100%	30%	Y	Y	Y	Dry	0	Data wrap on
FM16 (FM6)	South Wambo	16.10.20	0945	RuggedTroll	-	-	-	-	100%	30%	Y	Y	Y	Pool	0.111	Data wrap on
Barro Logger SWC	South Wambo	16.10.20	0955	BaroTroll	-	-	-	-	100%	30%	Y	Y	Y	-	-	Data wrap on
Upstream old FM1	North Wambo			RuggedTroll	-	-	-	-							0	Data wrap on
Old FM1	North Wambo			RuggedTroll	-	-	-	-							0	Data wrap on
FM1 New Location	North Wambo			CS-CR800					-	-					0	
FM1 New Location BU	North Wambo			RuggedTroll	-	-	-	-							0	Data wrap on
FM2	North Wambo			CS-CR200					-	-					0	
BarroLogger NWC	North Wambo			BaroTroll	-	-	-	-						-	-	Data wrap on
FM3	North Wambo			CS-CR200					-	-					0	
FM4	North Wambo			CS-CR200					-	-					0	
FM4 BU	North Wambo			RuggedTroll	-	-	-	-							0	Data wrap on
FM12 SCUP	Stoney			RuggedTroll	-	-	-	-							0	Data wrap on
FM14 SCtrib	Stoney Ck Trubutary			RuggedTroll	-	-	-	-							0	Data wrap on
Stoney Ck Up Barro	Stoney			BaroTroll	-	-	-	-						-	-	Data wrap on
FM13 SCDown	Stoney			RuggedTroll	-	-	-	-							0	Data wrap on
Stoney Ck Down Barro	Stoney			BaroTroll	-	-	-	-						-	-	Data wrap on
FM8 Brosel	South Wambo			RuggedTroll	-	-	-	-							0	Data wrap on
FM15 (FM6)	South Wambo			RuggedTroll	-	-	-	-							0	Data wrap on
FM16 (FM6)	South Wambo			RuggedTroll	-	-	-	-							0	Data wrap on
Barro Logger SWC	South Wambo			BaroTroll	-	-	-	-						-	-	Data wrap on

AECOM

60245396 - Wambo Coal - Quarterly Flow Station Field Sheet

Flow Station No.	Location (Creek)	Date	Time	Logger Type	Solar Panel Output (V)	Battery (V)	Solar Panel Cleaned	Battery Replaced	Memory Used (%)	Battery Used (%)	Data Collected	Sensor Operating	Logger Operating	Stream Observations	Height of Water Above Sensor (mm)	Comments
Upstream old FM1	North Wambo	23-01-21	1000	RuggedTroll	-	-	-	-	100%	25%	Y	Y	Y	Flowing	0.195	Data wrap on
Old FM1	North Wambo	21-01-21	1100	RuggedTroll	-	-	-	-	37%	16%	Y	Y	Y	Pool	0.075	Data wrap on New logger
FM1 New Location	North Wambo	23-04-21	1030	CS-CR800	Cycling	14.07	Y	N	-	-	Y	Y	Y	Dry	0	
FM1 New Location BU	North Wambo	23-04-21	1040	RuggedTroll	-	-	-	-	100%	25%	Y	Y	Y	Dry	0	Data wrap on New logger
FM2	North Wambo	23-04-21	1115	CS-CR200	>20	12.35	Y	N	-	-	Y	Y	Y	Dry	0	
FM2 BU	North Wambo	23-04-21	1145	RuggedTroll	-	-	-	-	25%	3%	Y	Y	Y	Dry	0	
BarroLogger NWC	North Wambo	23-04-21	1155	BaroTroll	-	-	-	-	97%	16%	Y	Y	Y	- Dry	-	Data wrap on New barrologger
FM3	North Wambo	23-04-21	0940	CS-CR200	15.46	12.61	Y	N	-	-	Y	Y	Y	Dry	0	
FM3 BU	North Wambo	23-04-21	0915	RuggedTroll	-	-	-	-	15%	3%	Y	Y	Y	Dry	0	
FM4	North Wambo	23-04-21	0935	CS-CR200	13.45	12.37	Y	N	-	-	Y	Y	Y	Dry	0	
FM4 BU	North Wambo	23-04-21	0955	RuggedTroll	-	-	-	-	46%	16%	Y	Y	Y	Dry	0	Data wrap on New logger
FM12 SCUP	Stoney	23-04-21	1015	RuggedTroll	-	-	-	-	100%	43%	Y	Y	Y	Flowing	0.375	Data wrap on
FM14 SCwb	Stoney Ck Trubutary	23-04-21	0930	RuggedTroll	-	-	-	-	100%	44%	Y	Y	Y	Flowing	0.150	Data wrap on
Stoney Ck Up Barro	Stoney	23-04-21	1040	BaroTroll	-	-	-	-	100%	42%	Y	Y	Y	- Flowing	-	Data wrap on
FM13 SCDown	Stoney	23-04-21	1130	RuggedTroll	-	-	-	-	100%	44%	Y	Y	Y	Flowing	0.150	Data wrap on
Stoney Ck Down Barro	Stoney	23-04-21	1150	BaroTroll	-	-	-	-	100%	42%	Y	Y	Y	- Flowing	-	Data wrap on
FM9 Bressi	South Wambo	23-04-21	1230	RuggedTroll	-	-	-	-	100%	29%	Y	Y	Y	Flowing	0.340	Data wrap on
FM15 (FM5)	South Wambo	23-04-21	1430	RuggedTroll	-	-	-	-	100%	33%	Y	Y	Y	Flowing	0.445	Data wrap on
FM16 (FM6)	South Wambo	23-04-21	1420	RuggedTroll	-	-	-	-	100%	33%	Y	Y	Y	Flowing	0.280	Data wrap on
Barro Logger SWC	South Wambo	23-04-21	1430	BaroTroll	-	-	-	-	100%	35%	Y	Y	Y	- Flowing	-	Data wrap on

Flow Station No.	Location (Creek)	Date	Time	Logger Type	Solar Panel Output (V)	Battery (V)	Solar Panel Cleaned	Battery Replaced	Memory Used (%)	Battery Used (%)	Data Collected	Sensor Operating	Logger Operating	Stream Observations	Height of Water Above Sensor (mm)	Comments
Upstream old FM1	North Wambo			RuggedTroll	-	-	-	-							0	Data wrap on
Old FM1	North Wambo			RuggedTroll	-	-	-	-							0	Data wrap on
FM1 New Location	North Wambo			CS-CR800						-					0	
FM1 New Location BU	North Wambo			RuggedTroll	-	-	-	-							0	Data wrap on
FM2	North Wambo			CS-CR200						-					0	
FM2 BU	North Wambo			RuggedTroll	-	-	-	-							0	
BarroLogger NWC	North Wambo			BaroTroll	-	-	-	-						-	-	Data wrap on
FM3	North Wambo			CS-CR200						-					0	
FM3 BU	North Wambo			RuggedTroll	-	-	-	-							0	
FM4	North Wambo			CS-CR200						-					0	
FM4 BU	North Wambo			RuggedTroll	-	-	-	-							0	Data wrap on
FM12 SCUP	Stoney			RuggedTroll	-	-	-	-							0	Data wrap on
FM14 SCtrib	Stoney Ck Trubutary			RuggedTroll	-	-	-	-							0	Data wrap on
Stoney Ck Up Barro	Stoney			BaroTroll	-	-	-	-						-	-	Data wrap on
FM13 SCDown	Stoney			RuggedTroll	-	-	-	-							0	Data wrap on
Stoney Ck Down Barro	Stoney			BaroTroll	-	-	-	-						-	-	Data wrap on
FM9 Bressi	South Wambo			RuggedTroll	-	-	-	-							0	Data wrap on
FM15 (FM5)	South Wambo			RuggedTroll	-	-	-	-							0	Data wrap on
FM16 (FM6)	South Wambo			RuggedTroll	-	-	-	-							0	Data wrap on
Barro Logger SWC	South Wambo			BaroTroll	-	-	-	-						-	-	Data wrap on

60248386 - Wambo Flow Station 1 CR800 Data Logger Status Summary Status Summary
29/04/2020 2:00:55 PM

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: 32.51 °C
Memory: 4194304 bytes
CPU Drive Free: 442368 bytes
USR Drive Free: 0 bytes
Watchdog Errors: 0

Program Information

Current Program: CPU:WaterLevel_V2_1A_10.CR8
Start Time: 13/12/2017 11:24:39 AM
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: 59 - If recurring, there may be a hardware or program error.
Skipped Records in Daily: 5 - If recurring, there may be a hardware or program error.
Skipped Records in BatteryData: 59 - If recurring, there may be a hardware or program error.
Variable Out of Bounds: 0

Battery Information

Battery Voltage: 8.95 - The battery voltage is low
Lithium Battery: 3.39
Number of times the datalogger's 12V supply has dropped below operating threshold: 391642 - Check your battery
Number of times voltage has dropped below 5V: 0

60248386 - Wambo Flow Station 2 CR200 Series Data Logger Status Summary 29/04/2020 3:01:23 PM

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: 13.37

RF Information

Radio Address: 0
Network Address: 0
Hop Sequence: 0
Power Mode: NO_RF
Signal Level: 0

60248386 - Wambo Flow Station 3 CR200 Series Data Logger Status Summary 29/04/2020 12:18:41 PM

Datalogger Information

OS Version: v07
OS Date: 090723
PakBus Address: 3
Watchdog Errors: 0

Program Information

Current Program: WaterLevel_CSA.

Program Errors

Skipped Scans: 0
Variable Out of Bounds: 0

Battery Information

Battery Voltage: 13.37

RF Information

Radio Address: 0
Network Address: 0
Hop Sequence: 0
Power Mode: NO_RF
Signal Level: 0

60248386 - Wambo Flow Station 4 CR200 Series Data Logger Status Summary 29/04/2020 8:48:51 AM

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: 13.47

RF Information

Radio Address: 0
Network Address: 0
Hop Sequence: 0
Power Mode: NO_RF
Signal Level: 0

60248386 - Wambo Flow Station 1 CR800 Data Logger Status Summary 4/08/2020 10:27:47 AM

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: 18.84 °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: 4/08/2020 10:27:53 AM
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: 14.06
Lithium Battery: 3.30
Number of times the datalogger's 12V supply has dropped below operating threshold: 27 - Check your battery
Number of times voltage has dropped below 5V: 0

60248386 - Wambo Flow Station 2 CR200 Series Data Logger Status Summary 4/08/2020 10:52:46 AM

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: 13.54

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 4/08/2020 8:54:03 AM

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: 13.60

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
4/08/2020 8:21:41 AM

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: 13.74

RF Information

Radio Address: 0
Network Address: 0
Hop Sequence: 0
Power Mode: NO_RF
Signal Level: 0

60248386 - Wambo Flow Station 1 CR800 Data Logger Status Summary 15/10/2020 12:57:21 PM

Datalogger Information

Reported Station Name: 6722
OS Version: CR800.Std.27
OS Date: 131010
OS Signature: 6757
PakBus Address: 801
Security Settings(1): 0
Security Settings(2): 0
Security Settings(3): 0
Panel Temperature: 29.82 °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: 4/08/2020 10:27:53 AM
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: 13.84
Lithium Battery: 3.36
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 15/10/2020 1:27:09 PM

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: 13.31

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 15/10/2020 11:43:37 AM

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: 13.39

RF Information

Radio Address: 0
Network Address: 0
Hop Sequence: 0
Power Mode: NO_RF
Signal Level: 0

60248386 - Wambo Flow Station 4 CR200 Series Data Logger Status Summary 15/10/2020 8:42:42 AM

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

60248386 – Wambo Flow Station 1 CR800 Data Logger Status Summary 28/01/2021 10:25:25 AM

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: 23.07 °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: 4/08/2020 10:27:53 AM
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: 13.99
Lithium Battery: 3.30
Number of times the datalogger's 12V supply has dropped below operating threshold: 0
Number of times voltage has dropped below 5V: 0

60248386 – Wambo Flow Station 2 CR200 Series Data Logger Status Summary 28/01/2021 11:37:06 AM

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: 13.53

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
28/01/2021 9:09:12 AM

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: 13.43

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 28/01/2021 9:08:42 AM

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: 13.43

RF Information

Radio Address: 0
Network Address: 0
Hop Sequence: 0
Power Mode: NO_RF
Signal Level: 0

Appendix B

Stream Theoretical Flow Rating and Profile Curves

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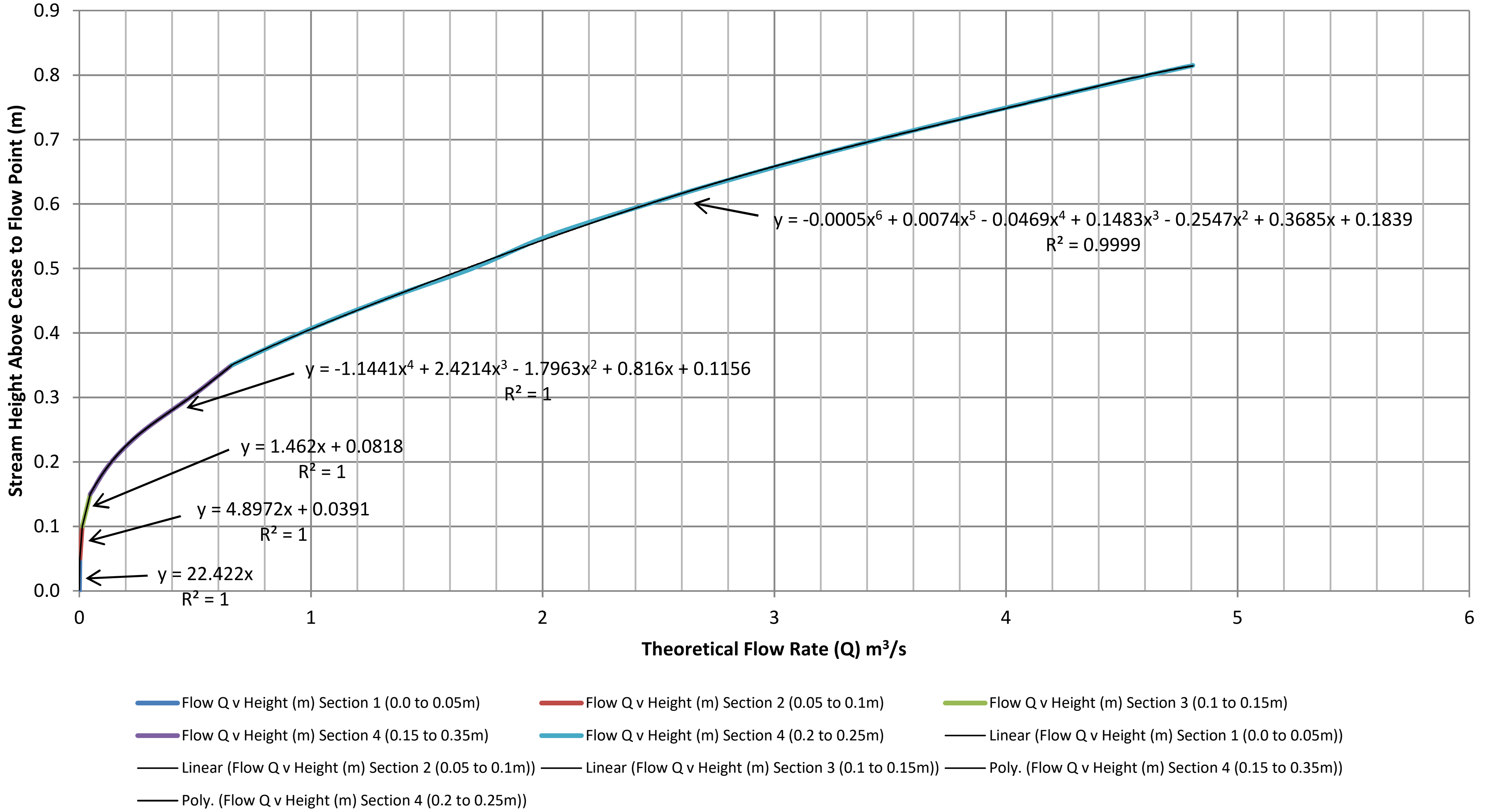
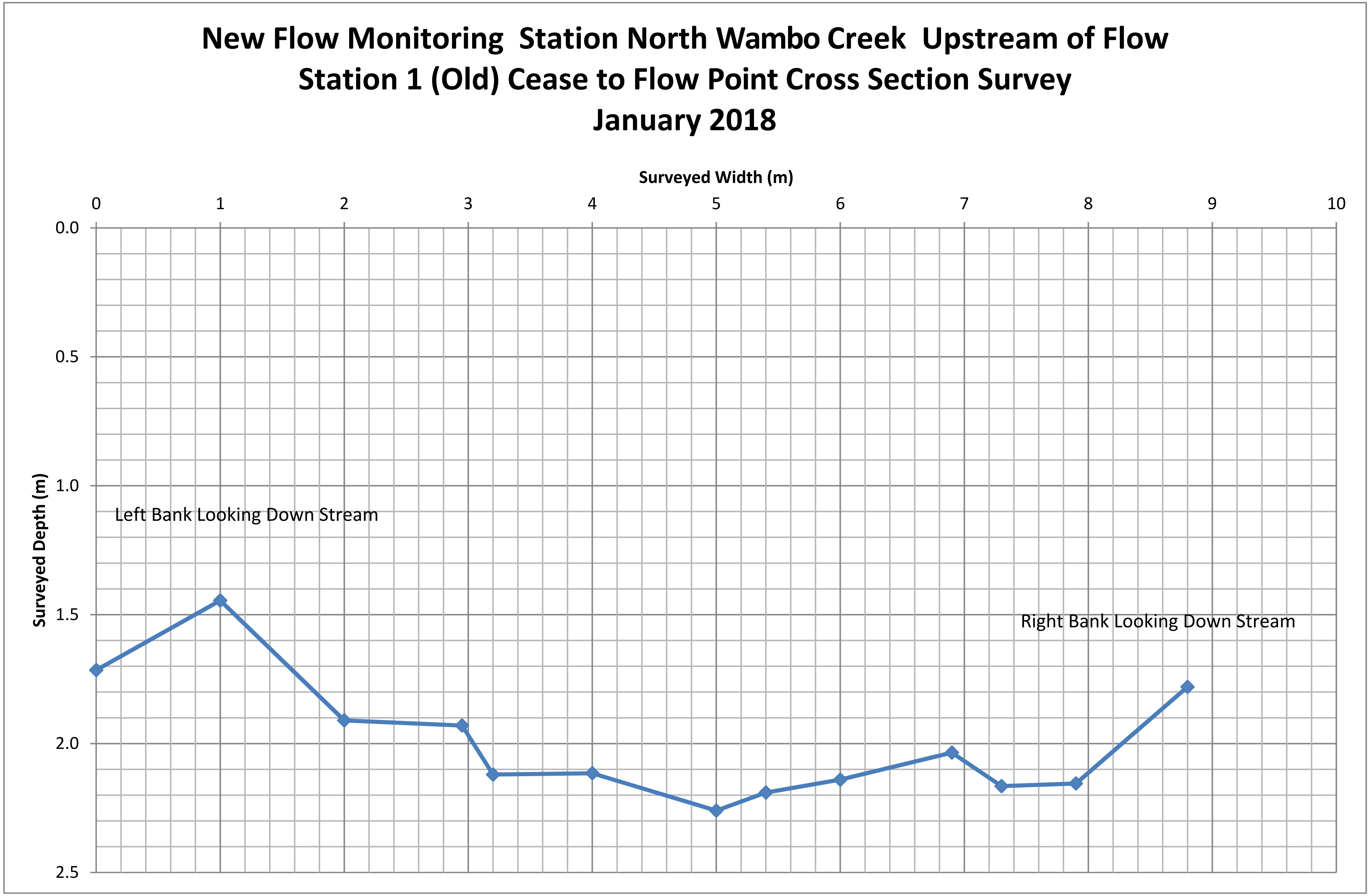
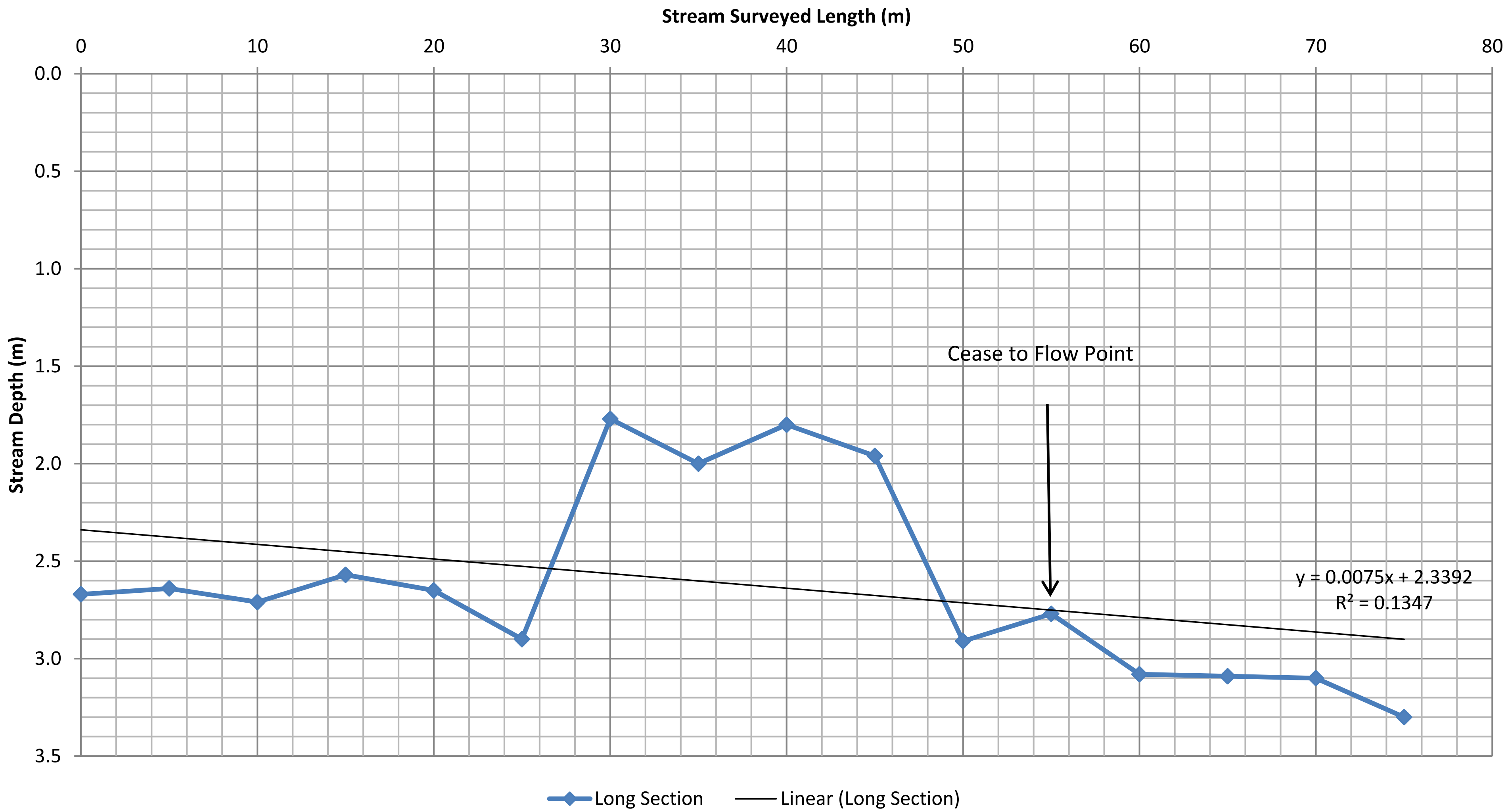
Flow Monitoring Station North Wambo Creek Upstream of Flow Monitoring Station 1 (Old) Theorectical Flow Rating Curve, January 2018

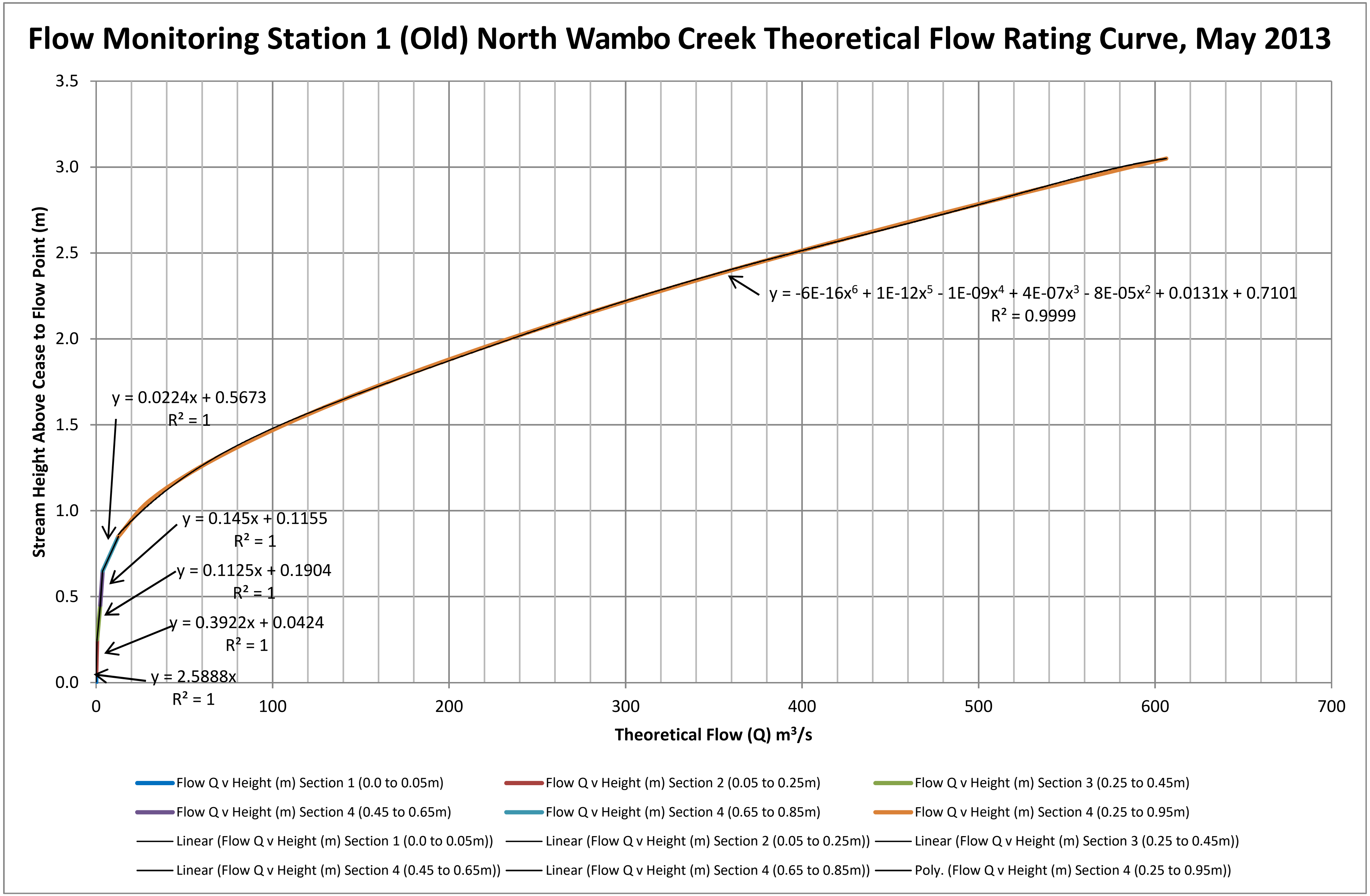


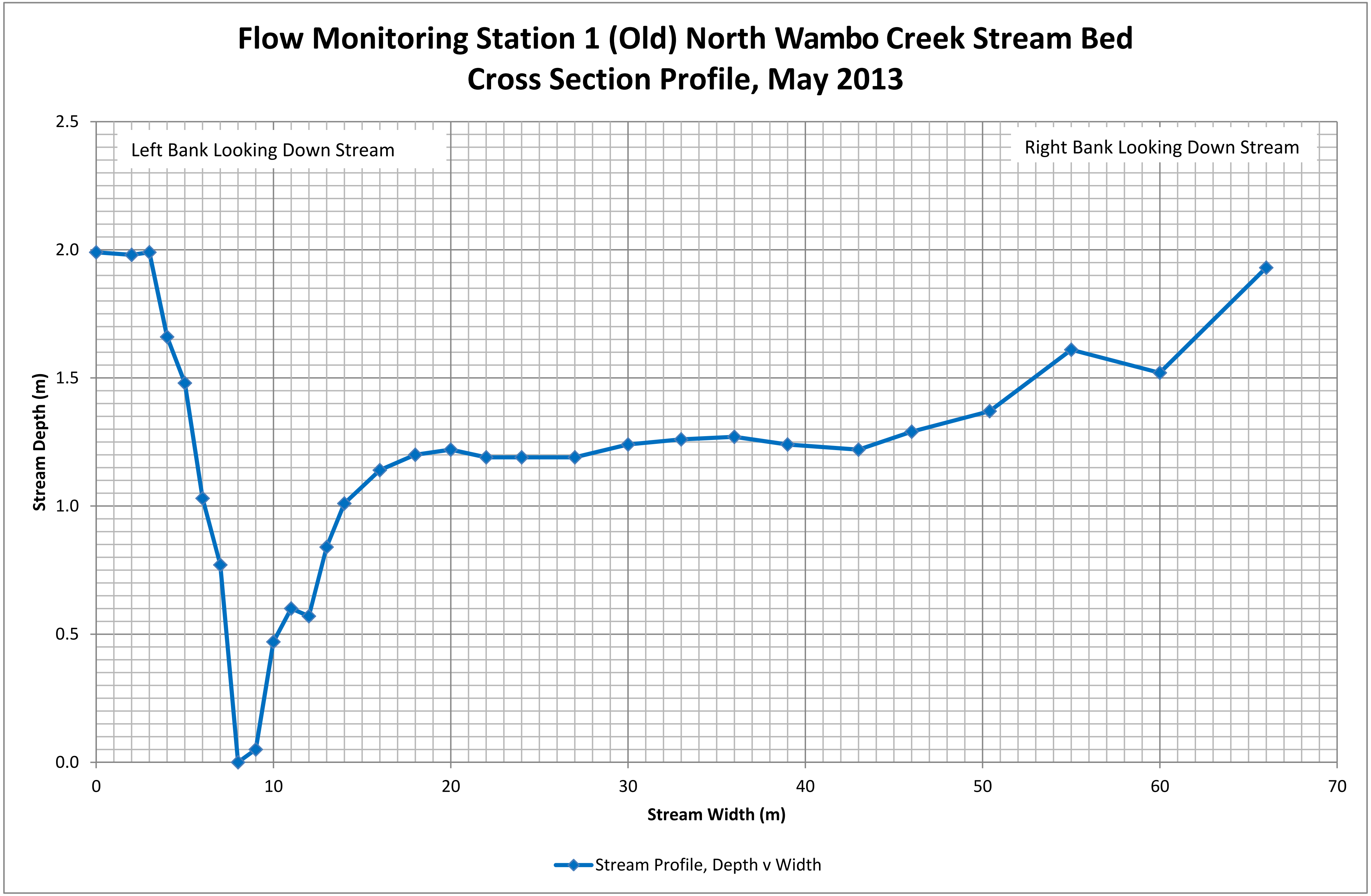


New Flow Monitoring Station North Wambo Creek Upstream of Flow Station 1 (Old) Cease to Flow Point Cross Section Survey
January 2018
Surveyed Width (m)
0
1
2
3
4
5
6
7
8
9
10
0.0
0.5
1.0
1.5
2.0
2.5
Surveyed Depth (m)
Left Bank Looking Down Stream
Right Bank Looking Down Stream

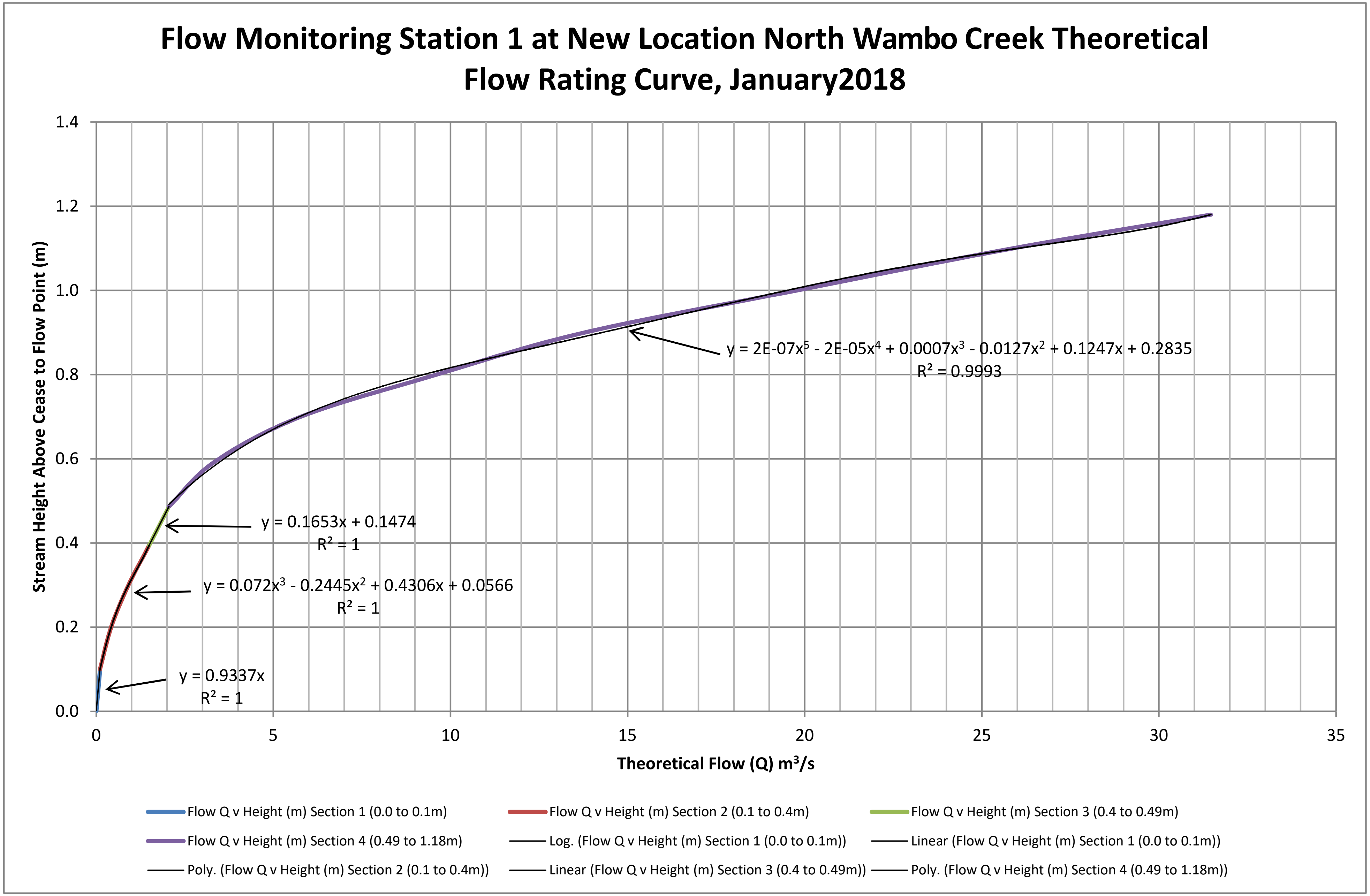
New Flow Monitoring Station North Wambo Creek Upstream of Flow Station 1 (Old) Long Section Profile Through Cease to Flow Point January 2018

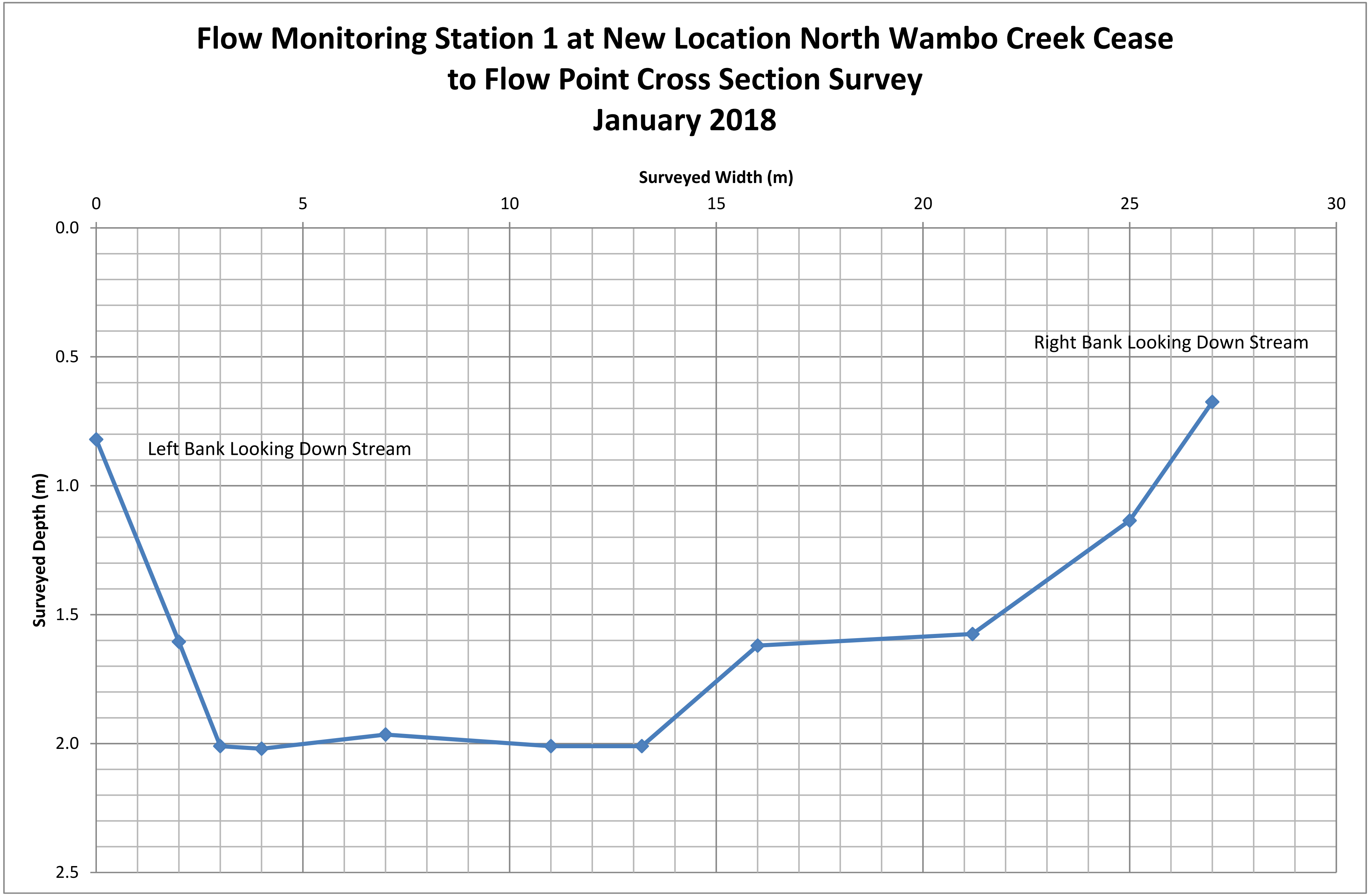


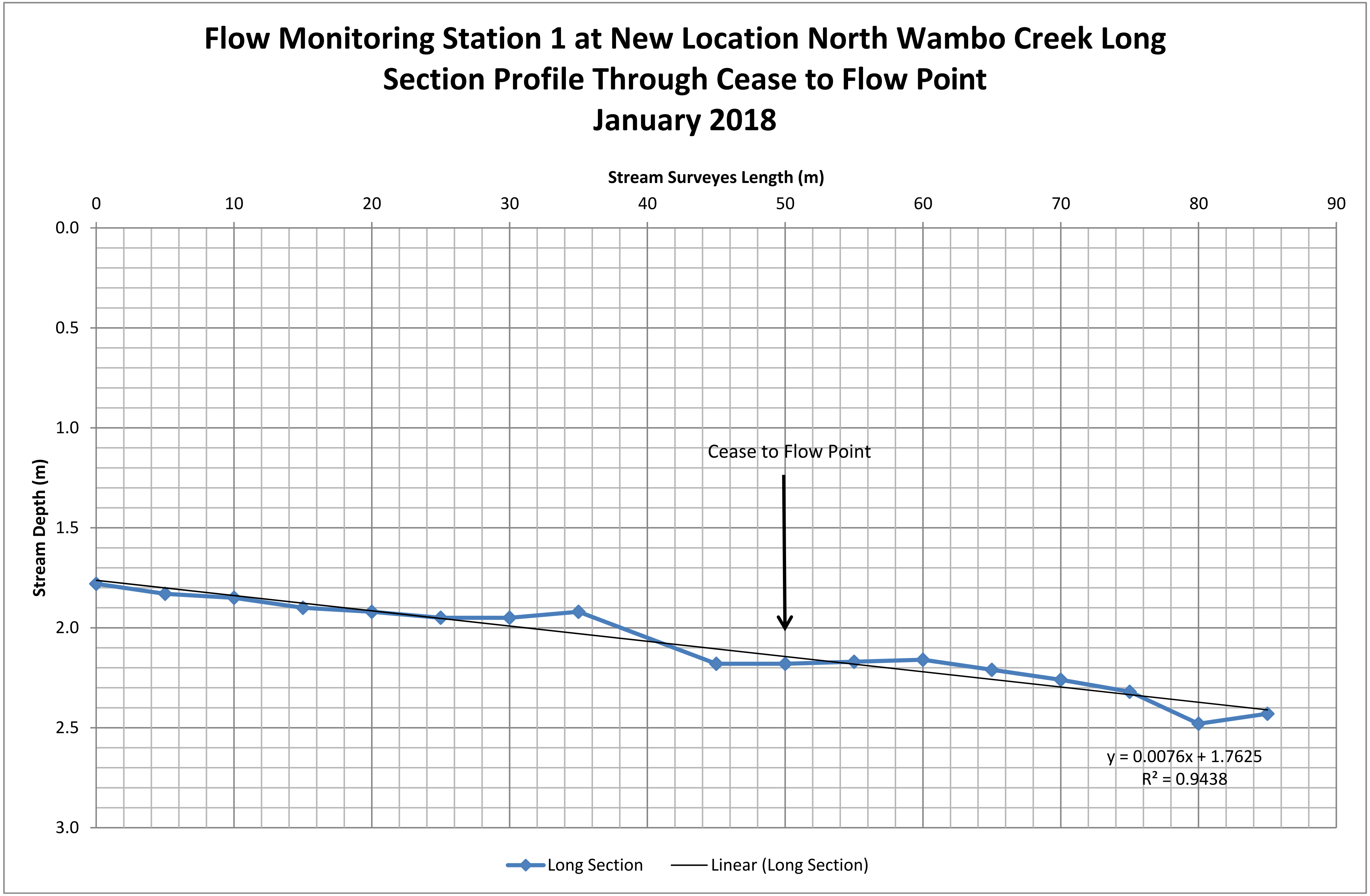

Flow Monitoring Station 1 (Old) North Wambo Creek Theoretical Flow Rating Curve, May 2013
Stream Height Above Cease to Flow Point (m)
Theoretical Flow (Q) m³/s
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
100
200
300
400
500
600
700
y = -6E-16x⁶ + 1E-12x⁵ - 1E-09x⁴ + 4E-07x³ - 8E-05x² + 0.0131x + 0.7101
R² = 0.9999
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))



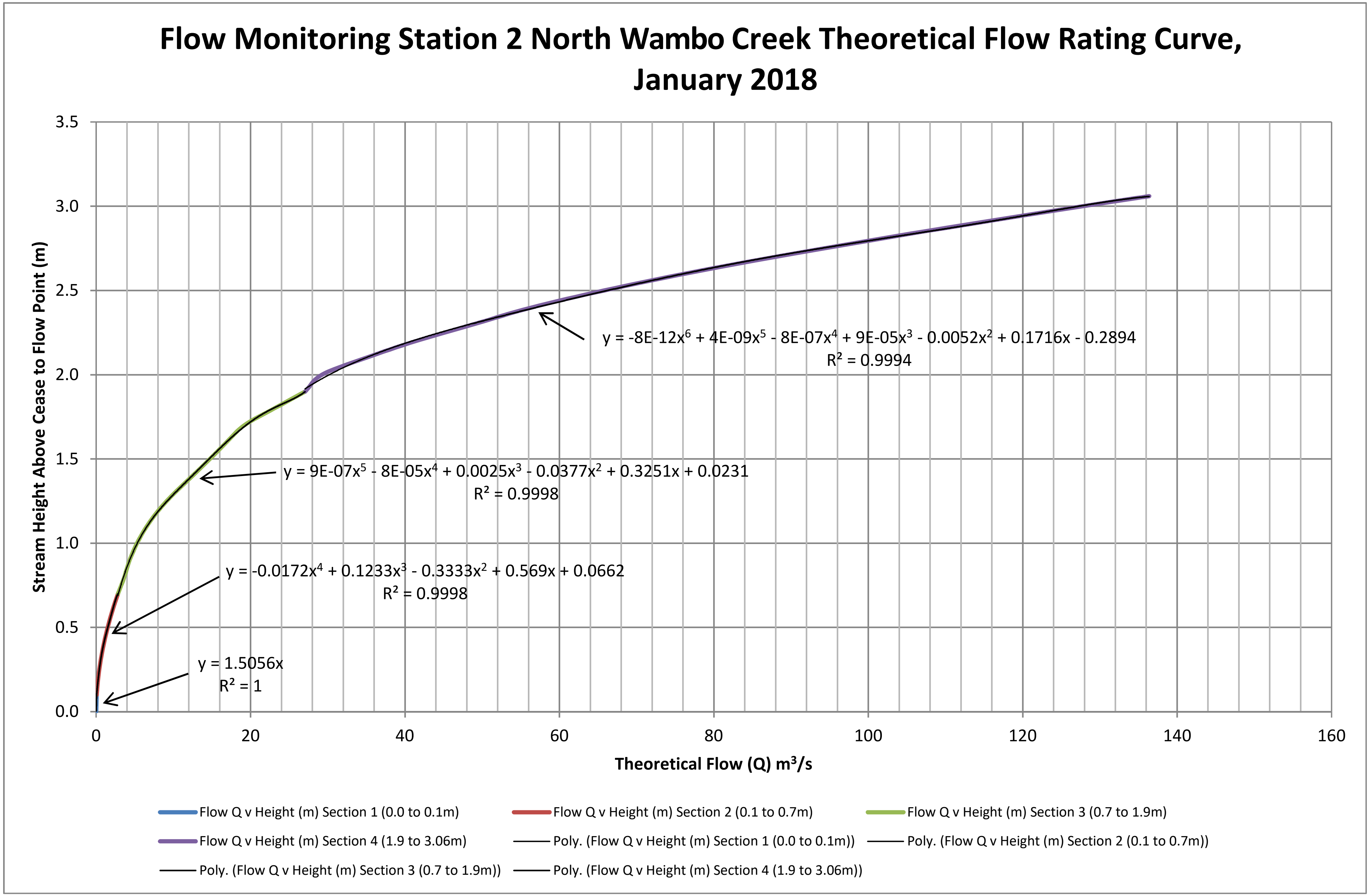
Flow Monitoring Station 1 (Old) North Wambo Creek Stream Bed
Cross Section Profile, May 2013
Left Bank Looking Down Stream
Right Bank Looking Down Stream
Stream Depth (m)
Stream Width (m)
0.0
0.5
1.0
1.5
2.0
2.5
0
10
20
30
40
50
60
70
Stream Profile, Depth v Width


Flow Monitoring Station 1 at New Location North Wambo Creek Theoretical Flow Rating Curve, January2018
Stream Height Above Cease to Flow Point (m)
Theoretical Flow (Q) m³/s
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
0
5
10
15
20
25
30
35
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))

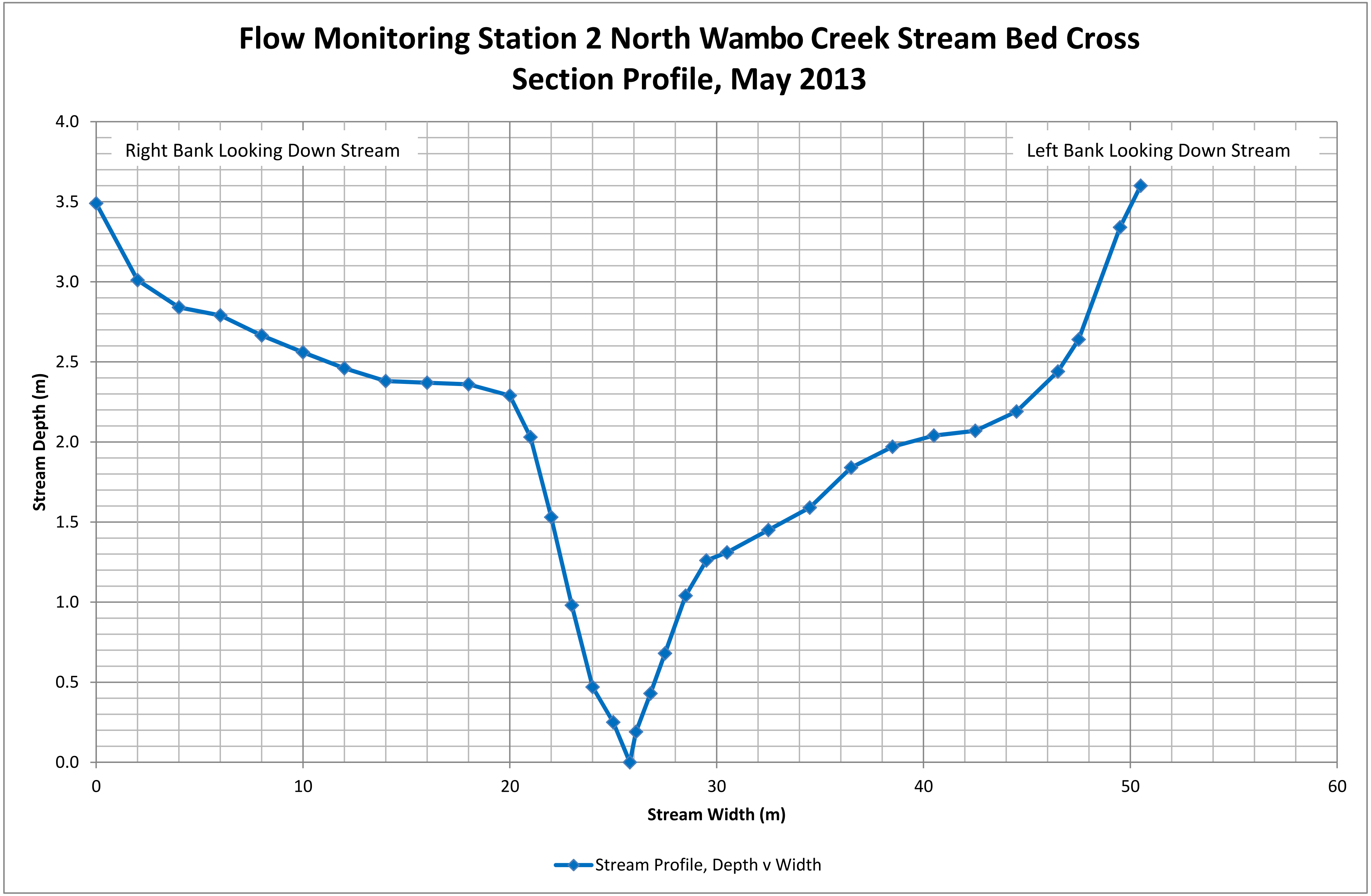

Flow Monitoring Station 1 at New Location North Wambo Creek Cease
to Flow Point Cross Section Survey
January 2018
Surveyed Width (m)
0
5
10
15
20
25
30
0.0
0.5
1.0
1.5
2.0
2.5
Surveyed Depth (m)
Left Bank Looking Down Stream
Right Bank Looking Down Stream

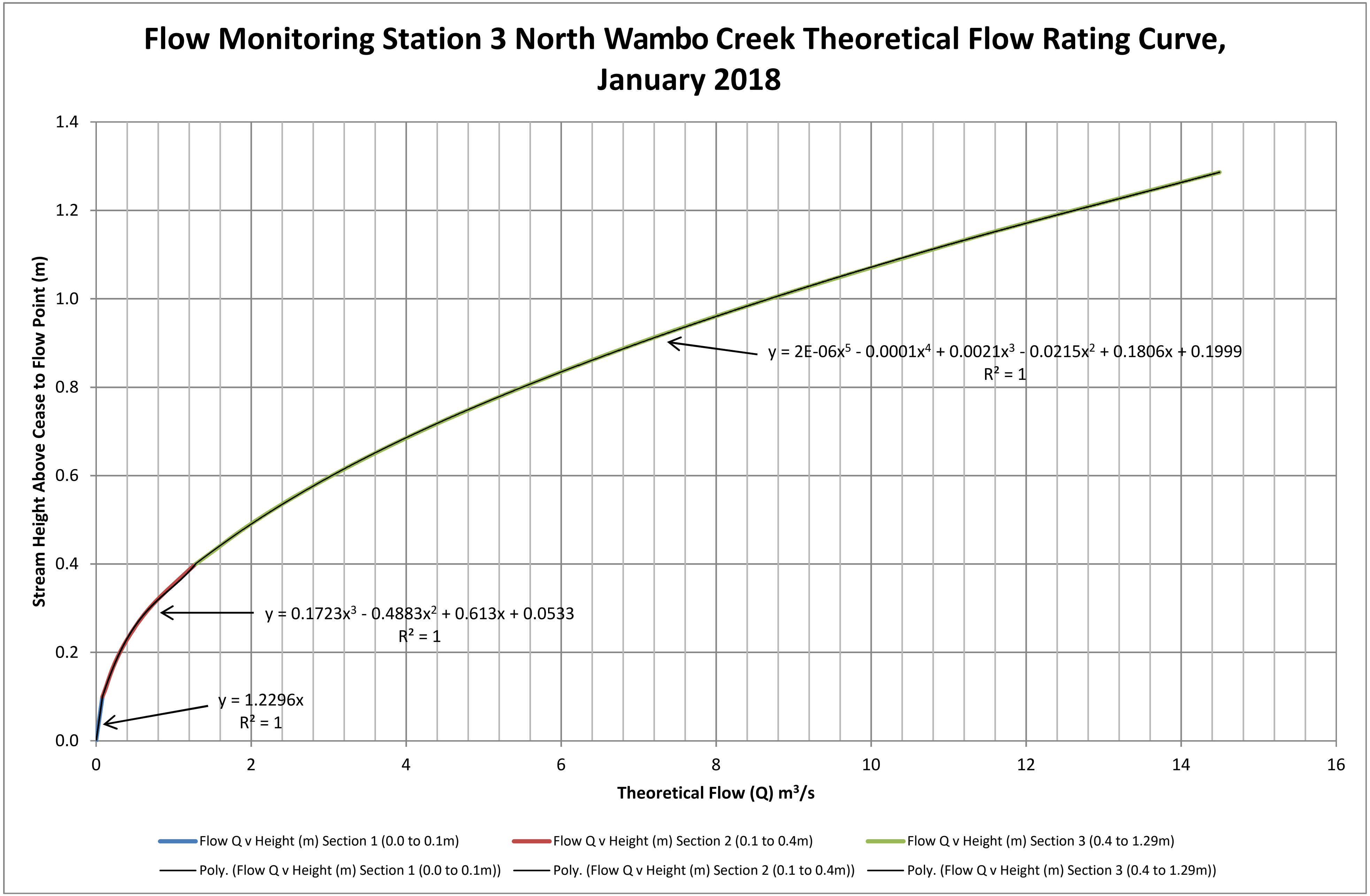


Flow Monitoring Station 1 at New Location North Wambo Creek Long Section Profile Through Cease to Flow Point
January 2018
Stream Surveyes Length (m)
0
10
20
30
40
50
60
70
80
90
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Stream Depth (m)
Cease to Flow Point
y = 0.0076x + 1.7625
R² = 0.9438
Long Section
Linear (Long Section)

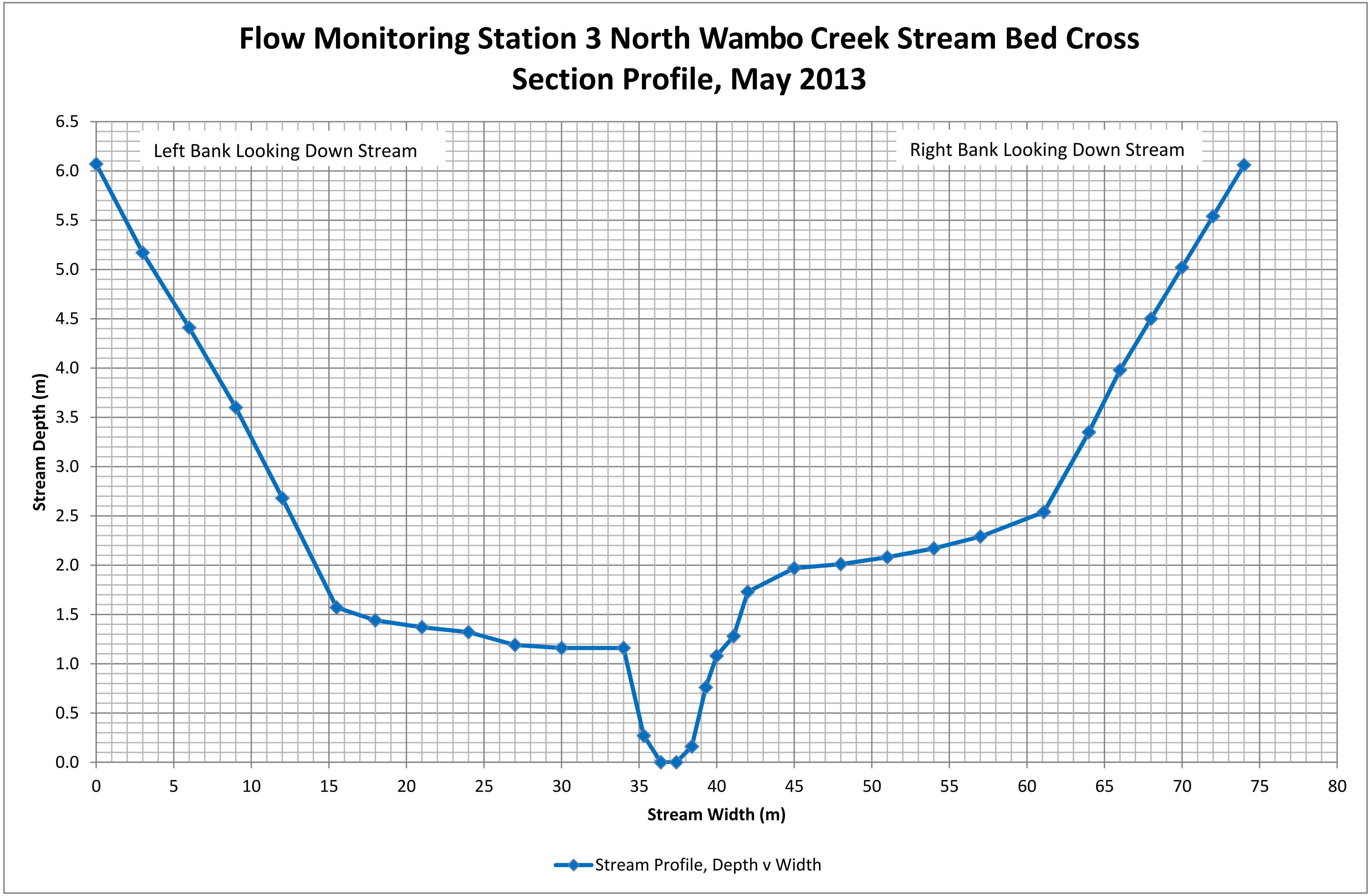


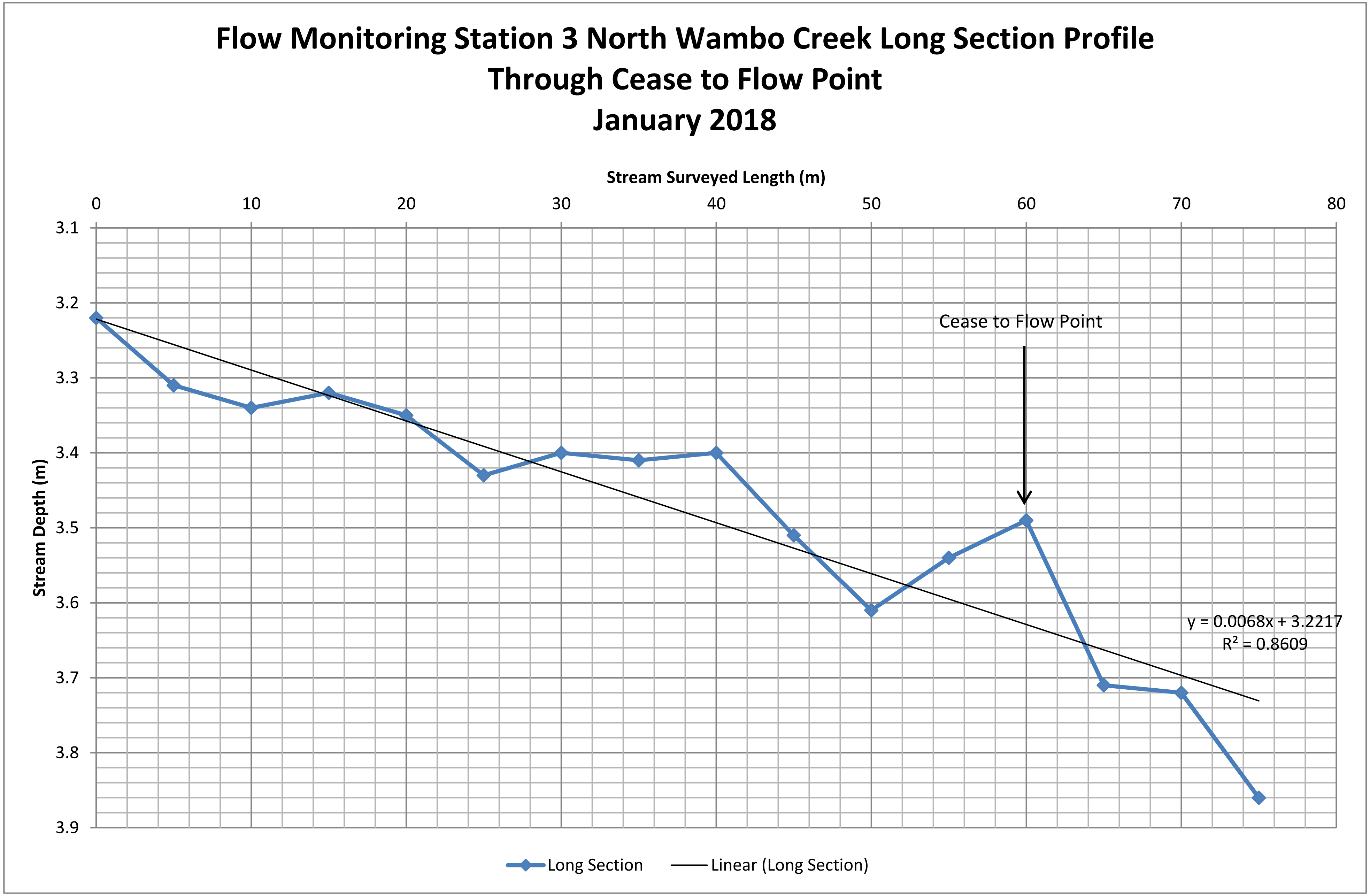
Flow Monitoring Station 2 North Wambo Creek Theoretical Flow Rating Curve, January 2018
Stream Height Above Cease to Flow Point (m)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
20
40
60
80
100
120
140
160
Theoretical Flow (Q) m³/s
y = -8E-12x⁶ + 4E-09x⁵ - 8E-07x⁴ + 9E-05x³ - 0.0052x² + 0.1716x - 0.2894
R² = 0.9994
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))

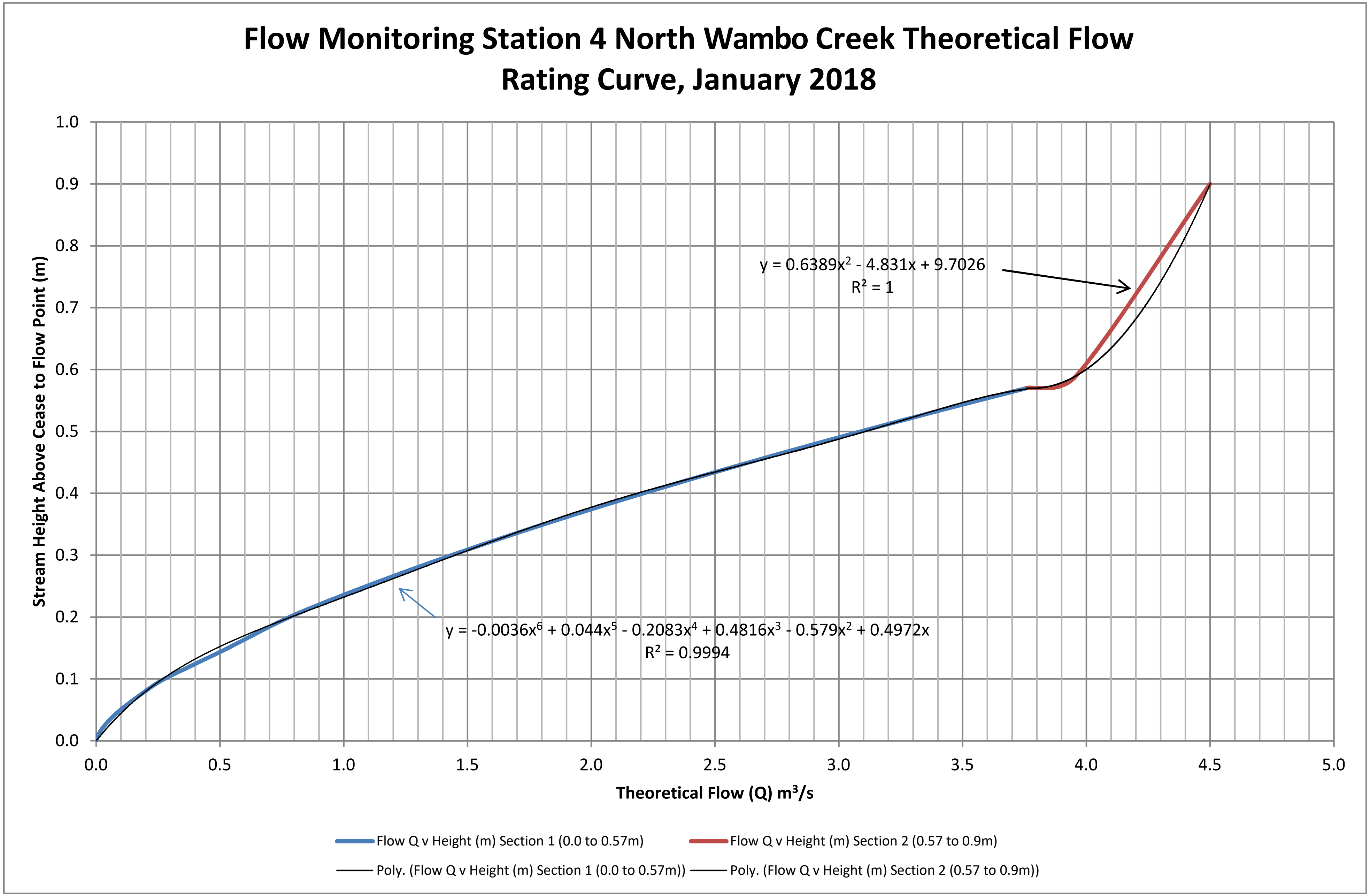

Flow Monitoring Station 2 North Wambo Creek Stream Bed Cross Section Profile, May 2013
Right Bank Looking Down Stream
Left Bank Looking Down Stream
Stream Depth (m)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
10
20
30
40
50
60
Stream Width (m)
Stream Profile, Depth v Width



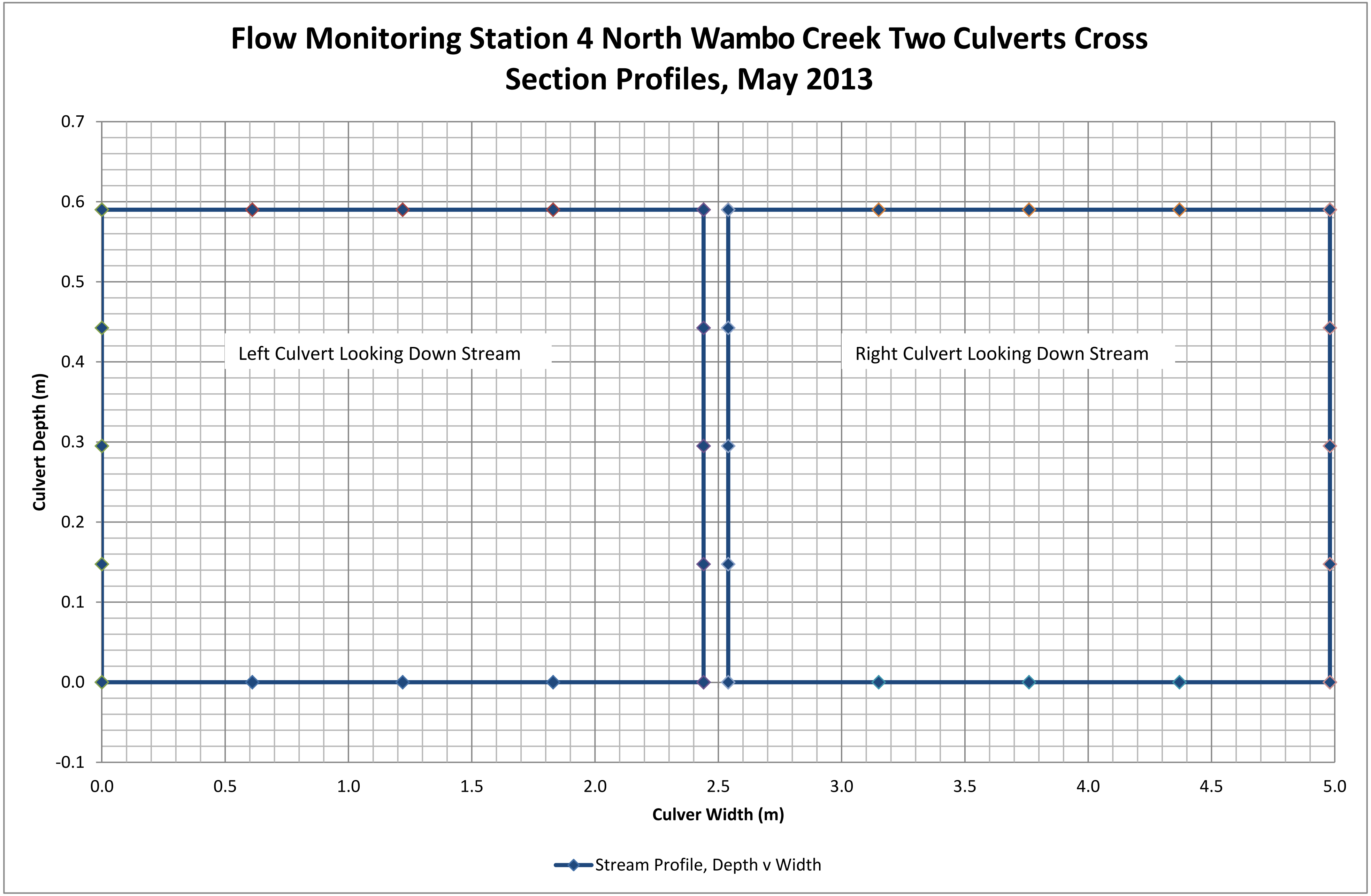
Flow Monitoring Station 3 North Wambo Creek Theoretical Flow Rating Curve, January 2018
Stream Height Above Cease to Flow Point (m)
Theoretical Flow (Q) m³/s
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
0
2
4
6
8
10
12
14
16
y = 2E-06x⁵ - 0.0001x⁴ + 0.0021x³ - 0.0215x² + 0.1806x + 0.1999
R² = 1
y = 0.1723x³ - 0.4883x² + 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))

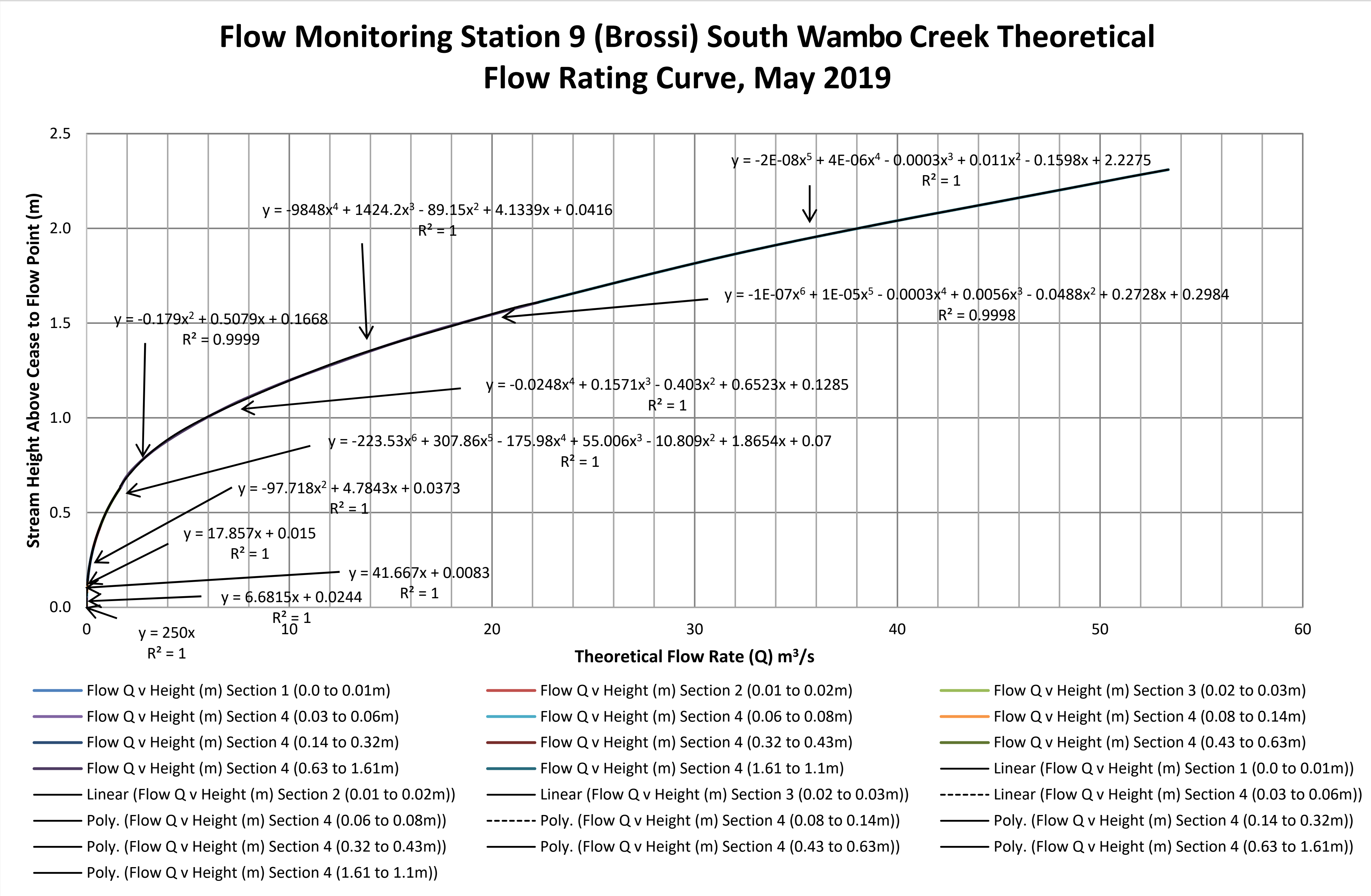

Flow Monitoring Station 3 North Wambo Creek Stream Bed Cross Section Profile, May 2013
Left Bank Looking Down Stream
Right Bank Looking Down Stream
Stream Depth (m)
Stream Width (m)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
Stream Profile, Depth v Width


Flow Monitoring Station 3 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
3.1
3.2
3.3
3.4
3.5
3.6
3.7
3.8
3.9
Stream Depth (m)
Cease to Flow Point
y = 0.0068x + 3.2217
R² = 0.8609
Long Section
Linear (Long Section)

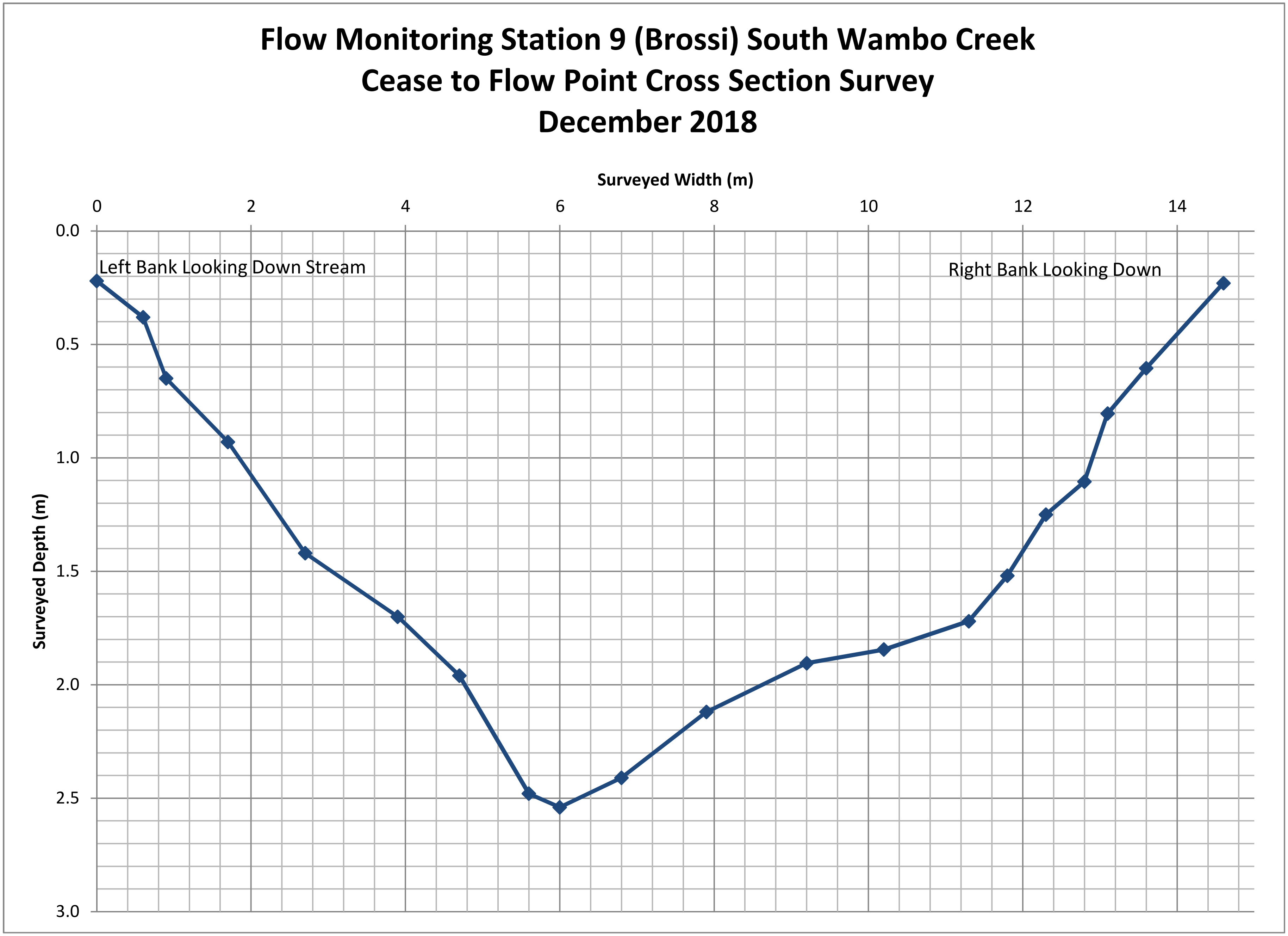


Flow Monitoring Station 4 North Wambo Creek Theoretical Flow
Rating Curve, January 2018
Stream Height Above Cease to Flow Point (m)
Theoretical Flow (Q) m³/s
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
y = 0.6389x² - 4.831x + 9.7026
R² = 1
y = -0.0036x⁶ + 0.044x⁵ - 0.2083x⁴ + 0.4816x³ - 0.579x² + 0.4972x
R² = 0.9994
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))

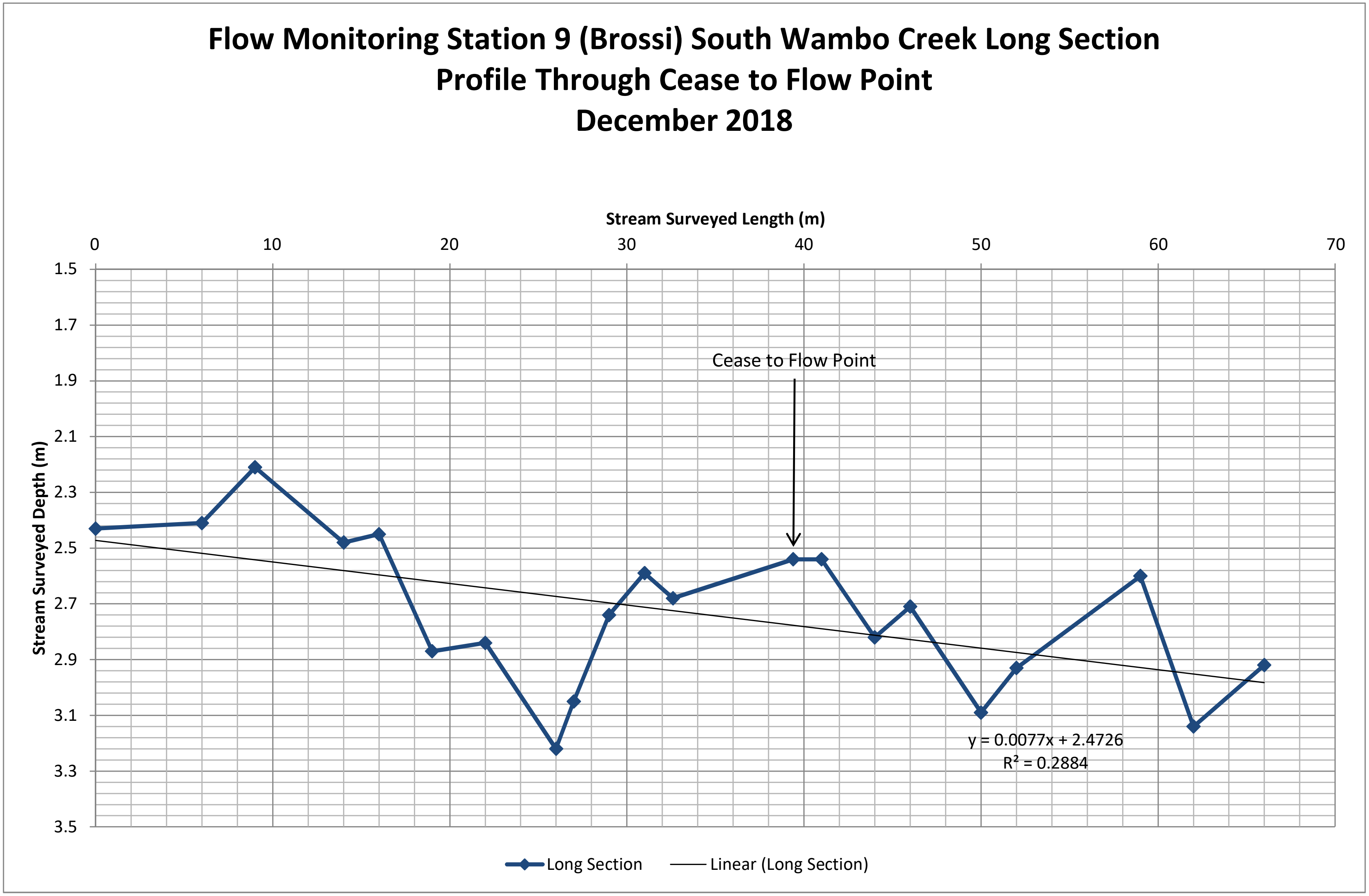

Flow Monitoring Station 4 North Wambo Creek Two Culverts Cross Section Profiles, May 2013
Left Culvert Looking Down Stream
Right Culvert Looking Down Stream
Culvert Depth (m)
Culver Width (m)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Stream Profile, Depth v Width



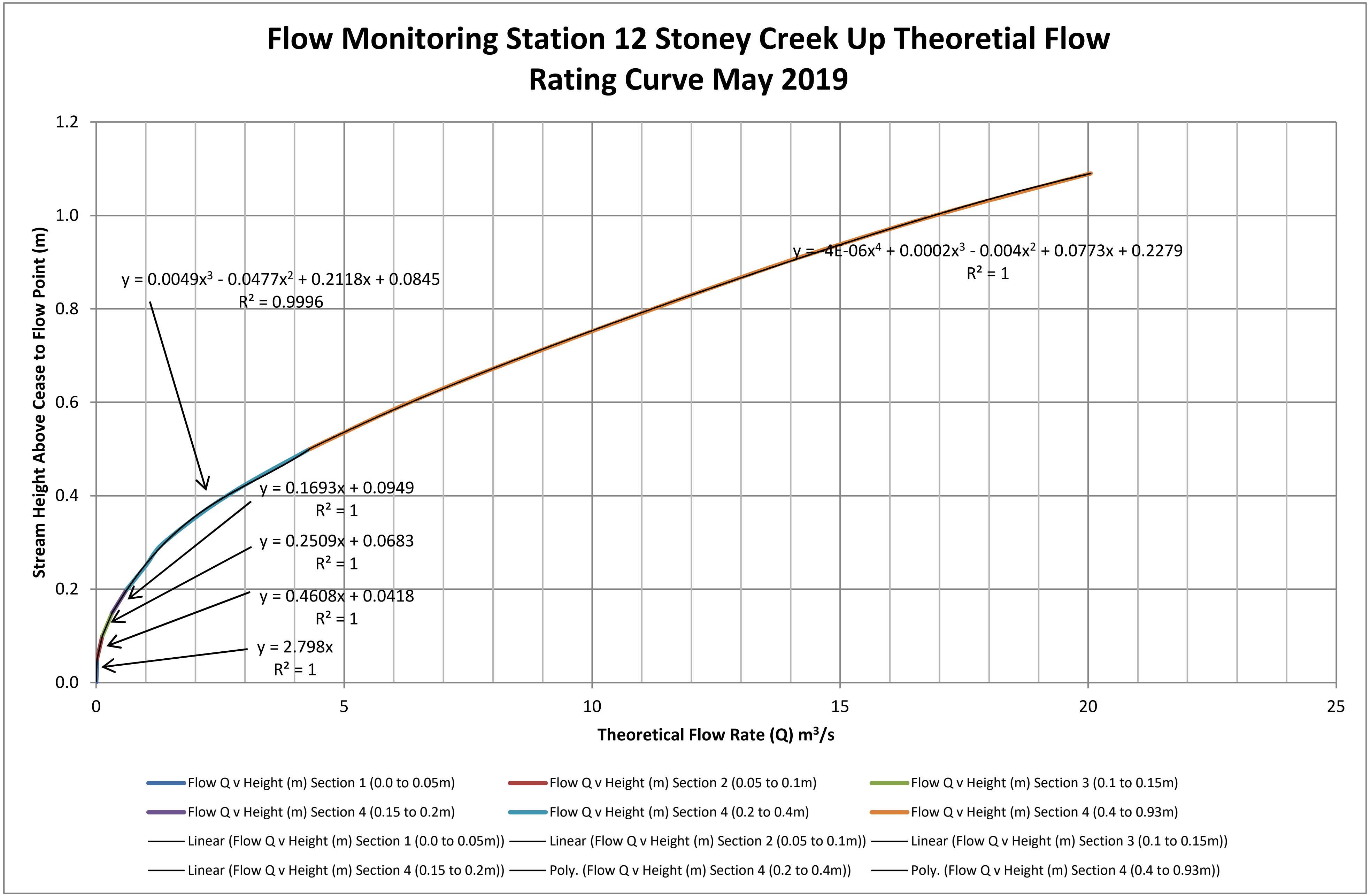
Flow Monitoring Station 9 (Brossi) South Wambo Creek Theoretical Flow Rating Curve, May 2019
Stream Height Above Cease to Flow Point (m)
Theoretical Flow Rate (Q) m³/s
2.5
2.0
1.5
1.0
0.5
0.0
0
10
20
30
40
50
60
y = -2E-08x⁵ + 4E-06x⁴ - 0.0003x³ + 0.011x² - 0.1598x + 2.2275
R² = 1
y = -9848x⁴ + 1424.2x³ - 89.15x² + 4.1339x + 0.0416
R² = 1
y = -1E-07x⁶ + 1E-05x⁵ - 0.0003x⁴ + 0.0056x³ - 0.0488x² + 0.2728x + 0.2984
R² = 0.9998
y = -0.179x² + 0.5079x + 0.1668
R² = 0.9999
y = -0.0248x⁴ + 0.1571x³ - 0.403x² + 0.6523x + 0.1285
R² = 1
y = -223.53x⁶ + 307.86x⁵ - 175.98x⁴ + 55.006x³ - 10.809x² + 1.8654x + 0.07
R² = 1
y = -97.718x² + 4.7843x + 0.0373
R² = 1
y = 17.857x + 0.015
R² = 1
y = 41.667x + 0.0083
R² = 1
y = 6.6815x + 0.0244
R² = 1
y = 250x
R² = 1
Flow Q v Height (m) Section 1 (0.0 to 0.01m)
Flow Q v Height (m) Section 2 (0.01 to 0.02m)
Flow Q v Height (m) Section 3 (0.02 to 0.03m)
Flow Q v Height (m) Section 4 (0.03 to 0.06m)
Flow Q v Height (m) Section 4 (0.06 to 0.08m)
Flow Q v Height (m) Section 4 (0.08 to 0.14m)
Flow Q v Height (m) Section 4 (0.14 to 0.32m)
Flow Q v Height (m) Section 4 (0.32 to 0.43m)
Flow Q v Height (m) Section 4 (0.43 to 0.63m)
Flow Q v Height (m) Section 4 (0.63 to 1.61m)
Flow Q v Height (m) Section 4 (1.61 to 1.1m)
Linear (Flow Q v Height (m) Section 1 (0.0 to 0.01m))
Linear (Flow Q v Height (m) Section 2 (0.01 to 0.02m))
Linear (Flow Q v Height (m) Section 3 (0.02 to 0.03m))
Linear (Flow Q v Height (m) Section 4 (0.03 to 0.06m))
Poly. (Flow Q v Height (m) Section 4 (0.06 to 0.08m))
Poly. (Flow Q v Height (m) Section 4 (0.08 to 0.14m))
Poly. (Flow Q v Height (m) Section 4 (0.14 to 0.32m))
Poly. (Flow Q v Height (m) Section 4 (0.32 to 0.43m))
Poly. (Flow Q v Height (m) Section 4 (0.43 to 0.63m))
Poly. (Flow Q v Height (m) Section 4 (0.63 to 1.61m))
Poly. (Flow Q v Height (m) Section 4 (1.61 to 1.1m))

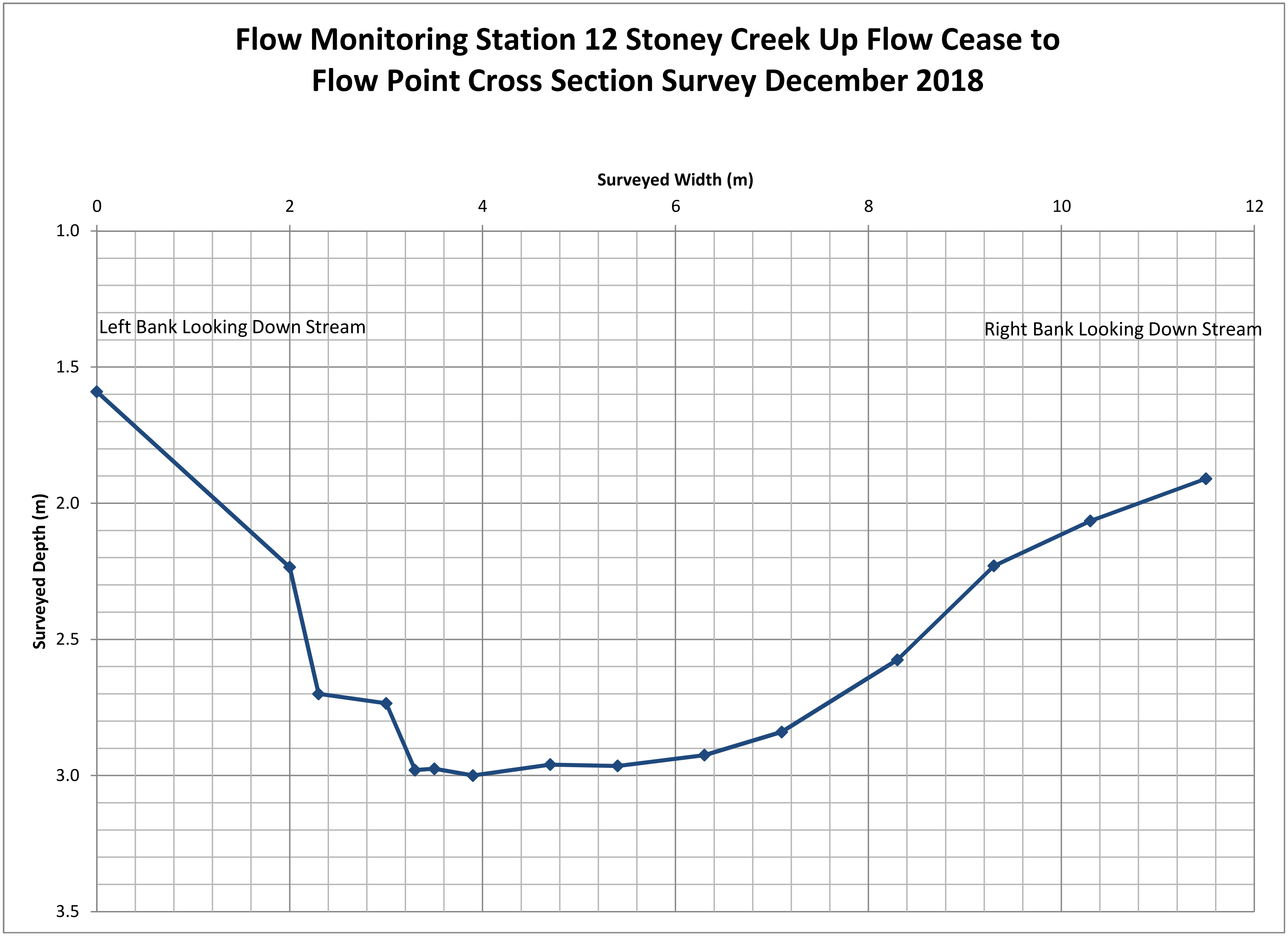


Flow Monitoring Station 9 (Brossi) South Wambo Creek
Cease to Flow Point Cross Section Survey
December 2018
Surveyed Width (m)
0
2
4
6
8
10
12
14
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Surveyed Depth (m)
Left Bank Looking Down Stream
Right Bank Looking Down

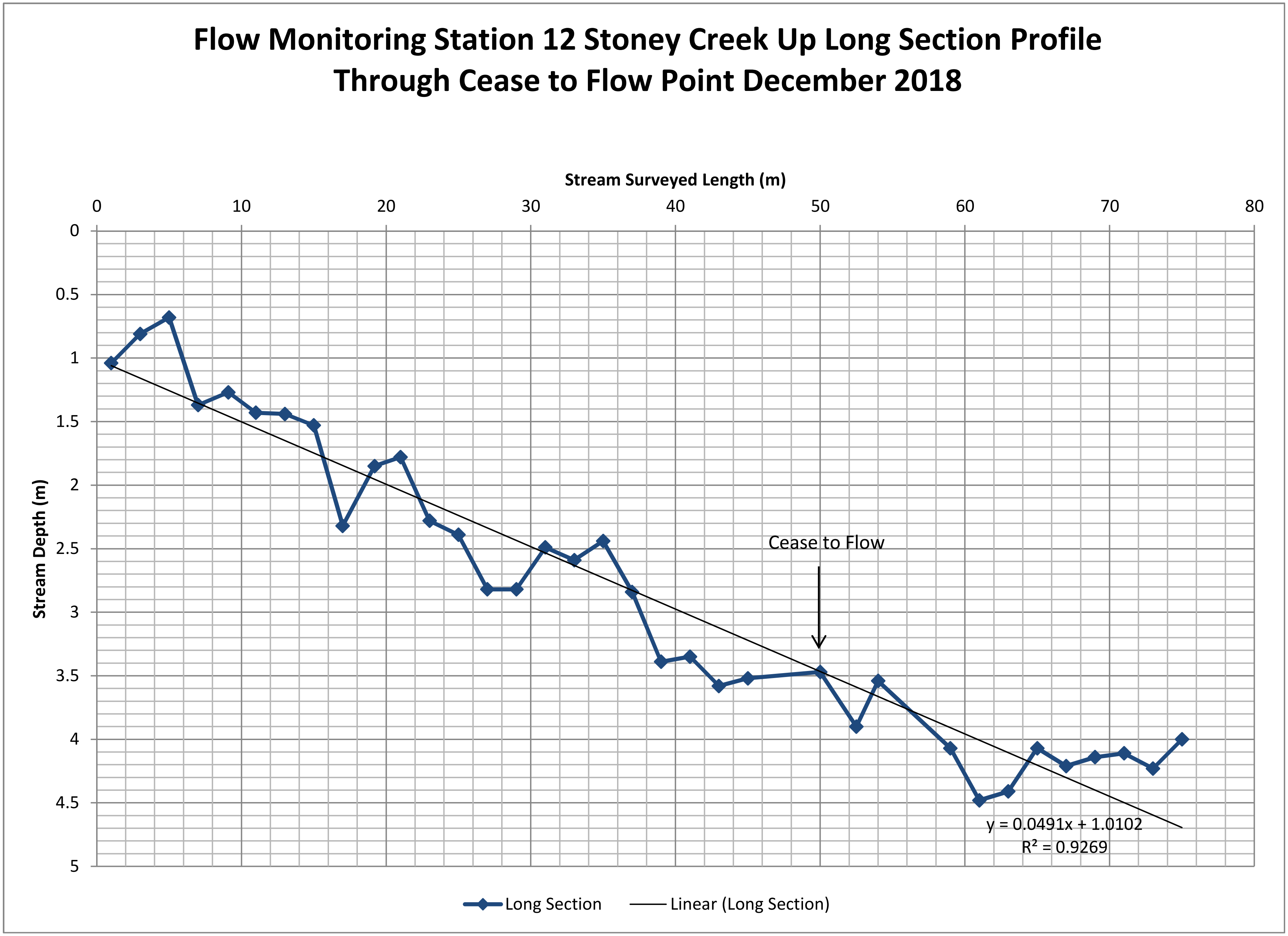


Flow Monitoring Station 9 (Brossi) South Wambo Creek Long Section
Profile Through Cease to Flow Point
December 2018
Stream Surveyed Length (m)
0
10
20
30
40
50
60
70
1.5
1.7
1.9
2.1
2.3
2.5
2.7
2.9
3.1
3.3
3.5
Stream Surveyed Depth (m)
Cease to Flow Point
y = 0.0077x + 2.4726
R² = 0.2884
Long Section
Linear (Long Section)

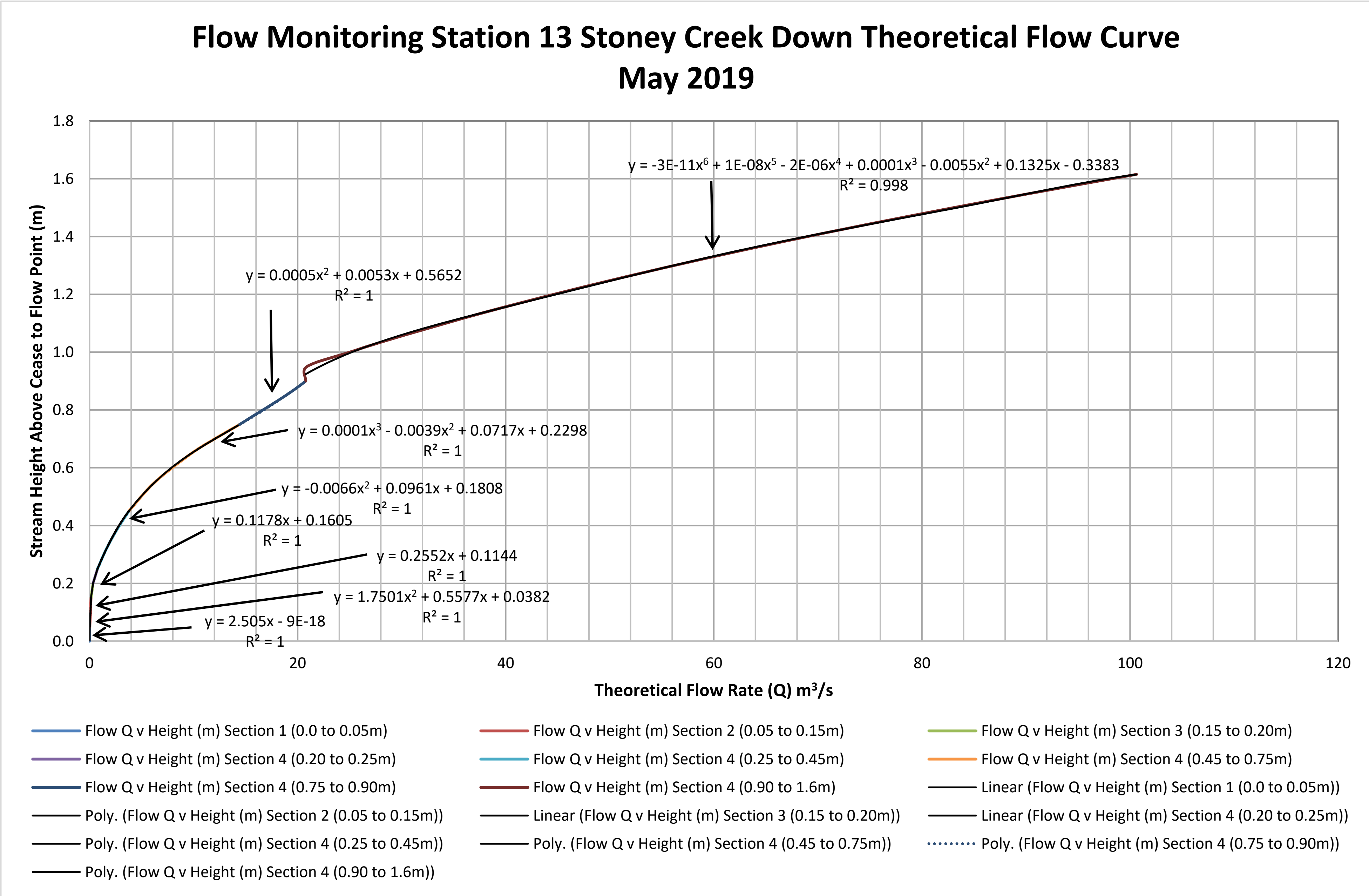

Flow Monitoring Station 12 Stoney Creek Up Theoretial Flow Rating Curve May 2019
Stream Height Above Cease to Flow Point (m)
Theoretical Flow Rate (Q) m³/s
y = 0.0049x³ - 0.0477x² + 0.2118x + 0.0845
R² = 0.9996
y = -4E-06x⁴ + 0.0002x³ - 0.004x² + 0.0773x + 0.2279
R² = 1
y = 0.1693x + 0.0949
R² = 1
y = 0.2509x + 0.0683
R² = 1
y = 0.4608x + 0.0418
R² = 1
y = 2.798x
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 12 Stoney Creek Up Flow Cease to Flow Point Cross Section Survey December 2018
Surveyed Width (m)
0
2
4
6
8
10
12
1.0
1.5
2.0
2.5
3.0
3.5
Surveyed Depth (m)
Left Bank Looking Down Stream
Right Bank Looking Down Stream

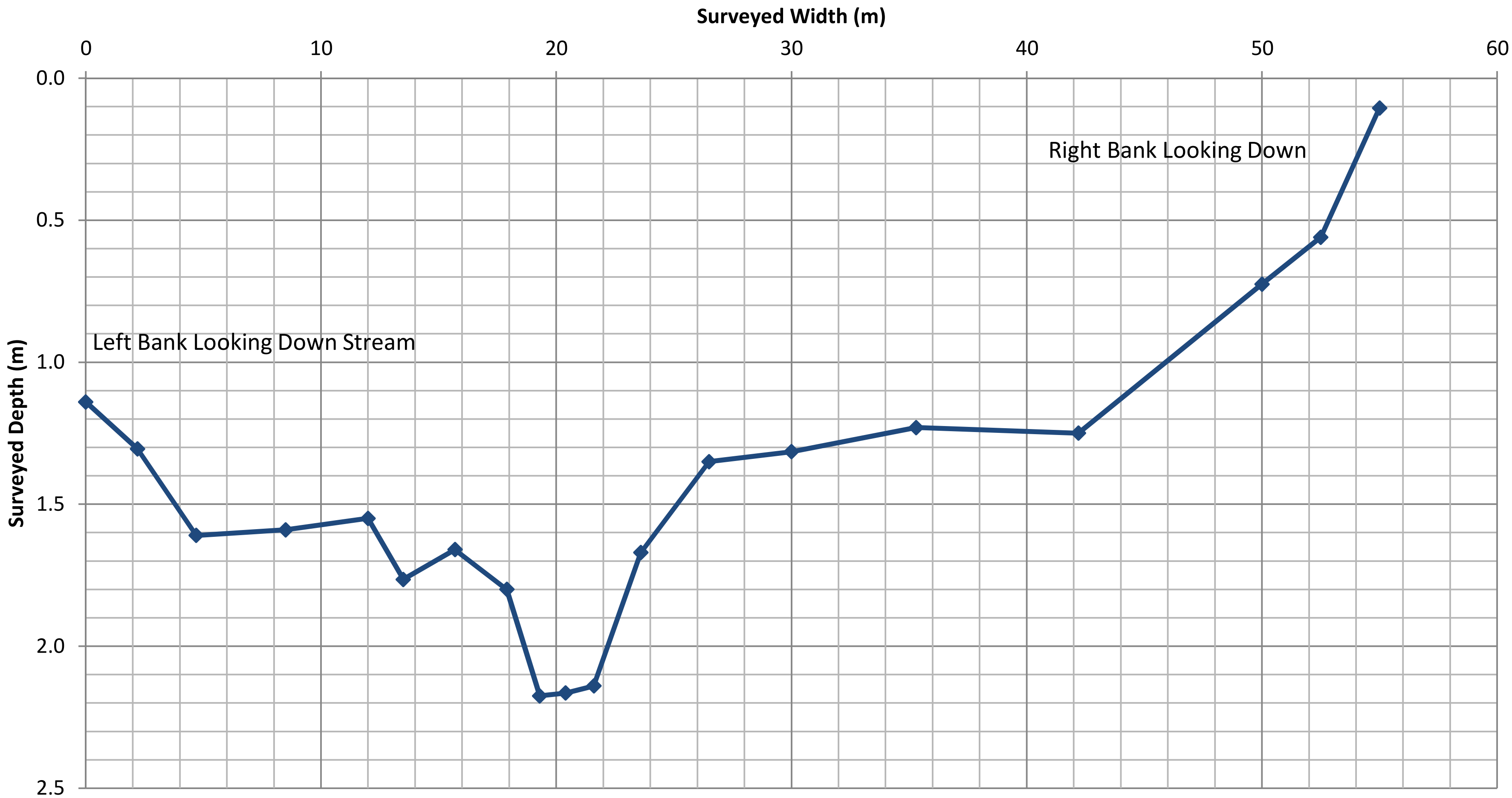


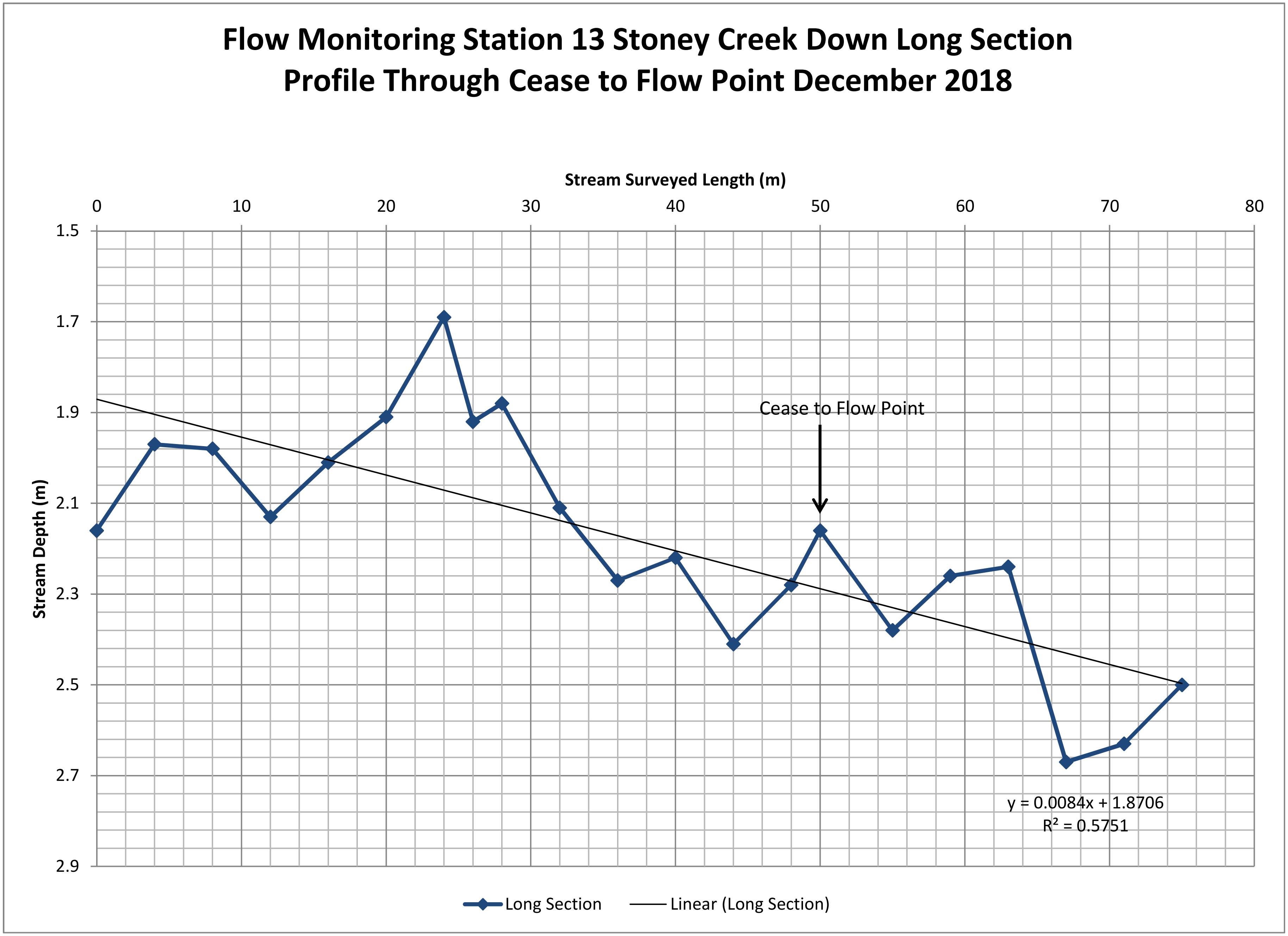
Flow Monitoring Station 12 Stoney Creek Up Long Section Profile
Through Cease to Flow Point December 2018
Stream Surveyed Length (m)
0
10
20
30
40
50
60
70
80
Stream Depth (m)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Cease to Flow
y = 0.0491x + 1.0102
R² = 0.9269
Long Section
Linear (Long Section)



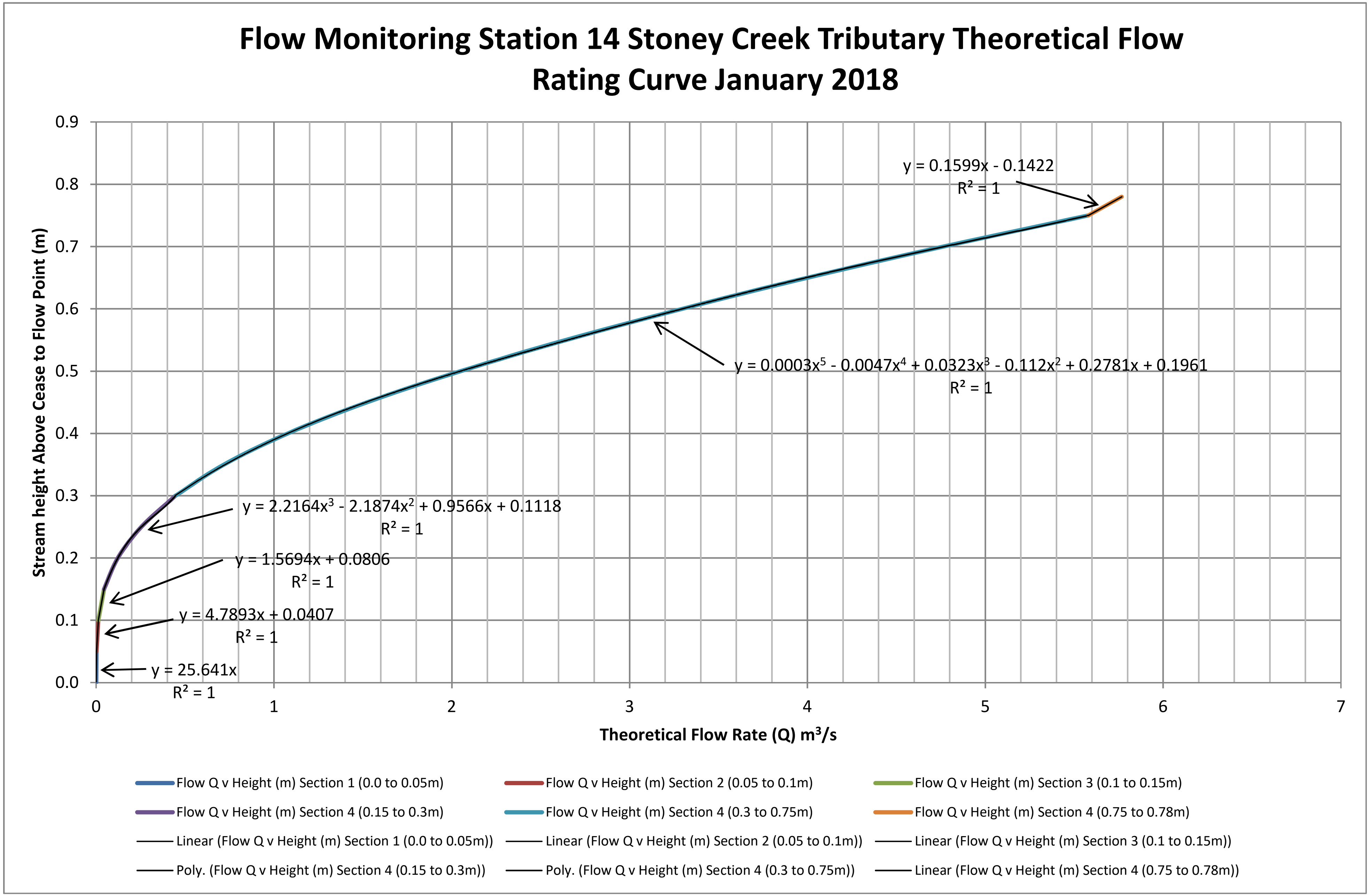
Flow Monitoring Station 13 Stoney Creek Down Theoretical Flow Curve
May 2019
y = -3E-11x⁶ + 1E-08x⁵ - 2E-06x⁴ + 0.0001x³ - 0.0055x² + 0.1325x - 0.3383
R² = 0.998
y = 0.0005x² + 0.0053x + 0.5652
R² = 1
y = 0.0001x³ - 0.0039x² + 0.0717x + 0.2298
R² = 1
y = -0.0066x² + 0.0961x + 0.1808
R² = 1
y = 0.1178x + 0.1605
R² = 1
y = 0.2552x + 0.1144
R² = 1
y = 1.7501x² + 0.5577x + 0.0382
R² = 1
y = 2.505x - 9E-18
R² = 1
Stream Height Above Cease to Flow Point (m)
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0
20
40
60
80
100
120
Theoretical Flow Rate (Q) m³/s
Flow Q v Height (m) Section 1 (0.0 to 0.05m)
Flow Q v Height (m) Section 2 (0.05 to 0.15m)
Flow Q v Height (m) Section 3 (0.15 to 0.20m)
Flow Q v Height (m) Section 4 (0.20 to 0.25m)
Flow Q v Height (m) Section 4 (0.25 to 0.45m)
Flow Q v Height (m) Section 4 (0.45 to 0.75m)
Flow Q v Height (m) Section 4 (0.75 to 0.90m)
Flow Q v Height (m) Section 4 (0.90 to 1.6m)
Linear (Flow Q v Height (m) Section 1 (0.0 to 0.05m))
Poly. (Flow Q v Height (m) Section 2 (0.05 to 0.15m))
Linear (Flow Q v Height (m) Section 3 (0.15 to 0.20m))
Linear (Flow Q v Height (m) Section 4 (0.20 to 0.25m))
Poly. (Flow Q v Height (m) Section 4 (0.25 to 0.45m))
Poly. (Flow Q v Height (m) Section 4 (0.45 to 0.75m))
Poly. (Flow Q v Height (m) Section 4 (0.75 to 0.90m))
Poly. (Flow Q v Height (m) Section 4 (0.90 to 1.6m))

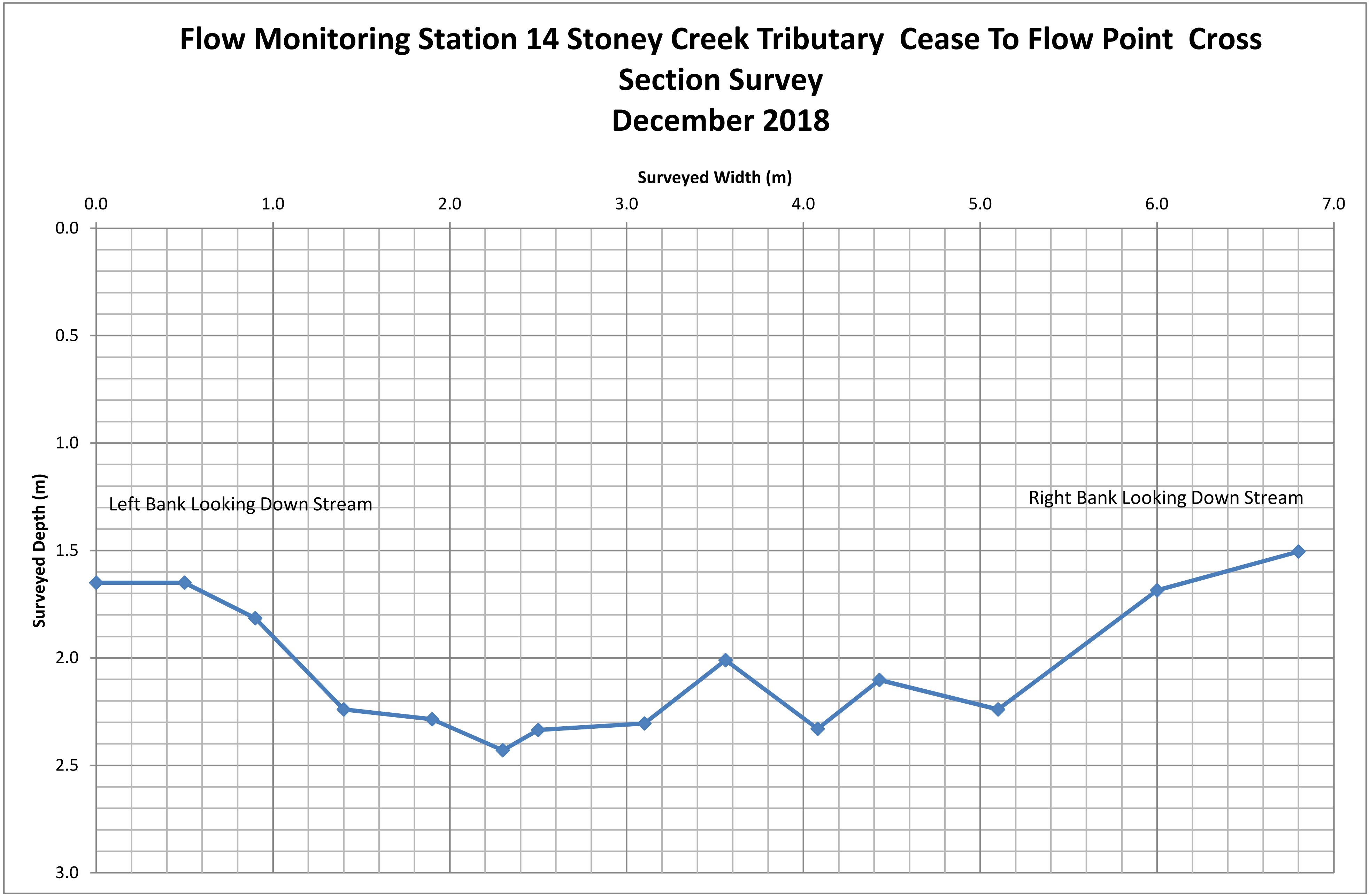
Flow Monitoring Station 13 Stoney Creek Down Cease to Flow Point Cross Section Survey December 2018



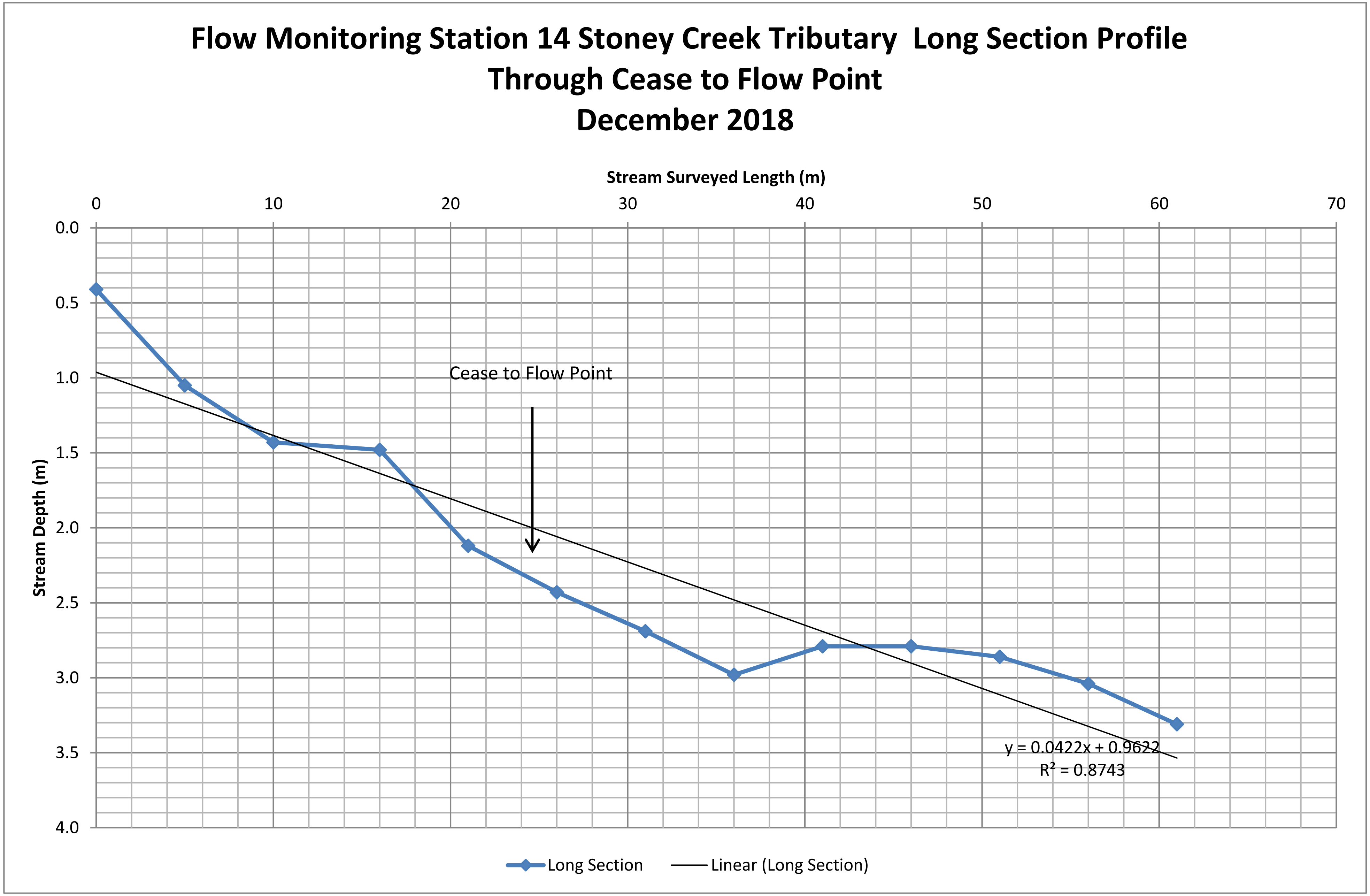


Flow Monitoring Station 13 Stoney Creek Down Long Section
Profile Through Cease to Flow Point December 2018
Stream Surveyed Length (m)
0
10
20
30
40
50
60
70
80
Stream Depth (m)
1.5
1.7
1.9
2.1
2.3
2.5
2.7
2.9
Cease to Flow Point
y = 0.0084x + 1.8706
R² = 0.5751
Long Section
Linear (Long Section)

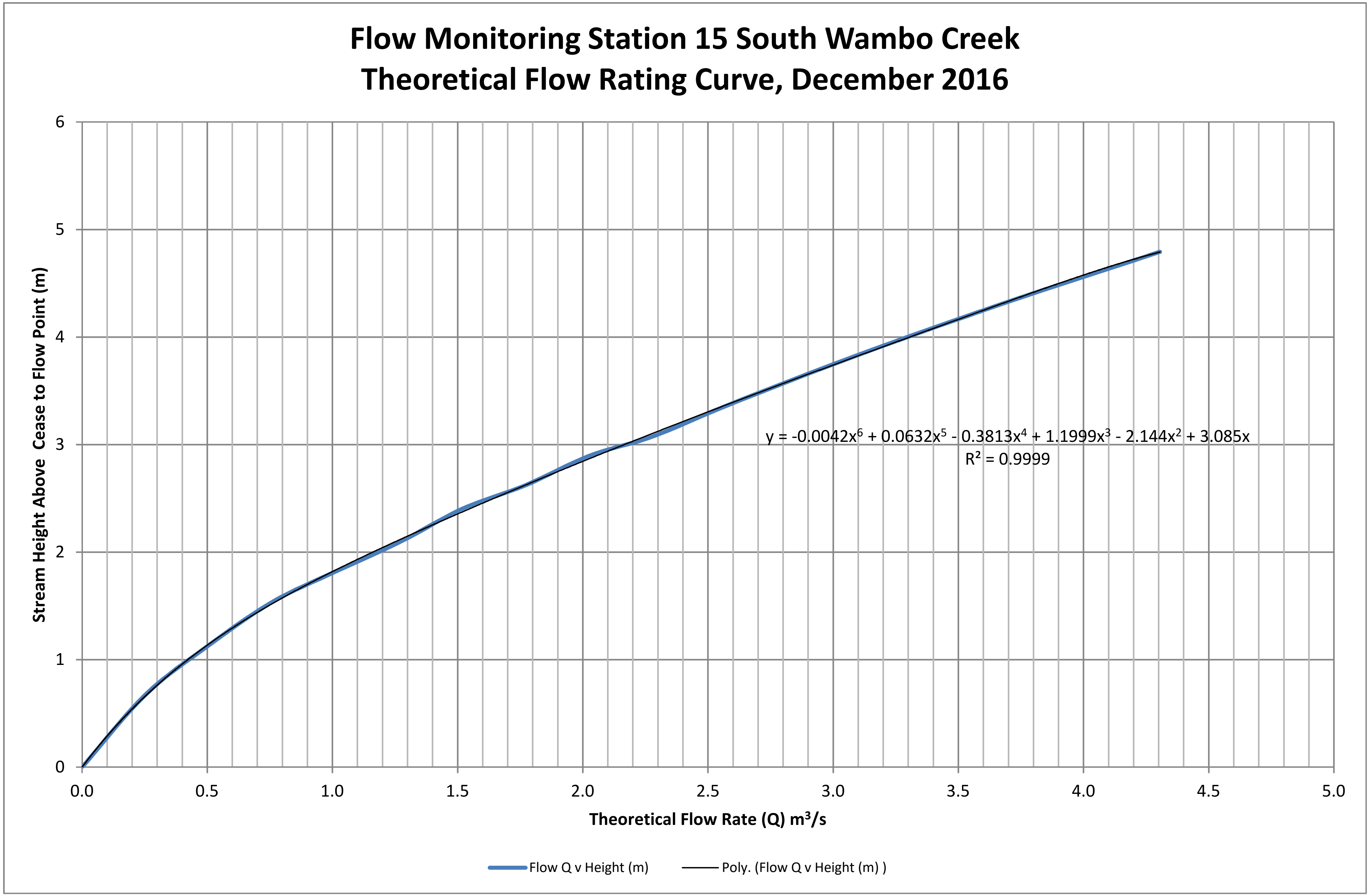

Flow Monitoring Station 14 Stoney Creek Tributary Theoretical Flow Rating Curve January 2018
y = 0.1599x - 0.1422
R² = 1
y = 0.0003x⁵ - 0.0047x⁴ + 0.0323x³ - 0.112x² + 0.2781x + 0.1961
R² = 1
y = 2.2164x³ - 2.1874x² + 0.9566x + 0.1118
R² = 1
y = 1.5694x + 0.0806
R² = 1
y = 4.7893x + 0.0407
R² = 1
y = 25.641x
R² = 1
Stream height Above Cease to Flow Point (m)
Theoretical Flow Rate (Q) m³/s
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
0
1
2
3
4
5
6
7
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))



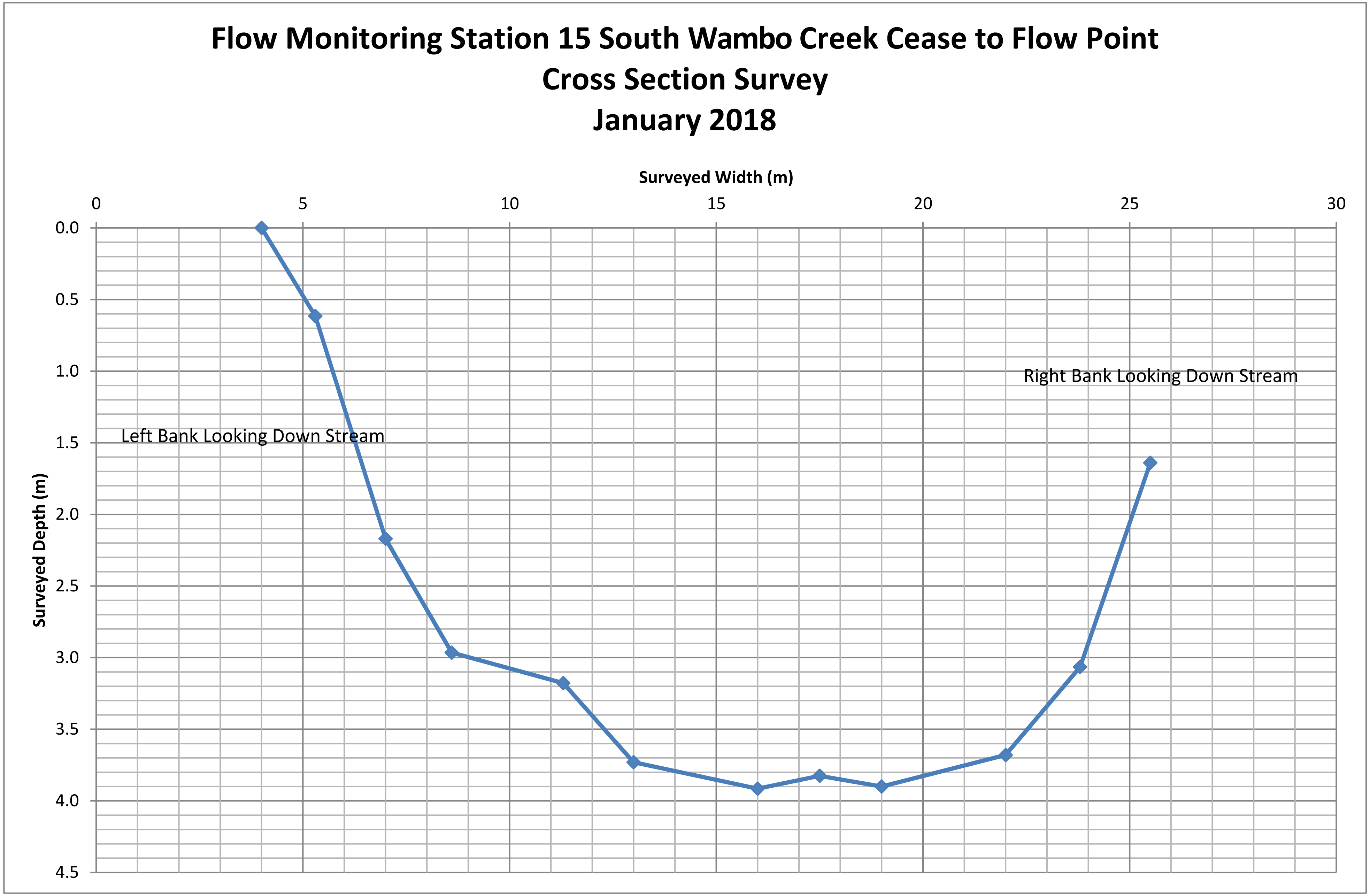
Flow Monitoring Station 14 Stoney Creek Tributary Cease To Flow Point Cross Section Survey
December 2018
Surveyed Width (m)
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
Surveyed Depth (m)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Left Bank Looking Down Stream
Right Bank Looking Down Stream

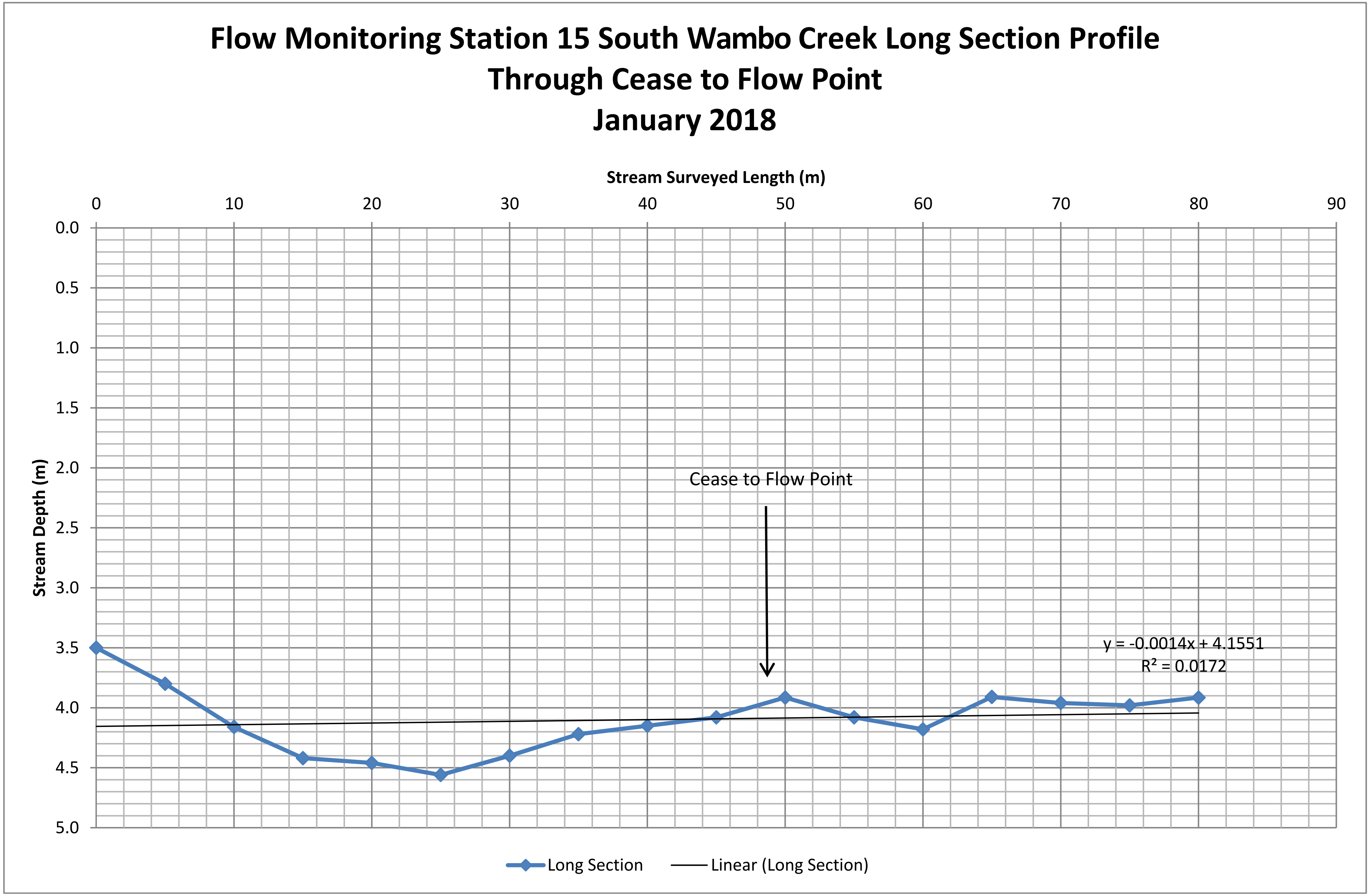


Flow Monitoring Station 14 Stoney Creek Tributary Long Section Profile
Through Cease to Flow Point
December 2018
Stream Surveyed Length (m)
0
10
20
30
40
50
60
70
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
Stream Depth (m)
Cease to Flow Point
y = 0.0422x + 0.9622
R² = 0.8743
Long Section
Linear (Long Section)

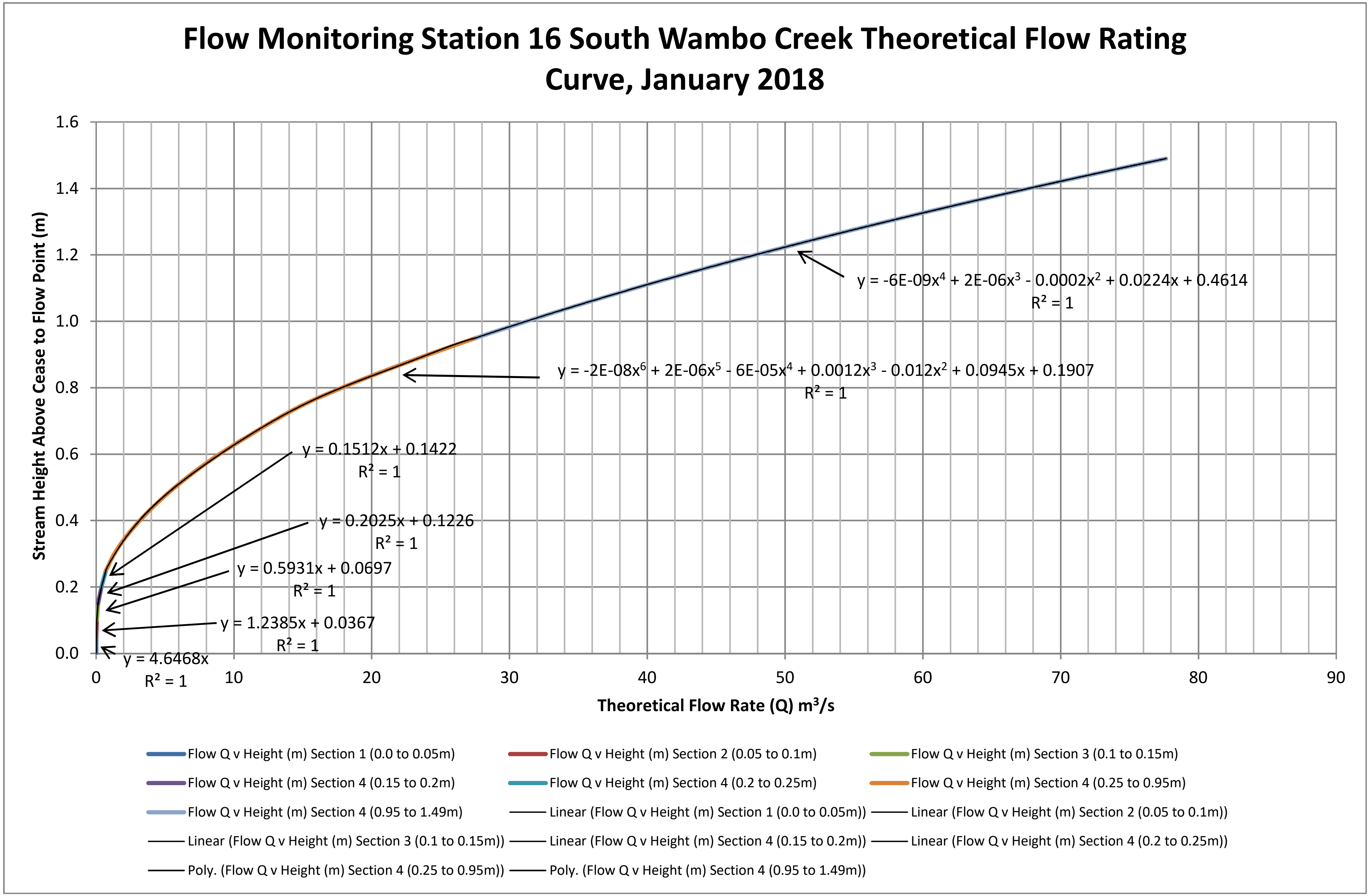


Flow Monitoring Station 15 South Wambo Creek
Theoretical Flow Rating Curve, December 2016
Stream Height Above Cease to Flow Point (m)
Theoretical Flow Rate (Q) m³/s
$y = -0.0042x^6 + 0.0632x^5 - 0.3813x^4 + 1.1999x^3 - 2.144x^2 + 3.085x$
$R^2 = 0.9999$
Flow Q v Height (m)
Poly. (Flow Q v Height (m))
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

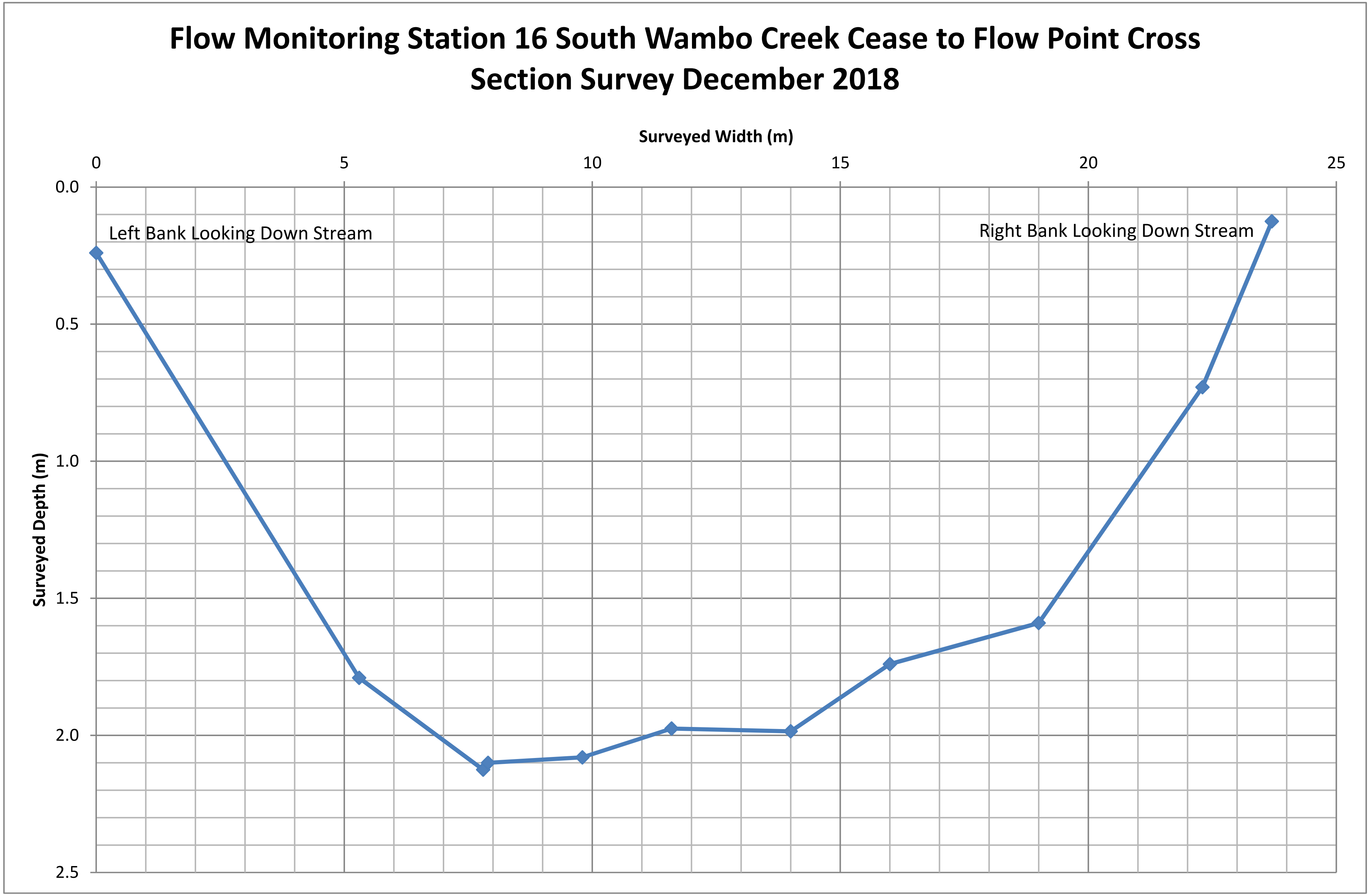

Flow Monitoring Station 15 South Wambo Creek Cease to Flow Point
Cross Section Survey
January 2018
Surveyed Width (m)
0
5
10
15
20
25
30
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
Surveyed Depth (m)
Left Bank Looking Down Stream
Right Bank Looking Down Stream



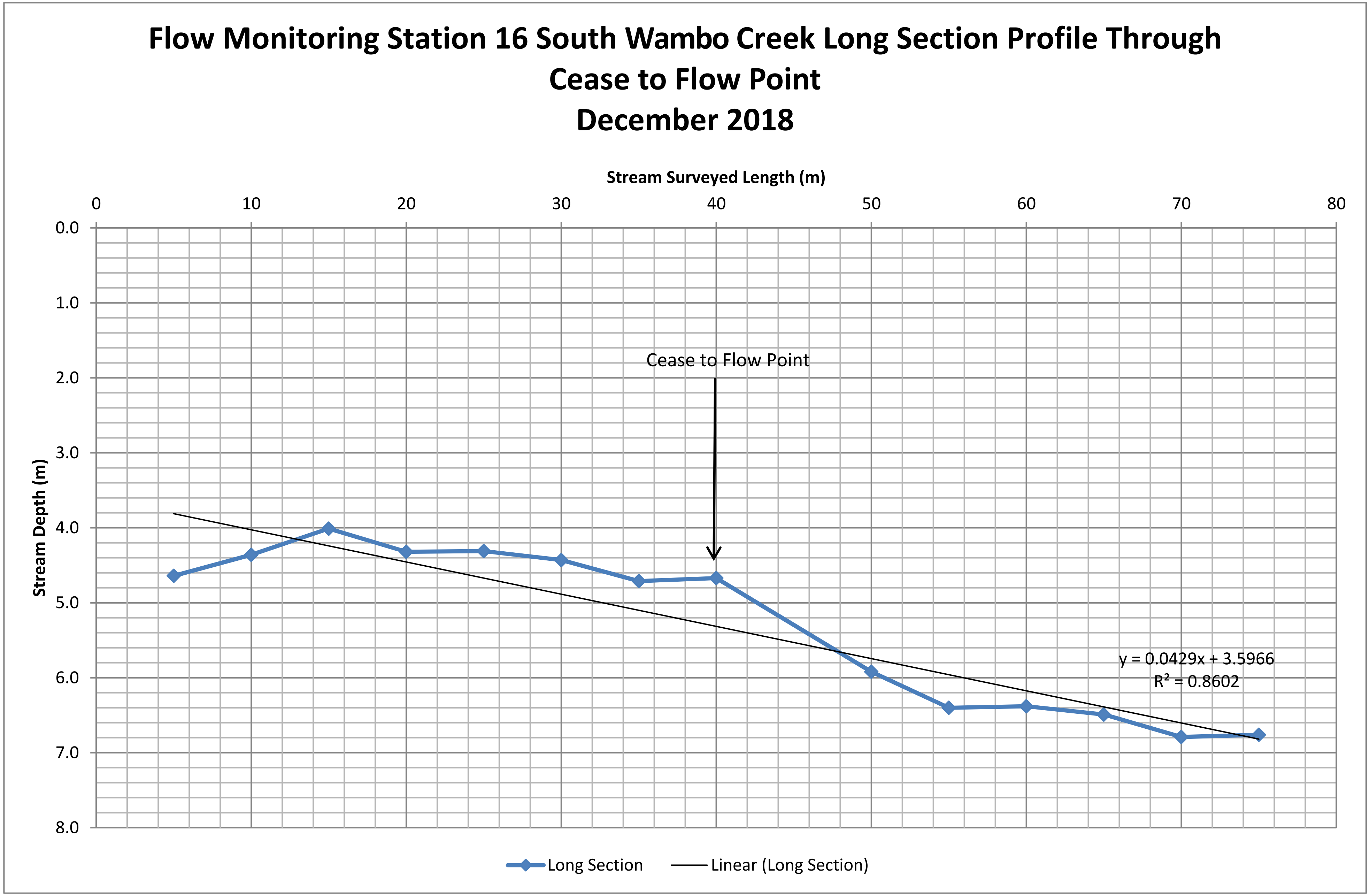
Flow Monitoring Station 15 South Wambo Creek Long Section Profile
Through Cease to Flow Point
January 2018
Stream Surveyed Length (m)
0
10
20
30
40
50
60
70
80
90
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Stream Depth (m)
Cease to Flow Point
y = -0.0014x + 4.1551
R² = 0.0172
Long Section
Linear (Long Section)



Flow Monitoring Station 16 South Wambo Creek Theoretical Flow Rating Curve, January 2018
Stream Height Above Cease to Flow Point (m)
Theoretical Flow Rate (Q) m³/s
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0
10
20
30
40
50
60
70
80
90
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 16 South Wambo Creek Cease to Flow Point Cross Section Survey December 2018
Surveyed Width (m)
0
5
10
15
20
25
0.0
0.5
1.0
1.5
2.0
2.5
Surveyed Depth (m)
Left Bank Looking Down Stream
Right Bank Looking Down Stream



Flow Monitoring Station 16 South Wambo Creek Long Section Profile Through
Cease to Flow Point
December 2018
Stream Surveyed Length (m)
0
10
20
30
40
50
60
70
80
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
Stream Depth (m)
Cease to Flow Point
y = 0.0429x + 3.5966
R² = 0.8602
Long Section
Linear (Long Section)

Appendix C

Stream Height, Theoretical Flow, Daily and Cumulative Rainfall Charts

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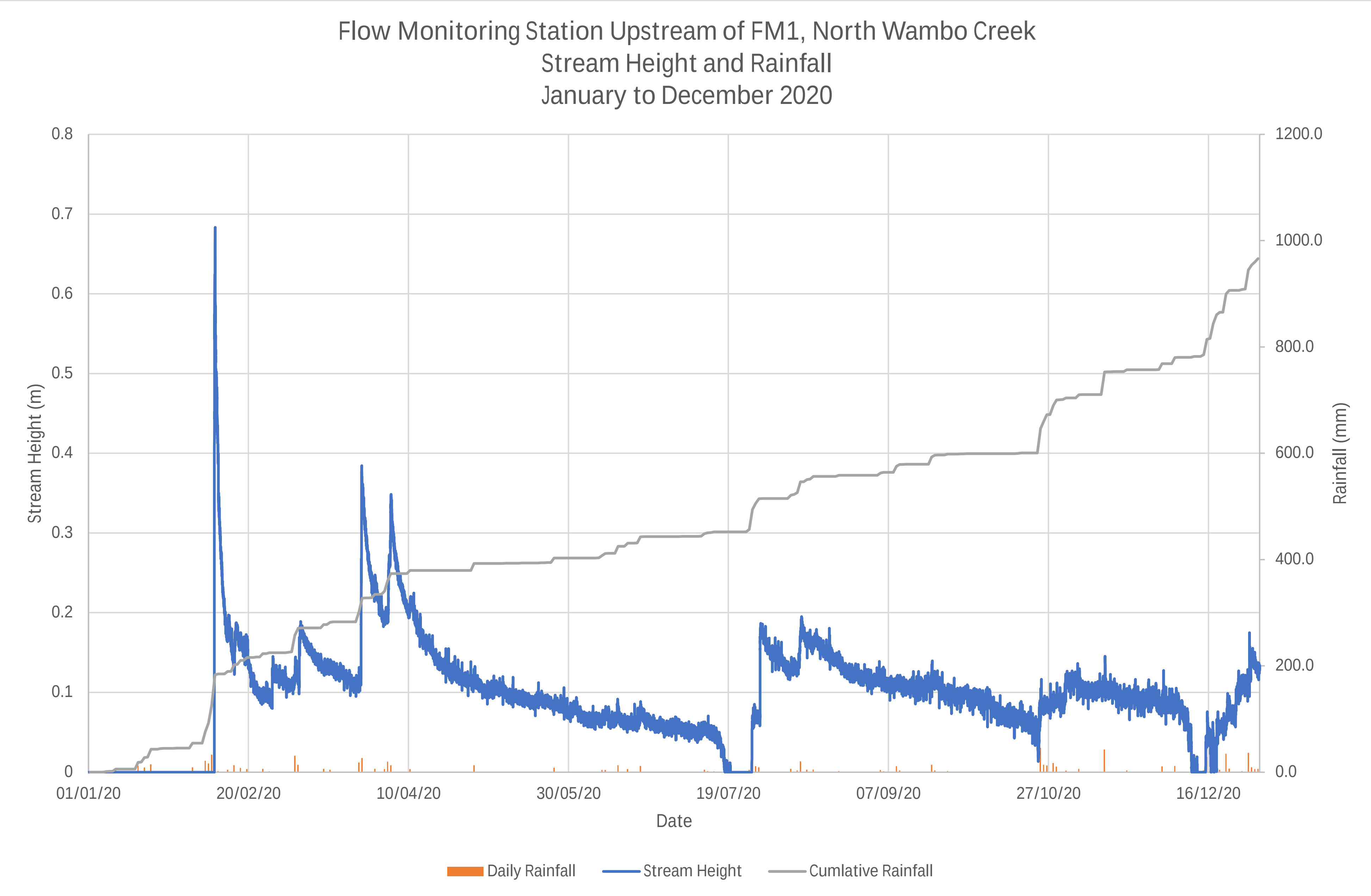
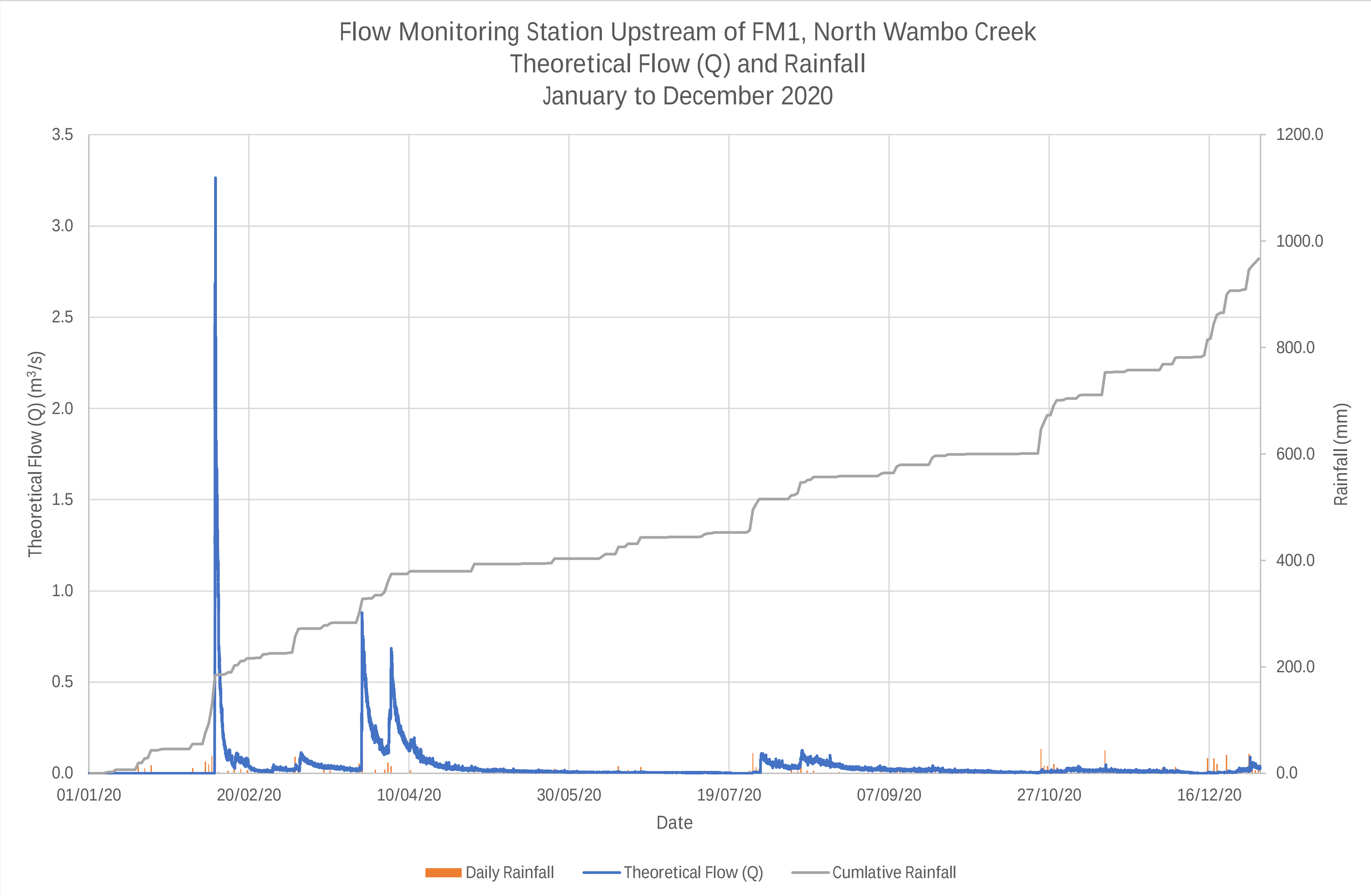
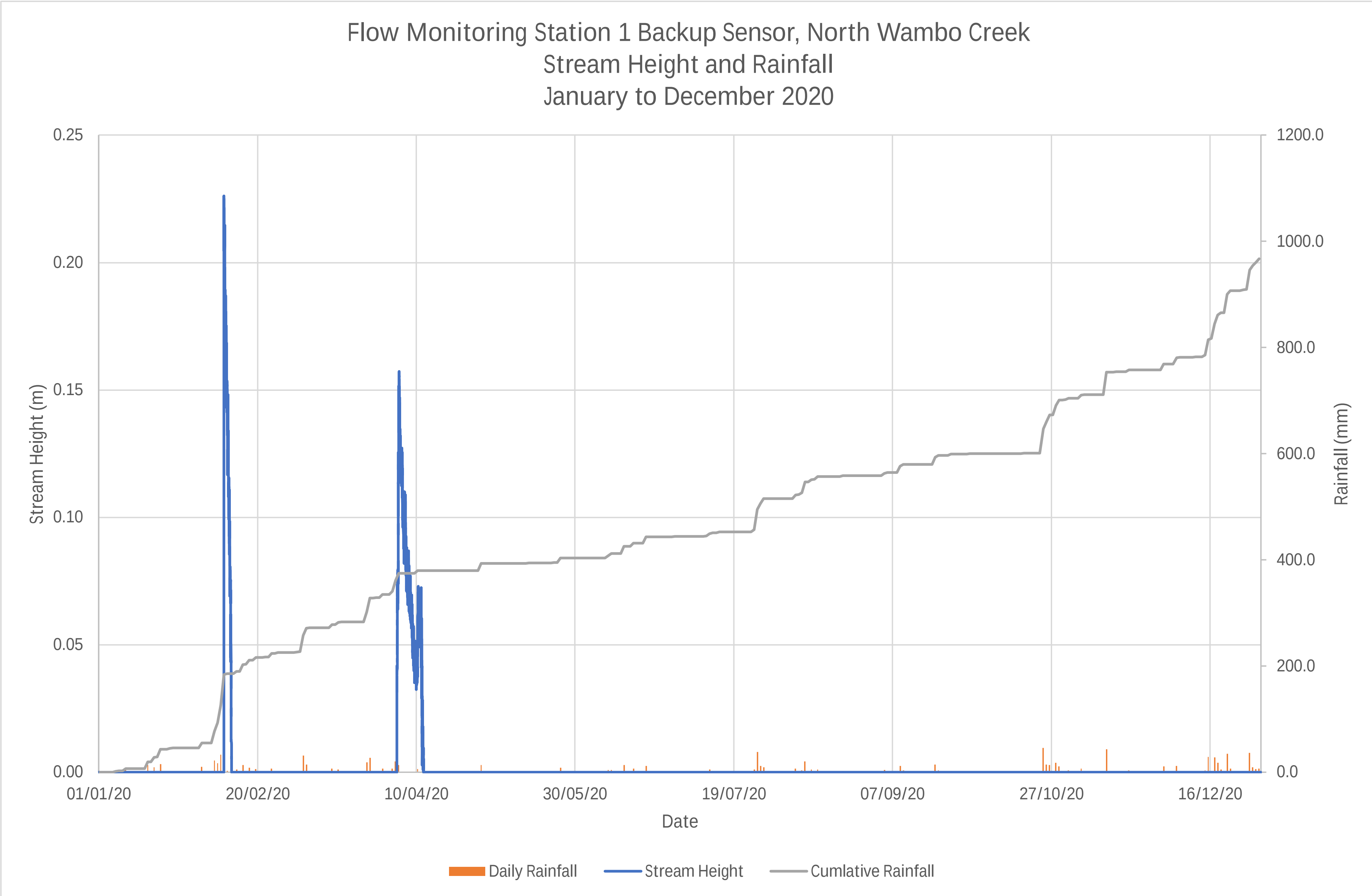
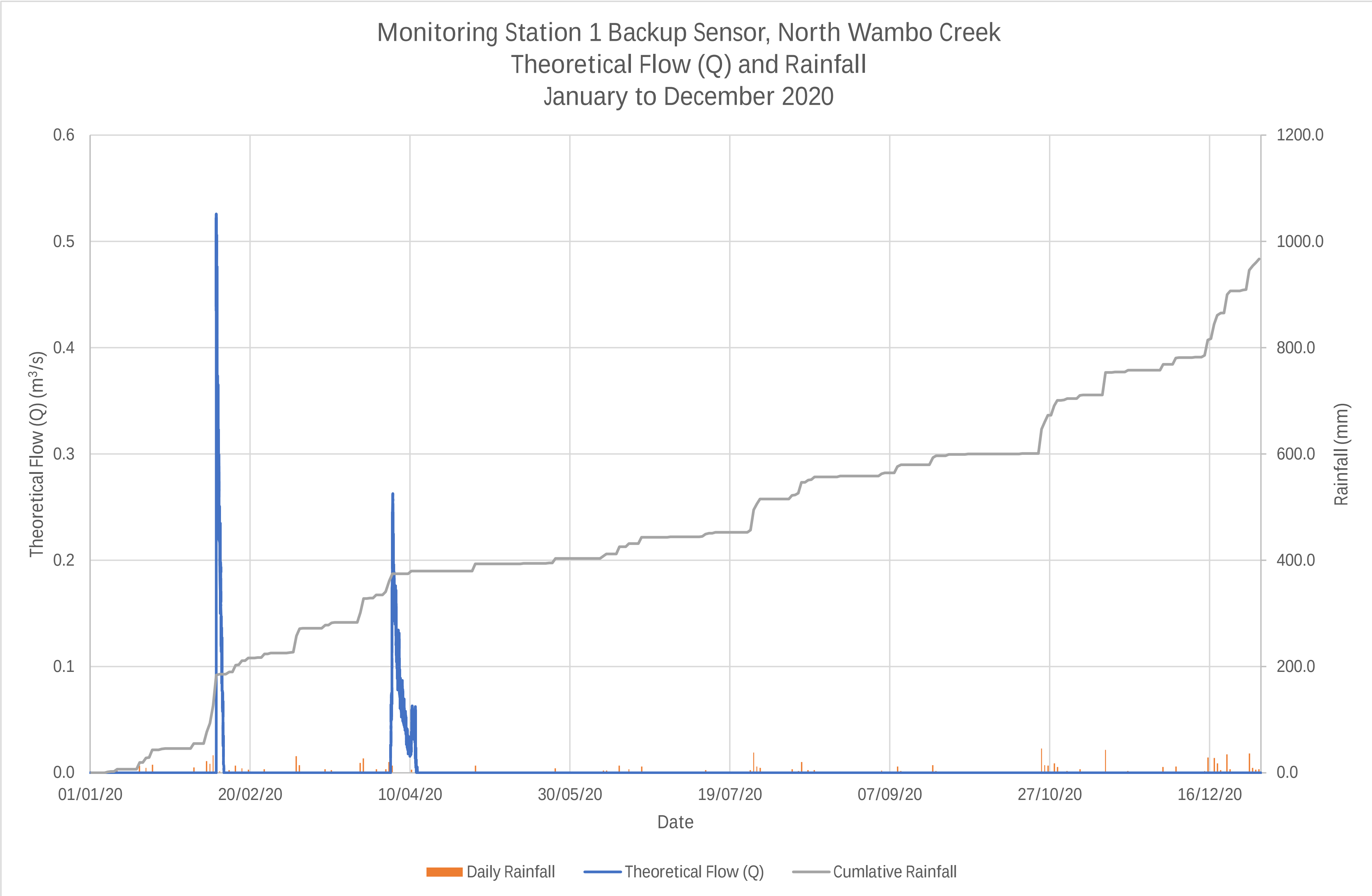


Flow Monitoring Station Upstream of FM1, North Wambo Creek
Stream Height and Rainfall
January to December 2020
Stream Height (m)
Rainfall (mm)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1200.0
1000.0
800.0
600.0
400.0
200.0
0.0
01/01/20
20/02/20
10/04/20
30/05/20
19/07/20
07/09/20
27/10/20
16/12/20
Date
Daily Rainfall
Stream Height
Cumlative Rainfall

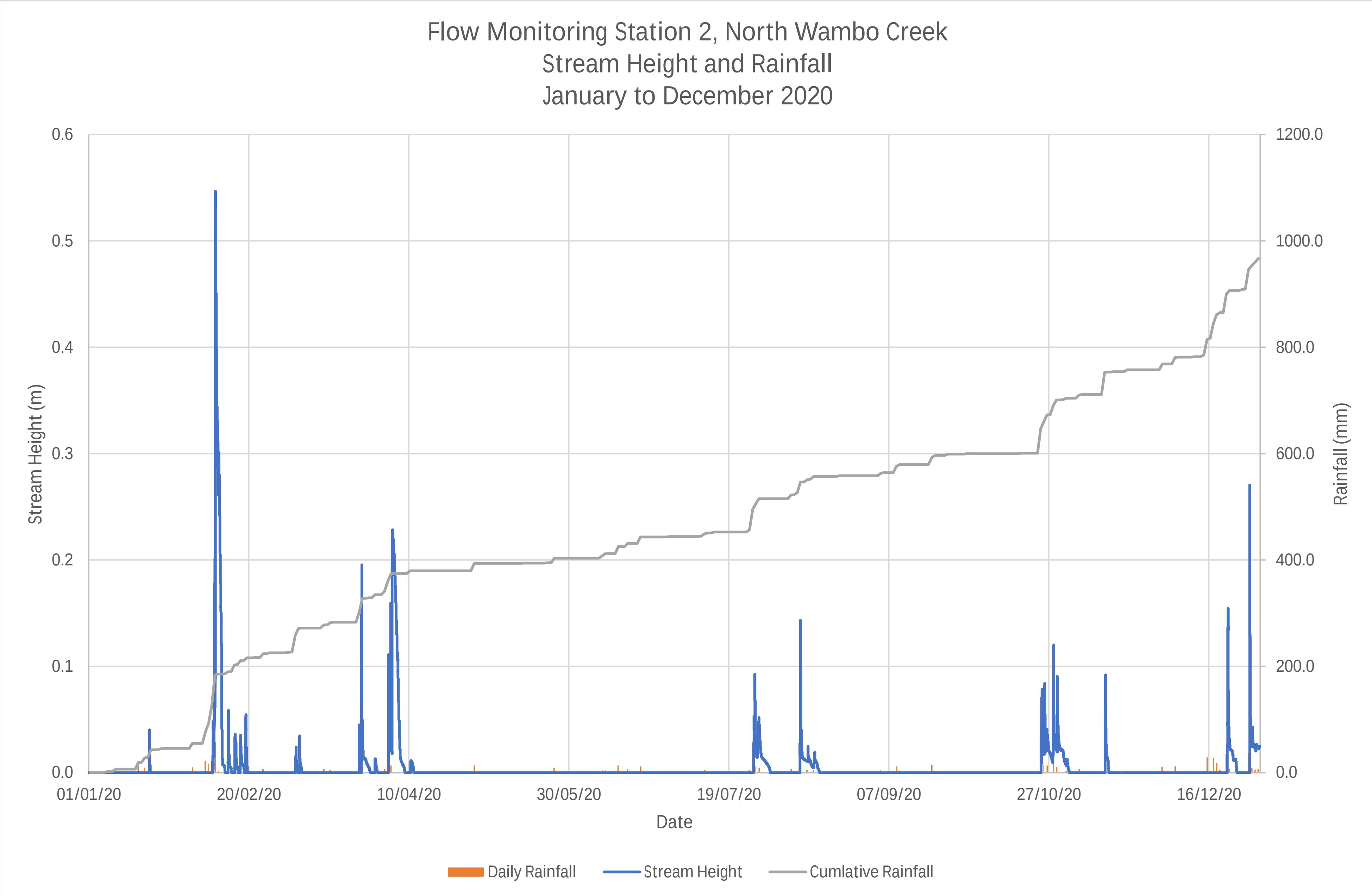


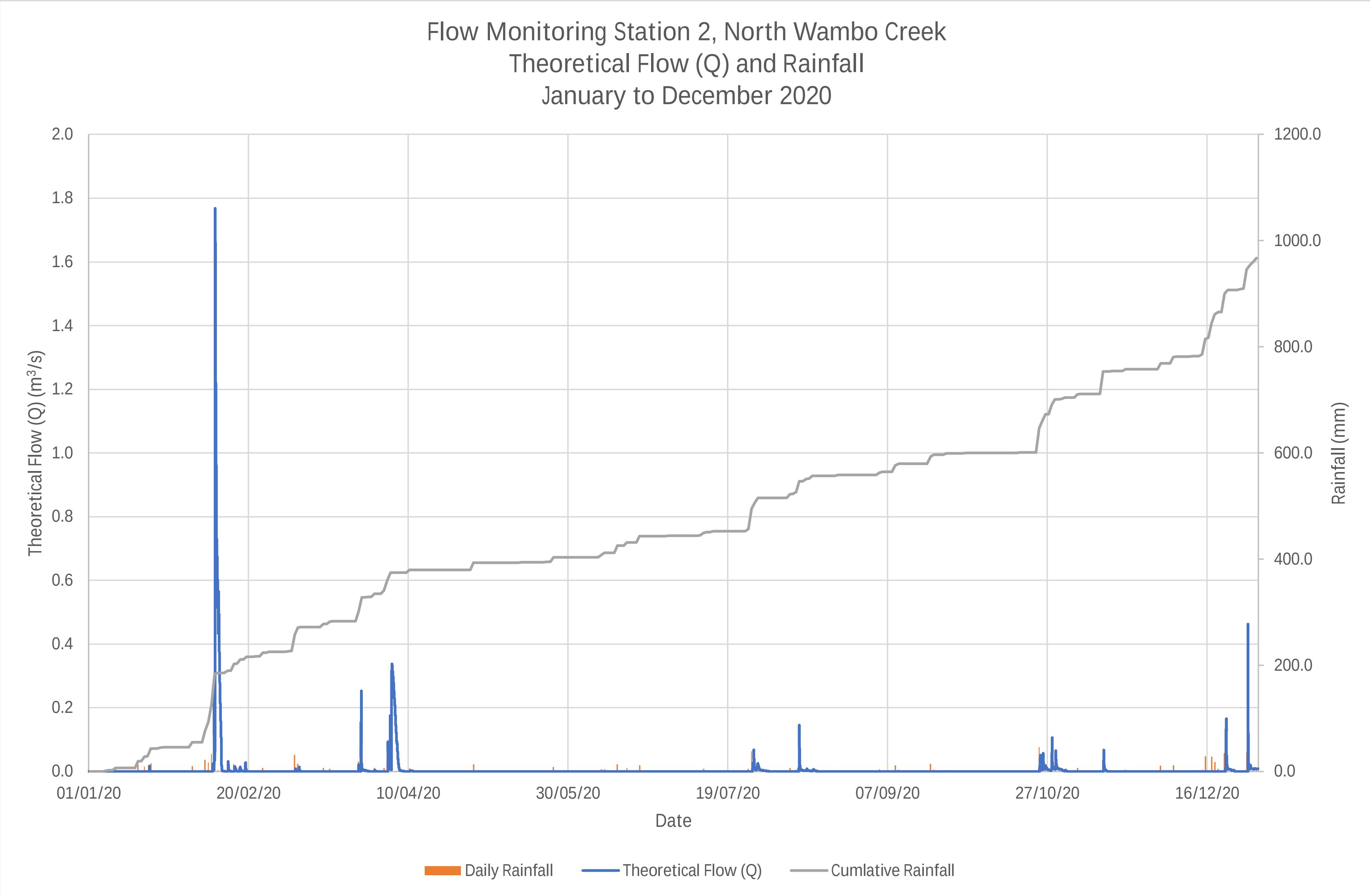
Flow Monitoring Station Upstream of FM1, North Wambo Creek
Theoretical Flow (Q) and Rainfall
January to December 2020
Theoretical Flow (Q) (m³/s)
Rainfall (mm)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1200.0
1000.0
800.0
600.0
400.0
200.0
0.0
01/01/20
20/02/20
10/04/20
30/05/20
19/07/20
07/09/20
27/10/20
16/12/20
Date
Daily Rainfall
Theoretical Flow (Q)
Cumlative Rainfall

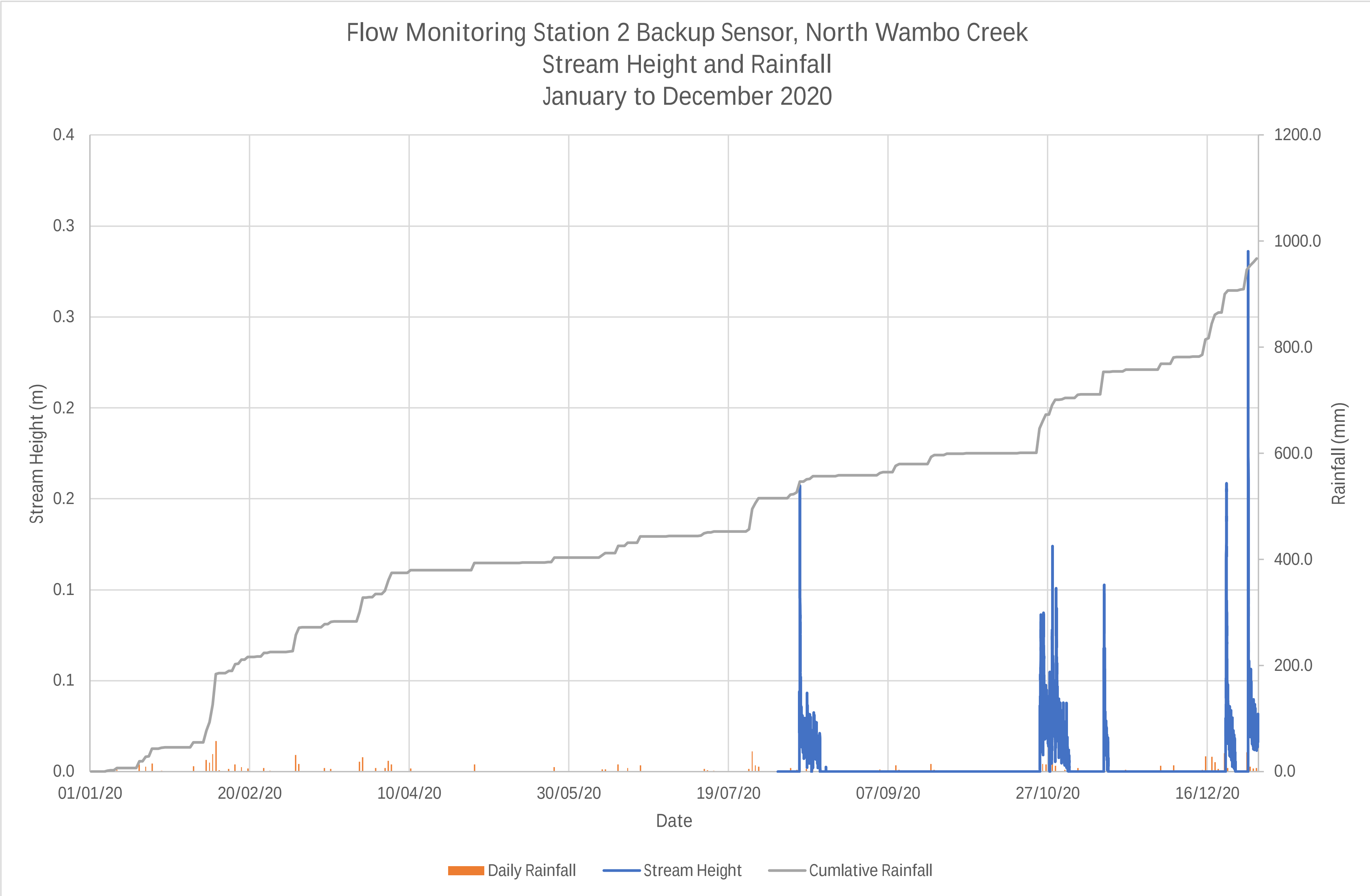

Flow Monitoring Station 1 Backup Sensor, North Wambo Creek
Stream Height and Rainfall
January to December 2020
Stream Height (m)
0.25
0.20
0.15
0.10
0.05
0.00
Rainfall (mm)
1200.0
1000.0
800.0
600.0
400.0
200.0
0.0
01/01/20
20/02/20
10/04/20
30/05/20
19/07/20
07/09/20
27/10/20
16/12/20
Date
Daily Rainfall
Stream Height
Cumlative Rainfall

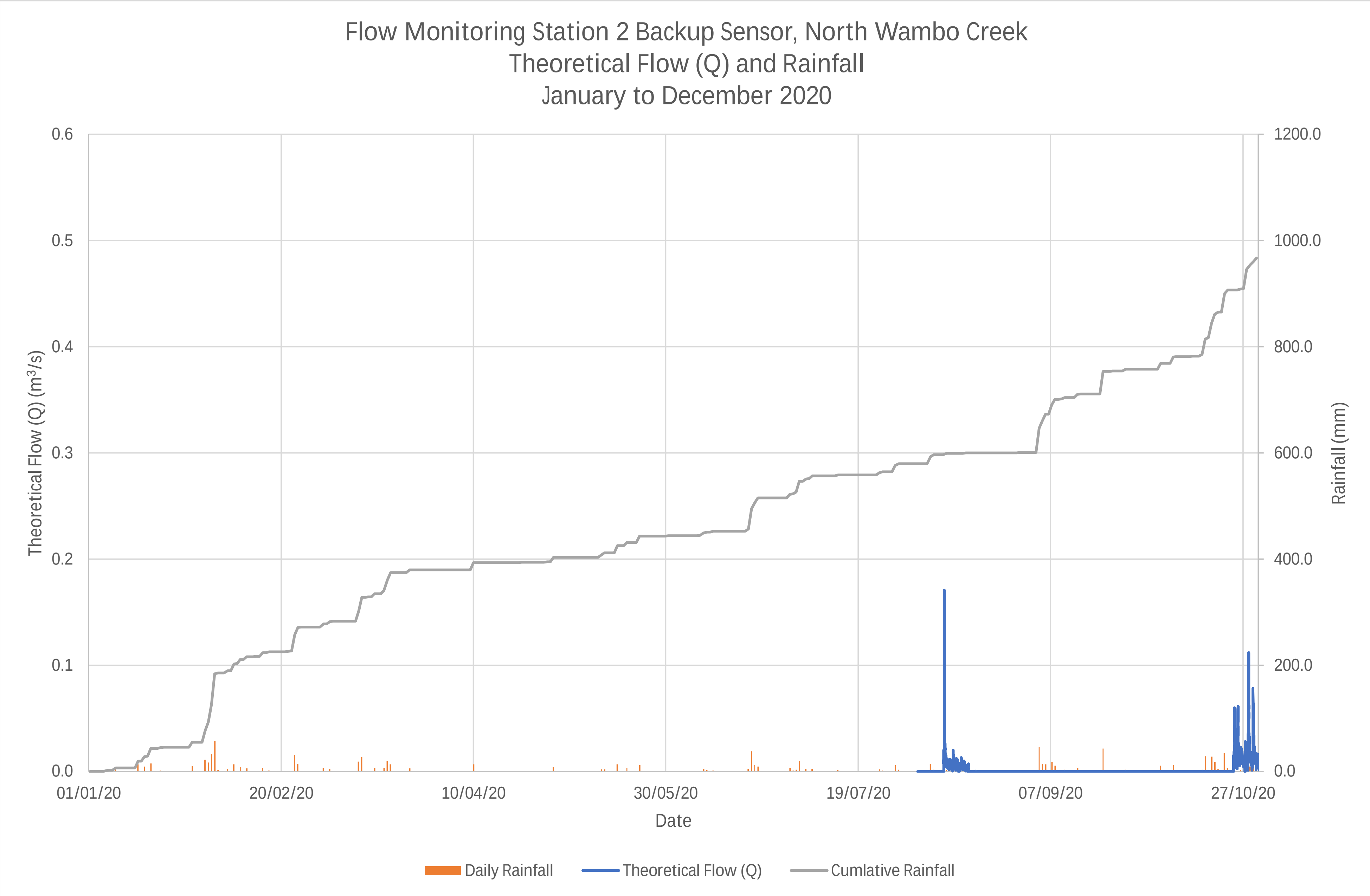


Monitoring Station 1 Backup Sensor, North Wambo Creek
Theoretical Flow (Q) and Rainfall
January to December 2020
Theoretical Flow (Q) (m3/s)
Rainfall (mm)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1200.0
1000.0
800.0
600.0
400.0
200.0
0.0
01/01/20
20/02/20
10/04/20
30/05/20
19/07/20
07/09/20
27/10/20
16/12/20
Date
Daily Rainfall
Theoretical Flow (Q)
Cumlative Rainfall

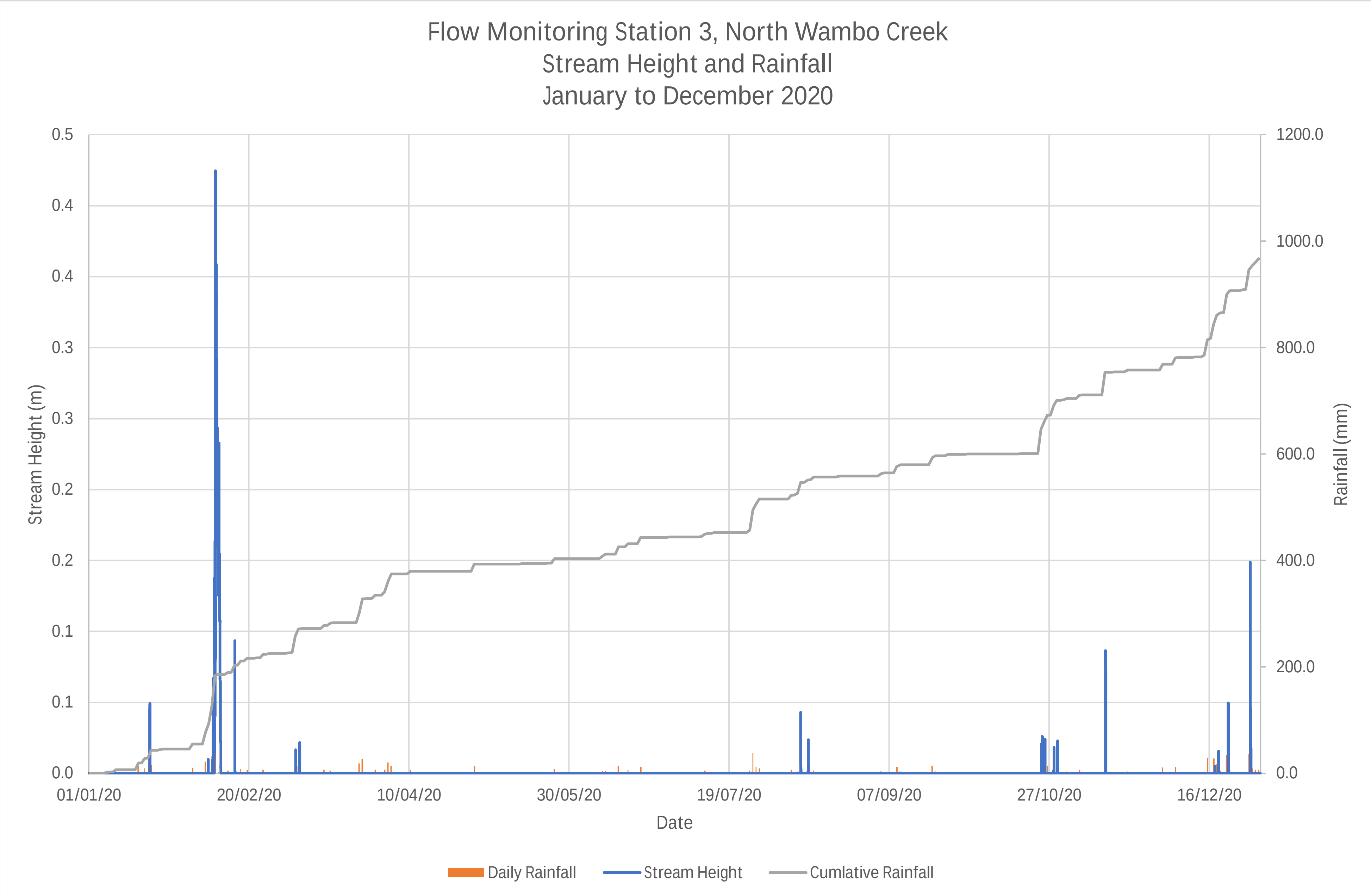

Flow Monitoring Station 2, North Wambo Creek
Stream Height and Rainfall
January to December 2020
Stream Height (m)
Rainfall (mm)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1200.0
1000.0
800.0
600.0
400.0
200.0
0.0
01/01/20
20/02/20
10/04/20
30/05/20
19/07/20
07/09/20
27/10/20
16/12/20
Date
Daily Rainfall
Stream Height
Cumlative Rainfall

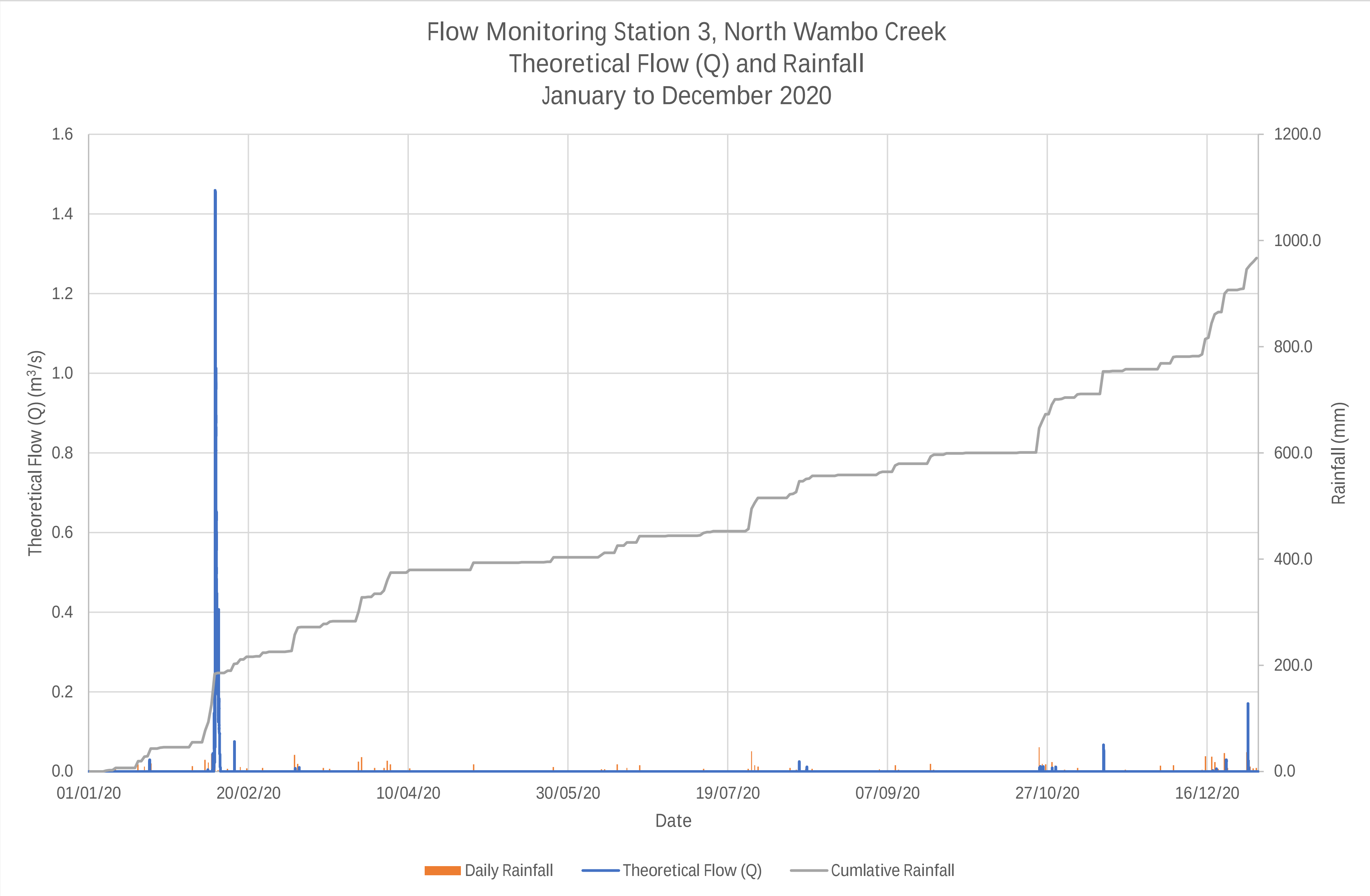

Flow Monitoring Station 2, North Wambo Creek
Theoretical Flow (Q) and Rainfall
January to December 2020
Theoretical Flow (Q) (m3/s)
Rainfall (mm)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1200.0
1000.0
800.0
600.0
400.0
200.0
0.0
01/01/20
20/02/20
10/04/20
30/05/20
19/07/20
07/09/20
27/10/20
16/12/20
Date
Daily Rainfall
Theoretical Flow (Q)
Cumlative Rainfall


Flow Monitoring Station 2 Backup Sensor, North Wambo Creek
Stream Height and Rainfall
January to December 2020
Stream Height (m)
0.4
0.3
0.3
0.2
0.2
0.1
0.1
0.0
Rainfall (mm)
1200.0
1000.0
800.0
600.0
400.0
200.0
0.0
01/01/20
20/02/20
10/04/20
30/05/20
19/07/20
07/09/20
27/10/20
16/12/20
Date
Daily Rainfall
Stream Height
Cumlative Rainfall

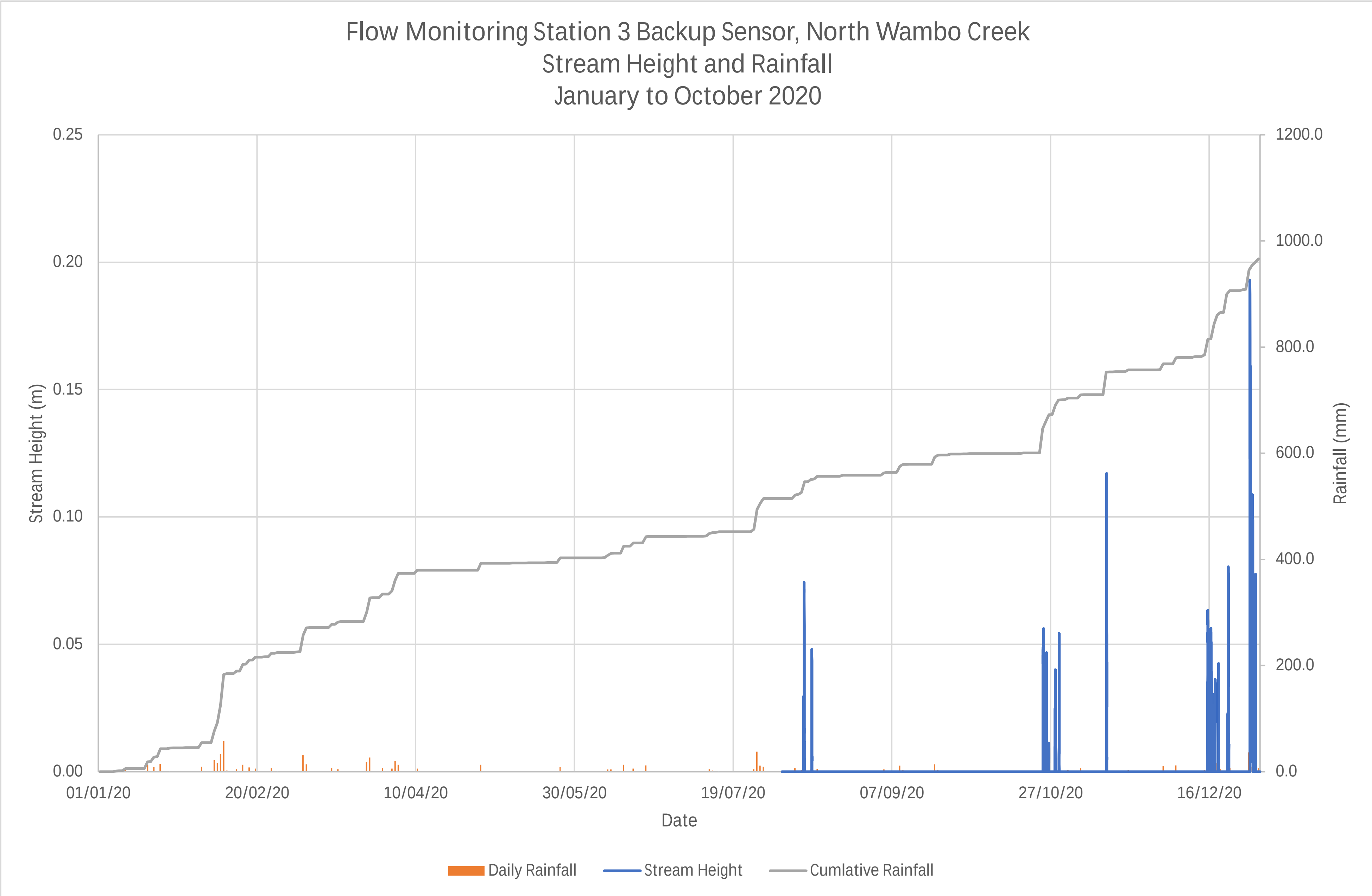


Flow Monitoring Station 2 Backup Sensor, North Wambo Creek
Theoretical Flow (Q) and Rainfall
January to December 2020
Theoretical Flow (Q) (m³/s)
Rainfall (mm)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.0
200.0
400.0
600.0
800.0
1000.0
1200.0
01/01/20
20/02/20
10/04/20
30/05/20
19/07/20
07/09/20
27/10/20
Date
Daily Rainfall
Theoretical Flow (Q)
Cumlative Rainfall

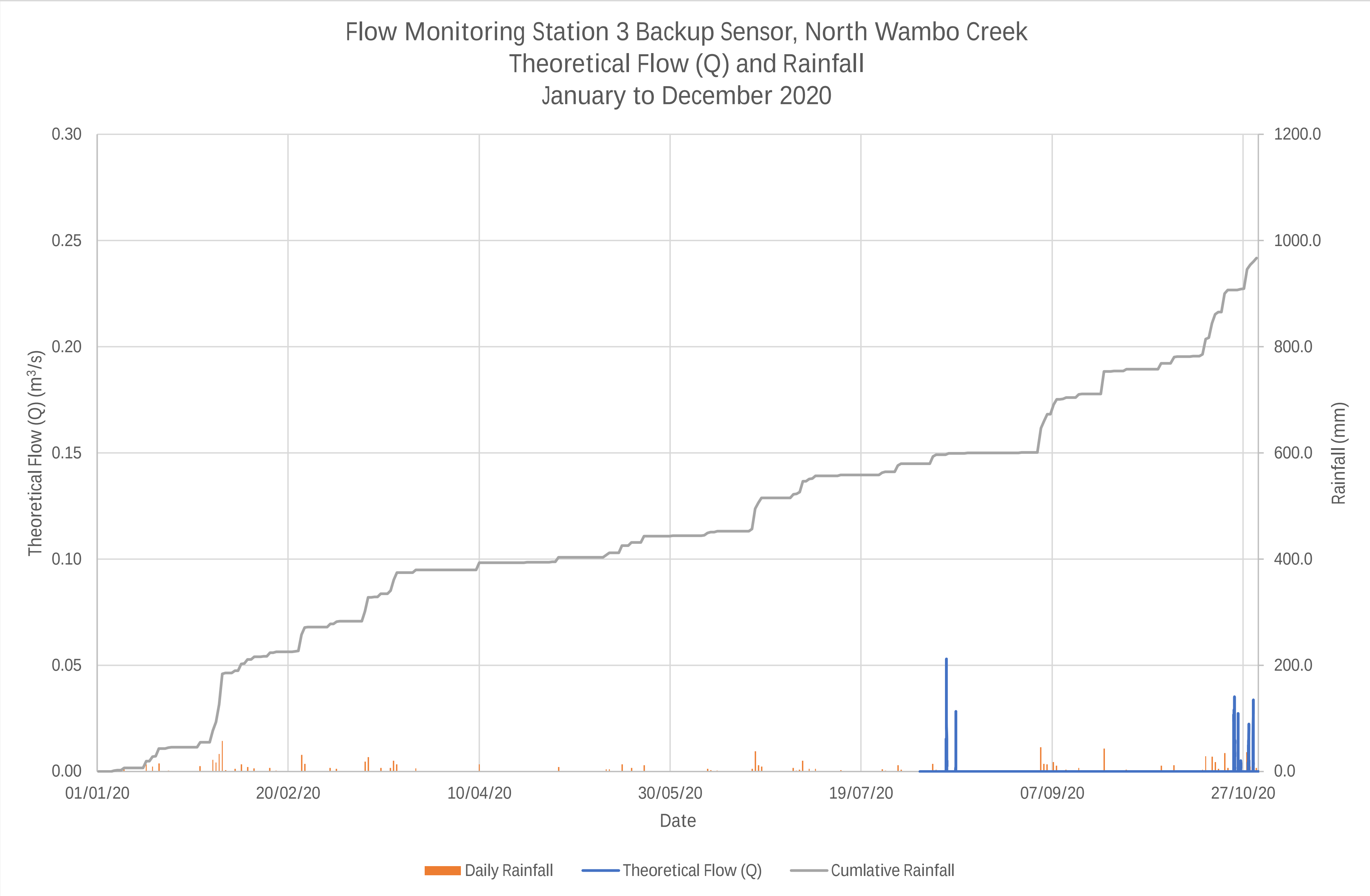

Flow Monitoring Station 3, North Wambo Creek
Stream Height and Rainfall
January to December 2020
Stream Height (m)
Rainfall (mm)
0.5
0.4
0.4
0.3
0.3
0.2
0.2
0.1
0.1
0.0
1200.0
1000.0
800.0
600.0
400.0
200.0
0.0
01/01/20
20/02/20
10/04/20
30/05/20
19/07/20
07/09/20
27/10/20
16/12/20
Date
Daily Rainfall
Stream Height
Cumlative Rainfall



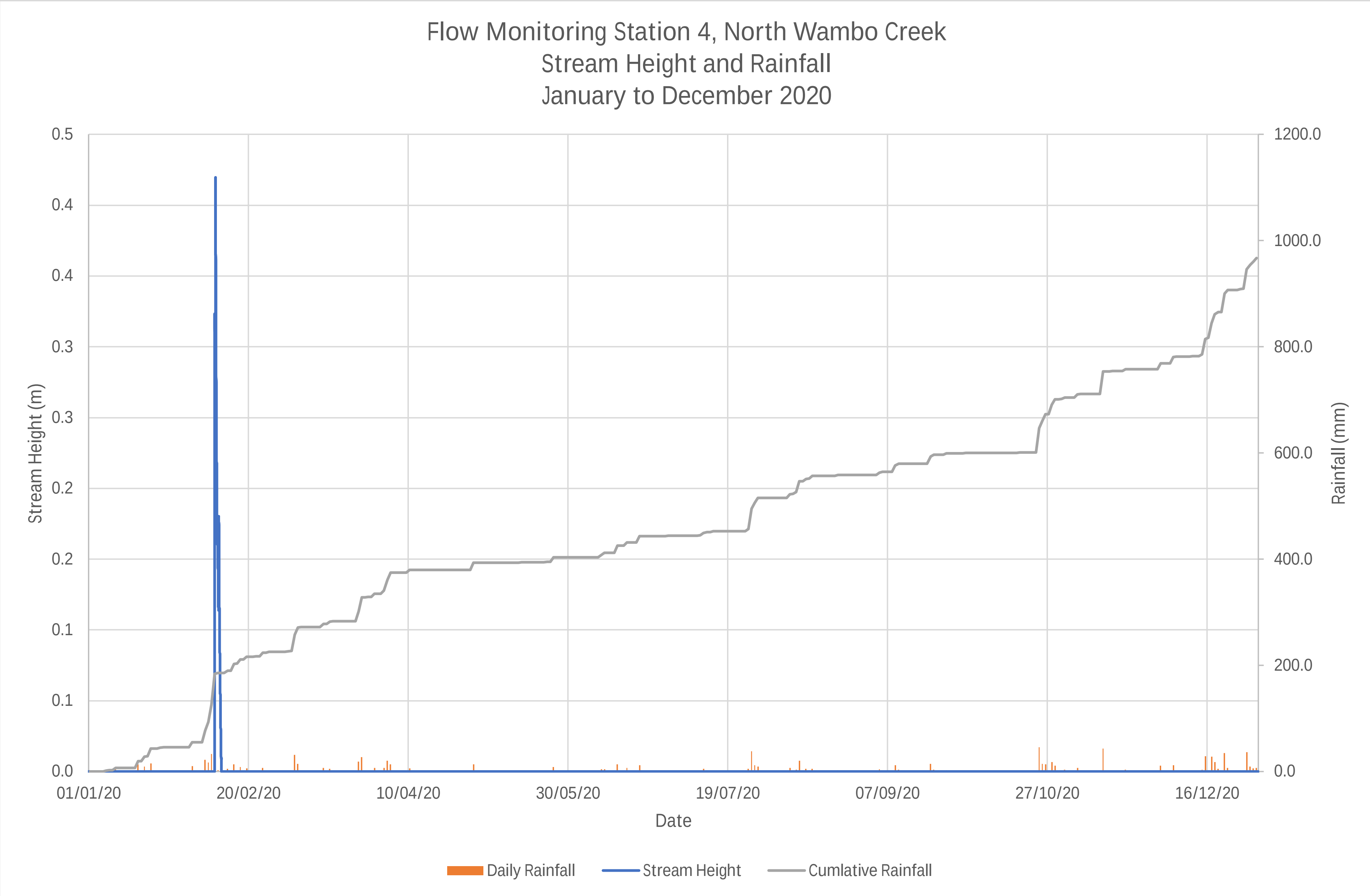
Flow Monitoring Station 3, North Wambo Creek
Theoretical Flow (Q) and Rainfall
January to December 2020
Theoretical Flow (Q) (m^3/s)
Rainfall (mm)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1200.0
1000.0
800.0
600.0
400.0
200.0
0.0
01/01/20
20/02/20
10/04/20
30/05/20
19/07/20
07/09/20
27/10/20
16/12/20
Date
Daily Rainfall
Theoretical Flow (Q)
Cumlative Rainfall



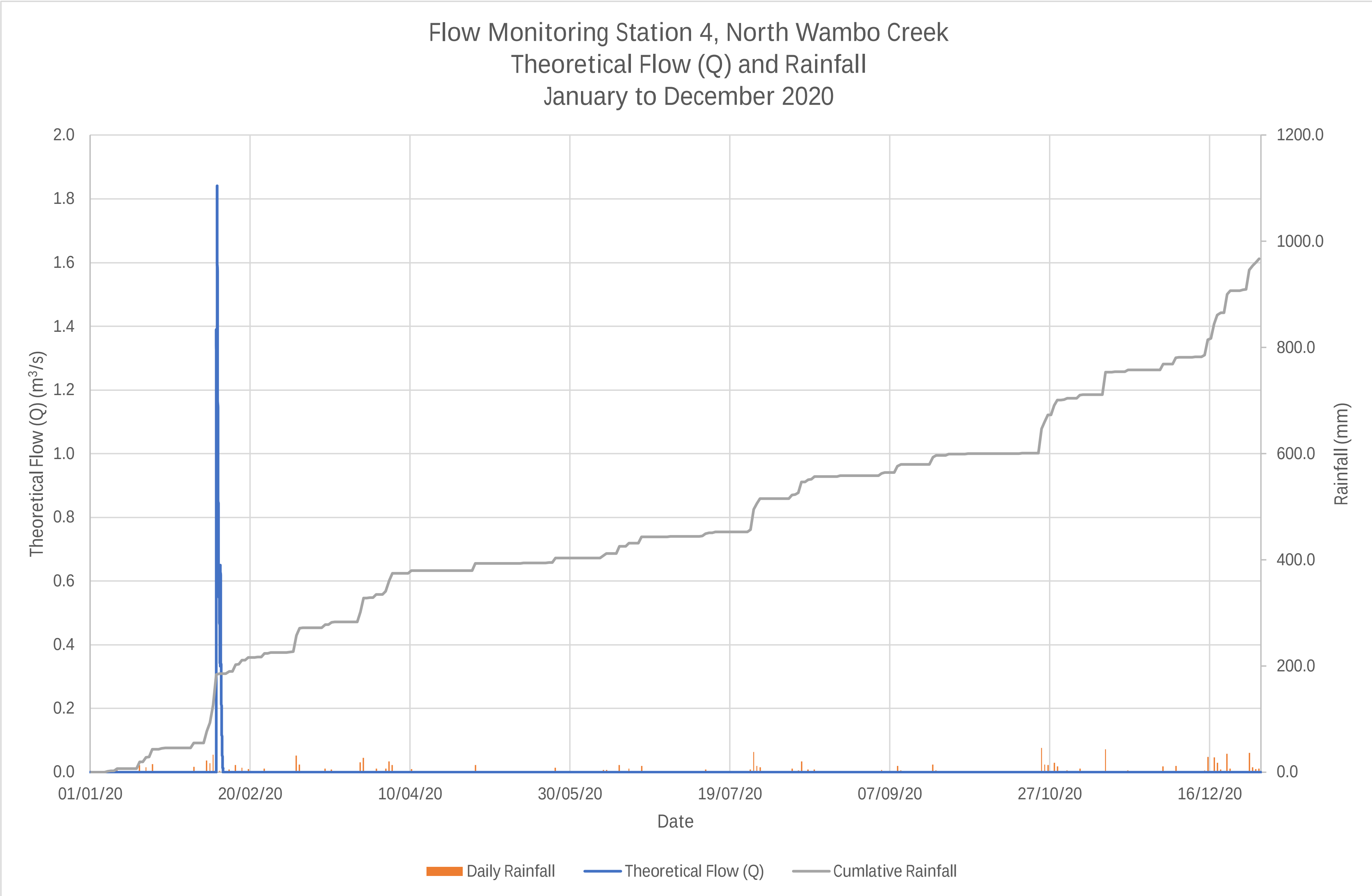
Flow Monitoring Station 3 Backup Sensor, North Wambo Creek
Stream Height and Rainfall
January to October 2020
Stream Height (m)
0.25
0.20
0.15
0.10
0.05
0.00
Rainfall (mm)
1200.0
1000.0
800.0
600.0
400.0
200.0
0.0
01/01/20
20/02/20
10/04/20
30/05/20
19/07/20
07/09/20
27/10/20
16/12/20
Date
Daily Rainfall
Stream Height
Cumlative Rainfall

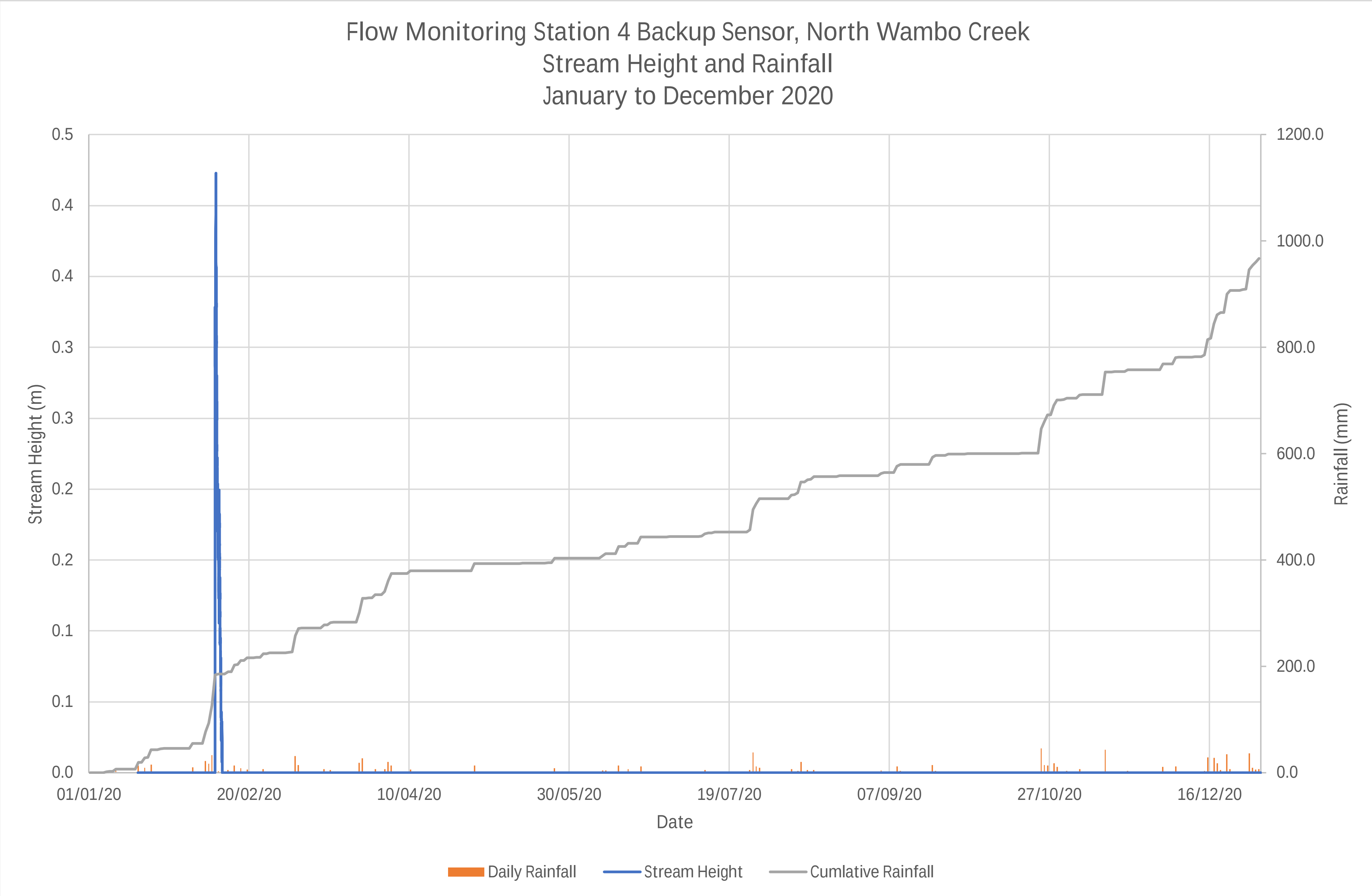


Flow Monitoring Station 3 Backup Sensor, North Wambo Creek
Theoretical Flow (Q) and Rainfall
January to December 2020
Theoretical Flow (Q) (m³/s)
Rainfall (mm)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
1200.0
1000.0
800.0
600.0
400.0
200.0
0.0
01/01/20
20/02/20
10/04/20
30/05/20
19/07/20
07/09/20
27/10/20
Date
Daily Rainfall
Theoretical Flow (Q)
Cumlative Rainfall

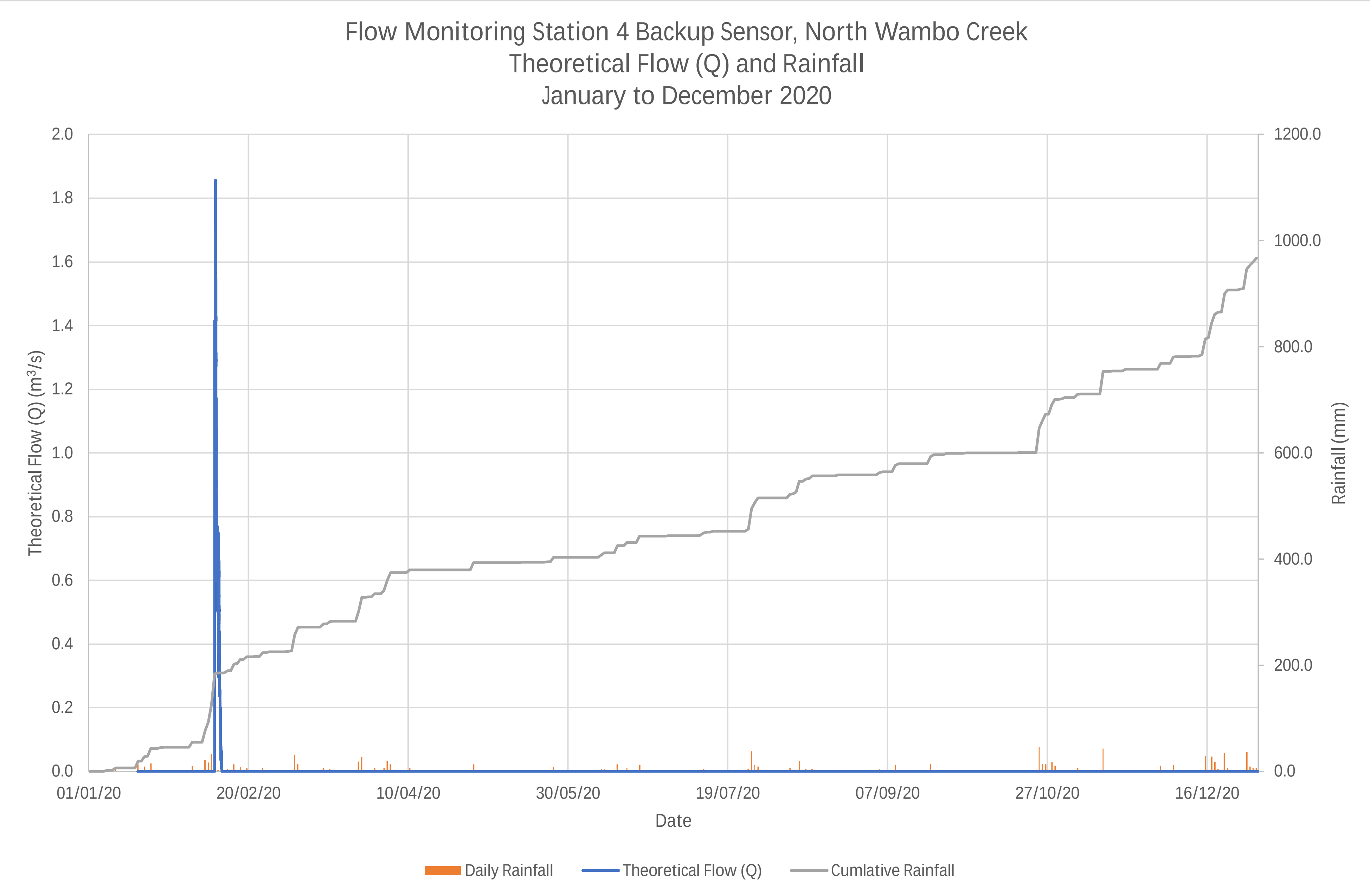


Flow Monitoring Station 4, North Wambo Creek
Stream Height and Rainfall
January to December 2020
Stream Height (m)
Rainfall (mm)
0.5
0.4
0.4
0.3
0.3
0.2
0.2
0.1
0.1
0.0
1200.0
1000.0
800.0
600.0
400.0
200.0
0.0
01/01/20
20/02/20
10/04/20
30/05/20
19/07/20
07/09/20
27/10/20
16/12/20
Date
Daily Rainfall
Stream Height
Cumlative Rainfall

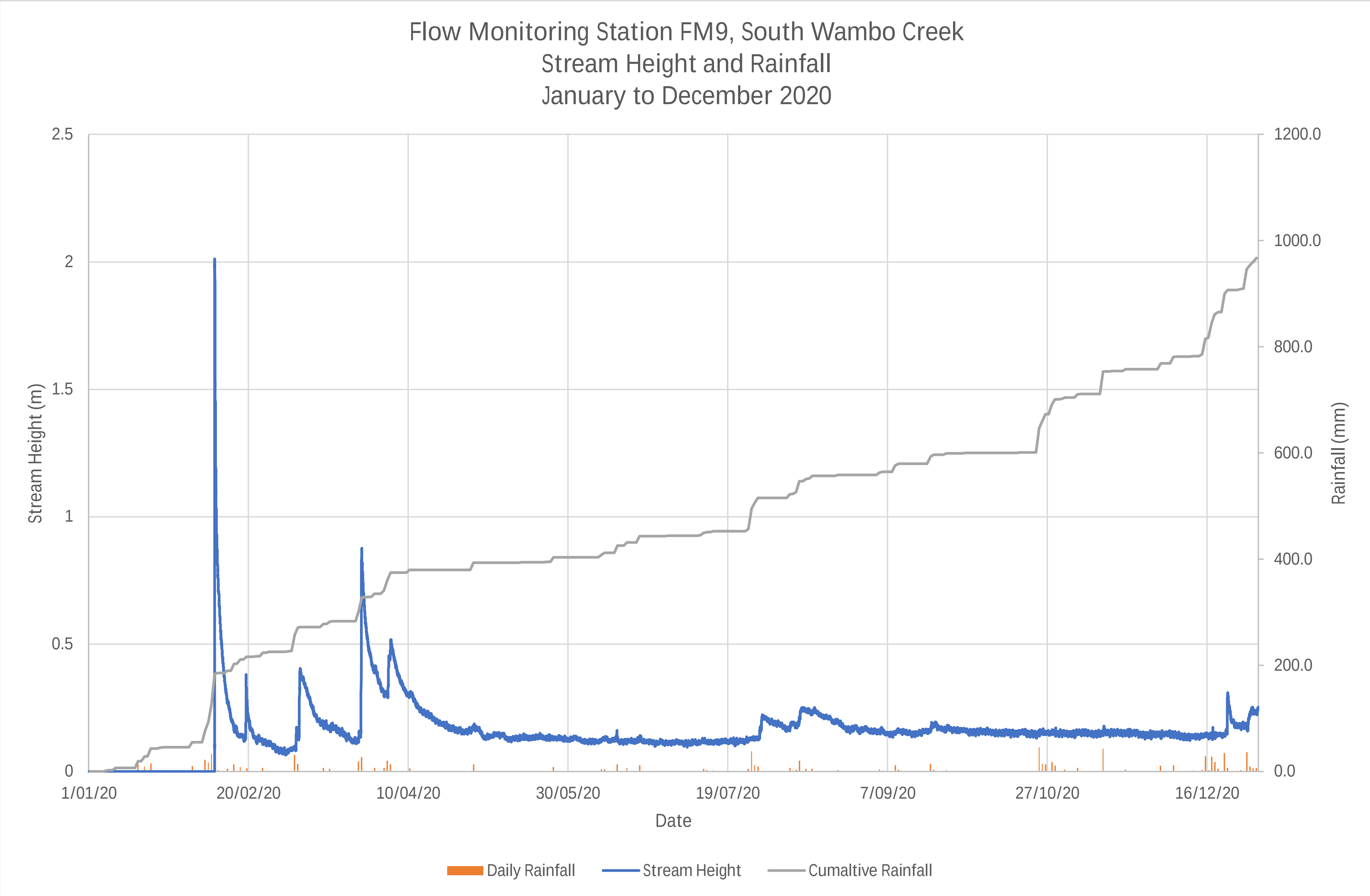

Flow Monitoring Station 4, North Wambo Creek
Theoretical Flow (Q) and Rainfall
January to December 2020
Theoretical Flow (Q) (m³/s)
Rainfall (mm)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1200.0
1000.0
800.0
600.0
400.0
200.0
0.0
01/01/20
20/02/20
10/04/20
30/05/20
19/07/20
07/09/20
27/10/20
16/12/20
Date
Daily Rainfall
Theoretical Flow (Q)
Cumlative Rainfall



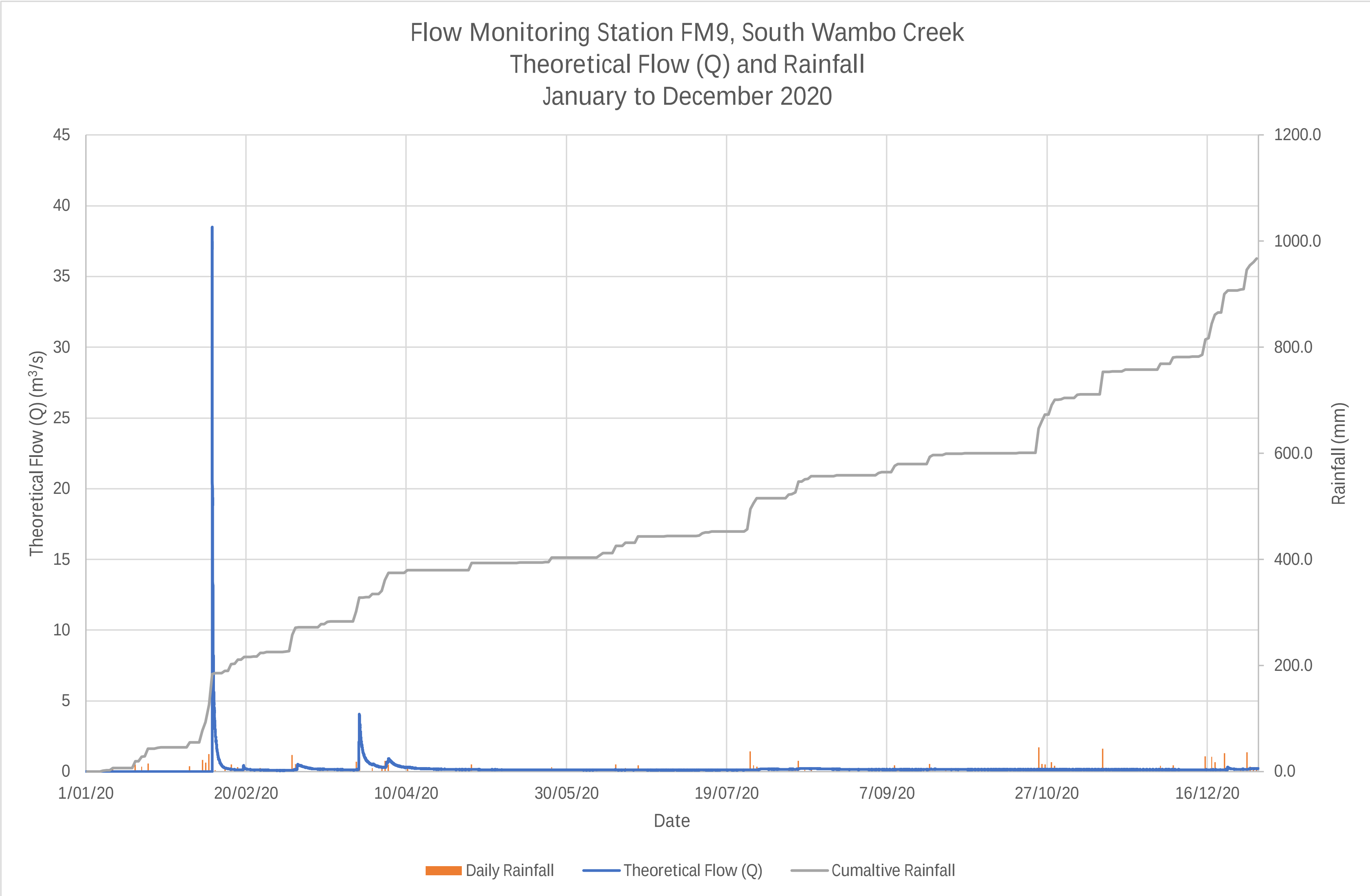
Flow Monitoring Station 4 Backup Sensor, North Wambo Creek
Stream Height and Rainfall
January to December 2020
Stream Height (m)
0.5
0.4
0.4
0.3
0.3
0.2
0.2
0.1
0.1
0.0
Rainfall (mm)
1200.0
1000.0
800.0
600.0
400.0
200.0
0.0
01/01/20
20/02/20
10/04/20
30/05/20
19/07/20
07/09/20
27/10/20
16/12/20
Date
Daily Rainfall
Stream Height
Cumlative Rainfall



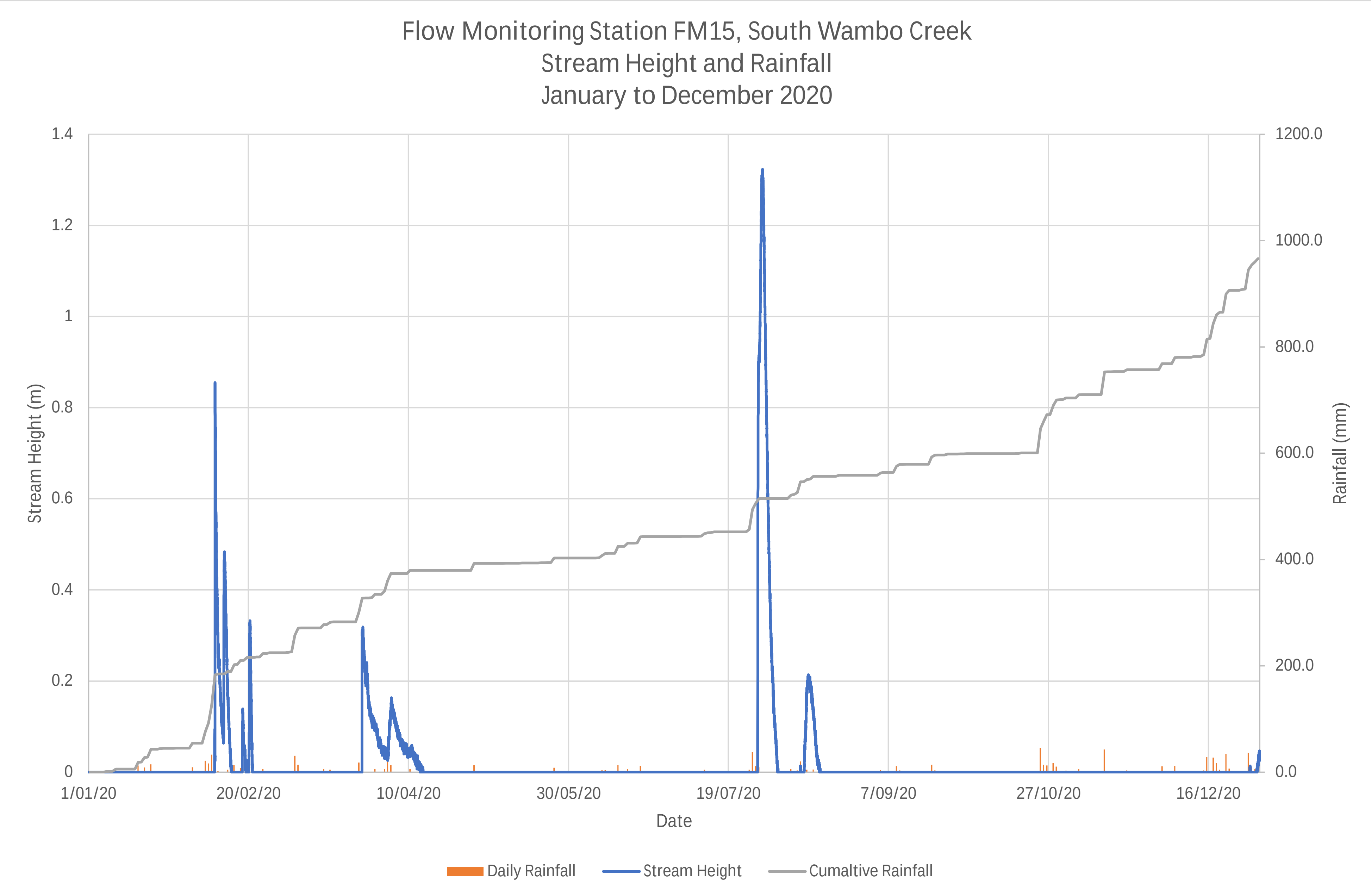
Flow Monitoring Station 4 Backup Sensor, North Wambo Creek
Theoretical Flow (Q) and Rainfall
January to December 2020
Theoretical Flow (Q) (m³/s)
Rainfall (mm)
Date
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1200.0
1000.0
800.0
600.0
400.0
200.0
0.0
01/01/20
20/02/20
10/04/20
30/05/20
19/07/20
07/09/20
27/10/20
16/12/20
Daily Rainfall
Theoretical Flow (Q)
Cumlative Rainfall

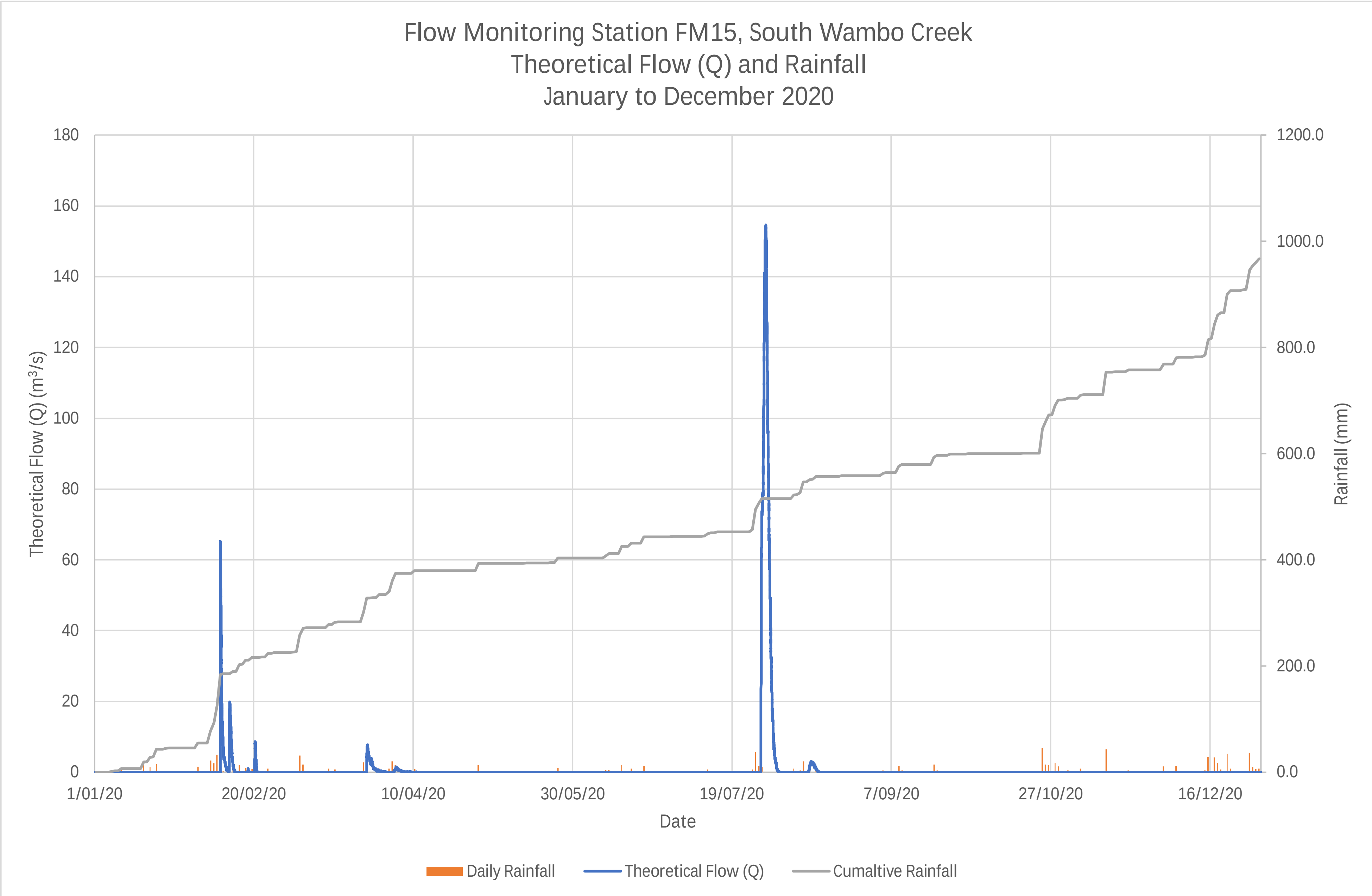


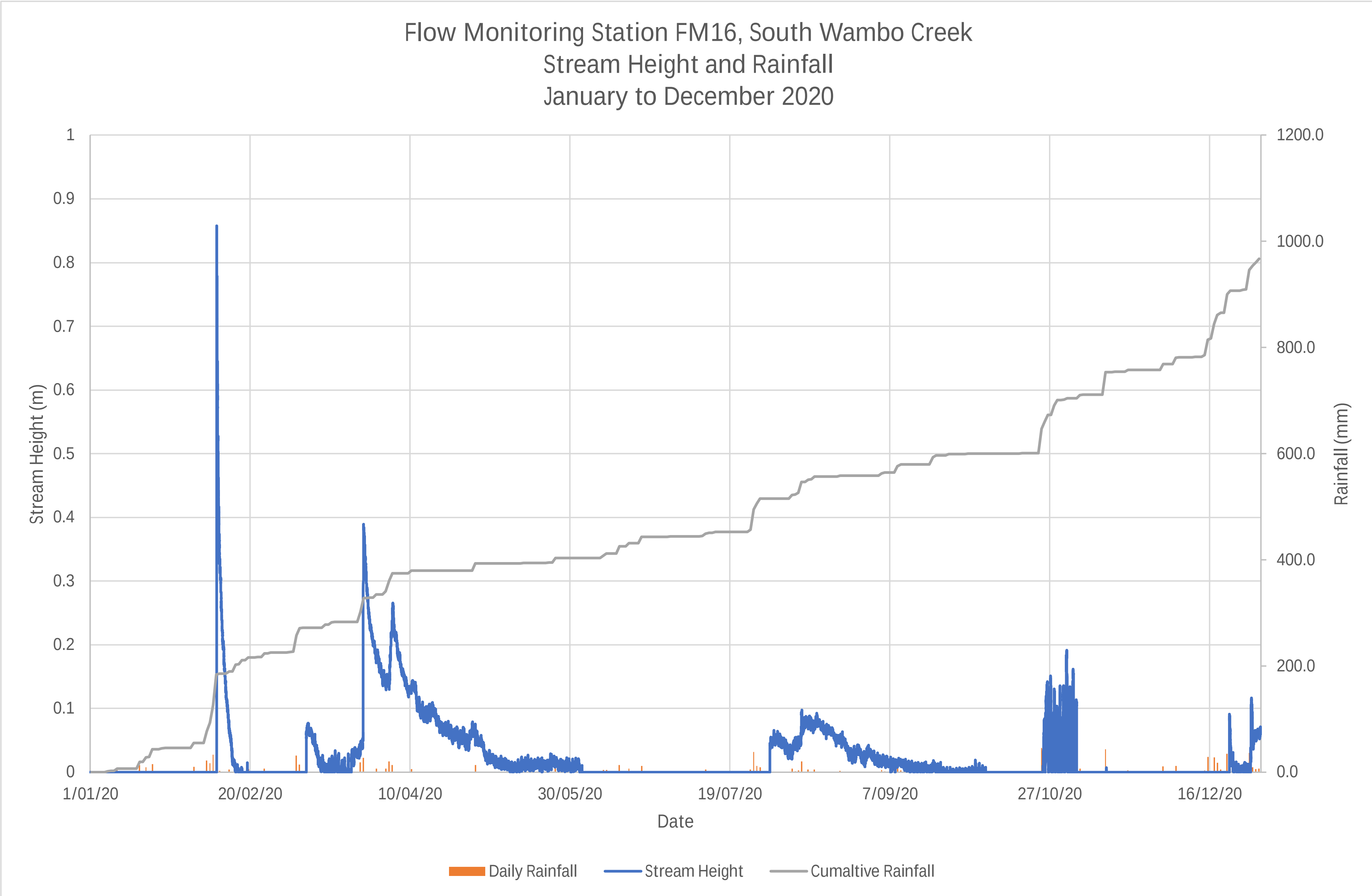
Flow Monitoring Station FM9, South Wambo Creek
Stream Height and Rainfall
January to December 2020
Stream Height (m)
Rainfall (mm)
2.5
2
1.5
1
0.5
0
1200.0
1000.0
800.0
600.0
400.0
200.0
0.0
1/01/20
20/02/20
10/04/20
30/05/20
19/07/20
7/09/20
27/10/20
16/12/20
Date
Daily Rainfall
Stream Height
Cumaltive Rainfall



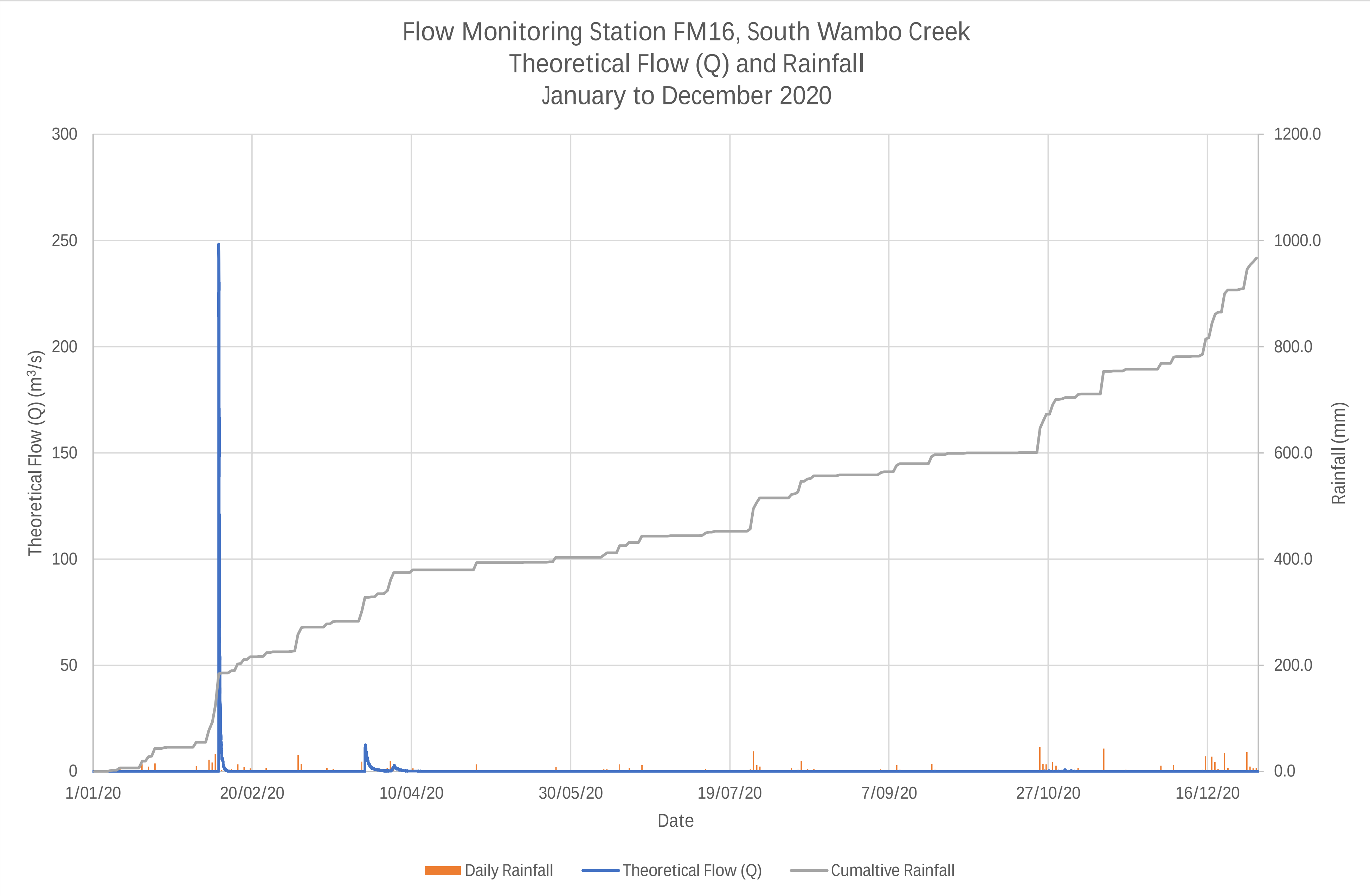
Flow Monitoring Station FM9, South Wambo Creek
Theoretical Flow (Q) and Rainfall
January to December 2020
Theoretical Flow (Q) (m³/s)
Rainfall (mm)
45
40
35
30
25
20
15
10
5
0
1200.0
1000.0
800.0
600.0
400.0
200.0
0.0
1/01/20
20/02/20
10/04/20
30/05/20
19/07/20
7/09/20
27/10/20
16/12/20
Date
Daily Rainfall
Theoretical Flow (Q)
Cumaltive Rainfall


Flow Monitoring Station FM15, South Wambo Creek
Stream Height and Rainfall
January to December 2020
Stream Height (m)
Rainfall (mm)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1200.0
1000.0
800.0
600.0
400.0
200.0
0.0
1/01/20
20/02/20
10/04/20
30/05/20
19/07/20
7/09/20
27/10/20
16/12/20
Date
Daily Rainfall
Stream Height
Cumaltive Rainfall

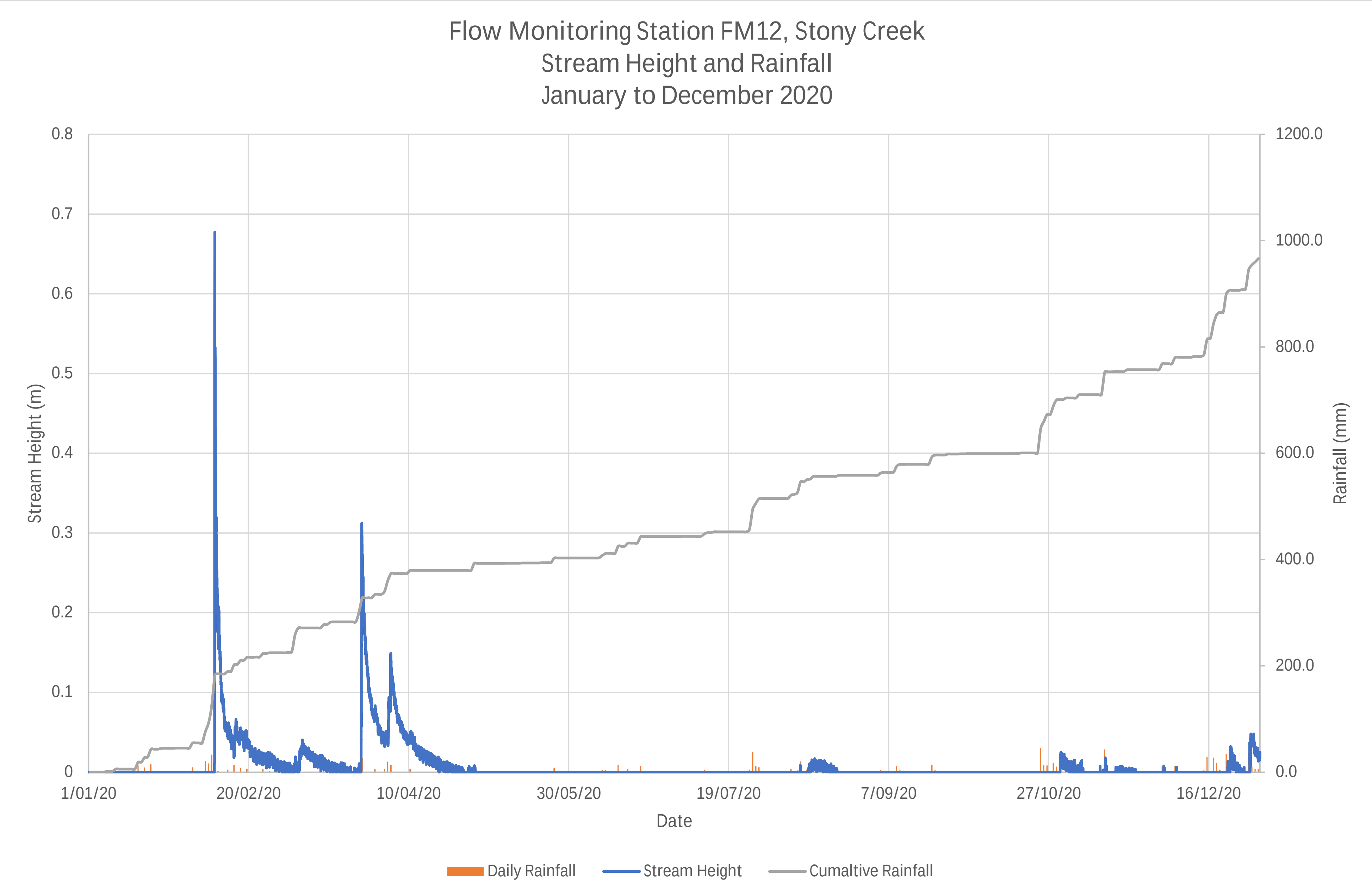

Flow Monitoring Station FM15, South Wambo Creek
Theoretical Flow (Q) and Rainfall
January to December 2020
Theoretical Flow (Q) (m³/s)
Rainfall (mm)
Date
180
160
140
120
100
80
60
40
20
0
1200.0
1000.0
800.0
600.0
400.0
200.0
0.0
1/01/20
20/02/20
10/04/20
30/05/20
19/07/20
7/09/20
27/10/20
16/12/20
Daily Rainfall
Theoretical Flow (Q)
Cumaltive Rainfall



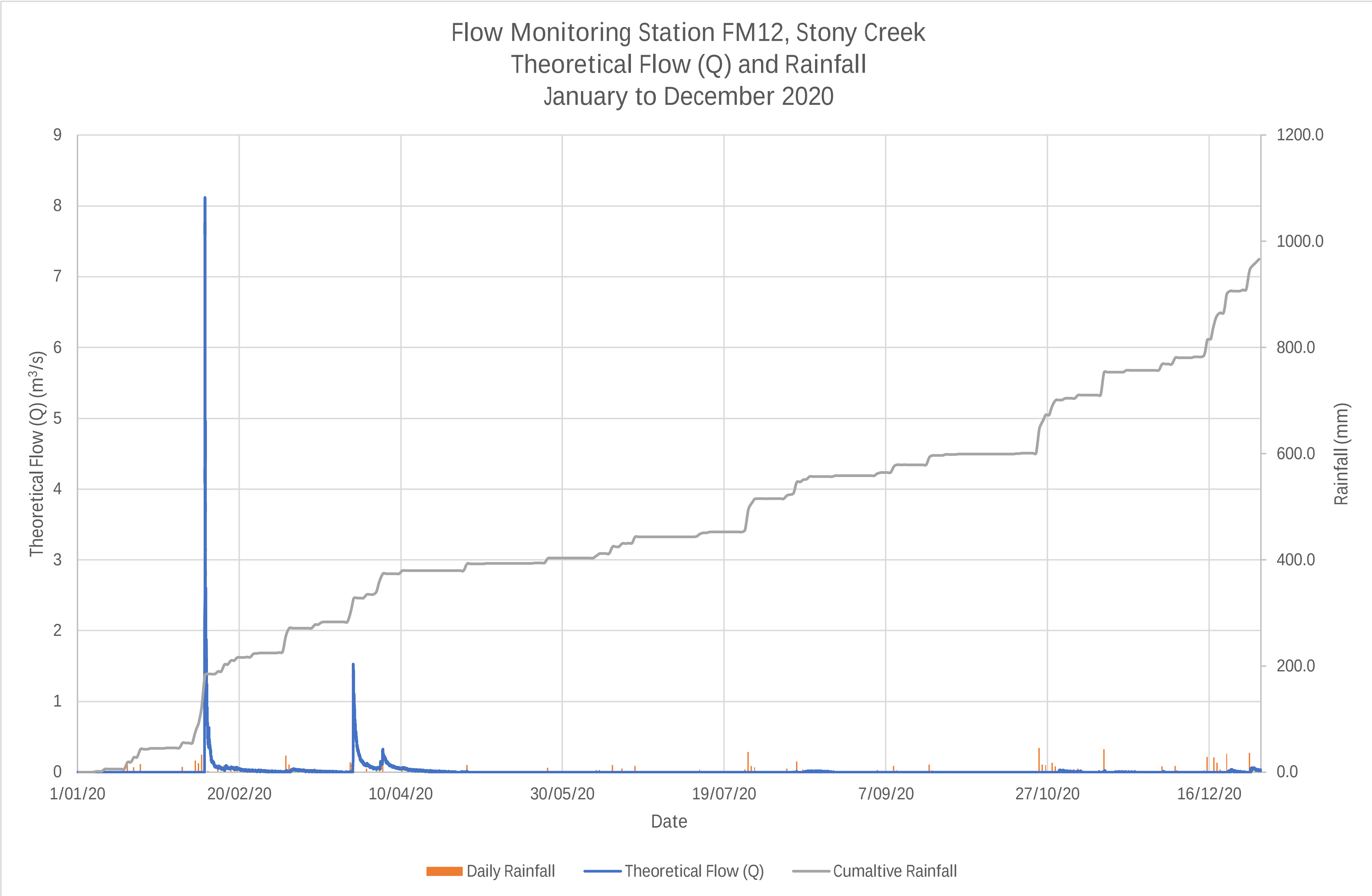
Flow Monitoring Station FM16, South Wambo Creek
Stream Height and Rainfall
January to December 2020
Stream Height (m)
Rainfall (mm)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1200.0
1000.0
800.0
600.0
400.0
200.0
0.0
1/01/20
20/02/20
10/04/20
30/05/20
19/07/20
7/09/20
27/10/20
16/12/20
Date
Daily Rainfall
Stream Height
Cumaltive Rainfall

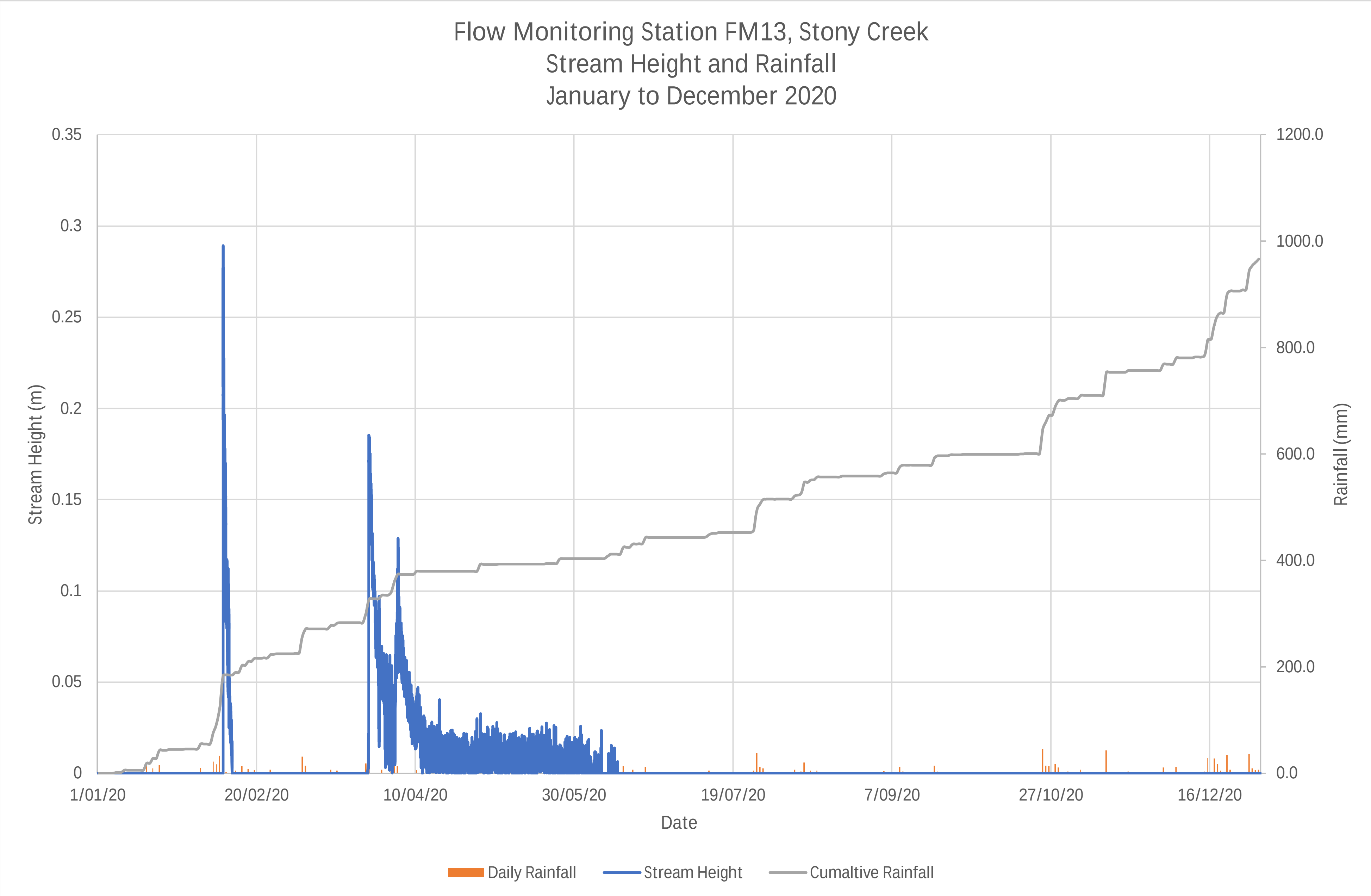


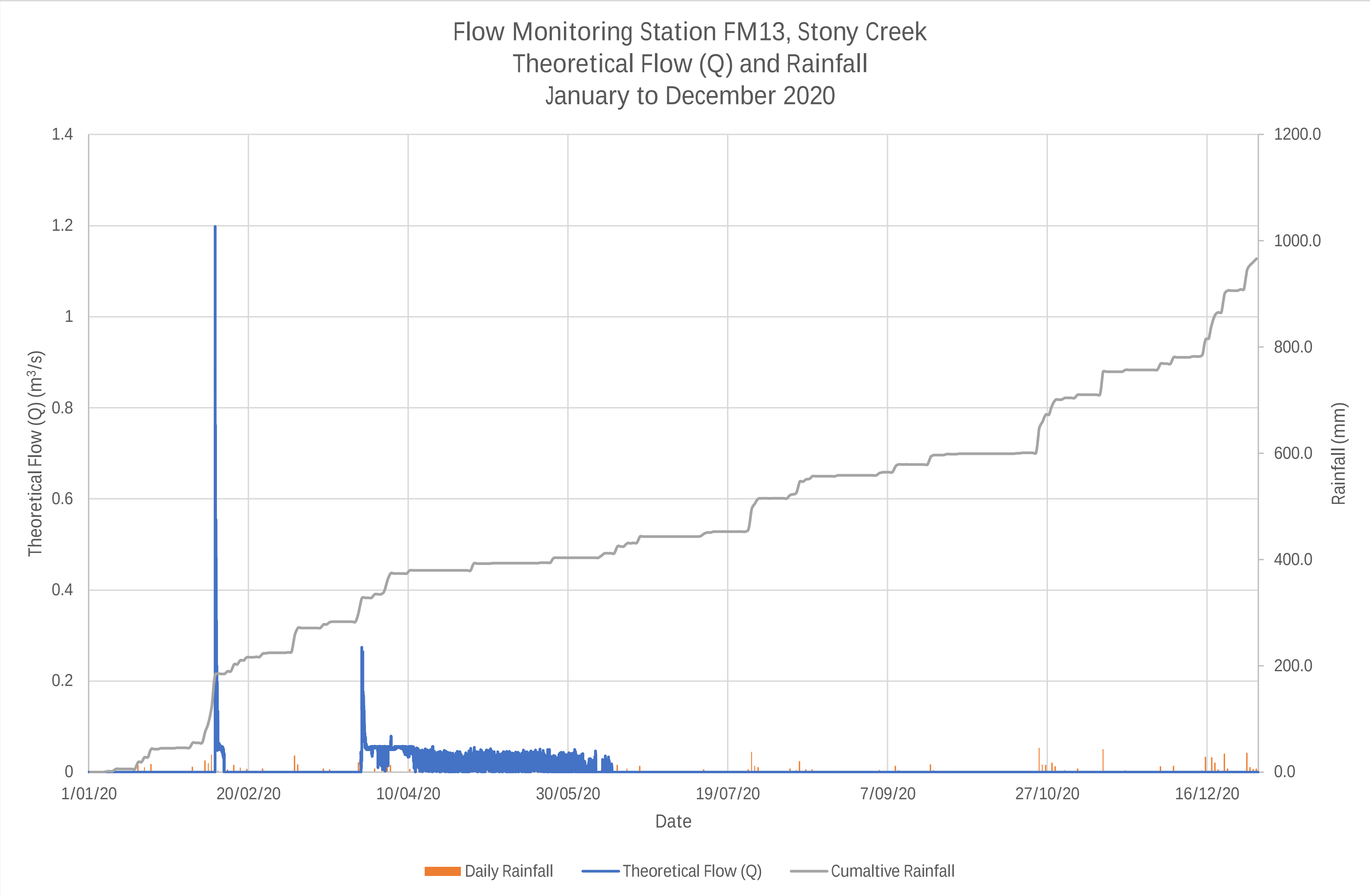
Flow Monitoring Station FM16, South Wambo Creek
Theoretical Flow (Q) and Rainfall
January to December 2020
Theoretical Flow (Q) (m³/s)
Rainfall (mm)
Date
300
250
200
150
100
50
0
1200.0
1000.0
800.0
600.0
400.0
200.0
0.0
1/01/20
20/02/20
10/04/20
30/05/20
19/07/20
7/09/20
27/10/20
16/12/20
Daily Rainfall
Theoretical Flow (Q)
Cumaltive Rainfall



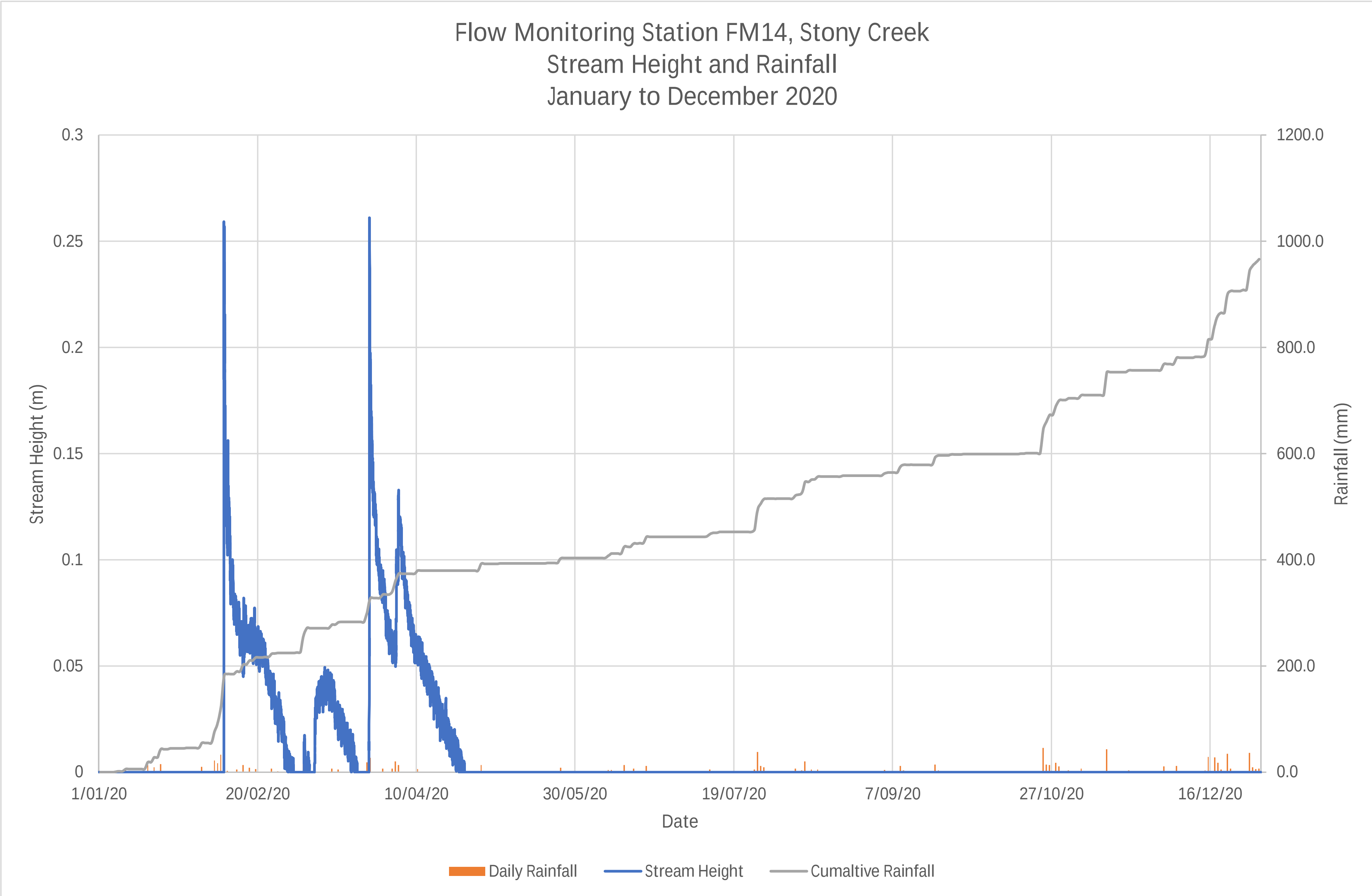
Flow Monitoring Station FM12, Stony Creek
Stream Height and Rainfall
January to December 2020
Stream Height (m)
Rainfall (mm)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1200.0
1000.0
800.0
600.0
400.0
200.0
0.0
1/01/20
20/02/20
10/04/20
30/05/20
19/07/20
7/09/20
27/10/20
16/12/20
Date
Daily Rainfall
Stream Height
Cumaltive Rainfall


Flow Monitoring Station FM12, Stony Creek
Theoretical Flow (Q) and Rainfall
January to December 2020
Theoretical Flow (Q) (m3/s)
Rainfall (mm)
Date
0
1
2
3
4
5
6
7
8
9
0.0
200.0
400.0
600.0
800.0
1000.0
1200.0
1/01/20
20/02/20
10/04/20
30/05/20
19/07/20
7/09/20
27/10/20
16/12/20
Daily Rainfall
Theoretical Flow (Q)
Cumaltive Rainfall

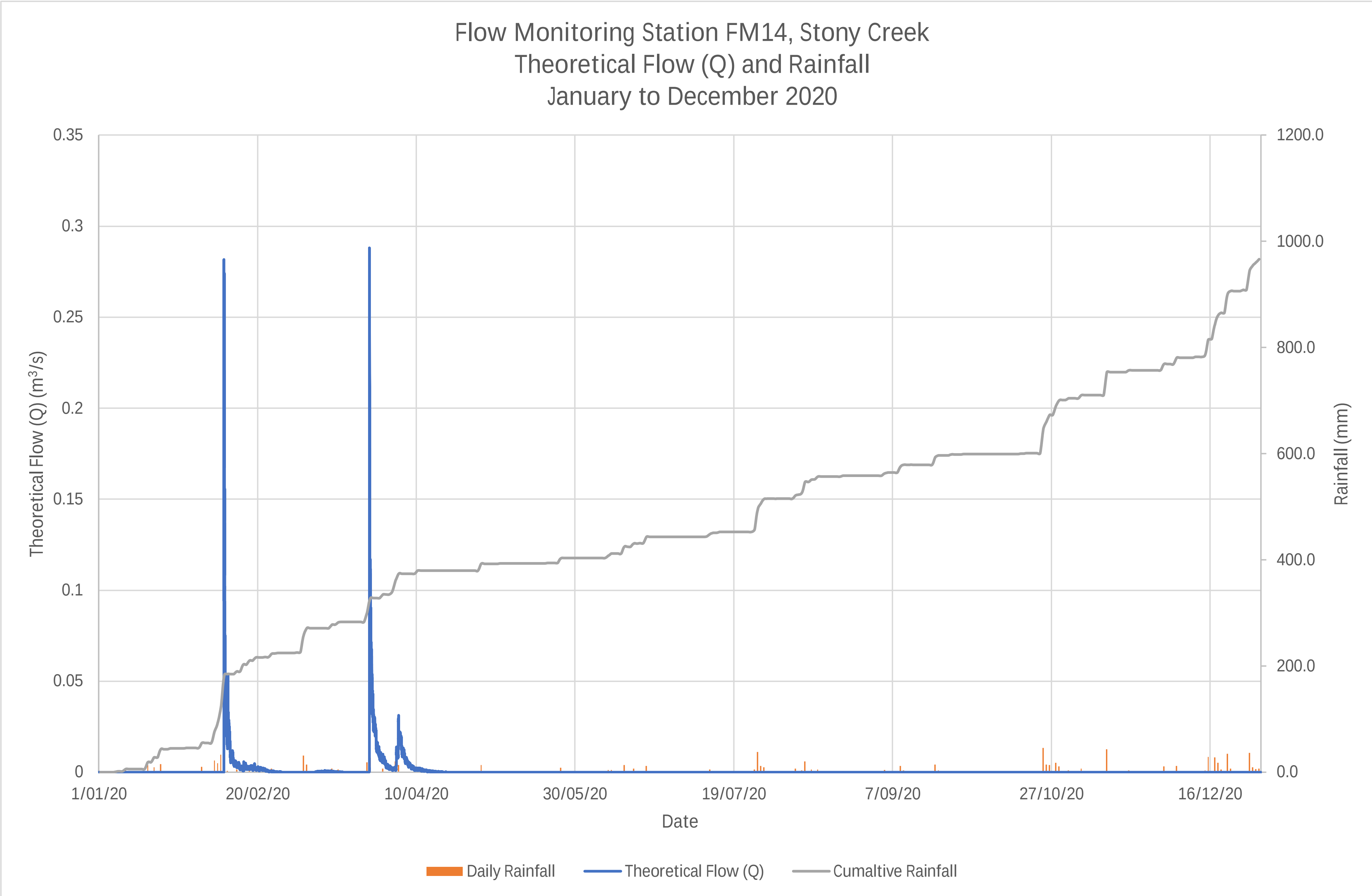

Flow Monitoring Station FM13, Stony Creek
Stream Height and Rainfall
January to December 2020
Stream Height (m)
Rainfall (mm)
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
1200.0
1000.0
800.0
600.0
400.0
200.0
0.0
1/01/20
20/02/20
10/04/20
30/05/20
19/07/20
7/09/20
27/10/20
16/12/20
Date
Daily Rainfall
Stream Height
Cumaltive Rainfall



Flow Monitoring Station FM13, Stony Creek
Theoretical Flow (Q) and Rainfall
January to December 2020
Theoretical Flow (Q) (m³/s)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Rainfall (mm)
1200.0
1000.0
800.0
600.0
400.0
200.0
0.0
1/01/20
20/02/20
10/04/20
30/05/20
19/07/20
7/09/20
27/10/20
16/12/20
Date
Daily Rainfall
Theoretical Flow (Q)
Cumaltive Rainfall



Flow Monitoring Station FM14, Stony Creek
Stream Height and Rainfall
January to December 2020
Stream Height (m)
0.3
0.25
0.2
0.15
0.1
0.05
0
Rainfall (mm)
1200.0
1000.0
800.0
600.0
400.0
200.0
0.0
1/01/20
20/02/20
10/04/20
30/05/20
19/07/20
7/09/20
27/10/20
16/12/20
Date
Daily Rainfall
Stream Height
Cumaltive Rainfall



Flow Monitoring Station FM14, Stony Creek
Theoretical Flow (Q) and Rainfall
January to December 2020
Theoretical Flow (Q) (m³/s)
Rainfall (mm)
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
1200.0
1000.0
800.0
600.0
400.0
200.0
0.0
1/01/20
20/02/20
10/04/20
30/05/20
19/07/20
7/09/20
27/10/20
16/12/20
Date
Daily Rainfall
Theoretical Flow (Q)
Cumaltive Rainfall

APPENDIX I

WAMBO COAL PTY LTD
2020 ANNUAL COMPLIANCE REPORT
(EPBC 2016/7636 AND EPBC 2016/7816)

WAMBO COAL PTY LTD
2020 ANNUAL COMPLIANCE REPORT

(EPBC 2016/7636 and EPBC 2016/7816)

1 January – 31 December 2020

Document Control

Title	Wambo Coal 2020 Annual Compliance Report (EPBC 2016/7636 and EPBC 2016/7816)
General Description	Review of compliance with the conditions of EPBC 2016/7636 and EPBC 2016/7816
Document Owner	Manager: Environment & Community

Revisions

Rev No	Date	Description	By	Checked	Signature
1	March 2021	Original	WCPL	ND	

This report addresses Condition 5 of the Wambo Coal Pty Limited (WCPL) Environment Protection and Biodiversity Conservation (EPBC) Approval 2016/7636 for the South Wambo Underground Mine Extension, which states:

> *The person taking the action must publish a report on the website addressing compliance with each of the conditions of this approval, including implementation of any management plan, program, strategy and review required by condition 1. The reporting period and report publication must comply with conditions D10 and D15 of Schedule 2 of the **state development consent**. Documentary evidence providing proof of the date of publication and non-compliance with any of the conditions of this approval must be provided to the **Department** (by email to EPBCMonitoring@environment.gov.au or an address as stipulated by the **Department**) at the same time as the compliance report is published. The person taking the action must continue to publish the report until such time as agreed in writing by the **Minister**.*

Table 1 provides a reconciliation of the conditions of EPBC 2016/7636 and their compliance status.

This report also addressed Condition 5 of the WCPL EPBC Approval 2016/7816 for the South Bates Extension Underground Mine, which states:

> *The person taking the action must publish a report on the website addressing compliance with each of the conditions of this approval, including implementation of any management plan, program, strategy and review required by condition 1. The reporting period and report publication must comply with conditions D10 and D15 of Schedule 2 of the **state development consent**. Documentary evidence providing proof of the date of publication must be provided to the **Department** (by email to EPBCMonitoring@environment.gov.au or an address as stipulated by the **Department**) at the same time as the compliance report is published. The person taking the action must continue to publish the report until such time as agreed in writing by the **Minister**.*

Table 2 provides a reconciliation of the conditions of EPBC 2016/7816 and their compliance status.

Table 1: EPBC Approval 2016/7636 Compliance Summary

Condition	Status	Comment
1. The person taking the action must: a. Not clear more than 0.9 ha of Central Hunter Valley Eucalypt Forest and 3.4 ha of foraging habitat for the Regent Honeyeater *(Anthochaera phrygia)*.	Compliant	The action has not yet been commenced. WCPL has not cleared more than 0.9 hectares (ha) of Central Hunter Valley Eucalypt Forest or more than 3.4 ha of foraging habitat for the Regent Honeyeater (*Anthochaera Phrygia*) as part of the action.
b. Implement conditions A1 and A2 of Schedule 2 of the **state development consent** to minimise the impacts of the action on **protected matters**.	Compliant	WCPL implements Conditions A1 and A2, Schedule 2 of the Development Consent (DA305-7-2003).
c. Implement environmental performance conditions B1-B11, B51-B55, B62-B73 and B75-B77 of Schedule 2 of the **state development consent**, where the conditions relate to avoiding, mitigating, managing, offsetting, monitoring or recording, or reporting on impacts to **protected matters**. In implementing these conditions, the approval holder must protect at least 18.3 ha of Central Hunter Valley Eucalypt Forest and at least 27.7 ha of foraging habitat for the Regent Honeyeater *(Anthochaera phrygia)* in perpetuity.	Compliant	WCPL implements Conditions B1-B11, B51-B55, B62-B73 and B75-B77 of Schedule 2 of the Development Consent (DA305-7-2003). WCPL has amended an existing VCA under the NSW *National Parks and Wildlife Act 1974* to conserve Remnant Woodland Enhancement Program Area E in perpetuity, which includes 18.3 ha of Central Hunter Valley Eucalypt Forest and Woodland and 27.7 ha of foraging habitat for the Regent Honeyeater.
2. Within 30 days after the **commencement of the action**, the person taking the action must advise the **Department** in writing of the actual date of **commencement of the action**.	Not applicable	The action has not yet been commenced. Mining at the approved South Wambo Underground Mine is planned to commence after completion of mining at the South Bates Underground Mine. WCPL will advise the Department in writing of the commencement of the action within 30 days of commencement.
3. Unless otherwise agreed to in writing by the **Minister**, the person taking the action must publish all management plans, programs, strategies and reviews required by condition 1. Each management plan, program, strategy and review must be published on the **website**, and notification must be provided to the **Department**, within 1 month of being approved by the Secretary of the NSW Department of Planning & Environment (or nominee of the Secretary).	Administrative non-compliance	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 and Biodiversity Management Plan. An Extraction Plan for areas related to the Action has not yet been prepared. Notification was not provided to the Department within one month of the approval of revised management plans, approved by the Secretary of the NSW Department of Planning, Industry and Environment (or nominee of the Secretary) in November 2020.

Condition	Status	Comment
4. The person taking the action must maintain accurate records substantiating all activities associated with or relevant to the conditions of approval, including measures taken to implement a management plan, program, strategy and review required by condition 1, and make them available upon request to the **Department**. Such records may be subject to audit by the **Department** or an independent auditor in accordance with section 458 of the **EPBC Act**, or used to verify compliance with the conditions of approval.	Compliant	WCPL maintains accurate records substantiating all activities associated with or relevant to the conditions of approval, including measures taken to implement a management plan, program, strategy and review required by condition 1. WCPL will make these records available upon request to the Department.
5. The person taking the action must publish a report on their **website** addressing compliance with each of the conditions of this approval, including implementation of any management plan, program, strategy and review required by condition 1. The reporting period and report publication must comply with conditions D10 and D15 of Schedule 2 of the **state development consent**. Documentary evidence providing proof of the date of publication and non-compliance with any of the conditions of this approval must be provided to the **Department** (by email to EPBCmonitoring@environment.gov.au or an address as stipulated by the **Department**) at the same time as the compliance report is published. The person taking the action must continue to publish the report until such time as agreed in writing by the **Minister**.	Compliant	The WCPL 2020 Annual Review (including this report) will be published on the Peabody Energy website https://www.peabodyenergy.com/Operations/Australia-Mining/New-South-Wales-Mining/Wambo-Approvals,-Plans-Reports.
6. Any potential or actual contravention of the conditions of this approval, including contravention of a commitment made in a management plan, program, strategy and review required by condition 1 must be reported to the **Department** within 7 days of the person taking the action becoming aware of the actual or potential contravention.	Not applicable	No events contravening (or potentially contravening) the conditions of this approval have occurred.
7. Upon the direction of the **Minister**, the person taking the action must ensure that an independent audit of compliance with the conditions of approval is conducted and a report submitted to the **Minister**. The independent auditor and audit criteria must be approved by the **Minister** prior to the commencement of the audit. The audit report must address the criteria to the satisfaction of the **Minister**.	Not applicable	Upon the direction of the Minister, WCPL will ensure that an independent audit of compliance with the conditions of approval is conducted and a report submitted to the Minister.
8. If, at any time after 5 years from the date of this approval, the person taking the action has not substantially commenced the action, then the person taking the action must not substantially commence the action without the written agreement of the **Minister**.	Not applicable	WCPL has not yet commenced the action. Mining at the approved South Wambo Underground Mine is planned to commence after completion of mining at the South Bates Underground Mine. If WCPL has not substantially commenced the South Wambo Underground Mine prior to 30 April 2022 (i.e. five years after the date EPBC 2016/7636 was granted), WCPL will seek the written agreement of the Minister prior to substantially commencing the action.

Table 2: EPBC Approval 2016/7816 Compliance Summary

Condition	Status	Comment
1. The person taking the action must: a. Implement administrative conditions A1 and A2 of Schedule 2 of the **state development consent** to minimise the impacts of the action on **protected matters**.	Compliant	WCPL implements Conditions A1 and A2, Schedule 2 of the Development Consent (DA305-7-2003).
b. Implement environmental performance conditions B1-B3, B7-B10, B51-B55 and B62- B68 of Schedule 2 of the **state development consent**, where the conditions relate to avoiding, mitigating, managing, offsetting, monitoring or recording, or reporting on impacts to **protected matters**.	Compliant	WCPL implements Conditions B1-B3, B7-B10, B51-B55 and B62-B68, Schedule 2 of the Development Consent (DA305-7-2003).
c. Notify the **Department** in writing of any proposed change to the **conditions** of the **state development consent**, referred to in conditions 1a and 1b, within 5 **business days** of formally proposing a change or becoming aware of any other proposed change.	Compliant	DA305-7-2003 Modification 16 associated with the proposed United Wambo Open Cut Coal Mine Project was lodged on 8 August 2016 and subsequently approved on 28 August 2019. The Referral for EPBC 2016/7816 was lodged on 22 November 2016 and described the changes proposed by the United Wambo Open Cut Coal Mine Project.
d. Notify the **Department** in writing of any change to conditions of the **state development consent**, referred to in conditions 1a to 1b, within 5 **business days** of a change to **conditions** being finalised.	Compliant	The Department was notified in writing of changes to the conditions in Development Consent (DA305-7-2003) (Modification 16) within the allocated time period following the conditions being finalised.
2. Within 25 **business days** after the **commencement of the action**, the person taking the action must advise the **Department** in writing of the actual date of **commencement of the action**.	Compliant	WCPL provided a notification to the Department of the actual date of commencement of the action (3 December 2018), however this was not completed within 30 days of the commencement of the action.
3. Unless otherwise agreed to in writing by the **Minister**, the person taking the action must publish all management plans and strategies required by conditions B1-B3, B7-B10, B51-B55 and B62-B68 of Schedule 2 of the **state development consent** on their website. Each management plan and strategy must be published on the **website** within 1 month of being approved by the **Secretary** and remain there for a period of no less than 5 years.	Compliant	Copies of all management plans, programs, strategies and reviews required by condition 1 of EPBC 2016/7636 are available to the public on the Peabody Energy website https://www.peabodyenergy.com/Operations/Australia-Mining/New-South-Wales-Mining/Wambo-Approvals,-Plans-Reports. Relevant management plans include the Extraction Plan for South Bates Extension Underground Mine Longwalls 17 to 20, Site Water Management Plan, Biodiversity Management Plan and Life of Mine Rejects Emplacement Strategy. Notification is provided to the Department within one month of the approval of any management plans, programs, strategies and reviews by the Secretary of the NSW Department of Planning & Environment (or nominee of the Secretary).

Condition	Status	Comment
4. The person taking the action must maintain accurate records substantiating all activities associated with or relevant to these conditions of **approval**, including measures taken to implement the management plans and strategies required by conditions B1-B3, B7-B10, B51-B55 and B62-B68 of Schedule 2 of the **state development consent**, and make them available upon request to the **Department**. Such records may be subject to audit by the **Department** or an independent auditor in accordance with section 458 of the **EPBC Act**, or used to verify compliance with the conditions of this **approval**.	Compliant	WCPL maintains accurate records substantiating all activities associated with or relevant to the conditions of approval, including measures taken to implement a management plan, program, strategy and review required by Conditions B1-B3, B7-B10, B51-B55 and B62-B68, Schedule 2. WCPL will make these records available upon request to the Department.
5. The person taking the action must publish a report on their website addressing compliance with each of the **conditions** of this **approval**, including implementation of any management plans and strategies required by condition 1. The reporting period and report publication must comply with conditions D10 and D15 of Schedule 2 of the **state development consent**. Documentary evidence providing proof of the date of publication must be provided to the **Department** (by email to EPBCMonitoring@environment.gov.au or an address as stipulated by the **Department**) at the same time as the compliance report is published. The person taking the action must continue to publish the report until such time as agreed in writing by the **Minister**.	Compliant	The WCPL 2020 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 or strategy required by condition 1 must be reported to the **Department** no later than 7 **business days** of the person taking the action becoming aware of the actual or potential contravention, by email to EPBCMonitoring@environment.gov.au or an address as stipulated by the **Department**.	Not applicable	No events contravening (or potentially contravening) the conditions of this approval have occurred.
7. Upon the direction of the **Minister**, the person taking the action must ensure that an independent audit of compliance with the conditions of **approval** is conducted and a report submitted to the **Minister**. The independent auditor and audit criteria must be approved by the **Minister** prior to the commencement of the audit. The audit report must address the criteria to the satisfaction of the **Minister**.	Not applicable	Upon the direction of the Minister, WCPL will ensure that an independent audit of compliance with the conditions of approval is conducted and a report submitted to the Minister.
8. If, at any time after 5 years from the date of this **approval**, the person taking the action has not substantially **commenced the action**, then the person taking the action must not **commence the action** without the written agreement of the **Minister**.	Compliant	WCPL commenced the action within five years of the date of the approval of EPBC 2016/7816.