Mount Thorley Warkworth

2020 Annual Review

Name of Operations	Mount Thorley Warkworth
Name of Operator	Coal & Allied (NSW) Pty Ltd (wholly owned subsidiary of Yancoal Australia Ltd)
Development consent /project approval	SSD-6464 & SSD-6465
Name of holder of development consent/project approval	Warkworth Mining Ltd Mt Thorley Operations Pty Ltd
Mining Lease #	Contained within Section 3.1 of this report
Name of holder of mining lease	Warkworth Mining Ltd Mount Thorley Operations Pty Ltd
Water Licence #	Contained within Section 3.1 of this report
Name of holder of water licence	Contained within Section 3.1 of this report
MOP/RMP start date	24/11/2020
MOP/RMP end date	30/11/2021
Annual Review Start Date	01/01/2020
Annual Review End Date	31/12/2020
I, Gary Mulhearn, certify that this audit report is a true and accurate record of the compliance status of Mount Thorley Warkworth for the period 1 January 2020 to 31 December 2020 and that I am authorised to make this statement on behalf of Coal & Allied (NSW) 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 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 the 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	Mr Gary Mulhearn
Title of Authorised Reporting Officer	Environment and Community Manager
Signature of Authorised Reporting Officer	
Date	29/4/2021

Executive Summary

Mount Thorley Warkworth (MTW) is an integrated operation of two open cut coal mines, Warkworth Mining Limited (WML) and Mount Thorley Operations (MTO). This Annual Review reports on the environmental performance of MTW for the period 1 January 2020 to 31 December 2020.

This report has been prepared in accordance with conditions of the development consents and Mining Leases (ML) held by MTW which require a report of the operation's environmental performance to be provided on an annual basis. The structure of the 2020 Annual Review aligns with the NSW Department of Planning, Industry and Environment (DPIE) *Post-approval requirements for State significant mining developments – Annual Review Guideline* (October 2015).

MTW produced 17.5 million tonnes of run-of-mine (ROM) coal during 2020, and 11.9 million tonnes of saleable coal, against an approved ROM coal production rate of 28 million tonnes per annum (mtpa).

Noise

There were no non-compliances recorded against MTW's consented noise limits. There was a decrease (from 94 to 72) in the number of supplementary attended noise measurements which exceeded the internal trigger levels for corrective action compared to 2019. A total of up to 1,090 hours of mine stoppages were recorded due to proactive and reactive measures to minimise noise and ensure compliance with noise criteria.

Blasting

During the reporting period 221 blast events were initiated at MTW. There were no non compliances against blasting conditions in MTWs development consents and licence conditions.

Air Quality

During 2020, MTW complied with all short term and annual average air quality criteria. A total of 1,526 hours of mine stoppage was recorded following implementation of proactive and reactive measures to minimise dust and ensure compliance with air quality criteria.

Heritage

Aboriginal and historic heritage matters continued to be managed in accordance with the MTW Aboriginal Heritage Management Plan (ACHMP) and Historic Heritage Management Plan (HHMP). No aboriginal heritage assessments or salvage programs were conducted at MTW in 2020.

Annual ACHMP and HHMP compliance inspections were conducted during the 2020 reporting period by a consultant archaeologist assisted by internal mine site personnel, representatives of the Aboriginal community and representatives from the sites Community Heritage Advisory Group (CHAG).

There were no incidents or any unauthorised disturbance to any heritage sites at MTW during the reporting period.

Surface Water
2020 was a wetter than average year with a total of 828.5 mm rainfall recorded at MTW's Charlton Ridge Meteorological station. The average annual rainfall at Charlton Ridge is 630mm, as calculated from 2007 to 2019 annual totals.

Construction of new sediment water management structures for the western advancing pre-strip at Warkworth commenced in quarter four 2020. These structures were designed in accordance with the NSW Blue Book, Managing Urban Stormwater: Soils and Construction, Volume 2E Mines and Quarries.

There were two externally reportable water related incidents during the reporting period which occurred on 9 February 2020 and 14 May 2020. The incident on 9 February 2020 involved the overtopping of two boundary dams at Warkworth (Dam 50N and Dam 53N) as a result of a greater than design rainfall event (91.4 mm). WML received notification on 19 February 2020 from DPIE that they would not be taking action at this time and on the 2 March 2020 from the EPA stating they would not be taking any regulatory action. The incident on the 14 May involved the overtopping of a surface water dam at Mount Thorley Operations (Dam 9S) as a result of the automatic valve between Dam 6S and Dam 9S remaining open, permitting Dam 9S to fill and overtop. An official caution was received from the EPA in October 2020. Further details on this incident and the actions taken by MTW are provided in **Section 10**.

Groundwater
Groundwater monitoring activities were undertaken in 2020 in accordance with the MTW Water Management Plan and groundwater monitoring programme. The monitoring results are used to establish and monitor trends in physical and geochemical parameters of surrounding groundwater potentially influenced by mining.

Groundwater monitoring data is reviewed on a quarterly basis. There were no non-compliances related to groundwater in 2020.

Visual Amenity
The Putty Road visual bund, which was extended to the west to the junction of the Sealed Geo Road (former Wallaby Scrub Road) during 2019, was seeded in 2020. Vegetation screening has also been implemented to the west of the former Wallaby Scrub Road to improve visual amenity for passing motorists. A boundary fence audit was undertaken across MTW in May 2020 to identify fences that required repairs, maintenance or replacement. Maintenance of fence lines along Putty Road was undertaken in June 2020.

Rehabilitation and Land Management
A total of 38.5 ha of new rehabilitation was completed during 2020 against a MOP target of 43.8 ha. A further 45.6ha of Stage 2 rehabilitation was seeded with the target vegetation community seed mixes in 2020. Total disturbance undertaken was 50.6 ha, slightly lower than the 2020 MOP projection of 51.8 ha.

The net rehabilitation progress (i.e. rehabilitation minus rehabilitation disturbance) for the current MOP period (2015 to 2020) is 345.1ha, which is 43.3ha lower than the MOP target of 388.4ha. The net rehabilitation will exceed the MOP forecast after the planned new and Stage 2 rehabilitation is completed in 2021. Cumulative new disturbance over the MOP period is 424.6ha which is slightly lower than the MOP forecast of 426.6ha for the same period.

Biodiversity and Offset Management

Restoration of the Warkworth Sands Woodland vegetation community continued in the Northern Biodiversity Area, with 4,500 tube stock planted. Restoration activities for the Central Hunter Grey Box – Ironbark Woodland River Oak Forest and Warkworth Sands Woodland continued in the Southern Biodiversity Area, with 9,000 tube stock planted. Planting at the Goulburn River Biodiversity area to increase the suitability of habitat for the Regent Honeyeater commenced with 12,000 infill tube stock planted into the cleared areas of Yellow Box – Grey Box – Red Gum Grassy Woodland and riparian woodland areas. The annual Rapid Condition Assessments and biennial Bird and Habitat Restoration monitoring were undertaken across all Biodiversity Areas in 2020.

Weed control, vertebrate pest management activities, seed collection, and fence repairs were conducted during 2020 across all Biodiversity Areas in accordance with the Offset Management Plans.

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1 STATEMENT OF COMPLIANCE

A Statement of Compliance against the relevant approvals is provided in **Table 1.1**. **Table 1.2** provides a brief summary of the non-compliances and a reference to where these are addressed within this Annual Review.

TABLE 1.1 STATEMENT OF COMPLIANCE

Approval	Were all conditions complied with?
DA SSD-6465 (MTO)	No
DA SSD-6464 (WML)	No

TABLE 1.2 NON COMPLIANCES

Relevant approval	Condition number	Condition description (summary)	Compliance status	Section in this Annual Review it is addressed.
SSD-6465 (MTO)	Schedule 3 Condition 22	Water Discharge	Non-compliant	10
SSD-6465 (MTO)	Schedule 3 Condition 6	Blasting Criteria	Non-compliant	9
SSD-6465 (MTO)	Schedule 3 Condition 27	Loders Creek Aboriginal Cultural Heritage Conservation Area	Non-compliant	9
SSD-6464 (WML)	Schedule 2 Condition 9	Surrender of Existing Development Consent	Non-compliant	9
SSD-6464 (WML)	Schedule 3 Condition 28	Retirement of Biodiversity Credits	Non-compliant	9
SSD-6464 (WML)	Schedule 3 Condition 30	Direct Land-Based Offsets	Non-compliant	9
SSD-6464 (WML)	Schedule 3 Condition 34	Additional Warkworth Sands Woodland Measures	Non-compliant	9
SSD-6464 (WML)	Schedule 3 Condition 43(c)	Aboriginal Heritage Management Plan – Research Program	Non-compliant	9

TABLE 1.3 COMPLIANCE STATUS KEY FOR TABLE 1.2

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 unlikely 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 unlikely 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)

Source: NSW Government Post-approval requirements for State significant mining developments – Annual Review Guideline (October 2015).

2 INTRODUCTION

Mount Thorley Warkworth Coal Mine (MTW), is an integrated operation consisting of Warkworth Mining Limited (WML) and Mount Thorley Operations (MTO) (**Figure 1**) situated 14 km southwest of Singleton, in the Upper Hunter Valley region of NSW. MTW is managed and operated by Coal & Allied (NSW) Pty Ltd, a wholly owned subsidiary of Yancoal Australia Limited (YAL). A summary of MTW tenements is shown in **Figure 2.**

2.1 Scope

This Annual Environmental Review (AER) covers the twelve-month reporting period from **1 January 2020 to 31 December 2020.**

This report summarises the environmental performance of MTW in accordance with conditions of the development consents and Mining Leases (ML) held by site. The structure of this 2020 Annual Review aligns with the *DPIE Post-approval requirements for State significant mining developments – Annual Review Guideline* (October 2015).

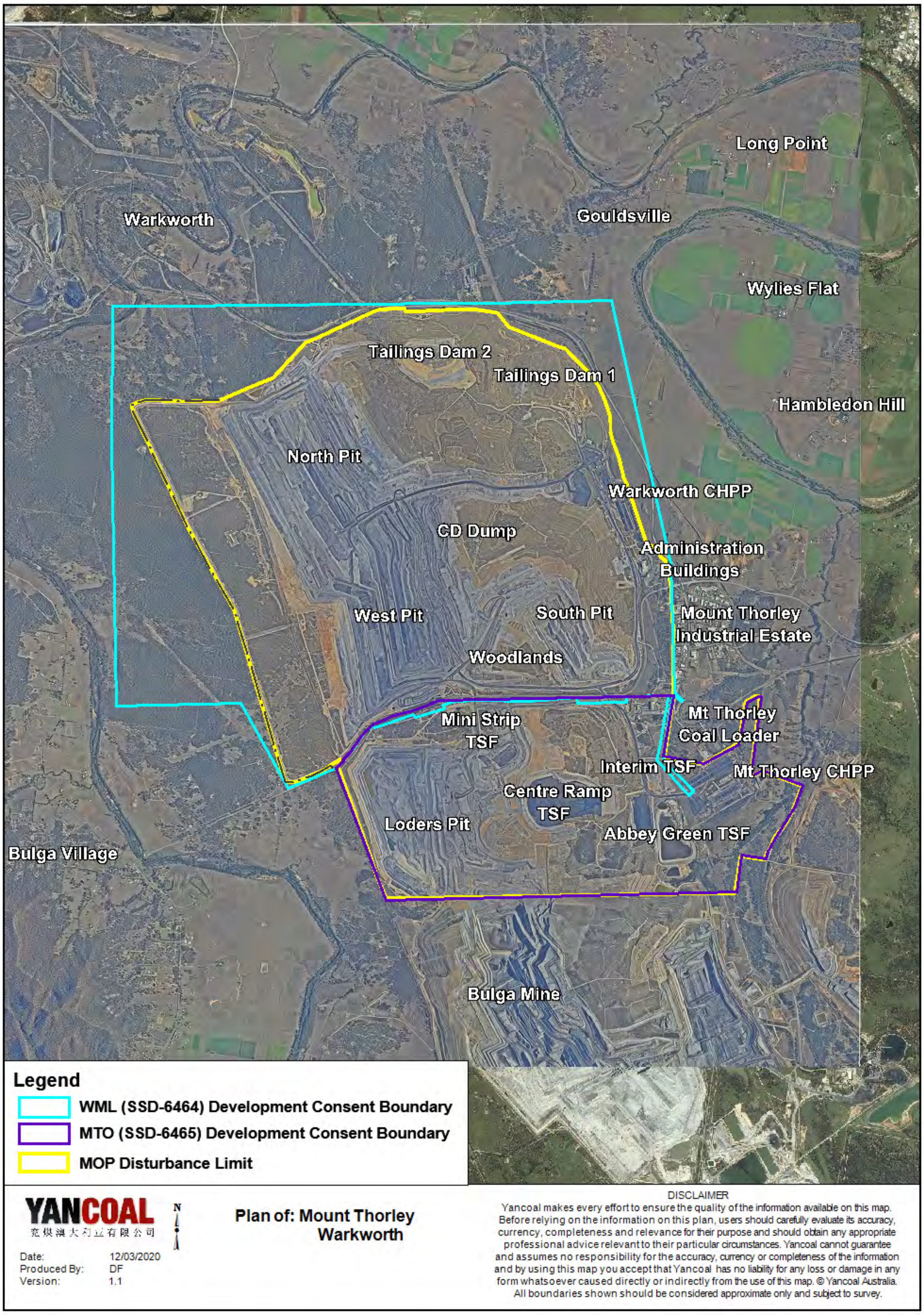


FIGURE 1: MTW SITE LAYOUT AND LOCALITY PLAN

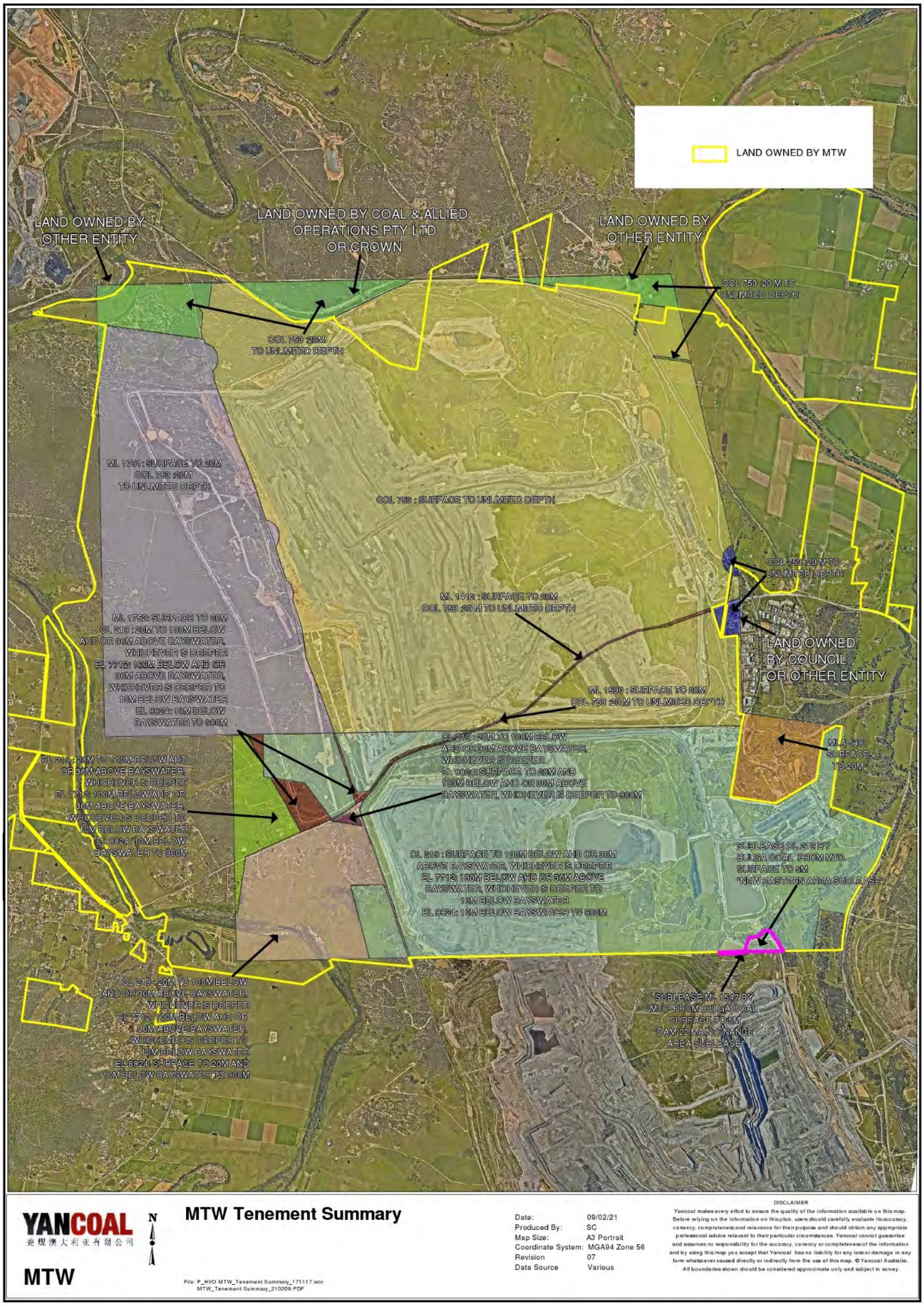


FIGURE 2: MTW TENEMENT SUMMARY

2.2 Mine Contacts

Table 2.1 outlines the contact details for site personnel responsible at Mount Thorley Warkworth.

TABLE 2.1 SITE PERSONNEL

Position	Name	Contact Number
General Manager – MTW	David Bennett	(02) 6570 1529
Environment & Community Manager - MTW	Gary Mulhearn	(02) 6570 1734

3 APPROVALS

3.1 Approvals, Leases and Licences

3.1.1 Current Approvals

The status of MTO and WML development consents, licenses and relevant approvals at 31 December 2020 are summarised in **Table 3.1** to **Table 3.6**.

TABLE 3.1 OPERATIONS APPROVALS- WARKWORTH

Approval Number	Description	Authority	Date of Approval / Variations
SSD-6464	Warkworth Continuation Project development consent	DPIE	26/11/2015
EPBC 2009/5081	Approval under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) to extend the existing Warkworth Coal Mine over an additional 705 hectares of land at Warkworth NSW including associated modifications to existing mine infrastructure	Commonwealth Department of the Environment and Energy	9/8/2012 – 31/3/2033 (varied on 14/10/2018)
EPBC 2002/629	Approval under the EPBC Act to construct and operate an open cut coal mine extension at the Warkworth Coal Mine	Commonwealth Department of the Environment and Energy	18/2/2004 – 25/02/2039 (varied on 6/4/2004, 24/5/2004, 19/11/2004, 13/7/2012, 14/10/2018)

TABLE 3.2 OPERATIONS APPROVALS - MOUNT THORLEY

Approval Number	Description	Authority	Date of Approval / Variations
SSD-6465	Mount Thorley Continuation Project development consent	DPIE	26/11/2015

TABLE 3.3 LICENCES AND PERMITS

Licence No	Description	Authority	Date of Approval / Variations
Warkworth			
EPL 1376	Environment Protection Licence	EPA	26/02/2020
5061122	Radiation Licence	EPA	01/07/2013
XSTR100160	Licence to Store – Explosives Act	WorkCover NSW	18/08/2019
Mount Thorley			
EPL 24	Environment Protection Licence	EPA	24/11/2016
EPL 1976	Environment Protection Licence	EPA	23/09/2020
5061110	Radiation Licence	EPA	01/07/2013

Note: Environment Protection Licences remain in force until the licence is surrendered by the licence holder or until it is suspended or revoked by the EPA or the Minister. A licence may only be surrendered with the written approval of the EPA.

TABLE 3.4 MINING TENEMENTS

Mining tenement	Type	Purpose	Status	Grant Date	Expiry Date
Warkworth Mining Ltd					
CCL 753	Consolidated Coal Lease	Prospecting and Mining Coal	Granted	23/05/1990	17/02/2023
ML 1412	Mining Lease	Prospecting and Mining Coal	Renewal Pending	11/01/1997	10/01/2018
ML 1590	Mining Lease	Prospecting and Mining Coal	Granted	27/02/2007	26/02/2028
ML 1751	Mining Lease	Prospecting, Mining Coal and Purposes	Granted	17/03/2017	17/03/2038

Mining tenement	Type	Purpose	Status	Grant Date	Expiry Date
Mount Thorley Operations Pty Ltd					
CL 219	Coal Lease	Prospecting and Mining Coal	Granted	23/09/1981	23/09/2023
(Part) ML 1547	Sub-Lease	Mining Purposes	Registered	The part sublease area known as the “Dam 22 Long Term Mining Sublease” was registered on 10th January 2018 for a term until 3 April 2025.	03/04/2025
ML 1752	Mining Lease	Prospecting, Mining Coal and Purposes	Granted	17/03/2017	17/03/2038
EL 7712	Exploration Licence	Prospecting Coal	Renewal Pending	23/2/2011	23/02/2020
EL 8824	Exploration Licence	Prospecting Coal	Granted	15/02/2019	15/02/2025
Mount Thorley Coal Loading Ltd					
MLA 548	Mining Lease Application	Mining Purposes	Application Pending	Mining Lease Application Lodged 13/11/2017	N/A

TABLE 3.5 WATER LICENCES

Licence Number	Type	Purpose	Legislation	Description	Renewal Date
20BL168821	Bore	Monitoring Bore	Part 5 Water Act 1912	Bores: MTAGP1, MTAGP2, ABGOH07, ABGOH43, ABGOH44, ABGOH45	Perpetuity
20BL171729	Bore	Monitoring Bore	Part 5 Water Act 1912	G3	Perpetuity
20BL171841	Bore	Monitoring Bore	Part 5 Water Act 1912	OH1126	Perpetuity
20BL171842	Bore	Monitoring Bore	Part 5 Water Act 1912	OH944	Perpetuity
20BL171843	Bore	Monitoring Bore	Part 5 Water Act 1912	OH1137	Perpetuity

Licence Number	Type	Purpose	Legislation	Description	Renewal Date
20BL171844	Bore	Monitoring Bore	Part 5 Water Act 1912	Bores: OH1123 (E), OH1123 (W)	Perpetuity
20BL171845	Bore	Monitoring Bore	Part 5 Water Act 1912	OH1124	Perpetuity
20BL171846	Bore	Monitoring Bore	Part 5 Water Act 1912	Bores: OH786, OH942	Perpetuity
20BL171847	Bore	Monitoring Bore	Part 5 Water Act 1912	Bores: OH1127, OH787	Perpetuity
20BL171848	Bore	Monitoring Bore	Part 5 Water Act 1912	OH1125	Perpetuity
20BL171849	Bore	Monitoring Bore	Part 5 Water Act 1912	OH1122	Perpetuity
20BL171850	Bore	Monitoring Bore	Part 5 Water Act 1912	OH1138	Perpetuity
20BL171891	Bore	Monitoring Bore	Part 5 Water Act 1912	Bores: OH1121, OH788, OH943	Perpetuity
20BL171892	Bore	Monitoring Bore	Part 5 Water Act 1914	Bores: WOH2153 (PZ2), WOH2154 (PZ1), WOH2155 (PZ4), WOH2156 (PZ3)	Perpetuity
20BL171893	Bore	Monitoring Bore	Part 5 Water Act 1918	Bores: WOH2141 (PZ6), Ground Water Alluvial Modelling	Perpetuity
20BL171894	Bore	Monitoring Bore	Part 5 Water Act 1913	WOH2139 (PZ5)	Perpetuity
20BL172272	Bore	Monitoring Bore	Part 5 Water Act 1912	PZ9S, PZ9D	Perpetuity
20BL172273	Bore	Monitoring Bore	Part 5 Water Act 1912	PZ8S, PZ8D	Perpetuity
20BL172439	Bore	Monitoring Bore	Part 5 Water Act 1912	Windermere	Perpetuity
20BL172518	Bore	Monitoring Bore	Part 5 Water Act 1912	Windermere: MBW01, MBW02, MBW03, MBW04	Perpetuity
20BL173276	Bore	Monitoring Bore	Part 5 Water Act 1912	Windermere	Perpetuity
20BL173065	Bore	Monitoring Bore	Part 5 Water Act 1912	SR012	Perpetuity
20FW213276 (formerly 20CW802601)	Flood Work Approval	Block Dam	Water Management Act 2000	Charlton Rd Levee	Expired
20WA209905 (Formerly 20SL051292)	Stream Diversion	Bywash Dams	Water Management Act 2000	Doctors Creek Bywash	31 July 2022
20CA209904 WAL - 19022	Stream Diversion	Bywash Dams	Water Management Act 2000	Sandy Hollow Creek	25 February 2023

Water Licence 20FW213276 was reviewed prior to its expiration date in August 2020. MTW did not renew the licence as the flood works at the Charlton road Levee are approved under SSD 6465.

TABLE 3.6 WATER ACCESS LICENCES

Licence Number	Description	Water Source	Water Sharing Plan	Water Source – Management Zone	Licence Allocation (ML)*
WAL963	Warkworth Mining Limited Hunter River Pump (General Security)	Hunter River	Hunter Regulated River WSP	Zone 2b (Hunter River from Wollombi Brook Junction to Oakhampton Rail Bridge)	243
WAL10543	Mount Thorley Joint Venture (MTJV) water supply scheme, held by Singleton Shire Council	Hunter River	Hunter Regulated River WSP	Zone 2b (Hunter River from Wollombi Brook Junction to Oakhampton Rail Bridge)	1,907 (MTW share is 1,009)
WAL43056	Warkworth Mining Limited (High Security)	Hunter River	Hunter Regulated River WSP	Zone 2b (Hunter River from Wollombi Brook Junction to Oakhampton Rail Bridge)	2,000
WAL10544	(Hunter Regulated River – Domestic and Stock)	Hunter River	Hunter Regulated River WSP	Zone 2b (Hunter River from Wollombi Brook Junction to Oakhampton Rail Bridge)	5
WAL18233	Old Farm	Hunter River Alluvium	Hunter Unregulated and Alluvial Water Sources WSP	Hunter Regulated River Alluvial Water Source – Downstream Glennies Creek Management Zone	5
WAL18558	Hawkes	Wollombi Brook	Hunter Unregulated and Alluvial Water Sources WSP	Lower Wollombi Brook Water Source	50
WAL19022	Sandy Hollow Creek	Unregulated River	Hunter Unregulated and Alluvial Water Sources WSP	Singleton Water Source	60

Licence Number	Description	Water Source	Water Sharing Plan	Water Source – Management Zone	Licence Allocation (ML)*
WAL40464 (previously 20BL170011)	Mt Thorley Pit Excavation	Permian Coal Seams	North Coast Fractured and Porous Rock Groundwater Sources WSP	Sydney Basin – North Coast Groundwater Source	180
WAL40465 (previously 20BL170012)	Warkworth Pit Excavation	Permian Coal Seams	North Coast Fractured and Porous Rock Groundwater Sources WSP	Sydney Basin – North Coast Groundwater Source	750

** Licence allocations are for 1 July to 30 June reporting year. Actual usage can exceed licence allocation in the table above if carryover provisions are available and have been applied during the water year.*

3.1.2 Management Plans, Programmes and Strategies

Table 3.7 details the management plans and strategies which are required under the Warkworth (SSD-6464) and Mount Thorley (SSD-6465) Development Consent instruments.

A Mining Operations Plan (MOP) was developed to replace the previous MOP and cover the existing MTW operations, as well as the approved operations outlined in the Environmental Impact Statements for the Warkworth Continuation 2014 and Mt Thorley Operations 2014. The MOP outlines the proposed operational and applicable environmental management activities planned for MTW. Details regarding the submission and approval dates for the current MOP are shown in **Table 3.8**.

TABLE 3.7 STATUS OF MANAGEMENT PLANS REQUIRED UNDER WARKWORTH CONTINUATION (SSD-6464) AND MOUNT THORLEY OPERATIONS (SSD-6465) DEVELOPMENT CONSENTS

Plan / Program / Strategy	Status (approval date)
Air Quality Management Plan	28/08/2019
Noise Management Plan	28/08/2019
Blast Management Plan	28/08/2019
Water Management Plan	13/05/2020
WML Biodiversity Management Plan	20/09/2018
Rehabilitation Management Plan (addressed in MOP)	24/11/2020 (MOP Amendment C)
Environmental Management Strategy	28/08/2019
MTW Historic Heritage Management Plan	11/10/2017
MTW Aboriginal Heritage Management Plan	28/08/2019
Wollombi Brook Aboriginal Cultural Heritage Conservation Area Conservation Management Plan	11/10/2017
Loder Creek Aboriginal Cultural Heritage Conservation Area Plan of Management	19/03/2019

Plan / Program / Strategy	Status (approval date)
Management Plan for Goulburn River Biodiversity Area	30/04/2018 (DP&E)
Management Plan for Bowditch Biodiversity Area	30/04/2018 (DP&E)
Management Plan for Southern Biodiversity Area	30/04/2018 (DP&E)
Management Plan for Northern Biodiversity Area	26/06/2017 (DP&E)
Management Plan for North Rothbury Biodiversity Area	30/04/2018 (DP&E)
Warkworth Sands Woodland Integrated Management Plan	Pending (Submitted to OEH 15/02/2017)
Warkworth Sands Woodland Performance Criteria	Pending (Submitted to OEH 15/02/2017)

TABLE 3.8 MOP APPROVAL STATUS FOR MOUNT THORLEY WARKWORTH

Mining Operations Plan	Date Submitted	Date Approved
Mount Thorley Warkworth MOP Amendment A 2018 - 2021	11/10/2018	14/12/2018
Mount Thorley Warkworth MOP Amendment B 2018 - 2021	23/5/2019	11/6/2019
Mount Thorley Warkworth MOP Amendment C 2020 - 2021	31/3/2020	24/11/2020

4 OPERATIONS DURING THE REPORTING PERIOD

4.1 Summary of Mining Activities

Areas to be mined are geologically modelled, a mine plan is formed and the relevant mining locations are surveyed prior to mining. **Figure 3** illustrates the mining process. MTW have no active underground workings.

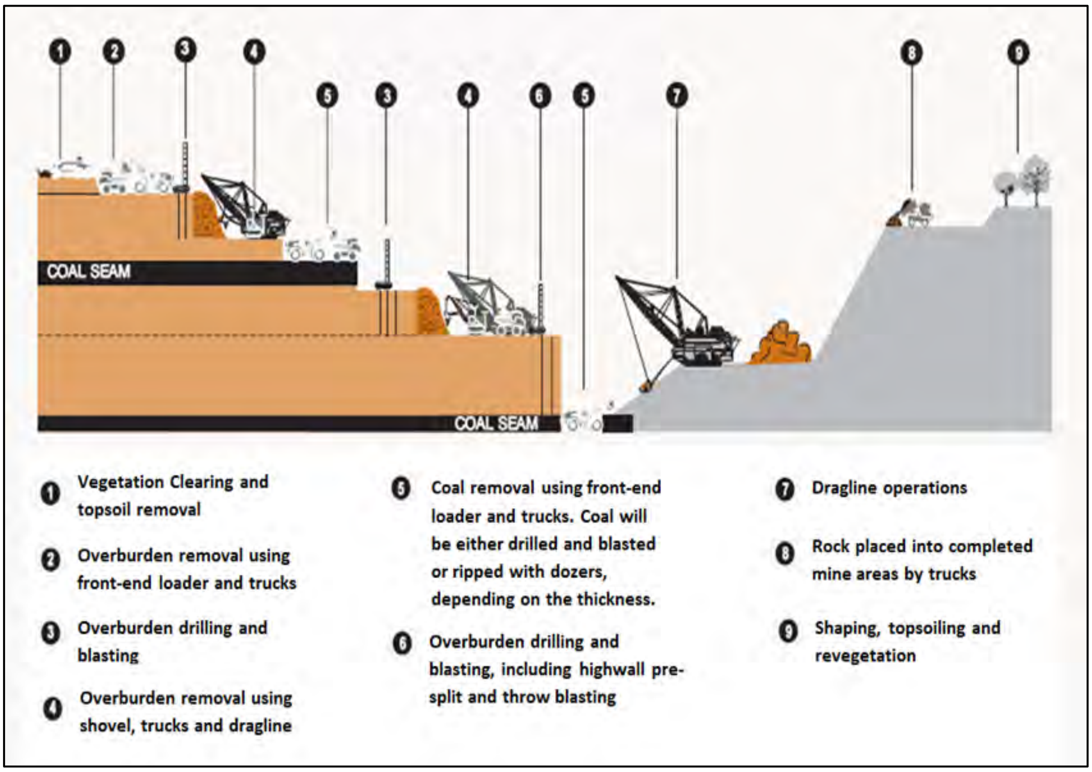


FIGURE 3: MINING PROCESS

Within Warkworth, mining activities will continue to advance in a westerly direction in both North and West Pits. South Pit has reached its final limit with regards to excavation and is available for dumping activities. Within Mount Thorley, two small areas in the northern and southwestern extents of the mining lease reached their final limits during 2020. Mount Thorley will now be utilised for tailings and overburden emplacement. Exploration drilling was conducted within the relevant mining leases ahead of mining and within the pit to gain further information on the resource. All mining related activity is in line with the current MOP.

The planned 2021 production and waste schedule for MTW is summarised below:

- 18.0 Mt ROM coal;
- 12.25 Mt Product coal;
- 112 Mbcm overburden (including rehandle)
- 5.7 Mt Tailings and reject

The forecasted ROM coal production represents approximately 65% of the approved maximum ROM coal production for MTW. Coal will continue to be transported via conveyer to the Mount Thorley Coal Loader and railed to the port.

4.2 Mineral Processing

All processing and rejects/tailings disposal activities undertaken in 2020 were consistent with the approved MOP and no changes were made to the processing and rejects/tailings disposal methods.

Active tailing emplacements included the Centre Ramp Tailings Storage Facility, Abbey Green South Tailings Storage Facility and Ministrip Tailings Storage Facility. Tailings Dam 2 was previously used to receive ash from Redbank Power Station but ceased in July 2014 following the cessation of operations at Redbank Power Station. During 2020 capping works on Tailings Dam 2 and the Interim Tailings Storage Facility continued. The Loders Pit Tailings Storage Facility was developed during 2020 and tailings deposition commenced into this facility in January 2021.

4.3 Production Statistics

MTW is permitted to extract up to 28 Mtpa of ROM coal, comprising up to 18 million tonnes of ROM coal from the Warkworth Mine and 10 million tonnes from the Mount Thorley Mine. MTW Production Statistics for the previous, current and future reporting period are summarised in **Table 4.1.**

TABLE 4.1 SUMMARY OF PRODUCTION AT MTW IN 2020

Material	Approved Limits	Reporting Period 2019	Reporting Period 2020	Forecast for 2021
Prime Overburden Waste (kbcm)	N/A	96,765	98,217	103,543
MTO ROM Coal (Mtpa)	10 (SSD-6465)	0.71	0.88	0.20
WML ROM Coal (Mtpa)	18 (SSD-6464)	16.90	16.60	17.80
ROM Coal (Mtpa)	28 (Combined)	17.61	17.49	17.99
Coarse Reject (kt)	N/A	4,236	5,063	5,172
Fine Reject – Tailings (kt)	N/A	1,196	1,116	577
Product (kt)	N/A	12,000	11,929	12.25

All product coal was transported by rail. MTW transported 11,839 kt of product coal via rail during the 2020 reporting period.

4.4 Summary of Changes (Developments and Equipment Upgrades)

- No significant changes from 2019 to 2020 to the mining fleet

5 ACTION(S) REQUIRED FROM PREVIOUS ENVIRONMENTAL MANAGEMENT REVIEW

An annual environmental inspection was not undertaken by DPI&E in 2020 and there were no actions required by DPI&E to be addressed in the 2020 AER.

6 ENVIRONMENTAL MANAGEMENT AND PERFORMANCE

6.1 Meteorological Data

Meteorological data is collected to assist in day to day operational decisions, planning, and environmental management and to meet development consent requirements. MTW operates a real time meteorological (weather) station located on Charlton Ridge. The meteorological station measures wind speed, wind direction, temperature, humidity, solar radiation, rainfall, and sigma theta. Instruments are installed, calibrated, and maintained according to the relevant Australian Standard AS 3580.14 (2011). Meteorological data is available to site personnel and provides mining operations with trend assessment details to inform operational decisions aimed at minimising impacts. Daily Meteorological data summaries are presented in the Monthly Environmental Monitoring reports, available via the MTW website: http://insite.yancoal.com.au.

6.2 Noise

6.2.1 Noise Management

MTW manages noise to ensure compliance with permissible noise limits at nearby private residences. A combination of both proactive and reactive control mechanisms is employed on a continuous basis to ensure effective management of noise emissions is maintained. Noise management strategies and processes employed at MTW are detailed in the MTW Noise Management Plan available for viewing via the MTW website: http://insite.yancoal.com.au.

MTW's 2020 noise performance metrics are shown below:

- Community noise complaints received – reduced by ~12% from 2019
- Number of Community Response Officer (CRO) (supplementary) noise measurements which exceed the internal trigger level for action – decreased to 72 from 94 in 2019; and
- Number of equipment downtime hours logged in response to noise management triggers – decreased by ~ 10% from 2019.

A range of noise management processes were undertaken during 2020. These are described herein.

6.2.1.1 Real Time Noise Management

MTW's Real-Time noise management framework provides an effective tool for managing instances of elevated noise, ensuring compliance is maintained, and responding to community concerns.

MTW utilise CROs to provide an interface between the mine and community. They are effective in implementing the management framework, validating real-time alerts through supplementary handheld noise measurements and audible observations, driving operational change as required, and responding to community complaints. A summary of supplementary handheld noise measurements conducted by the CROs in 2020 is presented in **Table 6.1**.

MTW's website allows members of the general public to access noise, meteorological, air quality data as well as any operational changes made during shift via MTW's interactive website. Viewer access: http://insite.yancoal.com.au

TABLE 6.1 SUMMARY OF SUPPLEMENTARY ATTENDED NOISE MONITORING CONDUCTED BY COMMUNITY RESPONSE OFFICERS 2020

Monitoring Location	Number of Assessments	Number of measurements >WML trigger^	Number of measurements > MTO trigger^	Average WML noise level ($L_{Aeq\ 5min}$ dB(A))*	Average MTO noise level ($L_{Aeq\ 5min}$ dB(A))*
Wollemi Peak Road (Bulga RFS)	1307	42	12	33.25	32.58
Bulga Village	622	4	0	32.53	31.98
Inlet Road	521	10	0	32.65	31.86
Inlet Road West	374	0	0	29.93	29.41
Long Point	998	0	0	31.01	-
South Bulga	0	-	-	-	-
Wambo Road	120	4	-	34.91	32.70
Total	3943	60	12	-	-

^Triggers are internally set thresholds for operational response and are specified in the MTW Noise Management Plan. The number of measurements greater than the trigger cannot be used an assessment or interpretation of compliance. A compliance assessment is provided in Sections 6.2.2 and 6.2.2.1.

**Average noise levels do not take account of measurements taken where the noise source of interest was recorded as inaudible.*

In response to the events listed in **Table 6.1** which were greater than the trigger, up to 1090 hours of equipment downtime were recorded to manage noise during 2020. This is a decrease (approximately 10%) to the number of downtime hours recorded in 2019 coinciding with a decrease in the number of supplementary noise measurements completed which exceed the trigger for management action.

6.2.2 Noise Performance

A total of 96 compliance measurements were undertaken by an independent acoustic specialist in accordance with the MTW Noise Monitoring Programme during the reporting period. Each measurement involves an assessment of mine noise against the various LAeq, 15 minute and LA1, 1min noise criteria. Noise monitoring results are presented in the Monthly Environmental Monitoring Reports, available via the MTW website https://insite.yancoal.com.au/document-library/monthly-reporting-mtw

In accordance with the requirements of the EPA's Noise Policy for Industry (NPfI), the applicability of the low frequency modification penalty has been assessed. There were no noise measurements taken during the reporting period which required the penalty to be applied.

TABLE 6.2 ATTENDED NOISE MEASUREMENTS EXCEEDING CONSENT CONDITIONS FOLLOWING APPLICATION OF NPFI LOW FREQUENCY MODIFYING FACTOR

Location	Date/Time	Relevant Criteria	Criterion (dB)*	L_{Aeq}(dB)	Revised L_{Aeq} (dB)	Exceeds by (dB)
N/A	-	-	-	-	-	-

6.2.2.1 Comparison against Last Years' Results

A comparison of non-compliances and exceedances between years is used as a measure of the effectiveness of noise management measures employed on site.

Details of this comparison are provided in **Table 6.3** which demonstrates a continuation of the effective management delivered in 2020.

TABLE 6.3 COMPARISON OF 2020 NOISE MONITORING RESULTS AGAINST PREVIOUS YEARS'

Year	Number of assessments	Number of exceedances	Number of non-compliances
2020	576	0	0
2019	588	1	0
2018	594	1	0
2017	576	0	0
2016	576	0	0
2015	665	0	0
2014	700	0	0
2013	456	11	7
2012	562	13	3
2011	572	11	4
2010	561	3	3
2009	569	10	4

A comparison of supplementary noise measurements undertaken during the previous and current reporting period is provided in **Table 6.4**. This data shows the considerable effort in undertaking supplementary noise measurements has continued in 2020, and average noise readings have been comparable.

TABLE 6.4 COMPARISON OF CRO (SUPPLEMENTARY) NOISE MEASUREMENT PERFORMANCE

Monitoring Location	Number of Assessments		Number of Measurements >WML Trigger^		Number of Measurements > MTO Trigger^		Average WML Noise Level ($L_{Aeq\ 5min}$ dB(A))*		Average MTO Noise Level ($L_{Aeq\ 5min}$ dB(A))*	
	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020
Wollemi Peak Road (Bulga RFS)	1072	1307	41	42	13	12	33.4	33.3	32.9	32.6
Bulga Village	651	622	3	4	-	0	32.4	32.5	31.1	32.0
Inlet Road	671	521	27	10	1	0	33.4	32.7	32.4	31.9
Inlet Road West	407	374	-	0	-	0	30.1	29.9	27.7	29.4
Long Point	1133	998	5	0	-	0	31.1	31.0	30.6	-
South Bulga	0	0	-	-	-	-	-	-	-	-
Wambo Road	305	120	4	4	-	-	33.5	34.9	31.7	32.7
Total	4239	3943	80	60	14	12	-	-	-	-

^Triggers are internally set thresholds for operational response and are specified in the MTW Noise Management Plan. The number of measurements greater than the trigger cannot be used an assessment or interpretation of compliance. Compliance assessment is provided in 6.2.3 and 6.2.4.

**Average noise levels do not take account of measurements taken where the noise source of interest was recorded as inaudible.*

6.2.2.2 Validation of Real Time Monitoring Results

A comparison of real time and independent attended noise monitoring results was undertaken for quarter four 2020. The comparison identified that the attended noise monitoring results were generally lower than the corresponding real time noise monitoring results i.e. real time noise monitor trigger is mainly conservative for the most closely located real time noise monitor and for the mostly closely aligned 15-minute monitoring periods. There were isolated exceptions to this, including;

- WML LAeq 15 minute attended monitoring measured noise levels were higher than the real time monitoring measured noise levels for two of eight attended monitoring locations in October and December.
- MTO LAeq, 15 minute attended monitoring measured noise levels were higher than the real time monitoring measured noise levels for two of eight attended monitoring locations in October.

On the occasions where the WML and MTO attended monitoring measured noise levels were higher, the recorded noise levels were significantly below noise limits specified in MTW's Noise Management Plan. The noise monitors can have difficulty assigning WML and MTO directional noise levels at times, such as where there is more than one noise source and where MTW is not the primary noise source. MTW's noise management process is that routine supplementary noise monitoring is also undertaken by the Community Response Officer each night and provides additional assessment of directional noise levels, allowing for swift targeted operational modifications where noise levels from MTW are exceeding the specified noise limit(s).

6.2.2.3 Comparison against EA Predictions

Table 6.5 provides a comparison of 2020 attended monitoring data and the predicted noise levels modelled in the 2014 Warkworth Continuation EIS. Comparison has been made against the modelled worst-case noise levels for Year 3 of the development (nominally 2017). The comparison data has been sourced from the modelled noise levels at the nearest residential receivers to the current monitoring locations. Reported 2020 data is the calculated quarterly average of WML contribution to measured LAeq (15 minute) results and the maximum monthly measured noise level obtained through compliance assessment (irrespective of applicability of noise criteria due to meteorological conditions).

Where a monitoring event has been assessed as being "inaudible" or "not measurable", a conservative value of 25dB has been used to calculate the LAeq average for the quarter. The comparison shows that measured noise is within the predicted noise level range.

TABLE 6.5 PREDICTED NIGHT TIME WML (EIS 2014) LAEQ (15 MINUTE) NOISE LEVELS AND AVERAGED AND MAXIMUM 2020 MONITORING RESULTS

Monitoring Location	Year 3 Modelled Noise	Quarter 1 2020 average & maximum		Quarter 2 2020 average & maximum		Quarter 3 2020 average & maximum		Quarter 4 2020 average & maximum	
	LAeq (15 minute) (dB)	LAeq (15 minute) (dB)		LAeq (15 minute) (dB)		LAeq (15 minute) (dB)		LAeq (15 minute) (dB)	
		Avg	Max	Avg	Max	Avg	Max	Avg	Max
Wollemi Peak Road*/Bulga RFS	≤38	27.0	31	25.0	30	29.7	34	29.7	34
Bulga Village	≤38	26.7	30	25.7	27	27.7	36	29.3	33
Gouldsville Road	≤35	29.3	30	27.3	32	28.3	35	29.0	30
Inlet Road	≤37	25.0	25	25.0	25	30.3	34	28.7	31
Inlet Road West*	≤35	25.0	25	25.0	25	26.3	34	23.3	25
Long Point*	≤35	21.7	25	25.0	25	25.0	25	26.0	28
South Bulga	≤38	25.0	25	26.7	30	26.7	30	25.0	25
Wambo Road	≤38	26.3	29	25.0	25	29.0	33	27.3	32

**Denotes – No nearby receiver location modelled*

6.3 Blasting

6.3.1 Blast Management

During the reporting period, the MTW blast monitoring network operated in accordance with AS2187.2-2006 to measure ground vibration and air blast overpressure of each event at a high sampling frequency. Monitors function as regulatory compliance instruments in accordance with the MTW Blast Monitoring Programme (appended to Blast Management Plan) and are located on (or in locations representative of) privately owned land. During 2020 monitors were located at:

- Abbey Green (Abbey Green Station, Putty Road, Glenridding);
- Bulga Village (Wambo Road, Bulga);
- Putty Road, Mount Thorley (known as MTIE)
- Wambo Road (Wambo Road, Bulga);
- Warkworth Village (former Warkworth Public School, Warkworth); and
- Wollemi Peak Road (intersection of Putty & Wollemi Peak Roads, Bulga).

These locations are shown on **Figure 4** below.

FIGURE 4: BLAST MONITORING LOCATIONS

6.3.2 Blast Performance

During the reporting period 221 blast events were initiated at MTW. Results of ground vibration and airblast overpressure recorded during 2020 are presented in **Figure 5** to **Figure 10**. All blasts returned results below the relevant airblast overpressure / ground vibration criteria for all monitoring locations.

Road closures occurred for all blasts within 500 metres of a public road. Public roads were also closed on occasions to mitigate potential impact upon road users from dust or when blast fume management zones encompassed public roads.

In accordance with Schedule 3, Conditions 9 and 10 of SSD-6464, Warkworth Mining Limited carried out blasting on site between 7am and 5pm Monday to Saturday inclusive. No blasts occurred on Sundays or on public holidays. Warkworth Mining Limited carried out not more than 3 blasts per day and not more than 12 blasts per week (averaged over a calendar year).

In accordance with Schedule 3, Conditions 7 and 8 of SSD-6465, Mt Thorley Operations Limited carried out blasting on site between 7am and 5pm Monday to Saturday inclusive. No blasts occurred on Sundays or on public holidays. Mt Thorley Operations carried out not more than 2 blasts per day and not more than 6 blasts per week (averaged over a calendar year).

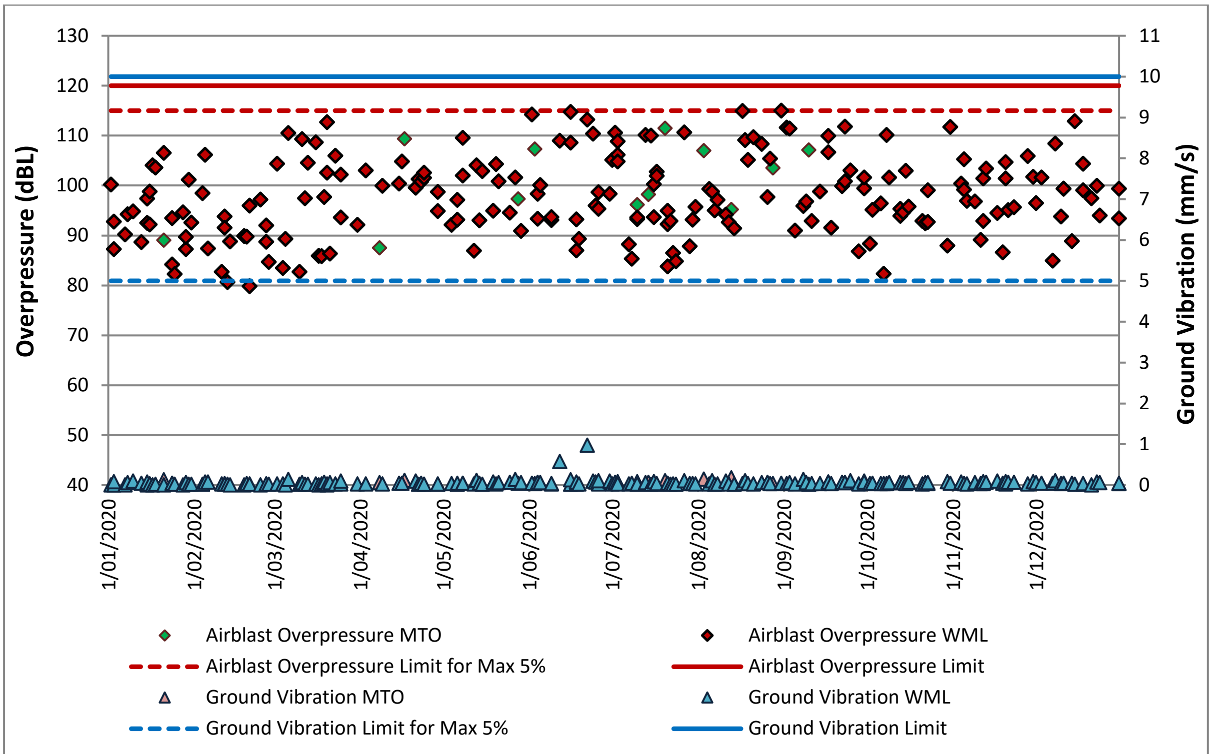


FIGURE 5: ABBEY GREEN BLAST RESULTS

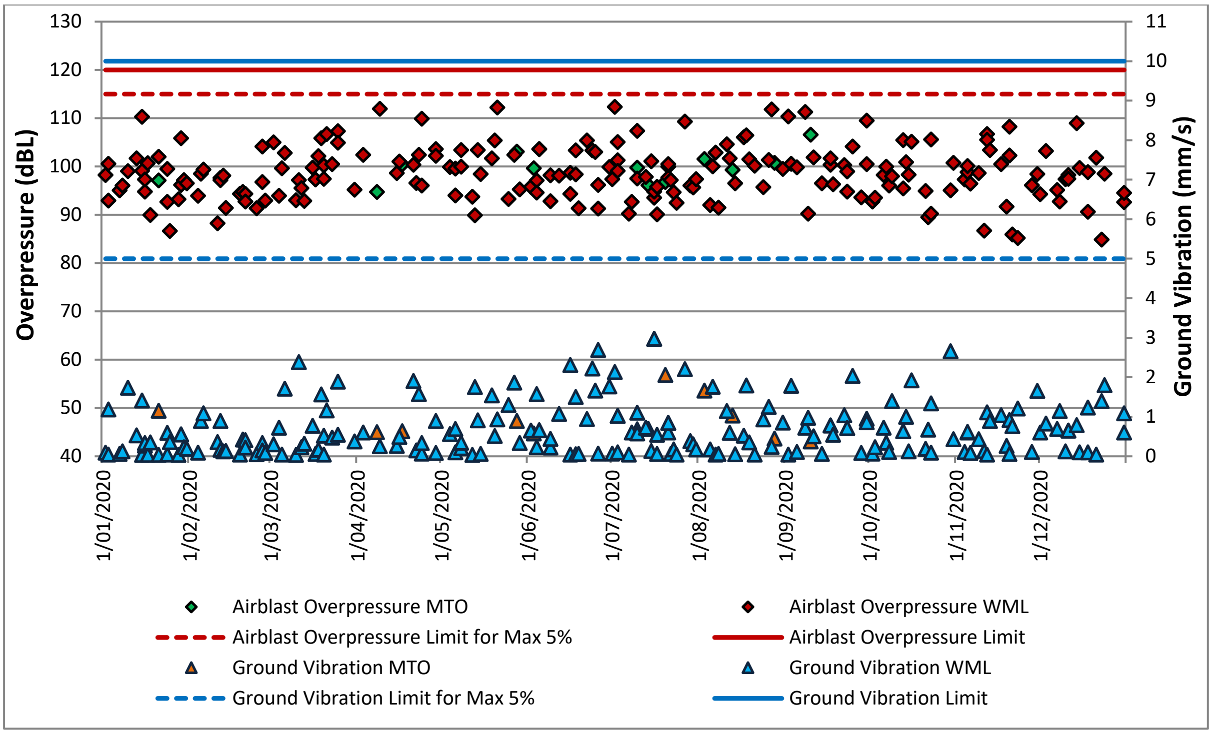


FIGURE 6: BULGA VILLAGE BLAST RESULTS

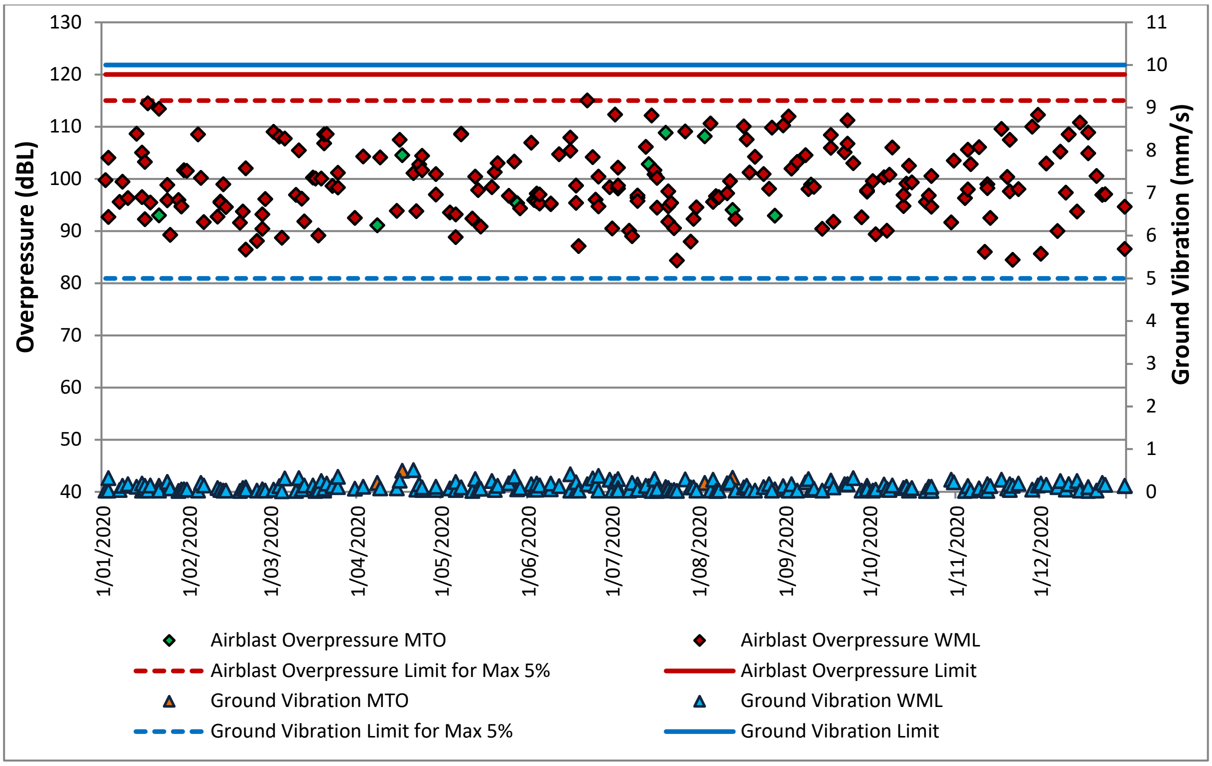


FIGURE 7: MTIE BLAST RESULTS

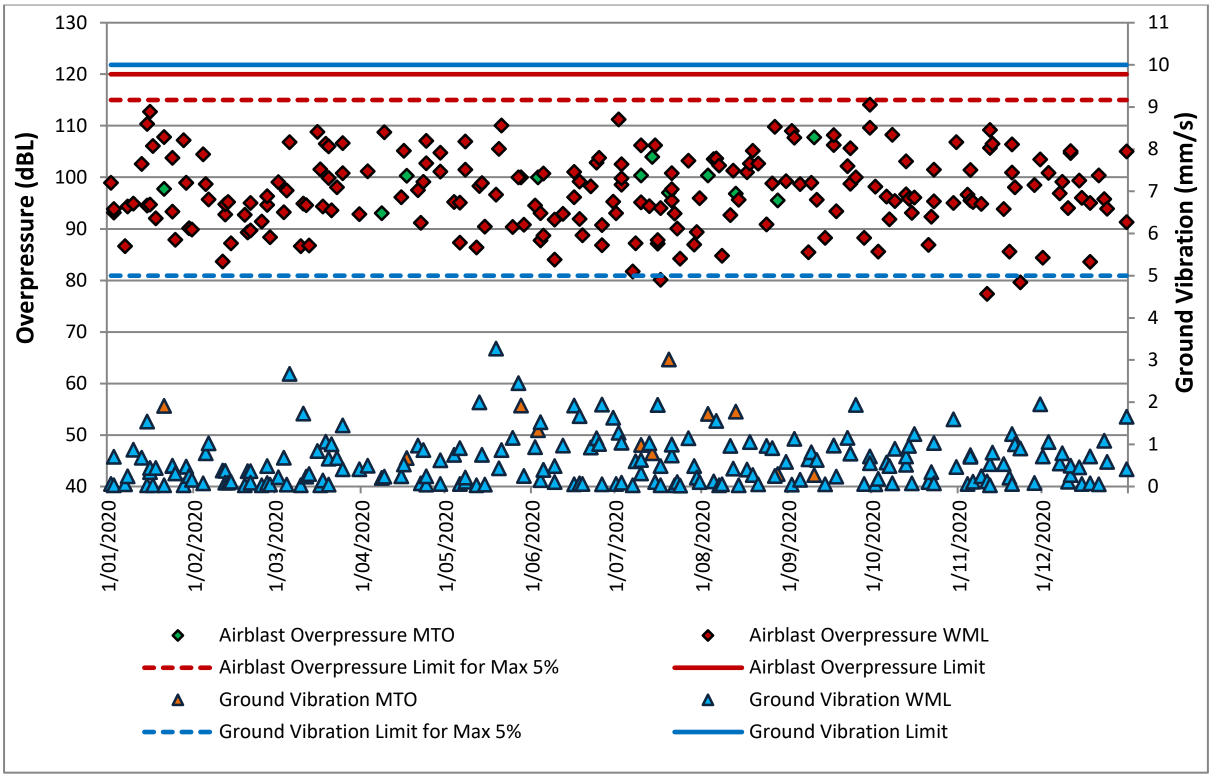


FIGURE 8: WOLLEMI PEAK ROAD BULGA BLAST RESULTS

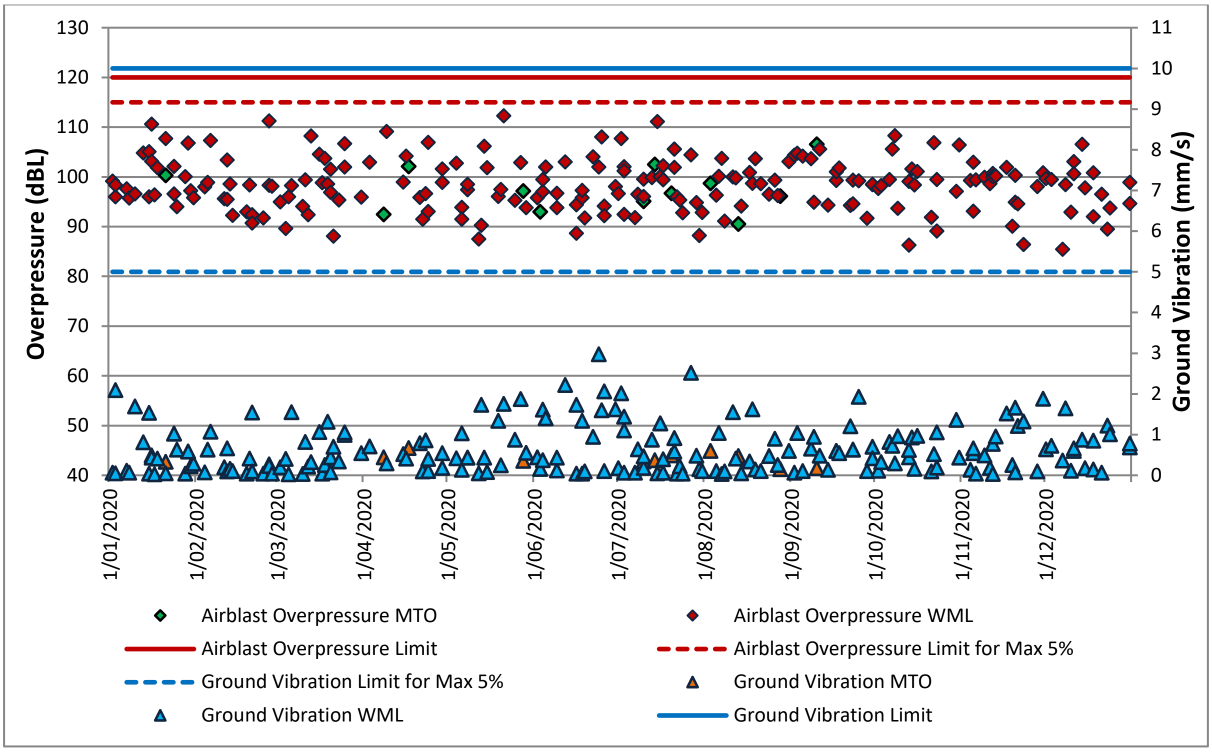


FIGURE 9: WAMBO ROAD BLAST RESULTS

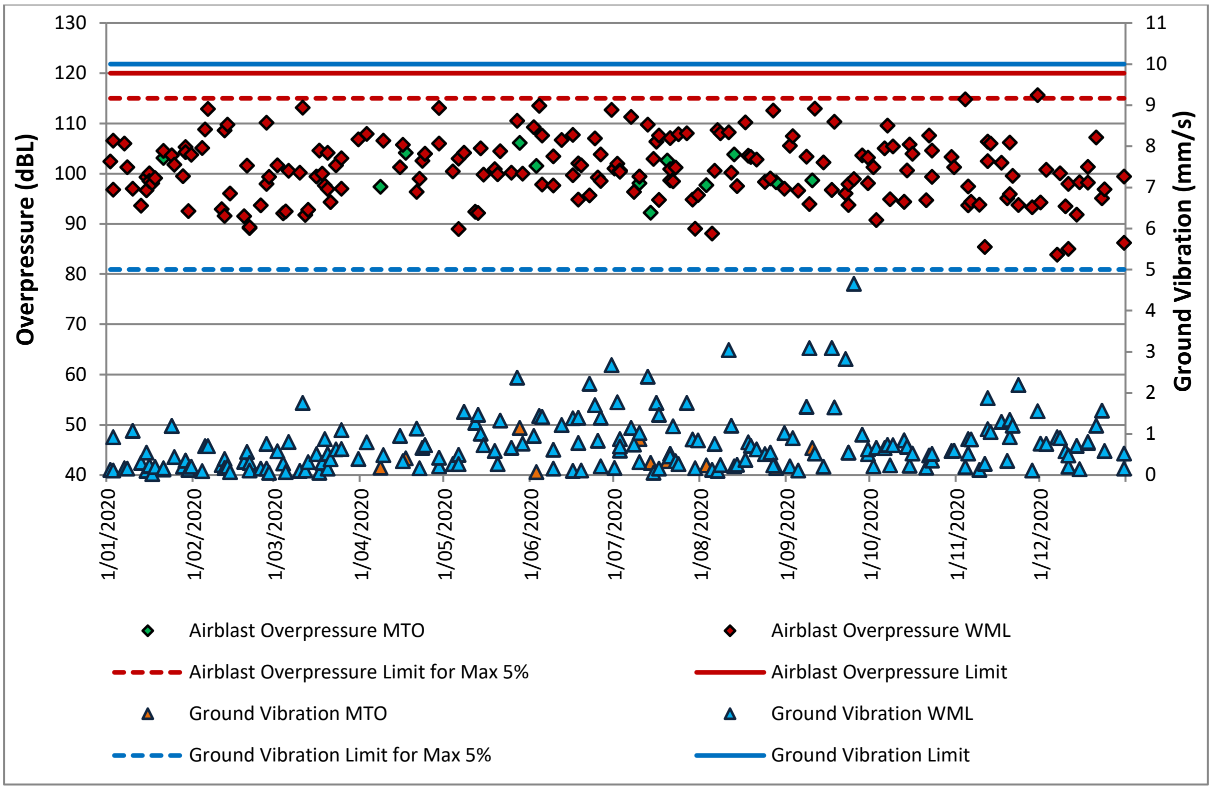


FIGURE 10: WARKWORTH BLAST RESULTS

6.3.2.1 Blast Fume Management

MTW operates a Post Blast Fume Generation Mitigation and Management Plan. This document outlines the practices to be utilised to reduce generation of post blast fume and reduce potential offsite impact from any fume which may be produced. This includes risk assessment of the likelihood of fume production, specialised blasting design, appropriate product selection, on-bench water management, implementation of fume management zones and use of blasting permissions to identify likely path of any fume which may be produced.

All blasts are observed for fume and any fume produced is ranked according to the Australian Explosive Industry & Safety Group (AEISG) Scale. During 2020, no blasts produced visible post-blast fume with a post-blast ranking Level 3 or higher according to the AEISG Scale.

Rankings for visible blast fume according to the AEISG scale for shots fired during 2020 and comparison to rankings distribution during previous years is provided in **Table 6.6.**

Table 6.6 Visible Blast Fume Rankings According to the AEISG Colour Scale

AEISG Ranking	2020	2019	2018
0	243	269	280
1	13	16	26
2	9	7	15
3	0	1	2
4	0	0	0
5	0	0	0
Total*	265	293	323

** Where a number of individual blasts were fired as a blast event, fume was assessed for each individual blast pattern rather than for the event as a whole.*

6.3.2.2 Comparison of Monitoring Results Against Previous Years' Performance and EA Predictions

Blasting results recorded in 2020 are similar to results recorded in previous years and are generally consistent with EA predictions.

6.4 Air Quality

6.4.1 Air Quality Management

Air quality management at MTW is prescribed by the Air Quality Management Plan (available at http://insite.yancoal.com.au), the management plan:

- Describes procedures required to ensure compliance with the approval conditions relating to air quality including the measures that MTW will use to manage air quality;
- Details the management framework and mitigation actions to be taken while operating; and
- Provides a mechanism for assessing air quality monitoring results against the relevant impact assessment criteria.

6.4.1.1 Real-Time Air Quality Management

MTW's real-time air quality monitoring stations continuously log information and transmit data to a central database, generating alarms when particulate matter levels exceed internal trigger limits. Following an alarm, an inspection is undertaken, and operations and equipment usage are modified as required to manage air quality in accordance with MTW's Air Quality Management Plan.

2,566 real-time alarms for air quality and wind conditions were received and acknowledged during 2020. In response, **1,526** hours of equipment downtime was recorded due to air quality management. A detailed breakdown of air quality related equipment stoppages (per month, per equipment type) is presented in **Figure 11**.

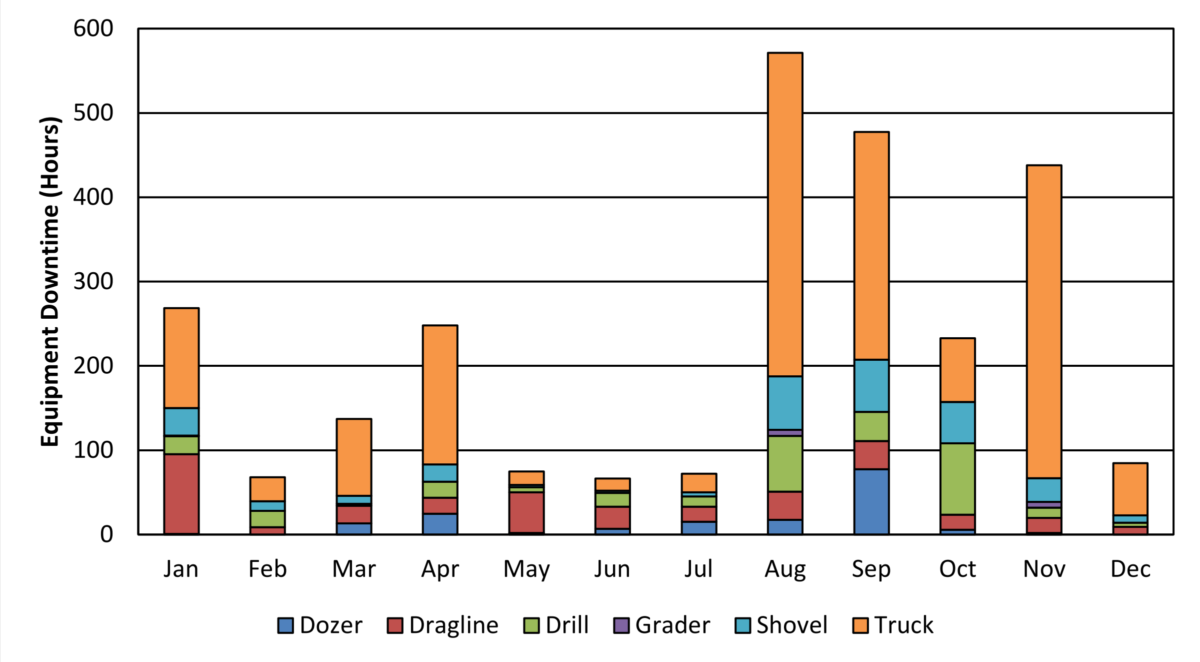


FIGURE 11: EQUIPMENT DOWNTIME FOR DUST MANAGEMENT BY MONTH (2020)

6.4.2 Air Quality Performance

6.4.2.1 Air Quality Monitoring

Air quality monitoring at MTW is undertaken in accordance with the MTW Air Quality Monitoring Programme and protocol for evaluating non-compliances. The monitoring network comprises an extensive array of monitoring equipment which is utilised to assess performance against the relevant conditions of MTW's approvals and EPL's. Air quality monitoring locations are shown in **Figure 12**. During 2020, MTW complied with all short term and annual average air quality criteria.

Air quality compliance criteria are shown in **Table 6.7,** along with a summary of MTW's performance against the criteria. Whilst MTW operates under two separate planning approvals the following compliance assessment has been undertaken on a 'whole of MTW site' basis, rather than individually assessing the contribution of each approval area to the measured results.

Air quality monitoring data is made publicly available through the MTW Monthly Environmental Monitoring Report and daily data can be accessed on http://insite.yancoal.com.au

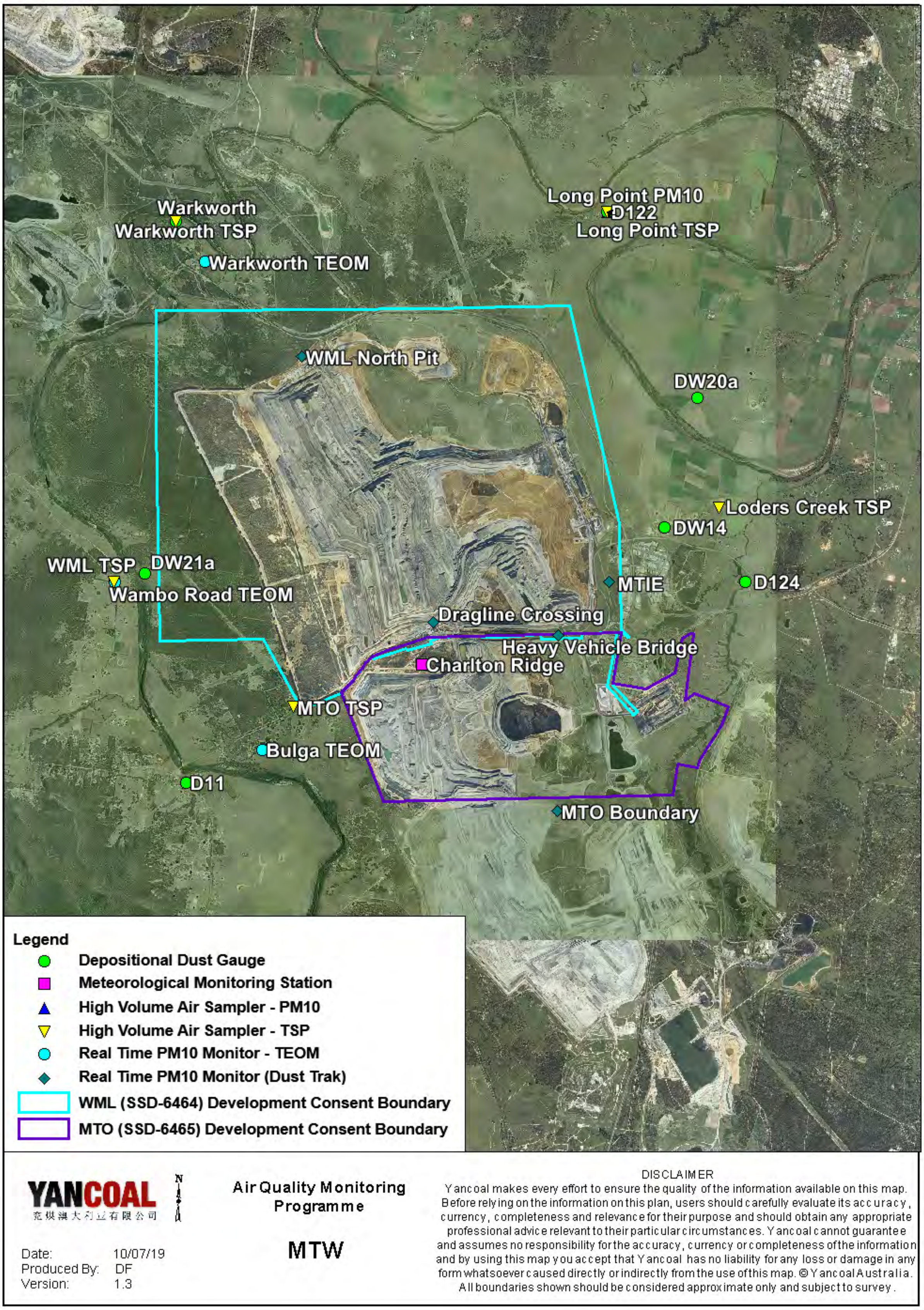


Figure 12: Air And Meteorological Monitoring Locations MTW 2020

TABLE 6.7 AIR QUALITY IMPACT ASSESSMENT CRITERIA AND 2020 COMPLIANCE ASSESSMENT

Pollutant	Criterion	Averaging Period	Compliance
Deposited Dust	4 g/m^2/month	Maximum total deposited dust level	100%
	2 g/m^2/month	Maximum increase in deposited dust level	100%
Total Suspended Particulate matter (TSP)	90 $\mu g/m^3$	Long Term (Annual)	100%
Particulate matter <10µm (PM_{10})	30 $\mu g/m^3$	Long Term (Annual)	100%
	50 $\mu g/m^3$	Short Term (24 hour)	100%

6.4.2.2 Deposited Dust

Deposited dust is monitored at seven (7) locations situated on, or representative of privately-owned land generally in accordance with AS3580.10.1 (2003). The annual average insoluble matter deposition rates in 2020 compared with the impact assessment criterion and previous years' data is shown in **Figure 13.**

There was one exceedance of the long-term impact assessment criteria, for maximum total deposited dust level, recorded at the Warkworth monitoring location. An external consultant was engaged to conduct an investigation which determined maximum MTW contribution to be not more than 1.3g/m2/month, or 24% of the total level of 5.5g/m2/month at Warkworth. As per MTW's approved Air Quality Management Plan, this does not constitute non-compliance because the exceedance is not attributable to either of WML or MTO and no further action is required.

After analysis of the single exceedance, all annual average insoluble matter deposition rates recorded on privately owned land were compliant with the long-term impact assessment criteria of 4g/m2/month. All monitoring locations also demonstrated compliance with the maximum allowable insoluble solids increase criteria of 2g/m2/month (**Figure 14**).

It should be noted that during 2020, monthly dust deposition rates equal to or greater than the long-term impact assessment criteria of 4g/m2/month were recorded at multiple sites. Where field observations denote a sample as contaminated (typically with insects, bird droppings or vegetation), the results are excluded from Annual Average compliance assessment. Meteorological conditions and the results of nearby monitors for the sampling period are also considered when determining MTW's level of contribution to any elevated result. Details of excluded results are presented in the relevant MTW Monthly Environmental Monitoring Report. The graphs below illustrate a general trend in decreased Depositional Dust in 2020 compared to 2019, except for the Warkworth and D122 monitoring locations. This is consistent with above average rainfall recorded in 2020 (828 mm), compared to below average rainfall totals in 2018 (457 mm) and 2019 (304 mm).

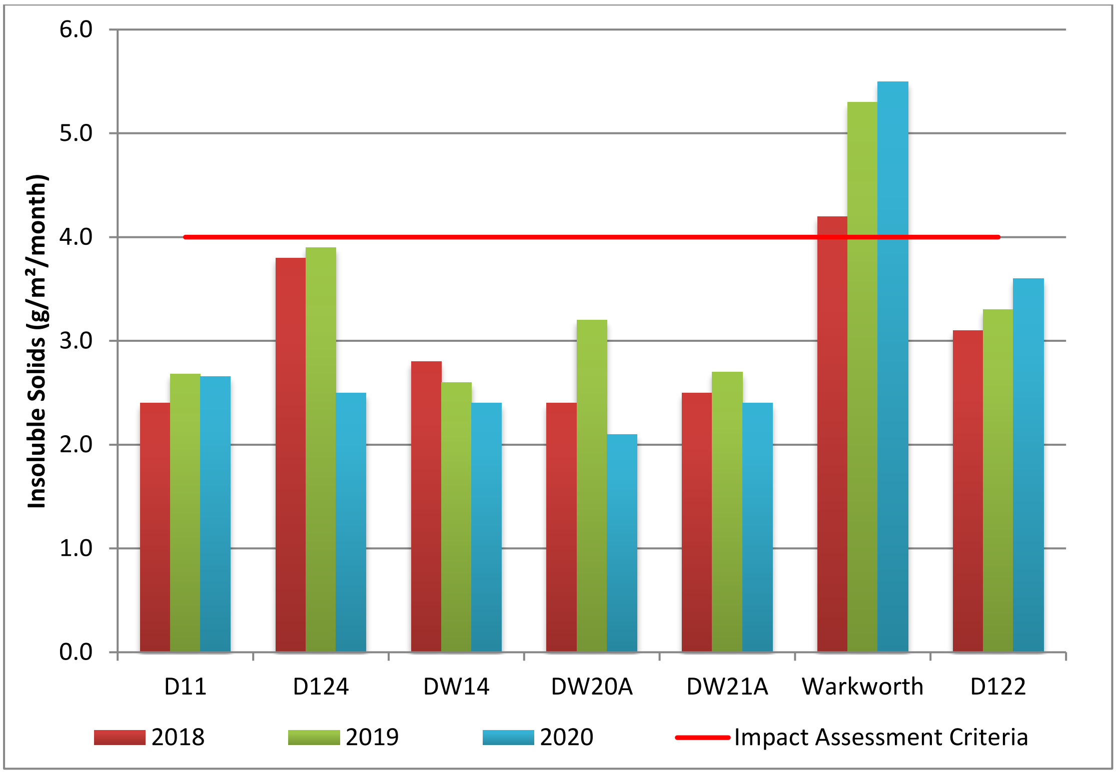


FIGURE 13: 2020 DEPOSITIONAL DUST RESULTS COMPARED AGAINST THE IMPACT ASSESSMENT CRITERIA AND PREVIOUS YEARS' RESULTS

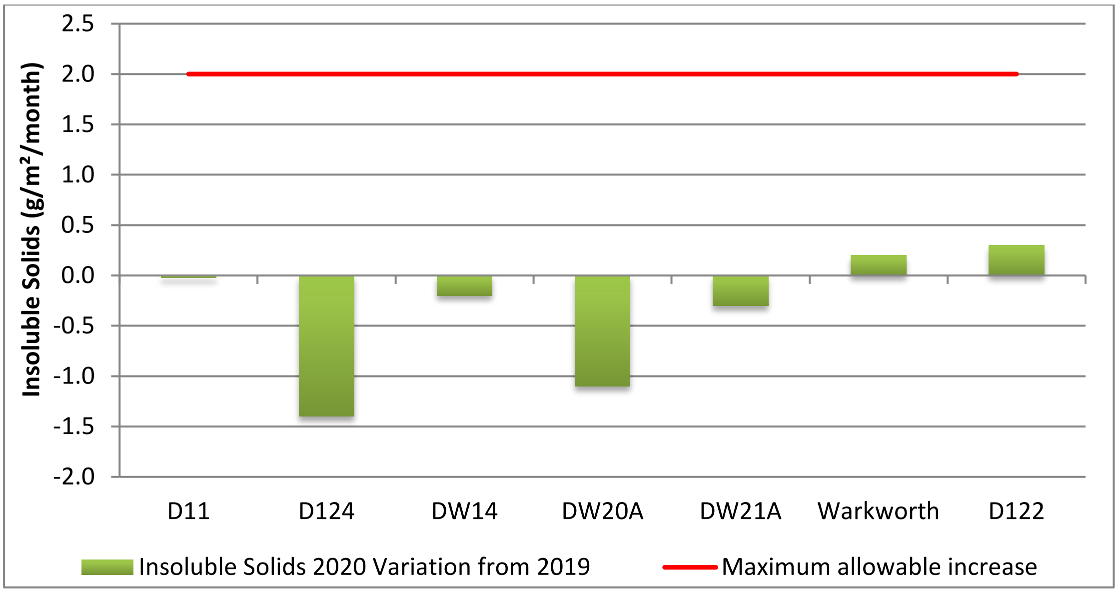


FIGURE 14: VARIATION IN INSOLUBLE SOLIDS DEPOSITION RATE FROM 2019 TO 2020 COMPARED AGAINST THE IMPACT ASSESSMENT CRITERIA

6.4.2.3 Total Suspended Particulates (TSP)

Total Suspended Particulates (TSP) are measured at five (5) locations situated on or representative of privately owned land in accordance with AS3580.9.3 (2003). Annual average TSP concentrations recorded in 2020 compared against the long-term impact assessment criterion and previous years' data, are shown **Figure 15**.

All annual average results were compliant with the impact assessment and land acquisition criteria.

During the reporting period, four (4) out of the 305 TSP measurements were not able to be fully collected on the scheduled sampling date (based on a sampling frequency of every six days) likely due to power failures.

The annual average TSP concentrations recorded in 2020 are lower than those recorded in previous years, which is likely related to above average rainfall for the year.

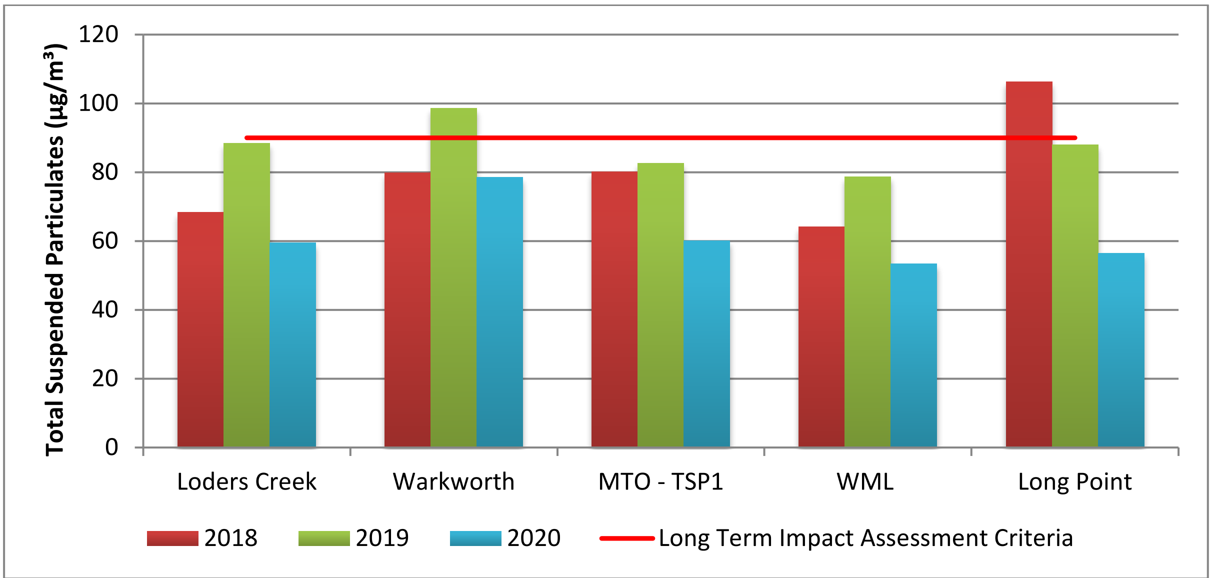


FIGURE 15: 2020 TSP ANNUAL AVERAGE COMPARED AGAINST THE IMPACT ASSESSMENT CRITERIA AND PREVIOUS YEARS' RESULTS

6.4.2.4 Particulate Matter <10µm (PM10)

Compliance assessment for Particulate Matter <10µm (PM_{10}) is measured at five (5) locations on privately owned land in accordance with AS3580.9.6 (2003). During 2020, all short term and annual average results were compliant with the impact assessment criteria.

6.4.2.5 Short term PM10 impact assessment criteria

Monitoring results for PM_{10} (24 hour) collected through the High-Volume Air Sampler monitoring network are compared against the short-term impact assessment criteria (**Figure 16**). All 24hr average results recorded by MTW's surrounding network of TEOM monitors are presented on a quarterly basis in **Figure 17** to **Figure 20.**

The figures show that levels were elevated in January. The elevated levels were primarily caused by smoke from bushfires which impacted the east coast of NSW at the end of 2019 and into early 2020, as well as generally elevated PM10 levels associated with hot, dry and windy days during drought conditions.

The DPIE provided MTW with a list of dates of "extraordinary events" for 2020 for the Upper Hunter, as shown in **Table 6.9** below. Extraordinary events include bushfires, dust storms and/or regional dust events. As per MTW's Development Consents, the short and long term impact assessment criteria do not apply on days declared as extraordinary events.

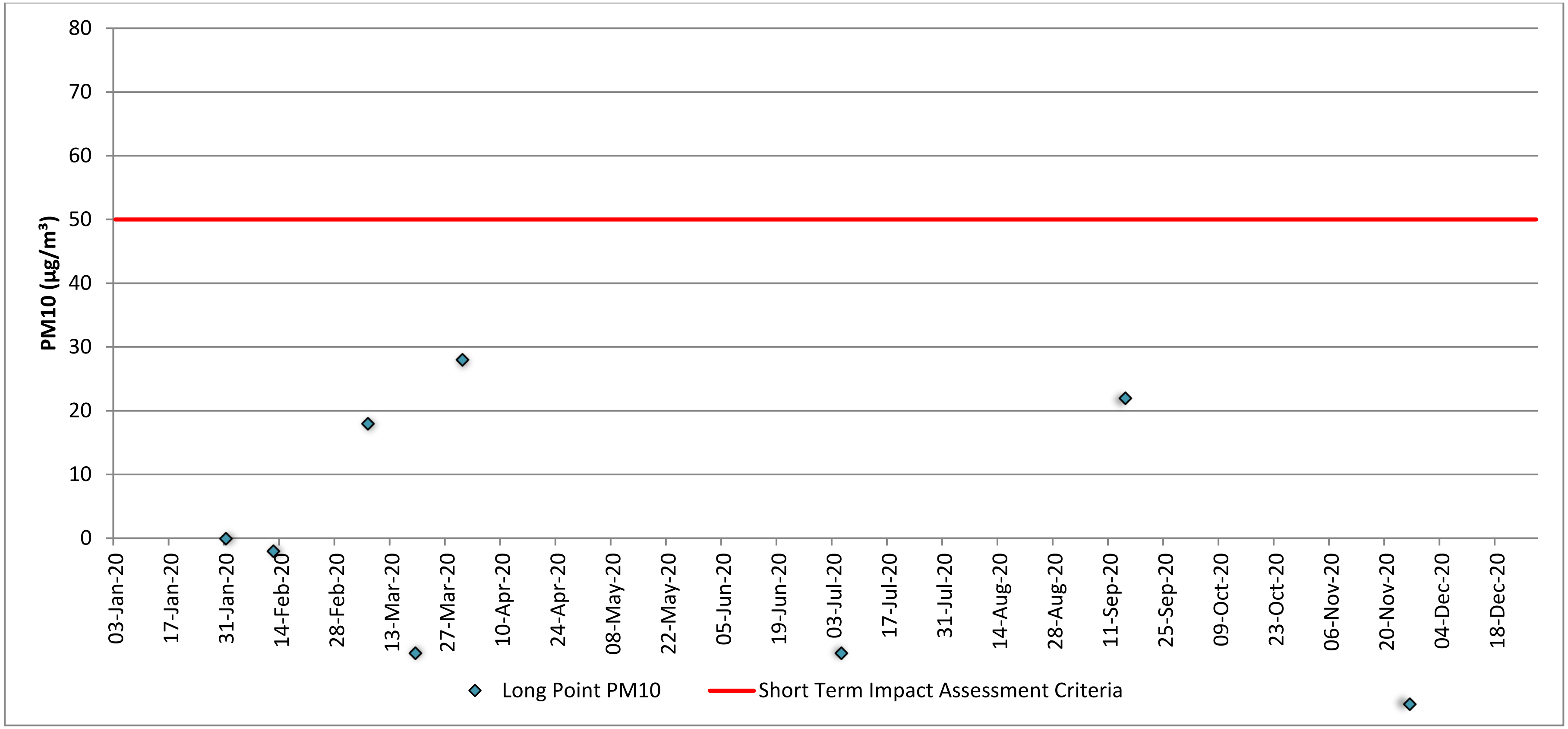


FIGURE 16: PM10 24HR MONITORING RESULTS (MEASURED BY MTW PM10 HVAS MONITOR)

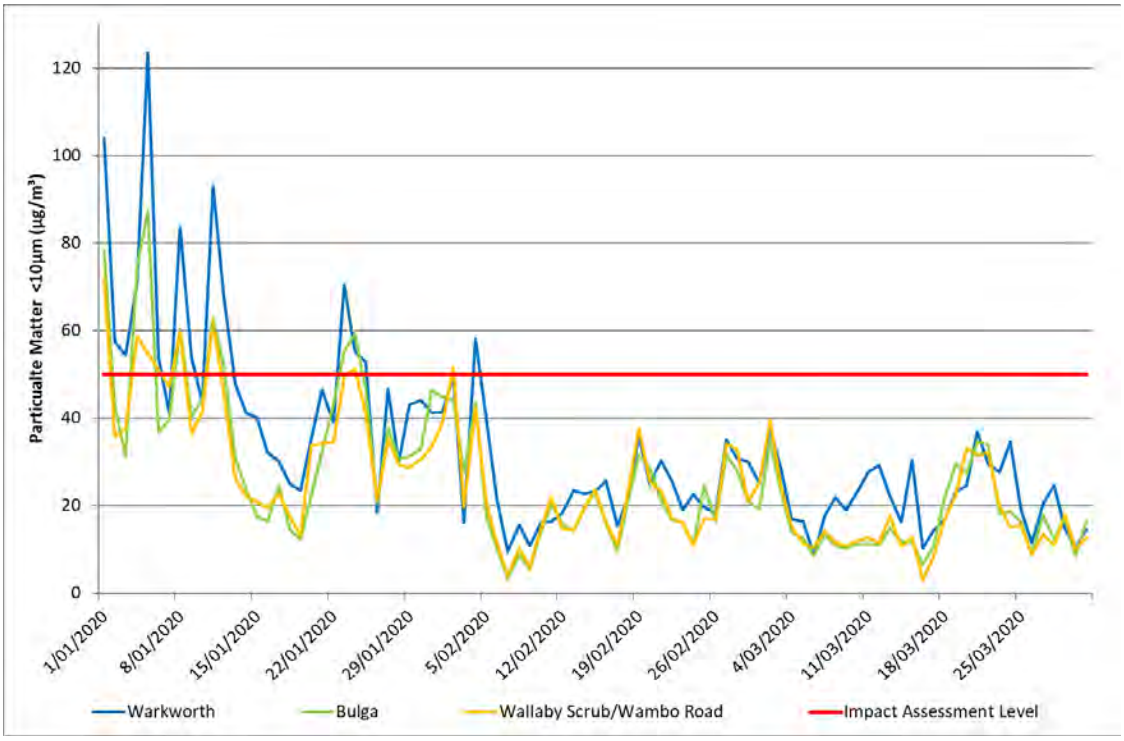


FIGURE 17: 24HR AVERAGE PM10 MEASURED AT TEOM MONITORS SURROUNDING MTW - QUARTER ONE 2020

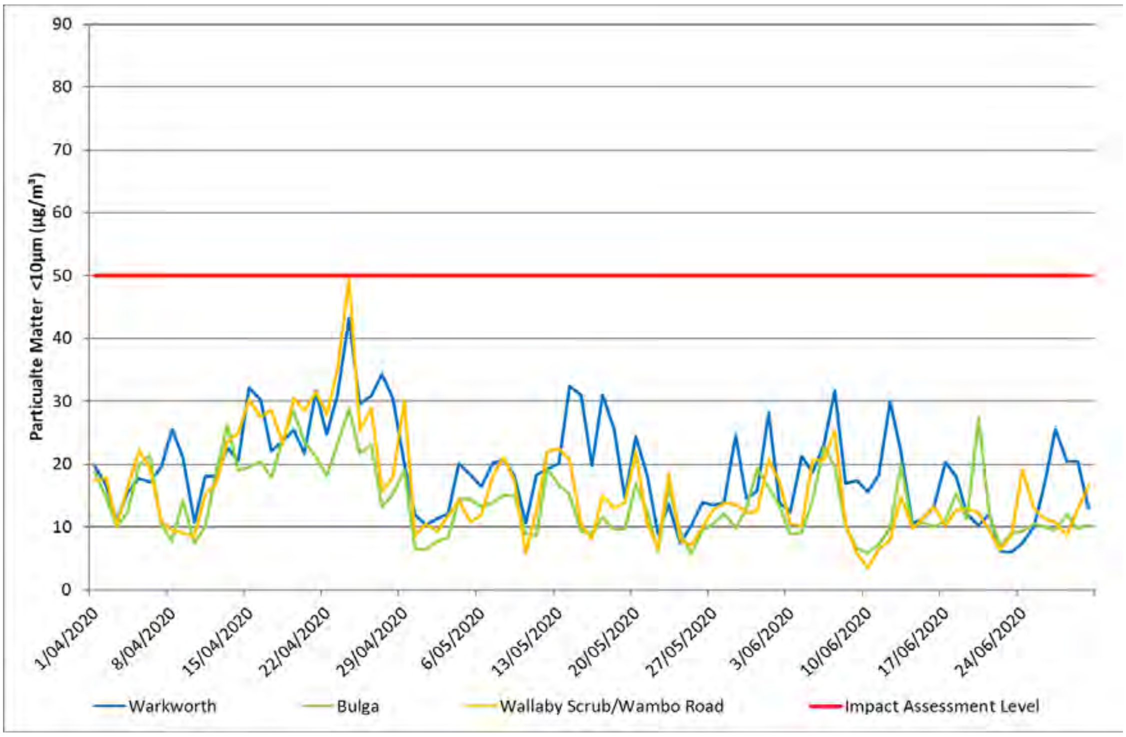


FIGURE 18: 24HR AVERAGE PM10 MEASURED AT TEOM MONITORS SURROUNDING MTW - QUARTER TWO 2020

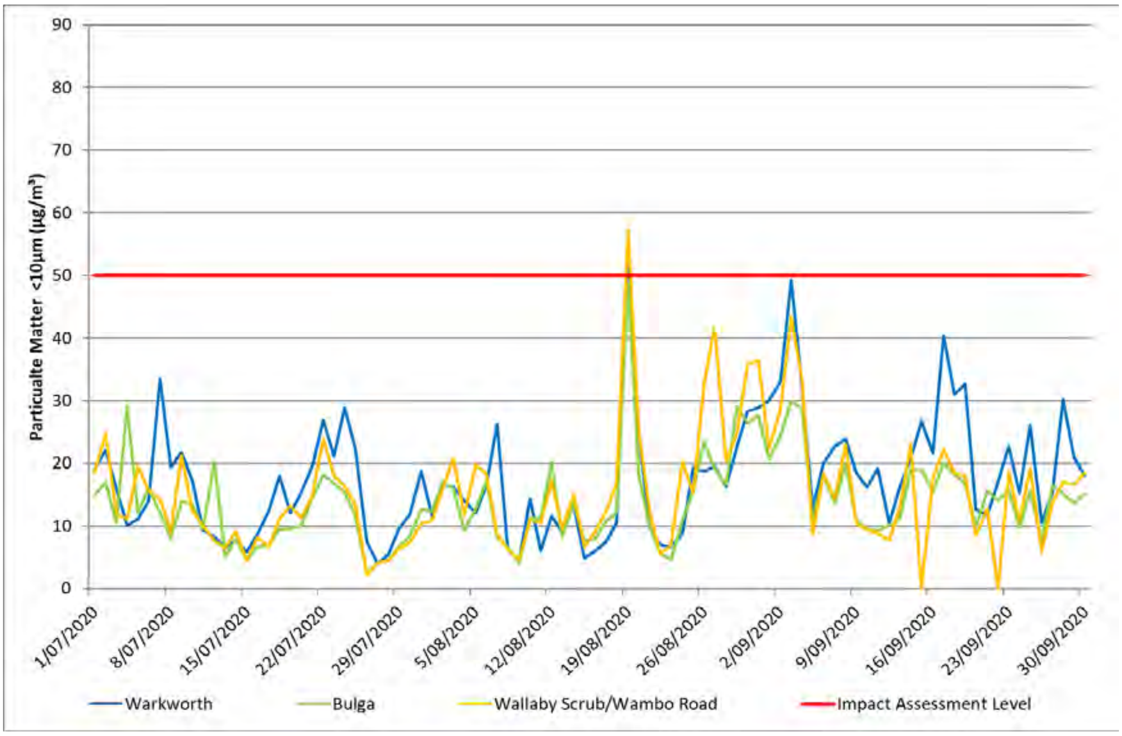


FIGURE 19: 24HR AVERAGE PM10 MEASURED AT TEOM MONITORS SURROUNDING MTW - QUARTER THREE 2020

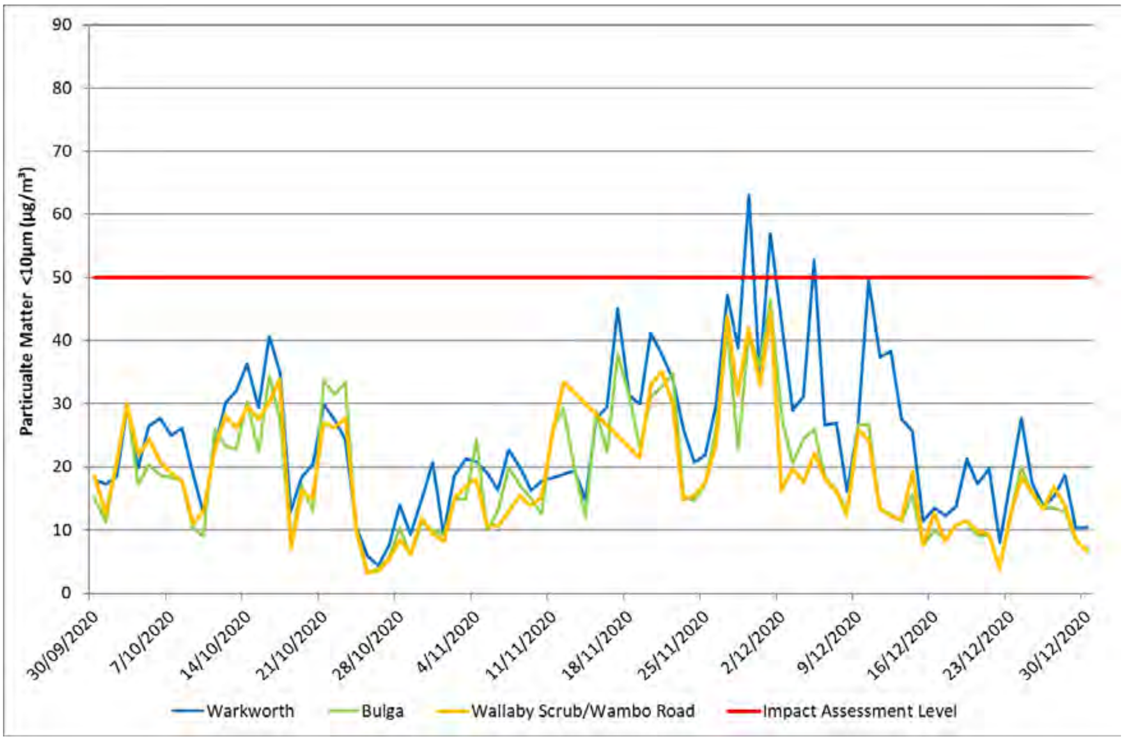


FIGURE 20: 24HR AVERAGE PM_{10} MEASURED AT TEOM MONITORS SURROUNDING MTW - QUARTER FOUR 2020

TABLE 6.8 EXTRAORDINARY EVENT DAYS

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	-

Excluding "extraordinary event" days, one high volume air sample and two TEOM PM_{10} measurement results potentially exceeded the 24 hour short term impact assessment criteria during the reporting period. The exceedances were investigated to determine the level of contribution from MTW activities in accordance with the compliance protocol outlined in the MTW Air Quality Management Plan. MTW was not a significant contributor to the exceedances and therefore no non-compliances were recorded.

A summary of the investigations undertaken for each short term PM10 exceedance are provided in **Table 6.10**

TABLE 6.9 24 HOUR PM_{10} INVESTIGATIONS - 2020

Date	Site	24hr PM_{10} result (µg/m³)	Estimated contribution from MTW (µg/m³)	Discussion
01/12/2020	Warkworth TEOM	56.9	29.5	An analysis of meteorological data has determined the maximum potential MTW contribution to the result to be in the order of 29.5µg/m3 or ~52% of the measured result. As the calculated contribution was less than 75% of the measured result, MTW operations are not considered to be a significant contributor to the result, as described in the MTW Air Quality Management Plan.

Date	Site	24hr PM_{10} result (µg/m³)	Estimated contribution from MTW (µg/m³)	Discussion
26/04/2020	Long Point HVAS PM_{10}	53.0	29.9	An analysis of meteorological data and background PM10 levels has determined the maximum potential MTW contribution to the result to be in the order of 29.9µg/m3 or ~56% of the measured result. As the calculated contribution was less than 75% of the measured result, MTW operations are not considered to be a significant contributor to the result, as described in the MTW Air Quality Management Plan.
05/12/2020	Warkworth TEOM	52.8	26.8	An analysis of meteorological data and background PM10 levels has determined the maximum potential MTW contribution to the result to be in the order of 26.8µg/m3 or ~51% of the measured result. As the calculated contribution was less than 75% of the measured result, MTW operations are not considered to be a significant contributor to the result, as described in the MTW Air Quality Management Plan.

6.4.2.6 Long term PM_{10} impact assessment criteria

Annual average PM_{10} concentrations have been compared with the long term PM_{10} impact assessment criterion and previous years' data (**Figure 21**). All annual average PM_{10} concentrations recorded on privately owned land (or representative of the nearest privately-owned property) were compliant with the assessment criterion.

The Bulga, Wallaby Scrub Road and Warkworth monitoring locations recorded decreases in annual average PM_{10} concentrations compared to 2019. This decrease is considered largely attributable to above average rainfall after three preceding years of below average rainfall.

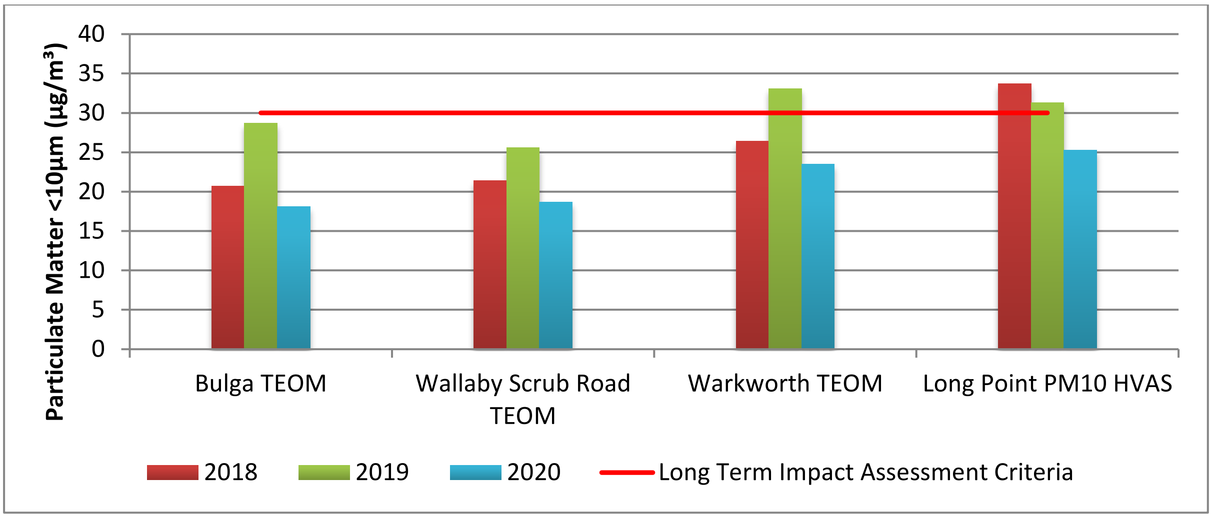


FIGURE 21: ANNUAL AVERAGE PM10 RESULTS 2018 TO 2020

6.4.2.7 Comparison of 2020 Air Quality data against EA predictions

Annual average PM_{10} results were partially below and partially above the modelled range for Year 3 of the development (nominally 2017) which is the mine plan year in the EA which provides the most appropriate comparison year. Refer to **Table 6.12**

TSP annual averages at all monitoring locations were higher than modelled predictions for the Year 3 scenario. Refer to **Table 6.13.**

The difference between modelled predictions and the measured results can be explained as a function of model inputs which do not account for PM_{10} or TSP contribution from regional particulate events such as bushfires, stock movement, dust from local roads and driveways and agricultural activity.

TABLE 6.10 2020 PM10 ANNUAL AVERAGE RESULTS COMPARED AGAINST CUMULATIVE PREDICTIONS FOR YEARS 3 - WARKWORTH CONTINUATION EIS (2014).

Monitoring Location	Long Term (annual average) PM_{10} criteria	
	Year 3 EIS Prediction (µg/m³)	**2020 Annual Average (µg/m³)**
Bulga OEH TEOM	23	18.1
Wallaby Scrub Road TEOM	16	18.7
Warkworth OEH TEOM	30	23.5
Long Point PM_{10}	16	25.3

TABLE 6.11 2020 TSP ANNUAL AVERAGE RESULTS COMPARED AGAINST CUMULATIVE PREDICTIONS FOR YEAR 3 – WARKWORTH CONTINUATION EIS (2014).

Monitoring Location	Long Term (annual average) TSP criteria	
	Year 3 EIS Prediction (µg/m³)	2020 Annual Average (µg/m³)
MTO TSP1	52	60.1
Loders Creek TSP	43	59.5
WML- HV2a	39	53.4
Warkworth	65	78.5
Long Point	38	56.5

6.5 Heritage Summary

6.5.1 Heritage Management

During the reporting period, Aboriginal Cultural Heritage and Historic Heritage was managed in accordance with the site's approved Aboriginal Heritage and Historic Heritage Management Plans. A summary of the performance in each of these areas is outlined below.

6.5.2 Heritage Performance

6.5.2.1 Aboriginal Heritage

6.5.2.1.1 Aboriginal Heritage Activities

No Aboriginal cultural heritage assessments or salvage programs were required at MTW during the reporting period. Aboriginal cultural heritage was managed in accordance with the MTW Aboriginal Heritage Management Plan (AHMP) and the Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW (the Due Diligence Code).

MTW was issued Care Agreement C0003708 on 26 April 2019 by the Office of Environment and Heritage (now Heritage NSW), which approved the transfer and safekeeping of Aboriginal objects and was a replacement of Care Agreement C0001841. On 19 October 2020, the Aboriginal objects specified in Care Agreement C003708 were transferred to the updated location for safekeeping. Heritage NSW was advised of the transfer on 29 October 2020.

There was one additional Aboriginal cultural heritage site identified during the reporting period. The site was identified by an MTW employee as part of the due diligence process associated with MTW's ground disturbance approvals process. The site was barricaded and MTW arranged for an inspection by a qualified archaeologist to record and document the site. An AHIMS site card was developed and submitted in accordance with the provisions outlined in the AHMP and the site was added to the MTW cultural heritage management GIS layer.

An AHMP compliance inspection covering the 2020 reporting period was undertaken on 22-23 December 2020. This inspection was conducted by representatives of the Aboriginal community, internal MTW personnel and a consultant archaeologist. A total of 39 Aboriginal cultural heritage sites were reviewed during this program, with no adverse findings identified. The Aboriginal Heritage Management Plan Inspection report is shown in **Appendix 1**.

The Upper Hunter Valley Aboriginal Cultural Heritage Working Group (CHWG) is the primary forum for Aboriginal community consultation on matters pertaining to cultural heritage. The CHWG is comprised of representatives from MTW and Registered Aboriginal Parties (RAPs) from Upper Hunter Valley Aboriginal community groups, corporations and individuals. There were no meetings of the CHWG during the reporting period. Further consultation with the CHWG is planned for the next reporting period to discuss upcoming salvage programs and general cultural heritage management processes.

6.5.2.1.2 Audits and Incidents

During the reporting period there were 40 Ground Disturbance Permits (GDP's) assessed for cultural heritage management considerations at MTW. Ground disturbance works were conducted based on an Aboriginal cultural heritage sites avoidance policy so that no un-salvaged sites were impacted by these activities. There were no known incidents, nor any unauthorised disturbance caused to Aboriginal cultural heritage sites at MTW during 2020.

An Independent Environmental Audit was conducted during 2020 that identified several cultural heritage management recommendations to be actioned by the site. These actions have been completed during the 2020 reporting period, namely:

- Finalisation of reports for salvages conducted in June 2017 and February 2018;
- Relocation of Aboriginal objects from HVO as per new Care Agreement; and
- Development of a project schedule and budget to progress management recommendations outlined in the HHMP and site-specific CMPs.

6.5.2.2 Historic Heritage

6.5.2.2.1 Historic Heritage Activities

MTW completed an aerial drone review of the three historical heritage sites during the 2020 reporting period to help inform ongoing management activities. Termite management was also implemented during the 2020 reporting period.

An Historic Heritage Management Plan (HHMP) compliance inspection covering the 2020 reporting period was conducted on 21 December 2020. This inspection was conducted by a consultant archaeologist, assisted by representatives of the Community Heritage Advisory Group (CHAG) and internal MTW personnel. A total of 3 historic heritage sites were inspected during this program. The Historic Heritage Management Plan Inspection Report is shown in **Appendix 2**.

In 2012 the CHAG was established as a community consultation forum for matters pertaining to management of historic (non-Indigenous) heritage located on MTW lands. The CHAG is comprised of community representatives with particular knowledge and interests in the historic heritage of the region such as historical groups, individuals and local government.

The MTW Historic Heritage Conservation Fund (HHCF) was launched by Singleton Council in December 2018, in accordance with Schedule 17 of the HHMP. Singleton Council advised correspondence received September 2020, that a total of 3 applications were made in 2020. Council in consultation with their consultant Heritage Advisor reviewed the 3 applications which indicated there were two conforming applications, and one non-conforming application. Conforming applications were intended to be sent to the Singleton Heritage Advisory Council (SHAC) to review prior to the SHAC recommending for approval or rejection to Council. MTW will continue to consult with Council during 2021 on the HHCF processes to ensure the positive outcomes that the funding is intended to achieve can be realised in the Singleton area.

There were no incidents or any unauthorised disturbance caused to historic heritage sites at MTW during 2020.

6.6 Visual Amenity and Lighting

6.6.1 Visual Amenity and Lighting Management

MTW aims to minimise visual amenity impacts from its operations. Two of the main controls used are lighting management and visual screening.

6.6.2 Visual Amenity and Lighting Performance

6.6.2.1 Lighting

MTW aims to provide sufficient lighting for work to be undertaken safely, whilst minimising disturbance to neighbouring residents and public road users, particularly nearby residents in Bulga Village, Mount Thorley, Warkworth Village, Long Point, Milbrodale and motorists on the Putty Road and Golden Highway.

Actions undertaken in 2020 to manage lighting impacts at MTW included:

- Routine night shift inspections conducted by Community Response Officers to observe operating practices and to ensure lights are not shining towards nearby residential areas or affecting public roads;
- Yellow lights are used in preference to white lights in areas based on risk and external exposure;
- Alternate sheltered dumps are operated, or work areas are shut down if lighting or visual amenity issues arise and cannot be sufficiently managed; and

- A review of fixed tower lighting at the Warkworth West Pit Park Up location, north or the Putty Road.

6.6.2.2 Visual Screening

Visual screening of MTW's operations incorporates various methods to best suit the terrain and infrastructure constraints around the boundary of the mine.

Visual bunding has an immediate screening effect, providing complete screening in areas where vegetation would be inadequate to filter views or where additional height is required. Bunds may be vegetated where practicable and feasible for visual amenity and to mitigate erosion.

Built screens (i.e. solid fences or walls), may be used as an alternative when bunds and tree screens are not practicable. Temporary screens (i.e. fencing and shade mesh) may also be used as required for interim screening.

The Putty Road visual bund, extended to the west to the junction of the Sealed Geo Road (former Wallaby Scrub Road) during 2019, was seeded in 2020. A section of deceased trees along the South Pit of Warkworth adjacent to the Putty Road were removed in 2019 to improve visual amenity, with infill planting which was intended to occur in 2020, to occur in 2021 in this area.
A boundary fence audit was undertaken across MTW in May 2020 to identify fences that required repairs, maintenance or replacement. Maintenance of fence lines along Putty Road was undertaken in June.

6.7 Water

6.7.1 Water Management

An adaptive management approach is implemented at MTW to achieve the following objectives for water management:

- Fresh water usage is minimised;
- Impacts on the environment and MTW neighbours are minimised; and
- Interference to mining production is minimal.

This is achieved by:

- Preferentially using mine water for coal preparation and dust suppression where feasible;
- An emphasis on control of water quality and quantity at the source;
- Segregating waters of different quality where practical;
- Recycling on-site water;
- Ongoing maintenance and review of the water management system; and
- Releasing water to the environment in accordance with statutory requirements.

Plans showing the layout of all water management structures and key pipelines are shown in **Figure 22**. The MTW Water Management Plan contains further detail on management practices and is available on the webpage https://insite.yancoal.com.au.

Improvements to water management in 2020 included mitigating the risk of unauthorised water releases from site with concept design and geotechnical assessments undertaken to improve water management of Warkworth's North Pit North area, and design and construction of sediment control water management infrastructure for the advancing pre-strip.

In accordance with the WMP, the new sediment control water management infrastructure has been sized using design methods of the "Blue Book": Managing Urban Stormwater; soils and construction (Volume 2E Mines and Quarries, NSW Dept of Environment and Climate Change, 2008). Design rainfall is the 85th percentile five-day rainfall depth of 31mm. Works commenced in November 2020 and were nearing completion at the end of the reporting period.

The remote boundary dam monitoring system installed during 2019 has been considered a success, and additional boundary dam monitoring systems were installed during 2020. Dams 1S, 2S and 10S had the units installed in December 2020, with the plan to be fully commissioned in the next reporting period. An additional two units were also purchased for installation at two new sediment dams constructed as part of the Warkworth pre-strip water management.

There were no new water storage facilities constructed during the reporting period. Capping of the sites Tailings Dam 2 (Dam 33N) continued during the reporting period.

There were two reportable water related incidents during the reporting period which occurred on 9 February 2020 and 14 May 2020. The incident on 9 February 2020 involved the overtopping of two boundary dams at Warkworth (Dam 50N and Dam 53N) as a result of a greater than design rainfall event (91.4 mm). WML received notification on 19 February 2020 from DPIE that they would not be taking action at this time and on 2 March 2020 from the EPA stating they would not be taking any regulatory action. The incident on the 14 May 2020 involved the overtopping of a Mount Thorley surface water dam (Dam 9S) as a result of the automatic valve between Dam 6S and Dam 9S remaining open, permitting Dam 9S to fill and overtop. An official caution was received from the EPA in October 2020. Further details on this incident and the actions taken by MTW are provided in **Section 10**.

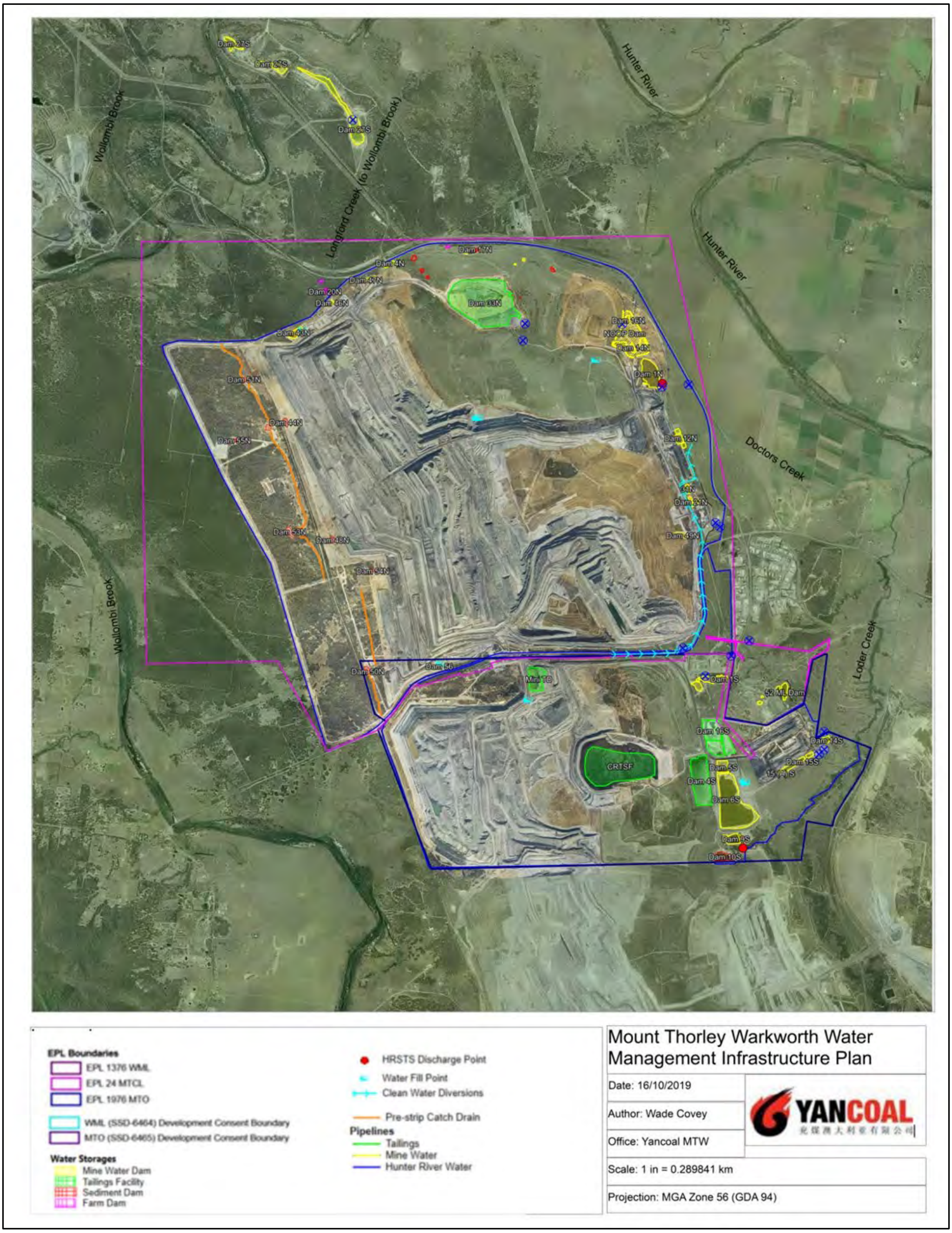


FIGURE 22: WATER MANAGEMENT INFRASTRUCTURE PLAN

6.7.2 Water Balance Performance

MTW uses a water balance to record and assess water flux, but also to forecast and plan water management needs. These annual site water balances are then compared to previous results. A 2020 static water balance for MTW is presented in **Table 6.14** and a simplified schematic of this balance is included in **Figure 23**. A salt flux schematic is shown **in Figure 24**.

TABLE 6.12 STATIC MODEL RESULTS, ANNUAL WATER BALANCE

Water Stream	Volume (ML) (% Total)
Inputs	
Rainfall Runoff	7,657 (68%)
Hunter River (MTJV supply scheme)	1,455 (13%)
Potable (Singleton Shire Council / trucked)	20 (<1%)
Groundwater	428 (4%)
Recycled to CHPP from tailings (not included in total)	5,529
Imported (LUG bore)	565 (5%)
Imported (Hunter Valley Operations)	0 (0%)
Water from ROM Coal	1075 (10%)
Total Inputs	**11,199**
Outputs	
Dust Suppression	3,030 (35%)
Evaporation – mine water dams	1,402 (16%)
Entrained in process waste	2,265 (26%)
Sharing with other mines	0 (0%)
Discharged (HRSTS)	0 (0%)
Water in coarse reject	580 78%)
Water in product coal	1,213 (14%)
Miscellaneous use (wash-down etc.)	110 (1%)
Total Outputs	**8,600**
Change in storage	**2,599**

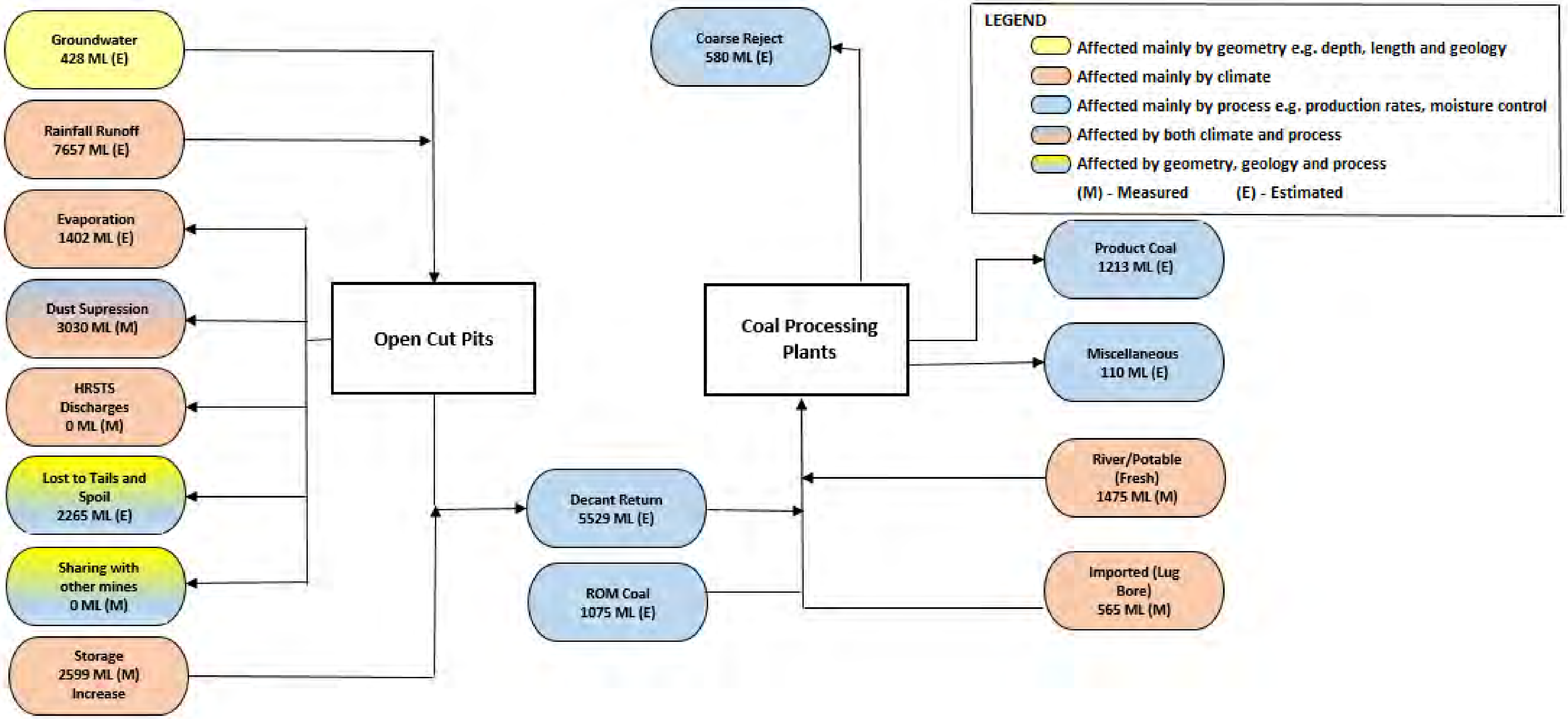


FIGURE 23: SCHEMATIC DIAGRAM MTW WATER FLUX

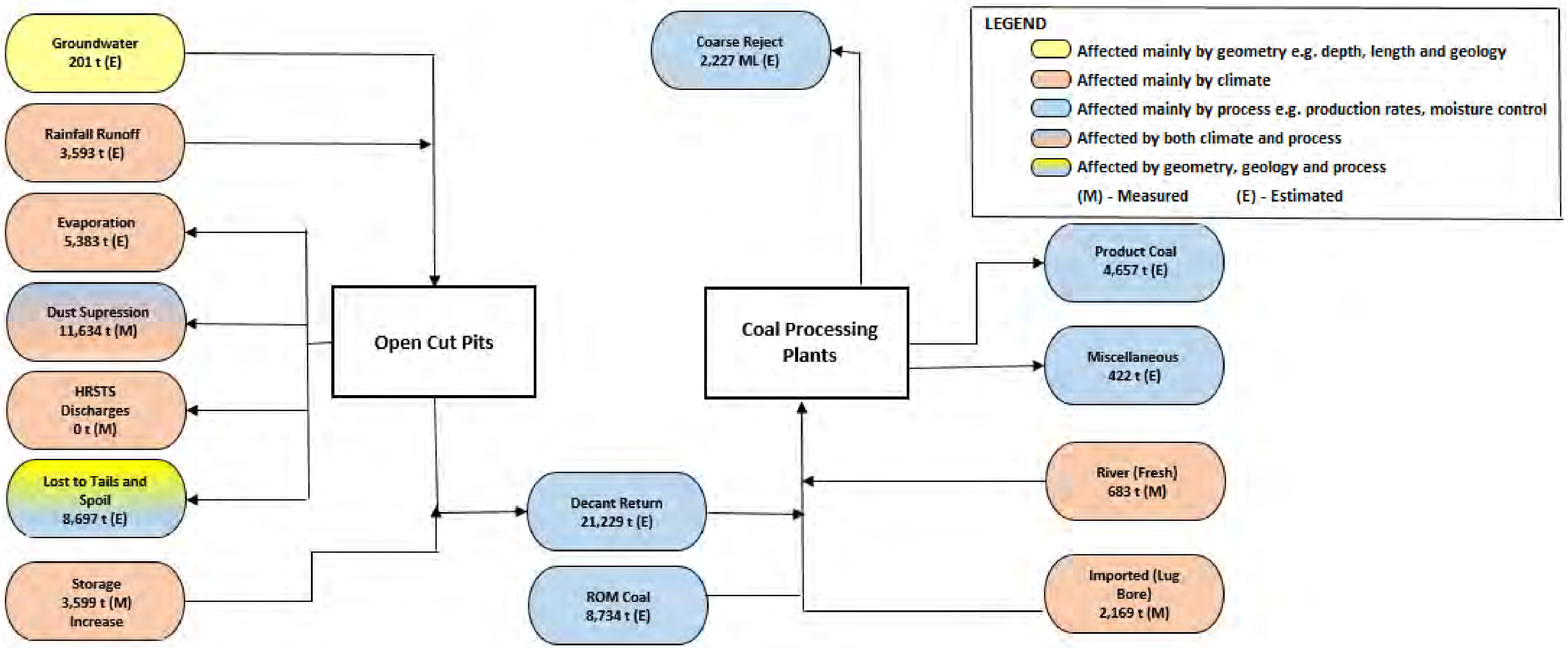


Figure 24: Schematic Diagram MTW Salt Flux

6.7.2.1 Water Inputs

A total of 828.5mm of rainfall was recorded at MTW in 2020 producing a calculated 7,657 ML of runoff from developed, disturbed and mining catchments. Water falling on clean water catchments is diverted off site into natural systems where possible. Rainfall runoff was the largest input to the site mine water balance in 2020.

As the site water inventory is drawn down, water is imported to meet site demand. During the reporting period 565 ML was imported from the LUG bore by MTW. This volume was a significant decrease on the previous reporting period (1,731ML extracted), due to on site water availability.

MTW also sources water from the Hunter River via the Mount Thorley Joint Venture (MTJV) water supply scheme. Singleton Shire Council holds the high security water licence on behalf of the scheme members. Singleton Shire Council maintains and operates the scheme to supply raw water to MTW, Glencore's Bulga Coal complex, and to meet Council's own needs. MTW's share of the MTJV allocation is 1,009 ML per water reporting year.

During the reporting period an additional 2,000 ML of high security water licenses were secured by MTW and a portion of this licence was transferred to the MTJV license to further supplement the operations water supply. It should be noted that due to the nature of the Water NSW reporting period, some temporary allocation assignments were executed in the 2020 AER reporting period, however, water was abstracted in the 2019 reporting period. A total of 1,455 ML of water was abstracted from the Hunter River during the reporting period for MTW operations which was comparable to the volume of water extracted in the previous reporting period. (1,594 ML extracted in 2019).

Groundwater Licences under Part 5 of the Water Act 1912 are held for each mining excavation area, to account for passive take via seepage inflows. Water Licences held by MTW are detailed in **Table 3.5.**

Licence conditions require the volume and quality of water taken by the works to be measured and reported on an annual water calendar year basis (i.e. financial year). Groundwater inflows via pit wall seepage are at low rates, with a significant proportion evaporating at the coal face. The remainder reports to the pit floor, where it may accumulate along with direct rainfall, rainfall runoff and leakage from spoils. As a result, it is not possible to physically measure the volume of water taken by these groundwater licences, nor the quality of waters extracted via seepage to the pits.

6.7.2.2 Water Outputs

Significant water uses at MTW in 2020 were for dust suppression on haul roads, mining areas and coal stockpiles (3,030ML), evaporation from Dams (1,402ML) and water entrained in process waste (2,265ML). Water usage for dust suppression on haul roads slightly decreased compared to the 2019 reporting period which may be attributed to wetter climatic conditions during the reporting period.
MTW participates in the Hunter River Salinity Trading Scheme (HRSTS), allowing discharge from licensed discharge points during declared discharge events associated with increased flow in the

Hunter River. HRSTS discharges are undertaken in accordance with HRSTS regulations, EPL 1376 and EPL 1976.

MTW maintains two licensed HRSTS discharge monitoring locations:

- Dam 1N, located at WML North, which discharges to Doctor's Creek; and
- Dam 9S, located at MTO South, which discharges to Loders Creek.

During the reporting period, MTW did not discharge under the HRSTS.

6.7.3 Surface Water Management

Surface water monitoring activities continued in 2020 in accordance with the MTW Water Management Plan and MTW Surface Water Monitoring Programme. MTW maintains a network of surface water monitoring sites located at selected site dams and surrounding natural watercourses as shown in **Figure 25**. Water quality monitoring is undertaken to verify the effectiveness of the water management system onsite, and to identify the emergence of potentially adverse effects on surrounding watercourses. Primary water storage dams are monitored routinely to verify the quality of mine water, used in coal processing, dust suppression, and other day to day activities around the mine.

Surface water monitoring data review involves a comparison of measured pH, EC and TSS results against internal trigger values which have been derived from the historical data set. The response to measured samples outside the trigger limits is detailed in the MTW Water Management Plan.

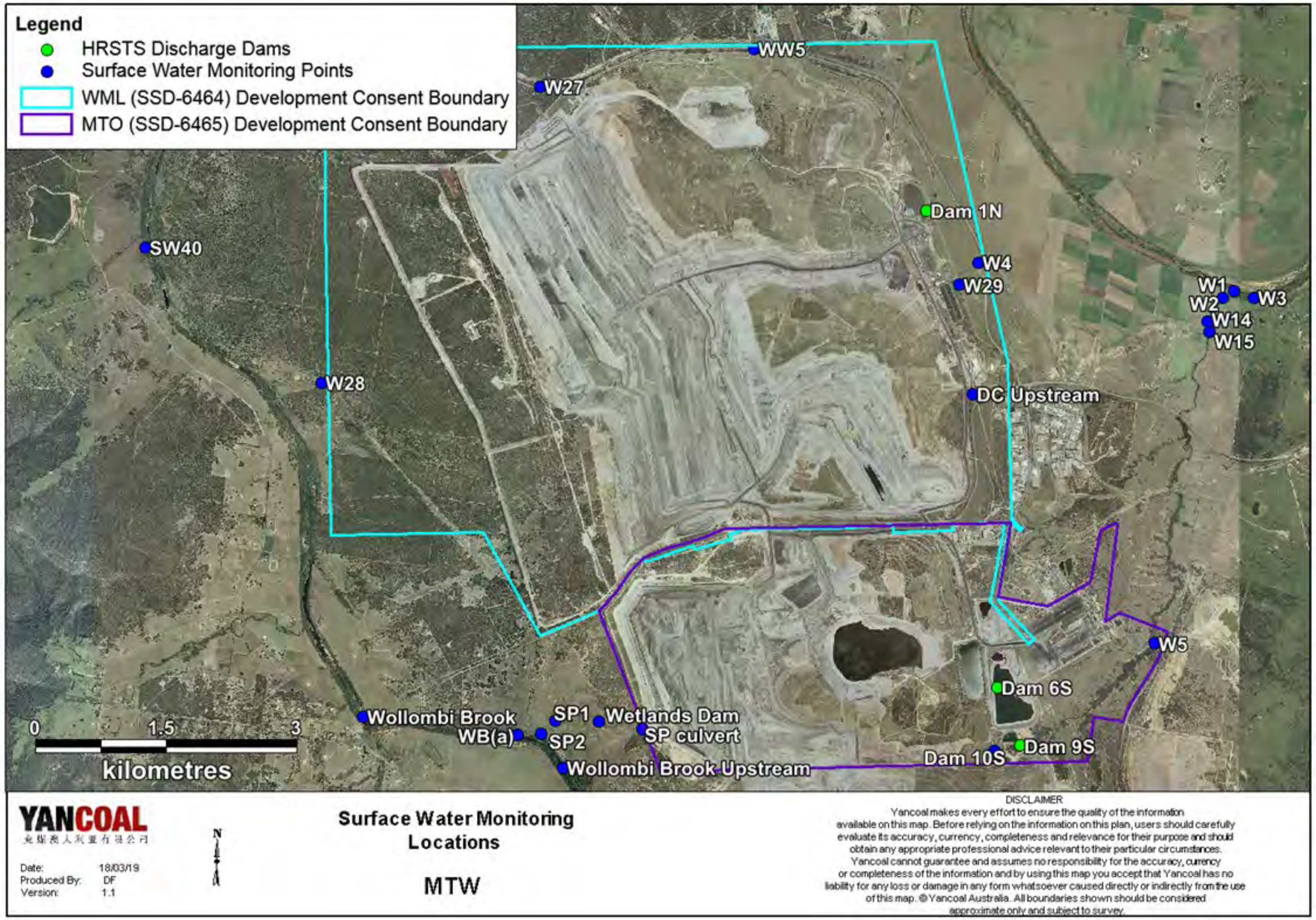


FIGURE 25: SURFACE WATER MONITORING POINTS

6.7.4 Surface Water Performance

Routine surface water monitoring was undertaken from twelve (12) sites and rain event sampling was undertaken from thirteen (13) sites (see **Table 6.15** below). Sampling of surface waters was carried out in accordance with AS/NZS 5667.6 (1998). Analysis of surface water was carried out in accordance with approved methods by a NATA accredited laboratory.

Water quality is evaluated through the assessment of pH, Electrical Conductivity (EC) and Total Suspended Solids (TSS). All surface water sites were also sampled for comprehensive analysis annually. The sampling frequency for ephemeral water sites was modified in 2016, from quarterly to a rain-event trigger system in an effort to ensure samples taken were more representative of typical water quality for those streams (up to eight sampling events per annum can now be taken under the revised sampling protocol). Due to above average rainfall during the reporting period, five rain event sampling runs were completed in 2020. All required sampling and analysis was undertaken, except as detailed in **Table 6.15**. Trigger tracking results are described in **Table 6.16**.

TABLE 6.13 MTW WATER MONITORING DATA RECOVERY FOR 2020 (BY EXCEPTION)

Location	Data Recovery (%)	Comment
SP1	60%	Site recorded as dry in October and November
SP2	60%	Site recorded as dry in February and no access in July
W28	60%	No safe access to site in February and March
Wetlands Dam	80%	Site recorded as dry in March
W5	85%	Site recorded as dry in January and February
WW5	25%	Site recorded as dry in June and insufficient water for sampling for September and December
W2	75%	Insufficient water for sampling in December
Wollombi Brook	50%	No safe access to site in June and September

Note: Missing data indicates that there was insufficient water to take a sample, or that there was no safe access.

A summary of all surface water monitoring results is provided in the MTW Monthly Environmental Monitoring Reports and can be viewed via MTW's website (https://insite.yancoal.com.au/).

Figure 26 to **Figure 31** show long term water quality trends for the Hunter River, Wollombi Brook, other surrounding tributaries and site dams.

Measurements of EC were generally stable during the reporting period across the majority of sites and consistent with historical seasonal trends. Single elevated EC levels were recorded at the Wollombi Brook Downstream (W28) and Loders Creek Downstream monitoring sites during the reporting period. It is expected that the readings were a result of the prolonged dry climatic conditions (drought) experienced during the previous reporting periods followed by rain events during the reporting period and not related to mining impacts.

Measurements of pH were generally stable during the reporting period across the majority of sites and consistent with historical seasonal trends. A few sites triggered 5th percentile/lowers limits during the reporting period, refer to **Table 6.16**. pH results recorded were neutral water quality or within 1 pH point of neutral. It is expected that the readings were a result of fresh surface water flows following rain events and not related to mining impacts.

A number of TSS limits were triggered in the reporting period, which were generally associated with rainfall events or sampling from pooled section of watercourses; these are outlined below in **Table 6.16**. MTW undertook investigations into the elevated TSS readings at W2 (Loders Creek), W3 (Hunter River), W4 (Doctors Creek), W5 (Loders Creek), W14 (Loders Creek), W27 (Longford Creek) and W29 (Doctors Creek) during the reporting period. The investigations concluded that the elevated results were most likely attributed to the rainfall event received prior to sampling. Monitoring results will continue to be watched. These results are also provided in the Monthly reports provided on the MTW Insite website (https://insite.yancoal.com.au/).

TABLE 6.14 SURFACE WATER MONITORING - TRIGGER TRACKING RESULTS

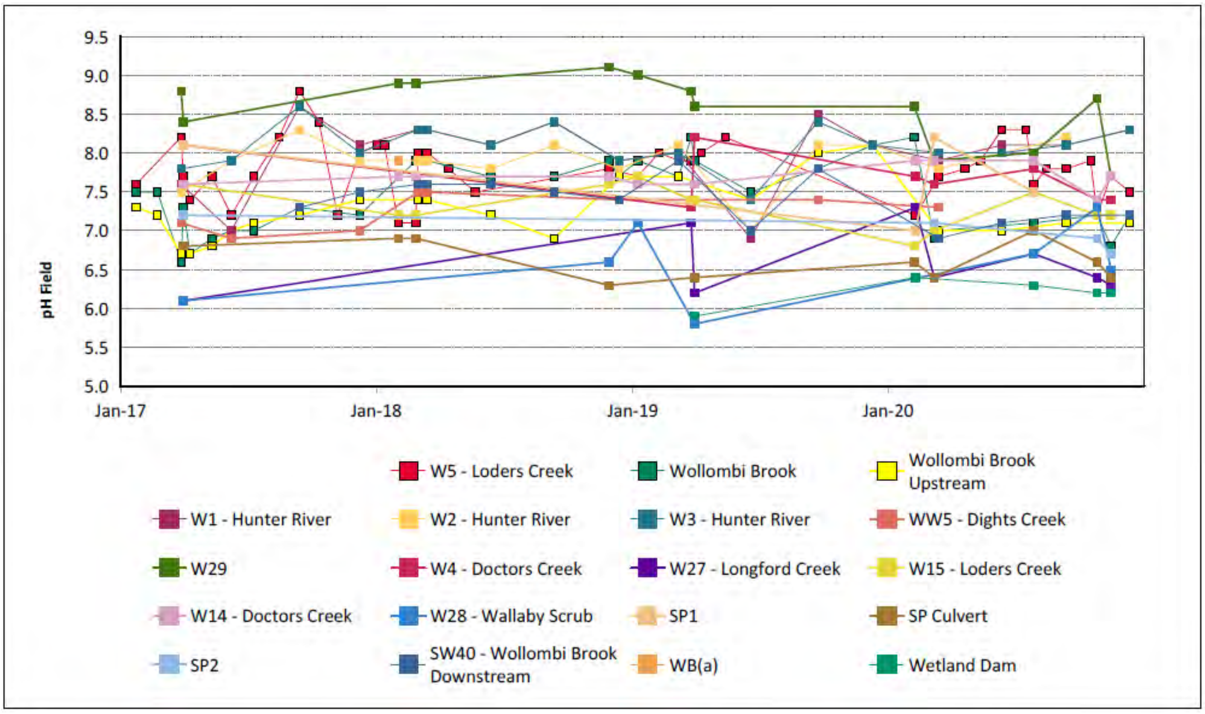
Site	Date	Trigger Limit Breached	Action Taken in Response
W14	16/10/2020	EC -95th Percentile	Watching Brief*
W28	14/11/2020	EC -95th Percentile	Watching Brief*
W5	09/02/2020	pH –5th Percentile	Watching Brief*
W15	07/02/2020	pH –5th Percentile	Watching Brief*
W15	07/03/2020	pH –5th Percentile	Watching Brief*
W15	25/10/2020	pH –5th Percentile	Watching Brief*
W15	14/11/2020	pH –5th Percentile	Watching Brief*
W27	07/03/2020	pH –5th Percentile	Watching Brief*
W29	27/07/2020	pH –5th Percentile	Watching Brief*
W29	14/11/2020	pH –5th Percentile	Watching Brief*
SW40	13/03/2020	pH –5th Percentile	Watching Brief*
SP1	09/02/2020	TSS – 50mg/L (ANZECC criteria)	Watching Brief* Elevated TSS results most likely attributable to rainfall event (91.4mm from 6 February to and including 9 February).
SP1	27/07/2020	TSS – 50mg/L (ANZECC criteria)	Watching Brief* Elevated TSS results most likely attributable to rainfall event (39.8mm on 26 July and another 13.4mm on 27 July).
W1	13/03/2020	TSS – 50mg/L (ANZECC criteria)	Watching Brief*. Note: Unlikely to be associated with MTW mining related impacts. Elevated TSS results most likely attributable to regional rainfall.
W1	11/06/2020	TSS – 50mg/L (ANZECC criteria)	Watching Brief*. Note: Unlikely to be associated with MTW mining related impacts. Elevated TSS results most likely attributable to regional rainfall.
W2	13/03/2020	TSS – 50mg/L (ANZECC criteria)	Watching Brief*.

Site	Date	Trigger Limit Breached	Action Taken in Response
			Note: Unlikely to be associated with MTW mining related impacts. Elevated TSS results most likely attributable to regional rainfall.
W2	11/06/2020	TSS – 50mg/L (ANZECC criteria)	Investigation undertaken. Note: Elevated TSS considered associated with recent rainfall and increased flow rates in the river at the time. Consistent with nearby W1 and W3 measurements. No signs of mining related impact.
W3	13/03/2020	TSS – 50mg/L (ANZECC criteria)	Watching Brief*. Note: Unlikely to be associated with MTW mining related impacts. Elevated TSS results most likely attributable to regional rainfall.
W3	11/06/2020	TSS – 50mg/L (ANZECC criteria)	Investigation undertaken. Note: Elevated TSS considered associated with recent rainfall and increased flow rates in the river at the time. Consistent with nearby W1 and W3 measurements. No signs of mining related impact.
W4	09/02/2020	TSS – 50mg/L (ANZECC criteria)	Watching Brief*. Elevated TSS results most likely attributable to a rainfall event (91.4mm from 6 February to and including 9 February).
W4	07/03/2020	TSS – 50mg/L (ANZECC criteria)	Watching Brief*. Elevated TSS results most likely attributable to rainfall event (56mm from 3 March to and including 7 March).
W4	27/07/2020	TSS – 50mg/L (ANZECC criteria)	Watching Brief*. Elevated TSS results most likely attributable to rainfall event (39.8mm on 26 July and another 13.4mm on 27 July).
W4	14/11/2020	TSS – 50mg/L (ANZECC criteria)	Investigation undertaken. Elevated TSS most likely attributable to rainfall event (32.2mm on 14 November).
W5	09/02/2020	TSS – 50mg/L (ANZECC criteria)	Watching Brief*. Elevated TSS results most likely attributable to a rainfall event (91.4mm from 6 February to and including 9 February).
W5	27/07/2020	TSS – 50mg/L (ANZECC criteria)	Watching Brief*. Elevated TSS results most likely attributable to rainfall event (39.8mm on 26 July and another 13.4mm on 27 July).

Site	Date	Trigger Limit Breached	Action Taken in Response
W5	14/11/2020	TSS – 50mg/L (ANZECC criteria)	Elevated TSS most likely attributable to rainfall event (32.2mm on 14 November).
W14	09/02/2020	TSS – 50mg/L (ANZECC criteria)	Watching Brief*. Elevated TSS results most likely attributable to a rainfall event (91.4mm from 6 February to and including 9 February).
W14	07/03/2020	TSS – 50mg/L (ANZECC criteria)	Watching Brief*. Elevated TSS results most likely attributable to rainfall event (56mm from 3 March to and including 7 March).
W14	27/07/2020	TSS – 50mg/L (ANZECC criteria)	Watching Brief*. Elevated TSS results most likely attributable to rainfall event (39.8mm on 26 July and another 13.4mm on 27 July).
W14	14/11/2020	TSS – 50mg/L (ANZECC criteria)	Investigation undertaken. Elevated TSS most likely attributable to rainfall event (34.0mm on 14 November).
W15	27/07/2020	TSS – 50mg/L (ANZECC criteria)	Watching Brief*. Elevated TSS results most likely attributable to rainfall event (39.8mm on 26 July and another 13.4mm on 27 July).
W27	09/02/2020	TSS – 50mg/L (ANZECC criteria)	Watching Brief*. Elevated TSS results most likely attributable to a rainfall event (91.4mm from 6 February to and including 9 February).
W27	27/07/2020	TSS – 50mg/L (ANZECC criteria)	Watching Brief*. Elevated TSS results most likely attributable to rainfall event (39.8mm on 26 July and another 13.4mm on 27 July).
W27	25/10/2020	TSS – 50mg/L (ANZECC criteria)	Investigation undertaken. Elevated TSS most likely attributable to rainfall event (34.0mm on the 24 October).
W27	14/11/2020	TSS – 50mg/L (ANZECC criteria)	Elevated TSS most likely attributable to rainfall event (34.0mm on 14 November).
W29	07/02/2020	TSS – 50mg/L (ANZECC criteria)	Watching Brief*. Elevated TSS results most likely attributable to a rainfall event (91.4mm from 6 February to and including 9 February).
W29	07/03/2020	TSS – 50mg/L (ANZECC criteria)	Watching Brief*. Elevated TSS results most likely attributable to rainfall event (56mm

Site	Date	Trigger Limit Breached	Action Taken in Response
			from 3 March to and including 7 March).
W29	27/07/2020	TSS – 50mg/L (ANZECC criteria)	Watching Brief*. Elevated TSS results most likely attributable to rainfall event (39.8mm on 26 July and another 13.4mm on 27 July).
W29	25/10/2020	TSS – 50mg/L (ANZECC criteria)	Investigation undertaken. Elevated TSS most likely attributable to rainfall event (34.0mm on the 24 October).
W29	14/11/2020	TSS – 50mg/L (ANZECC criteria)	Investigation undertaken. Elevated TSS most likely attributable to rainfall event (34.0mm on 14 November).

* = Watching brief established pending outcomes of subsequent monitoring events.



Note: Missing data indicates that there was insufficient water to take a sample, or that there was no safe access.

FIGURE 26: WATERCOURSE pH TRENDS 2017 TO 2020

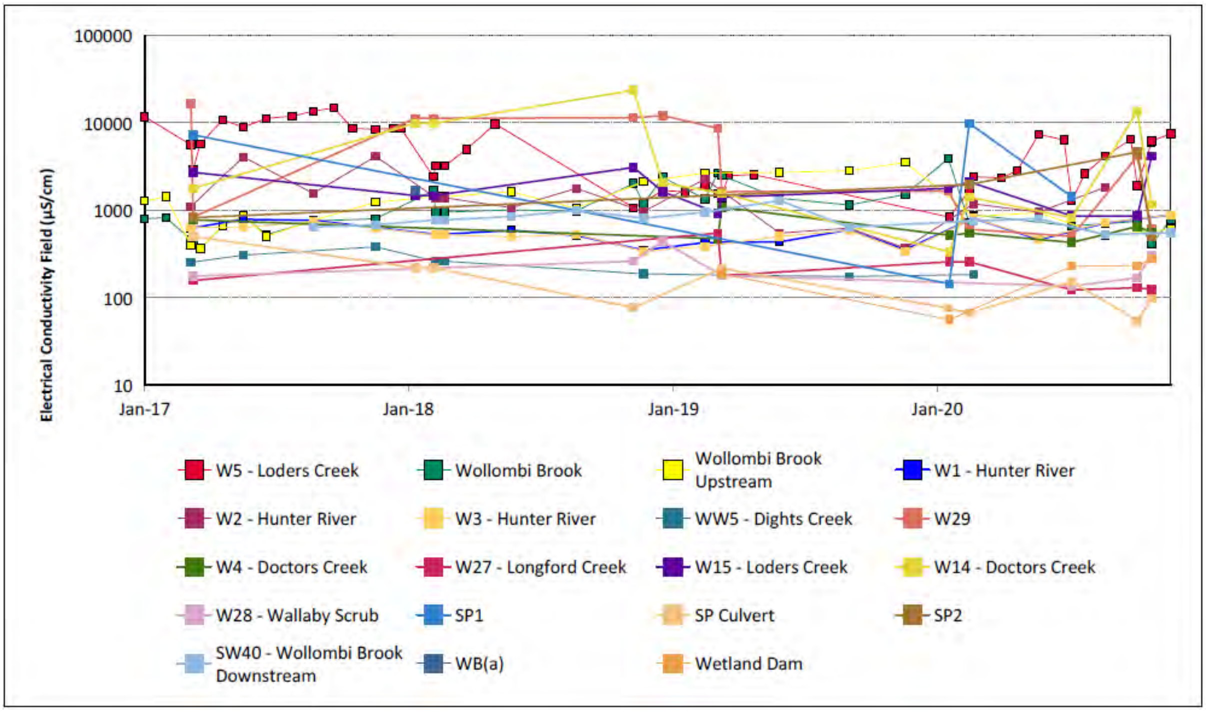


FIGURE 27: WATERCOURSE EC TRENDS 2017 TO 2020

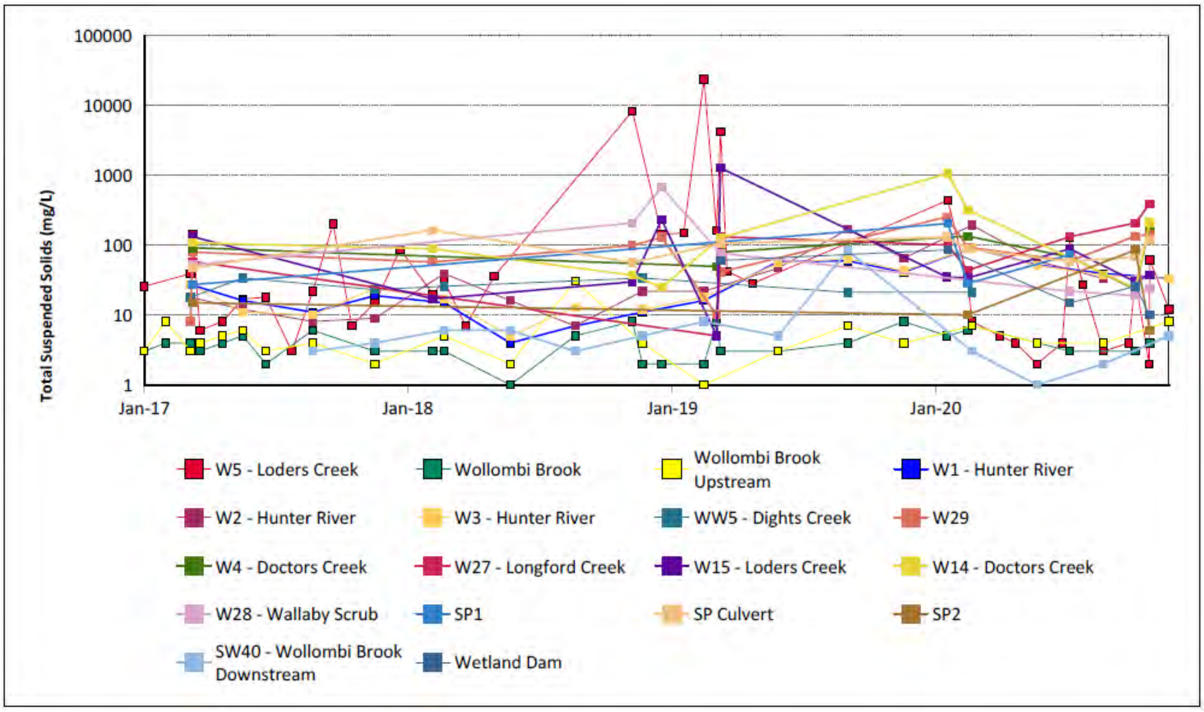


FIGURE 28: WATERCOURSE TSS TRENDS 2017 TO 2020

FIGURE 29: SITE DAMS PH TRENDS 2017 TO 2020

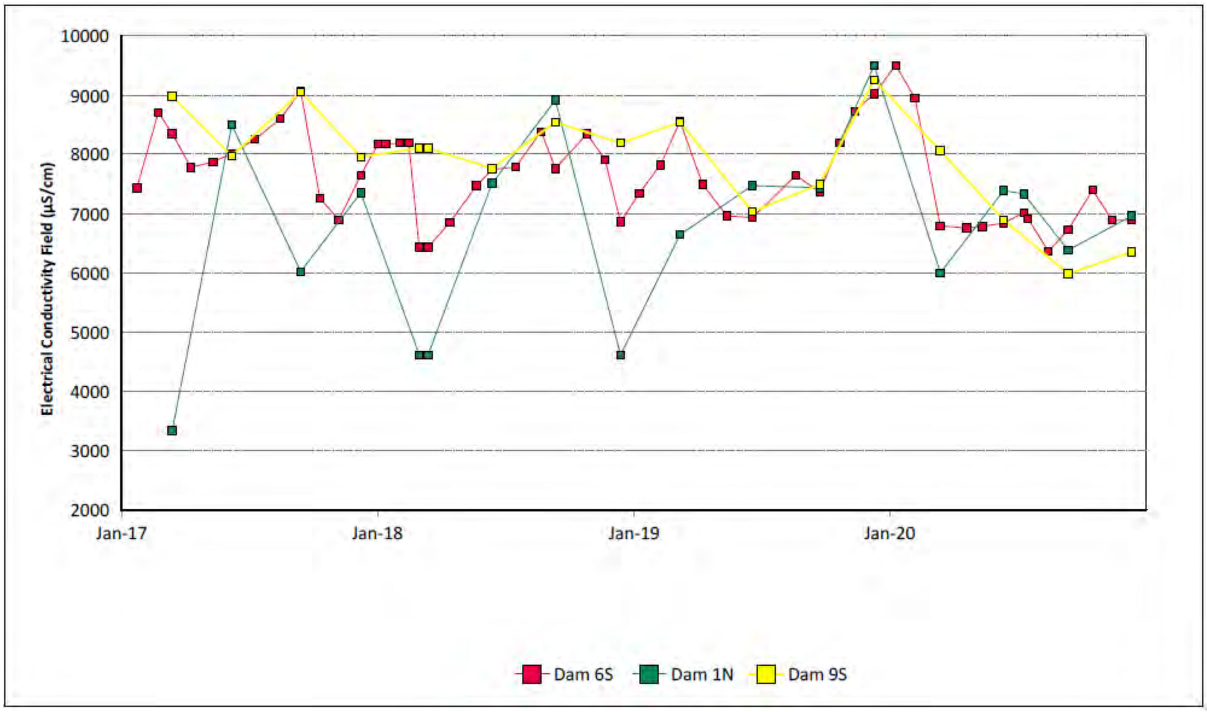


FIGURE 30: SITE DAMS EC TRENDS 2017 TO 2020

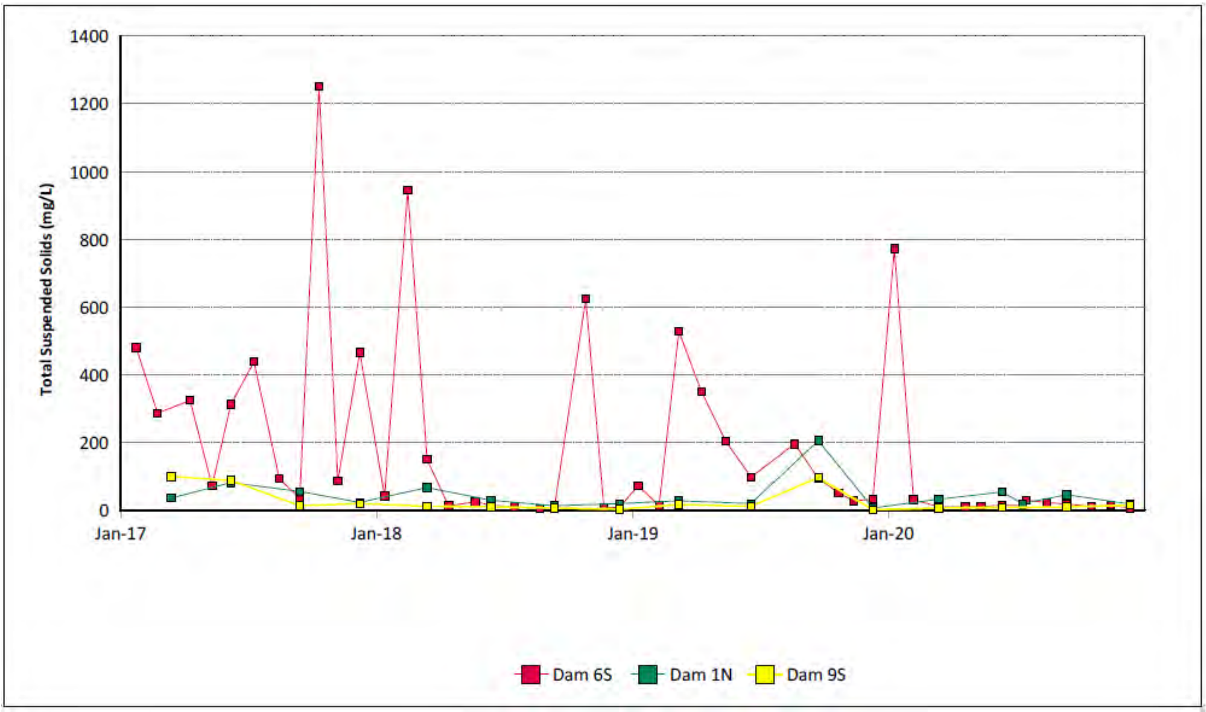


FIGURE 31: SITE DAMS TSS TRENDS 2017 TO 2020

6.7.4.1 Stream Health and Channel Stability

A programme to monitor and report on the stream and riparian vegetation health in Loders Creek and Wollombi Brook which may be potentially affected by the development commenced in 2016. The monitoring programme has previously been conducted in conjunction with a similar programme managed by Bulga Surface Operations.

The annual monitoring program includes the following:

- Documenting locations and dimensions of significant erosive or depositional features;
- Photographs upstream, downstream, at both the left and right banks;
- Rating the site with the Ephemeral Stream Assessment protocol developed by the CSIRO to assess the erosional state of the creek at the monitoring location (a measure of channel stability);
- Rating the site with the Rapid Appraisal of Riparian Condition (RARC) protocol developed by Land & Water Australia. This assesses the ecological condition of riparian habitats using indicators that reflect functional aspects of the physical, community and landscape features of the riparian zone (a measure of stream health); and
- Taking measurements of the channel cross-sections (transects) for comparison purposes for any future monitoring.

A copy of the annual stream health and stability monitoring report is provided as **Appendix 3**. This year of monitoring was subjected to a significantly wetter year than the previous rounds of monitoring and that was reflected by an increase in vegetation growth. As outlined in the report, stream health and channel stability monitoring results in 2020 indicated that channel stability in Wollombi Brook had remained generally the same as the previous year's monitoring cycle conditions.

The results of this monitoring survey indicate that both stream health and channel stability fluctuate over different sections of Loders Creek. The survey identified that some sections of Loders Creek are currently eroding and are vulnerable to further erosion with areas of significant erosion observed. These areas are generally associated with exposed dispersive sub-soils, which hamper vegetation establishment by the development of a hard surface crust when the soil is dry, and the 'melting' nature of the soil when wet.

The survey identified that the majority of Loders Creek displayed stable environments. Sections of the creek experience active erosion as a result of natural influences. Improvements were also identified during the 2020 survey, resulting from both natural occurrences as well as man-made upgrade works undertaken in 2018 at MTW Discharge Point.

As outlined in the report, stream health and channel stability monitoring results in 2020 indicated that channel stability in Wollombi Brook had remained generally the same as the previous year's monitoring cycle conditions and that the majority of Loders Creek displayed stable environments. Generally, the monitoring identified that both creeks have not significantly changed from what was observed during the previous survey.

6.7.5 Groundwater Management

Groundwater monitoring activities were undertaken in 2020 in accordance with the MTW Water Management Plan and groundwater monitoring programme. The monitoring results are used to establish and monitor trends in physical and geochemical parameters of surrounding groundwater potentially influenced by mining.

The groundwater monitoring programme at MTW measures the quality of groundwater against background data, EIS predictions and historical trends. Ground water quality is evaluated through the parameters of pH, EC, and standing water level. A comprehensive suite of analytes are measured on an annual basis, including major anions, cations and metals. MTW modified its groundwater sampling methodology during the reporting period following a recommendation in the 2018 annual groundwater review undertaken by an independent groundwater consultant. Accordingly bore purging is undertaken across the monitoring network for routine samples (where infrastructure allows) to ensure a representative sample is collected in accordance with industry standards.

Groundwater monitoring data is reviewed on a quarterly basis. The review involves a comparison of measured pH and EC results against internal trigger values (5th and 95th percentile) which have been derived from the historical data set. The response to results outside the trigger limits is detailed in the MTW Water Management Plan.

The monitoring locations are shown in **Figure 32** and the annual Ground Water Review report can be found in **Appendix 4.**

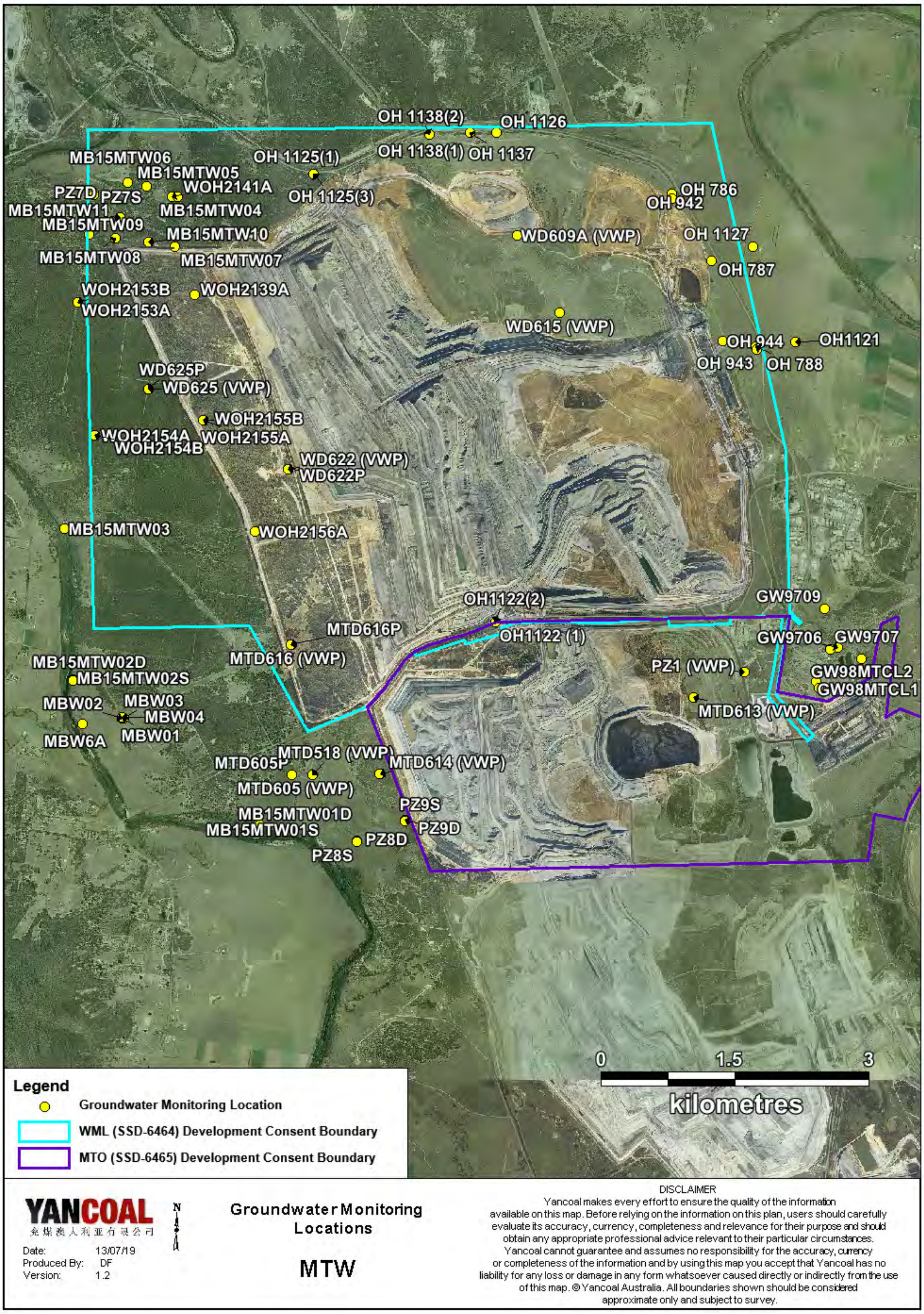


FIGURE 32: GROUNDWATER MONITORING NETWORK AT MTW IN 2020

6.7.6 Groundwater Performance

Sampling of ground waters was carried out on 275 occasions from 60 bores across MTW in accordance with AS/NZS 5667.6 (1998). Where laboratory analysis was undertaken, this was performed by a NATA accredited laboratory. Groundwater sampling and analysis was undertaken as required with the following exceptions detailed in **Table 6.17**.

TABLE 6.15 MTW WATER MONITORING DATA RECOVERY FOR 2020 (BY EXCEPTION)

Location	Data Recovery (%)	Comment
MB15MTW04	0%	Insufficient water for sampling in 2020
MB15MTW05	0%	Insufficient water for sampling in 2020
MB15MTW06	0%	Insufficient water for sampling in 2020
MB15MTW07	0%	No safe access in February. Insufficient water for sampling in May, August and November.
MB15MTW08	0%	No safe access in February. Insufficient water for sampling in May, August and November.
MB15MTW09	0%	No safe access in February. Insufficient water for sampling in May, August and November.
MB15MTW10	0%	No safe access in February. Insufficient water for sampling in May, August and November.
MB15MTW11	0%	No safe access in February. Insufficient water for sampling in May, August and November.
OH943	0%	Insufficient water for sampling in March, June, September and December
OH944	0%	Insufficient water for sampling in March, June, September and December
OH1137	0%	Insufficient water for sampling in March, June, September and December
PZ9S	0%	Insufficient water for sampling in March, June, September and December
WOH2156B	25%	Insufficient water for sampling in February, May and November

A summary of the monitoring results for MTW Groundwater Sites is provided in the Monthly Environmental Monitoring Reports, available via MTW's website (https://insite.yancoal.com.au/document-library/monthly-reporting-mtw).

The following sections present groundwater monitoring data in relation to the geographic locations and target stratigraphy for groundwater monitoring bores. Each location is discussed below, and a summary of monitoring data presented. Where monitoring results were recorded outside the internal trigger limit, these results are summarised in tables for each location.

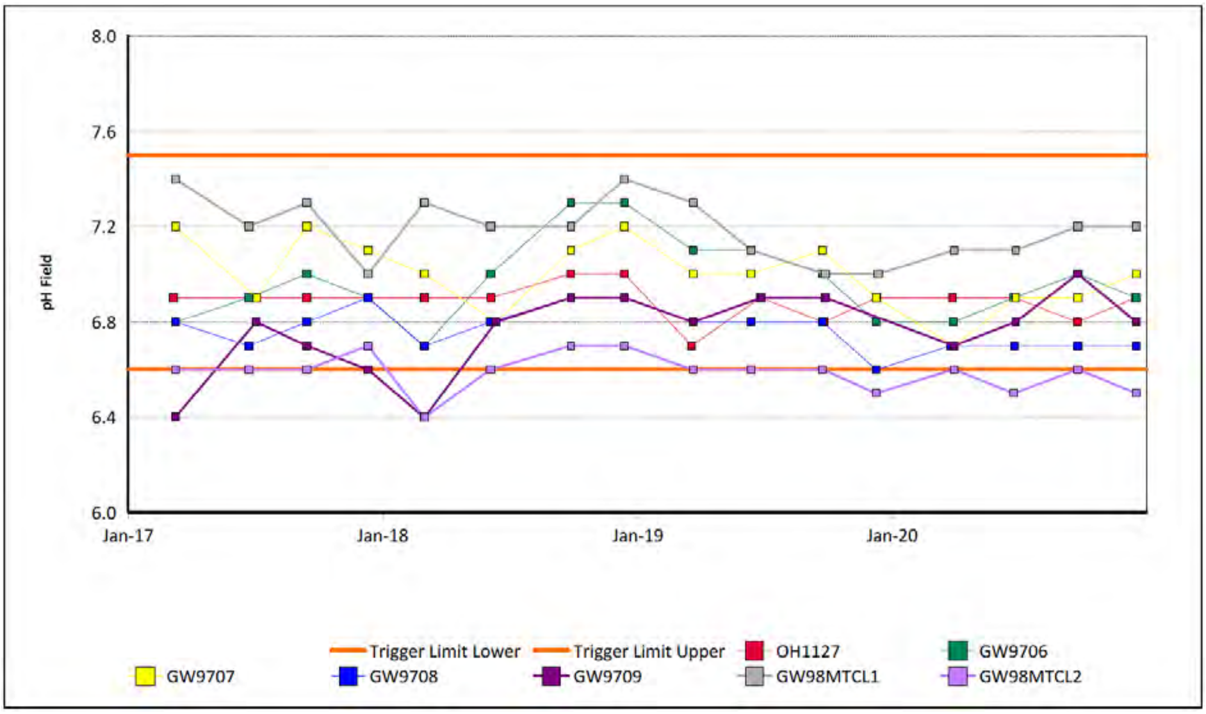
6.7.6.1 Bayswater Seam Bores

Groundwater monitoring in the Bayswater seam was undertaken from seven sites during 2020. A total of 28 samples were collected during the reporting period. The pH, EC and SWL trends for 2017 to 2020 for Bayswater groundwater bores are shown in **Figure 33** to **Figure 35** respectively. Trigger tracking results are shown in **Table 6.18**. Results were generally stable or have increased (SWL) during 2020. Further detailed overview of monitoring results from these bores is provided in **Appendix 4**.

TABLE 6.16 BAYSWATER SEAM GROUNDWATER 2020 INTERNAL TRIGGER TRACKING

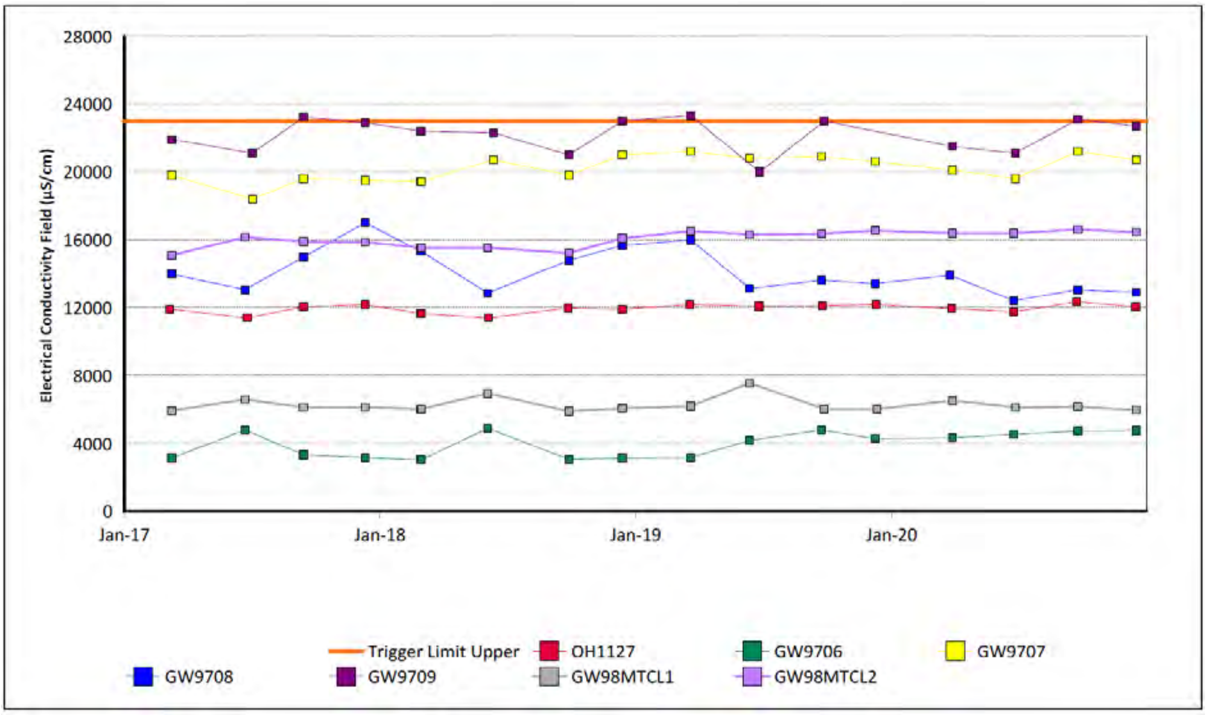
Location	Date	Trigger limit	Action taken in response
GW9709	23/09/2020	**EC – 95th percentile**	Watching Brief* Monitoring results back within trigger limits for December 2020 sample round.
GW98MTCL2	23/06/2020	**pH – 5th percentile**	Watching Brief* Monitoring results back within trigger limits for September 2020 sample round.
GW98MTCL2	16/12/2020	**pH – 5th percentile**	Watching Brief*

** = 1st/2nd trigger. Watching Brief established pending outcomes of subsequent monitoring events. No specific actions required*



Note: Missing data indicates that there was insufficient water to take a sample.

FIGURE 33: BAYSWATER SEAM PH TRENDS 2017 TO 2020



Note: Missing data indicates that there was insufficient water to take a sample.

FIGURE 34: BAYSWATER SEAM EC TRENDS 2017 TO 2020

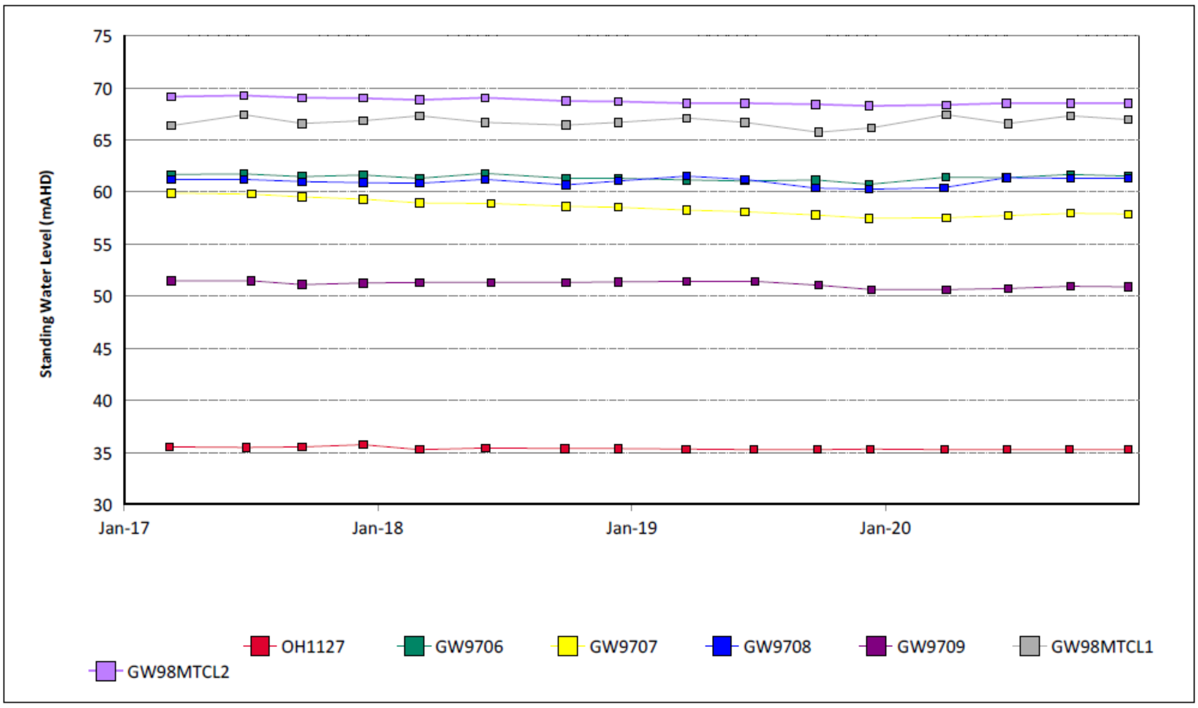


Figure 35: Bayswater SWL Trends 2017 to 2020

6.7.6.2 Bowfield Seam Bores

Groundwater monitoring in the Bowfield seam was undertaken at one site during 2020. A total of four samples were collected during the reporting period. The pH, EC and SWL trends for 2017 to 2020 are shown in **Figure 36, Figure 37, Figure 38** respectively. Water quality results were similar to historical data throughout the reporting period. The SWL in Bore OH1125 decreased during the reporting period. Bore OH1125(3) is located directly to the north of North Pit and the decline may relate to drawdown towards active mining within the pit to the south. As mentioned in the previous annual review, the trend may also be influenced by cumulative sources with the abstraction from LUG Bore contributing to the decline.

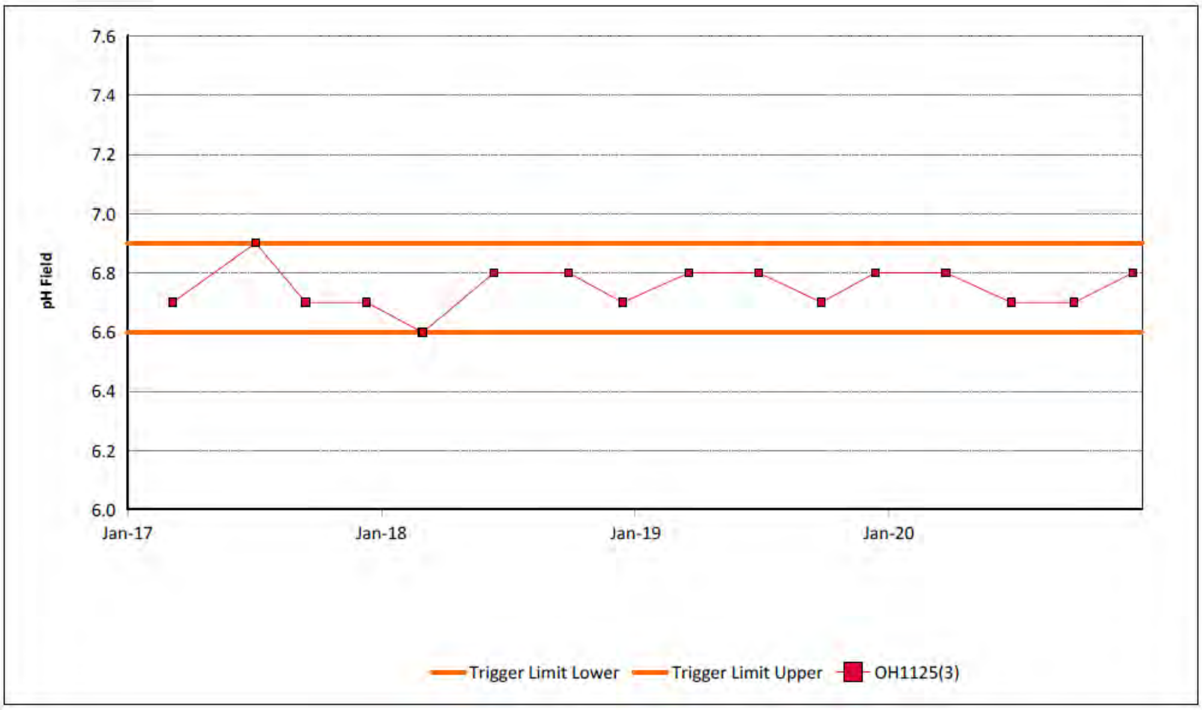


FIGURE 36: BOWFIELD SEAM pH TREND 2017 TO 2020

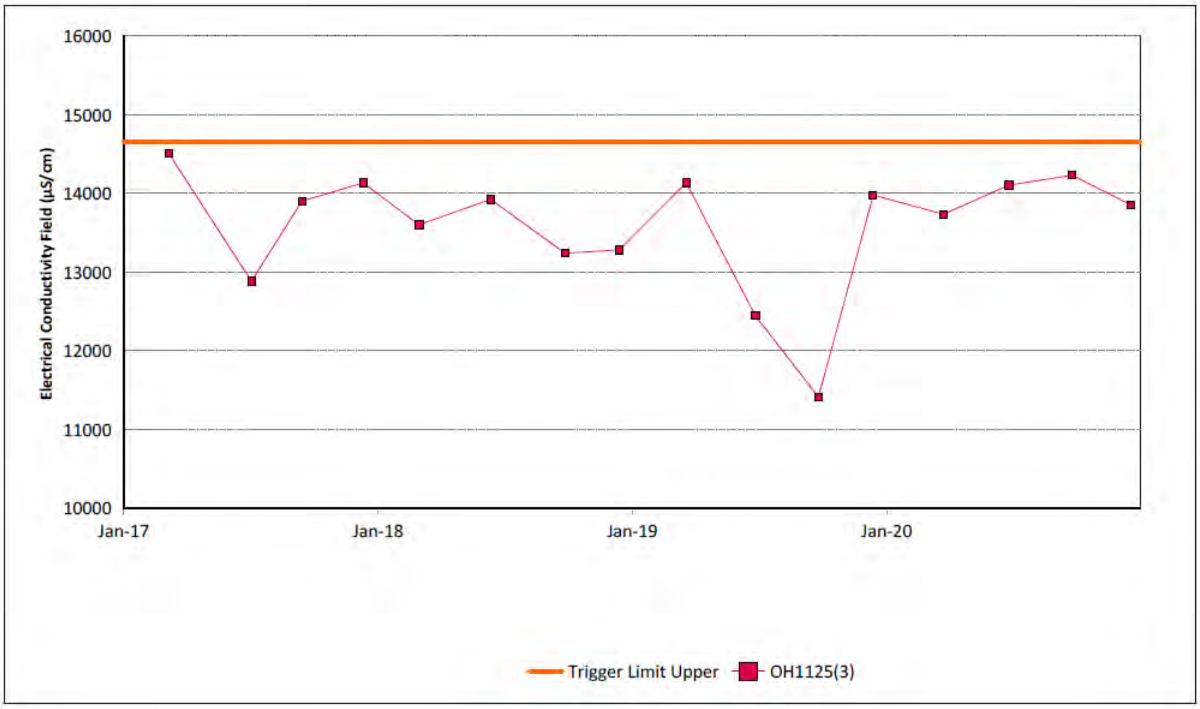


FIGURE 37: BOWFIELD SEAM EC TRENDS 2017 TO 2020

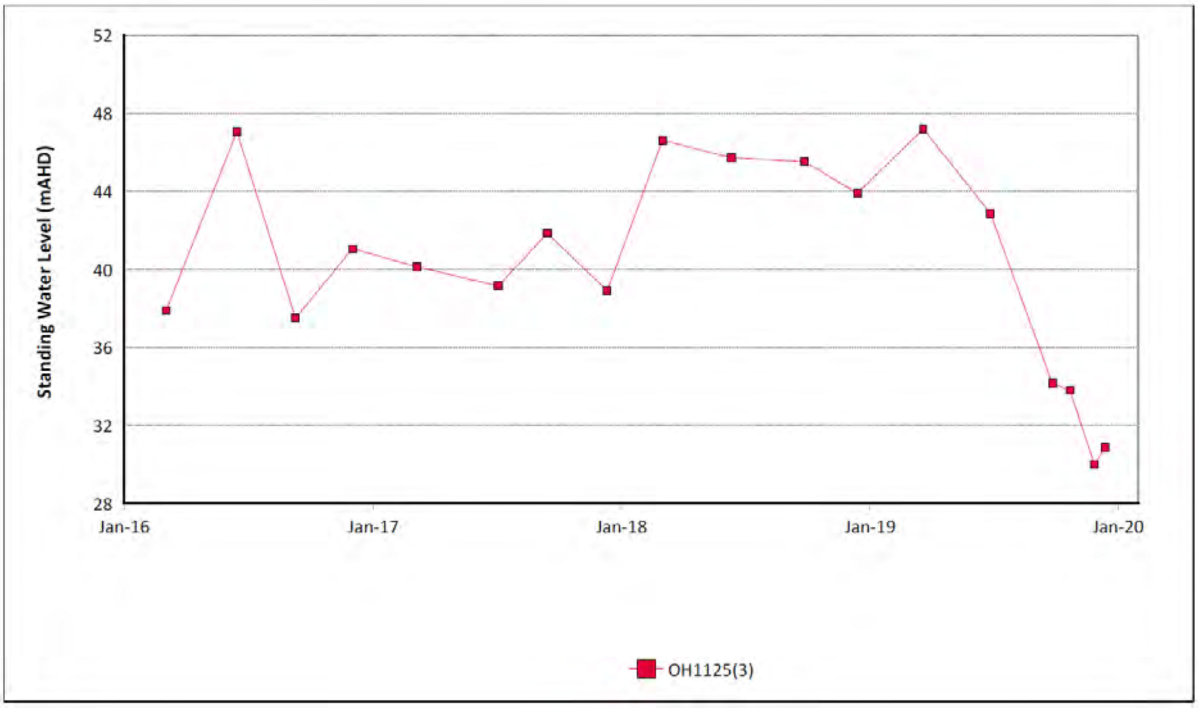


FIGURE 38: BOWFIELD SWL TRENDS 2017 TO 2020

6.7.6.3 Blakefield Seam Bores

Groundwater monitoring in the Blakefield seam was undertaken from three sites during 2020. A total of 12 samples were collected during the reporting period. The pH, EC and SWL trends for 2017 to 2020 are shown in **Figure 39, Figure 40** and **Figure 41** respectively. Trigger tracking results are shown in **Table 6.19**. Water quality trends were generally steady with an increasing pH trend observed in WOH2139A. The elevated pH is likely a result of the declining water levels due to depressurisation from the open cut operations. Groundwater levels generally declined within the Blakefield Seam over the 2020 reporting period. The SWL results are described further in the Annual Groundwater Review (**Appendix 4**).

TABLE 6.17 BLAKEFIELD SEAM GROUNDWATER 2020 INTERNAL TRIGGER TRACKING

Location	Date	Trigger limit	Action taken in response
WOH2139A	25/02/2020	**pH – 95th percentile**	Investigation Completed* As outlined in the 2019 Annual Groundwater Review pH values associated with bore WOH2139A are most likely attributable to the decreasing standing water level as a result of depressurisation from active mining in North Pit. Monitoring to continue to be undertaken quarterly.
WOH2139A	25/08/2020	**pH – 95th percentile**	Watching Brief* Monitoring results back within trigger limits for November 2020 sample round.

** = 1st/2nd trigger. Watching Brief established pending outcomes of subsequent monitoring events. No specific actions required*

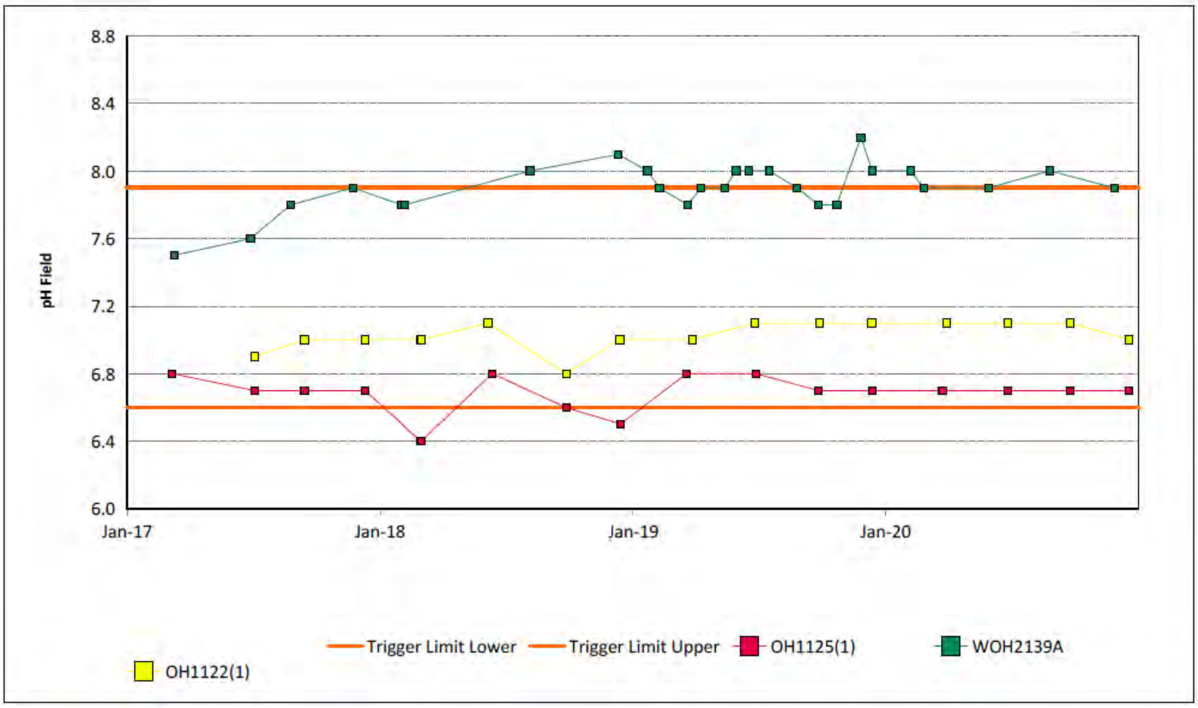


FIGURE 39: BLAKEFIELD SEAM GROUNDWATER PH TRENDS 2017 TO 2020

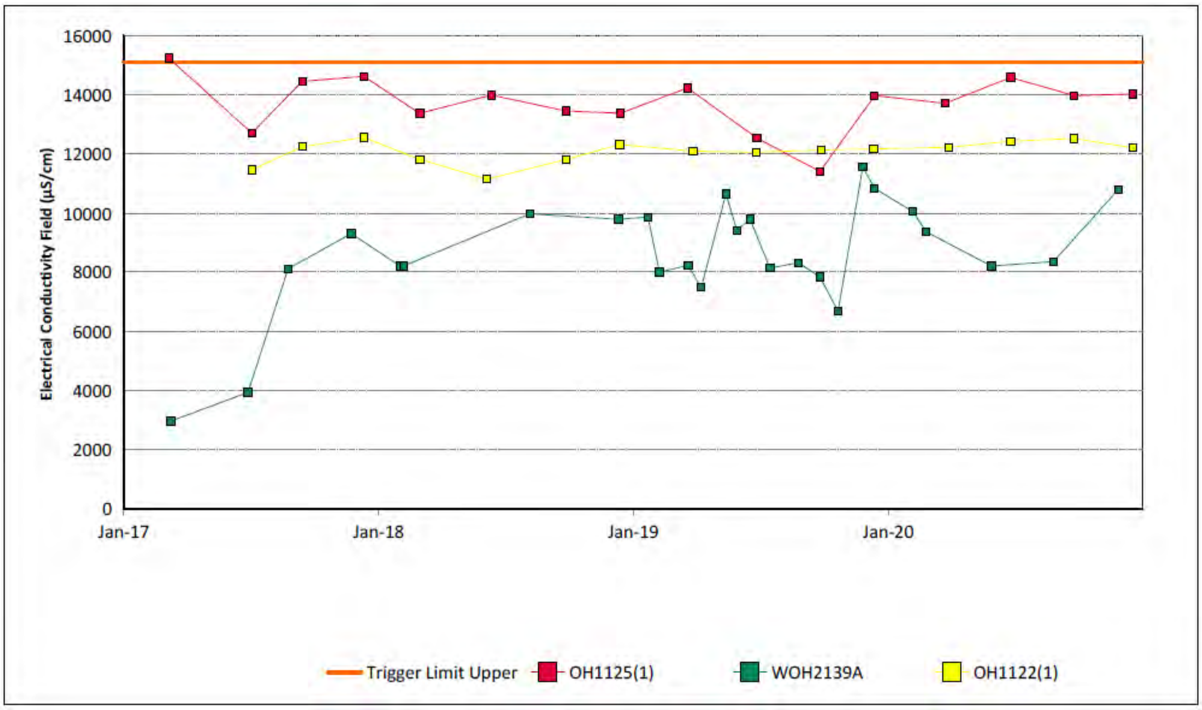


FIGURE 40: BLAKEFIELD SEAM GROUNDWATER EC TRENDS 2017 TO 2020

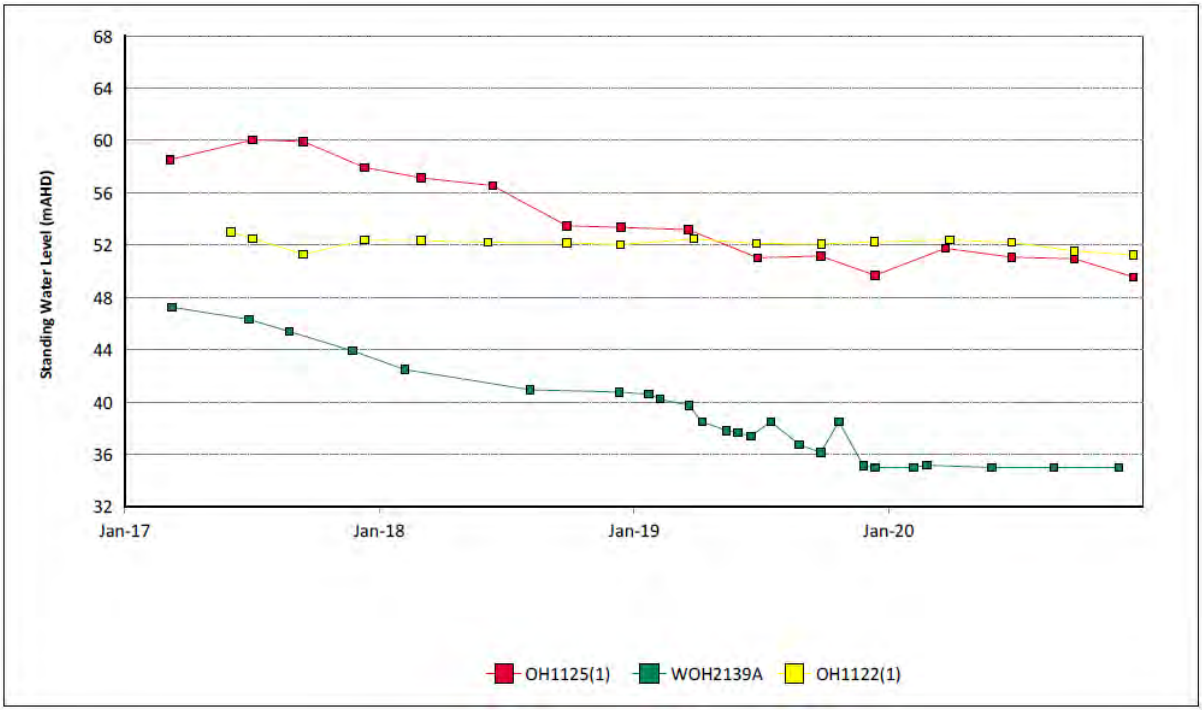


FIGURE 41: BLAKEFIELD SEAM GROUNDWATER SWL TRENDS 2017 TO 2020

6.7.6.4 Hunter River Alluvium Bores

Groundwater monitoring in the Hunter River Alluvium was undertaken from five sites during 2020. A total of 16 samples were collected during the reporting period. The pH, EC and SWL trends for 2017 to 2020 for Hunter River Alluvium groundwater bores are shown in **Figure 42** to **Figure 52**. Trigger tracking results are shown in **Table 6.20**. Bore OH787 recorded EC levels above the trigger throughout 2020. An investigation was completed with a change to the sampling methodology implemented in 2019 from considered the cause of the measured increase in EC.

Over 2020, all of the Hunter River Alluvium bores showed stable SWL results consistent with historical trends.

TABLE 6.18 HUNTER RIVER ALLUVIUM GROUNDWATER 2020 INTERNAL TRIGGER TRACKING

<table>
<tr><th>Location</th><th>Date</th><th>Trigger limit</th><th>Action taken in response</th></tr>
<tr><td rowspan="4">OH787</td><td>29/03/2020</td><td rowspan="4">EC – 95th percentile</td><td>Watching Brief*</td></tr>
<tr><td>26/06/2020</td><td>Investigation undertaken.
Results trending back within trigger levels following recent rainfall.</td></tr>
<tr><td>24/09/2020</td><td>Investigation Commenced</td></tr>
<tr><td>17/12/2020</td><td>Investigation undertaken.
A change to the sampling methodology implemented in 2019 i.e. low flow pumping/purging prior to all sampling and analysis, is considered the cause of the measured increase in EC.</td></tr>
<tr><td rowspan="3">OH788</td><td>27/03/2020</td><td rowspan="3">EC – 95th percentile</td><td>Investigation Undertaken.
Monitoring results back within trigger limits following recent rainfall.</td></tr>
<tr><td>21/09/2020</td><td>Watching Brief*</td></tr>
<tr><td>15/12/2020</td><td>Watching Brief*</td></tr>
<tr><td>OH786</td><td>26/06/2020</td><td>pH – 95th percentile</td><td>pH returned to within trigger limits for the September 2020 sample.</td></tr>
</table>

** = 1st/2nd trigger. Watching Brief established pending outcomes of subsequent monitoring events. No specific actions required*

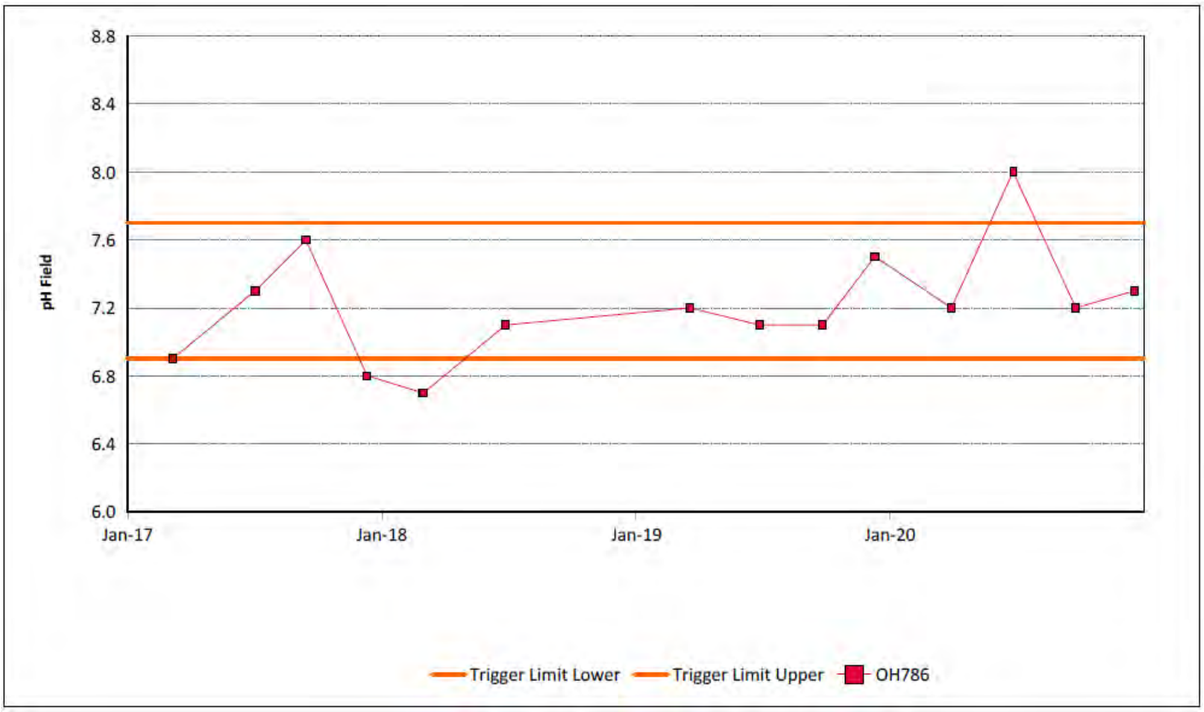


FIGURE 42: HUNTER RIVER ALLUVIUM BORE OH786 PH TREND 2017 TO 2020

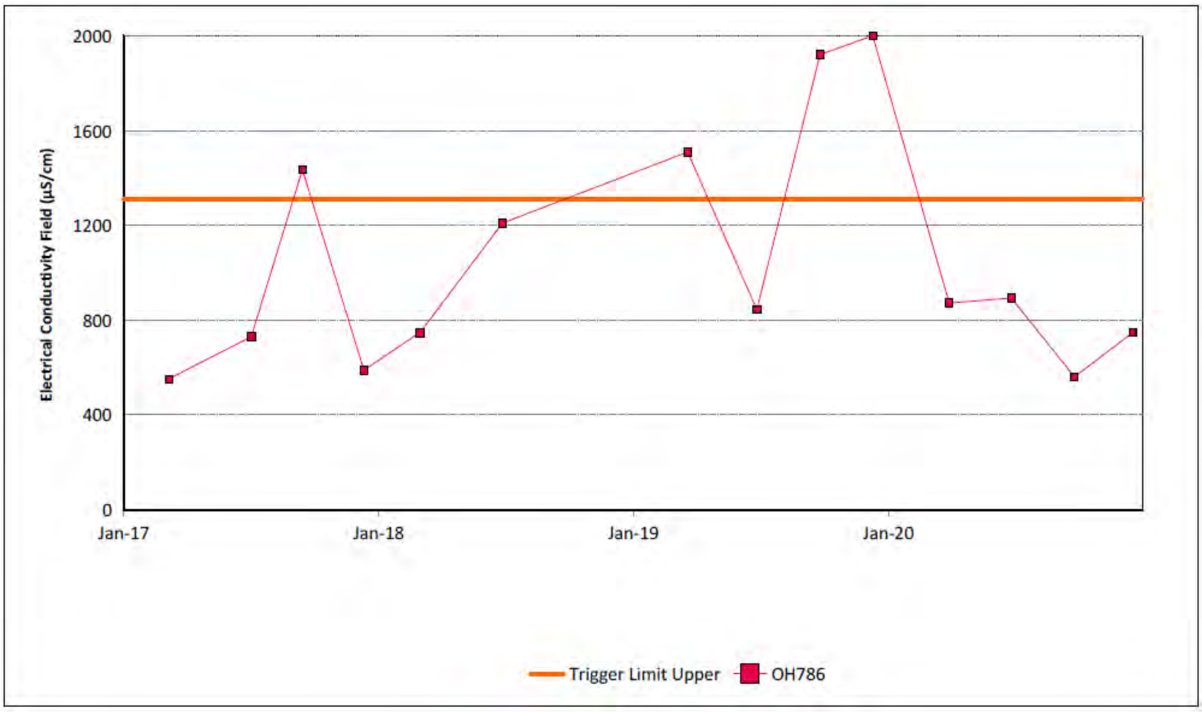


FIGURE 43: HUNTER RIVER ALLUVIUM BORE OH786 EC TREND 2017 TO 2020

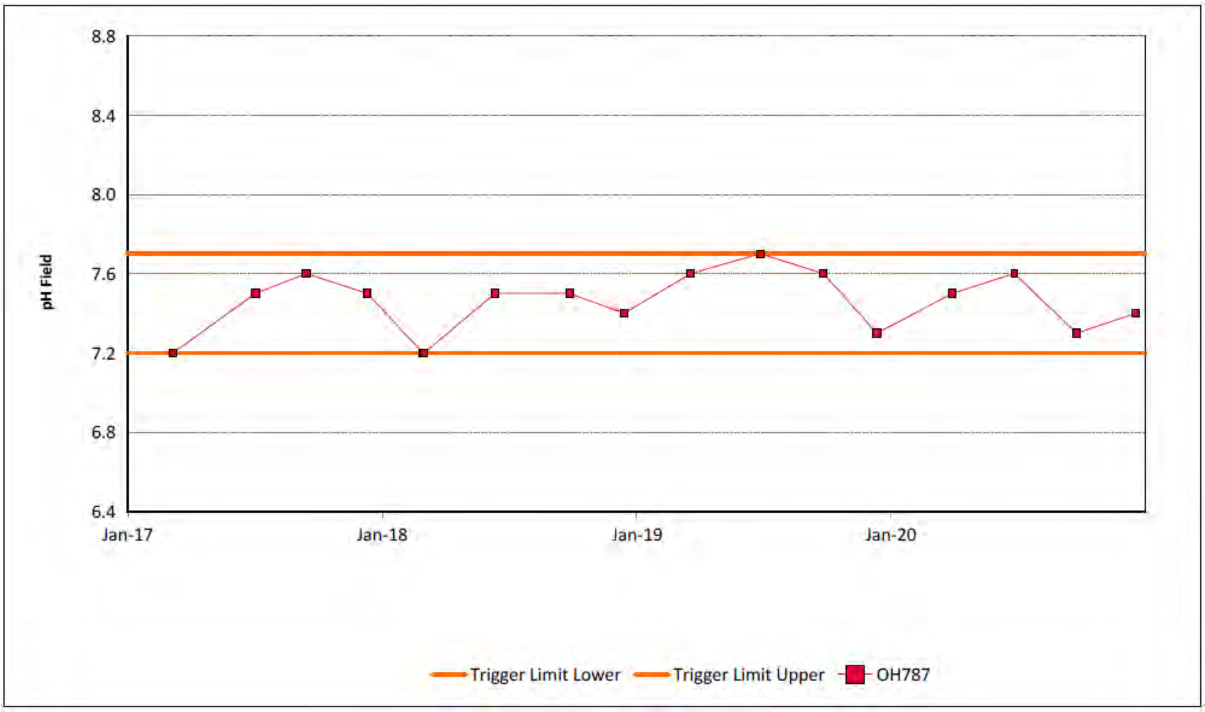


Figure 44: Hunter River Alluvium Bore OH787 pH Trend 2017 to 2020

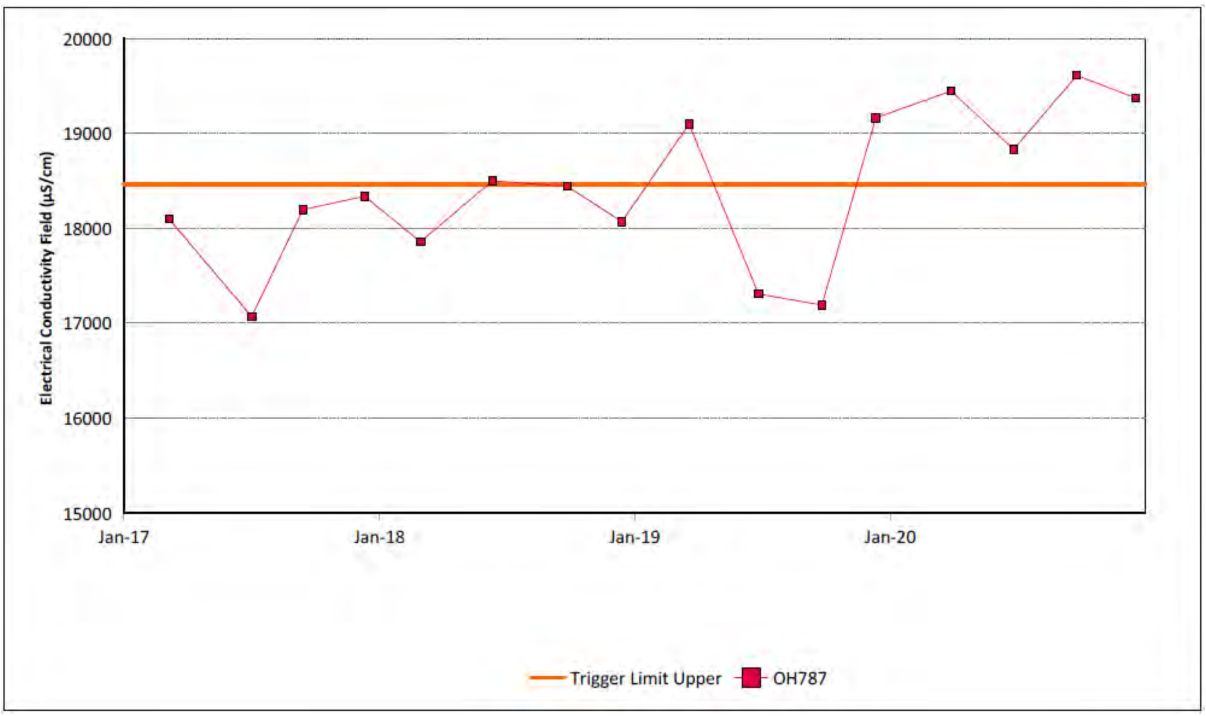


Figure 45: Hunter River Alluvium Bore OH787 EC Trend 2017 to 2020

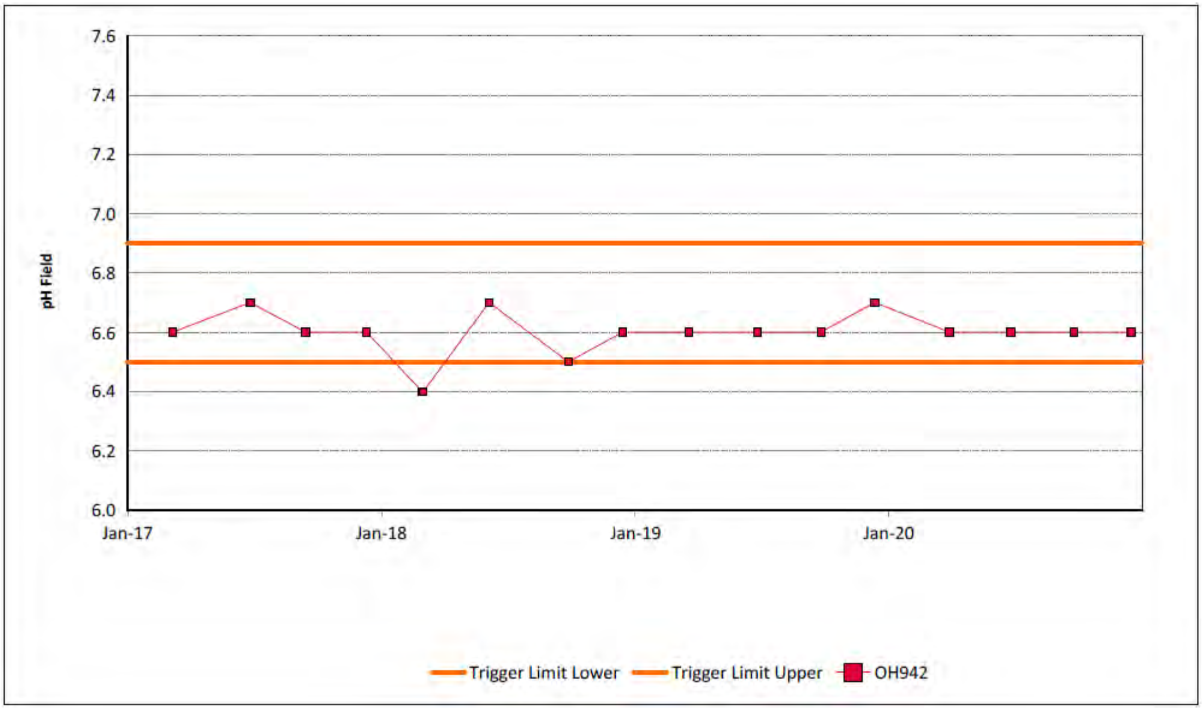


FIGURE 46: HUNTER RIVER ALLUVIUM BORE OH942 PH TREND 2017 TO 2020

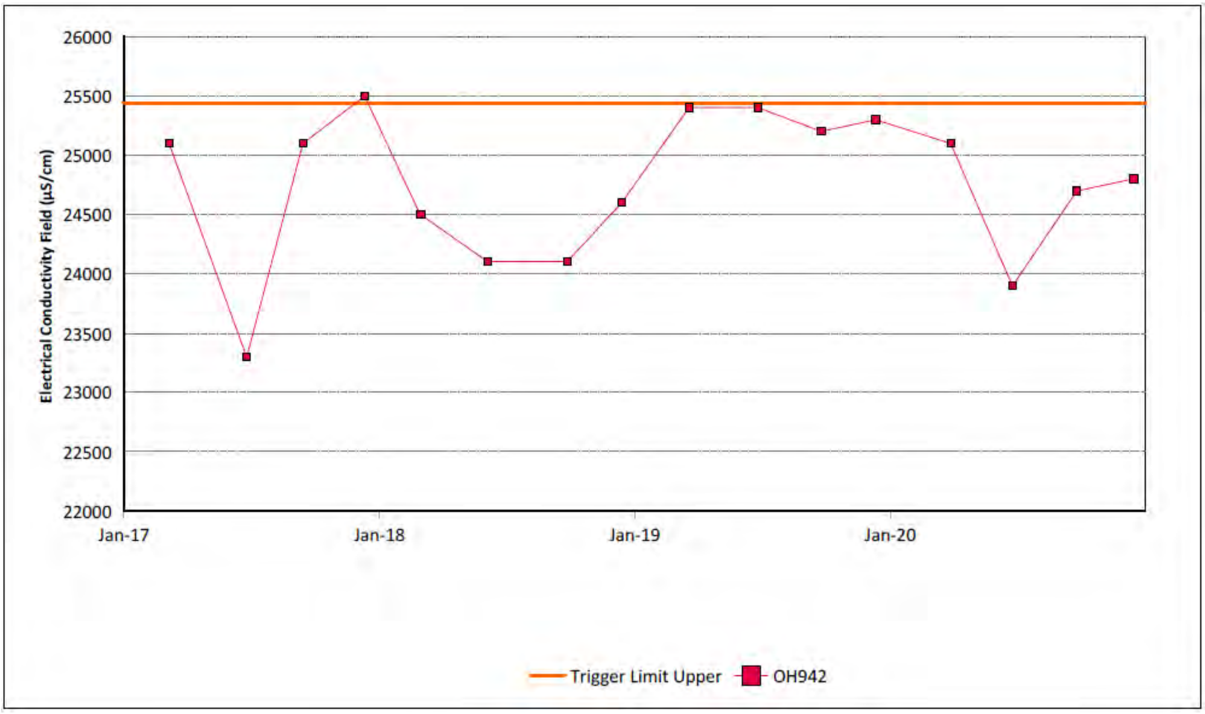
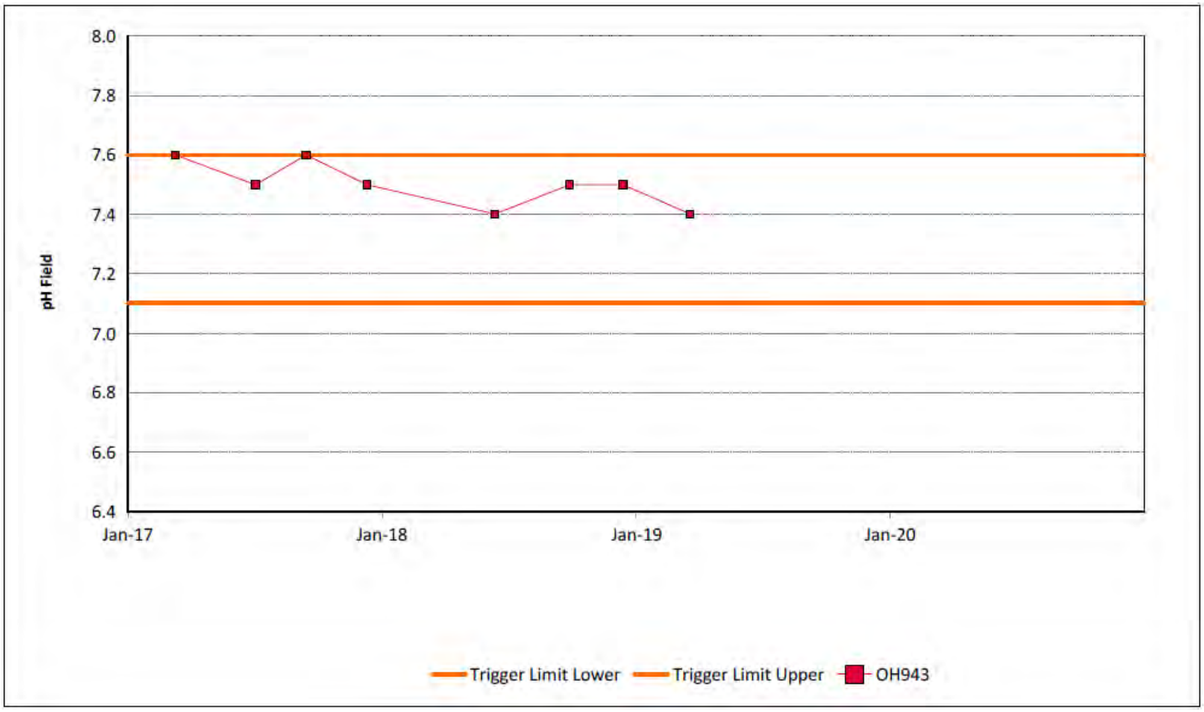
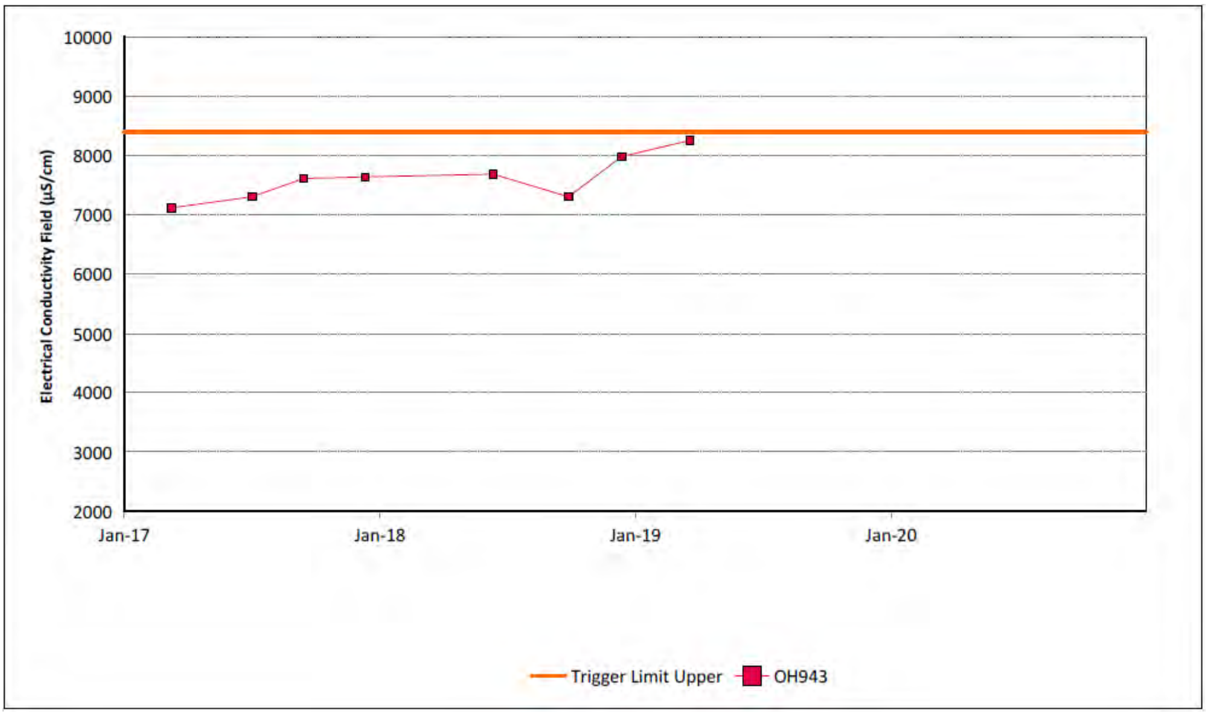


FIGURE 47: HUNTER RIVER ALLUVIUM BORE OH942 EC TREND 2017 TO 2020



Note: Missing data indicates that there was insufficient water to take a sample.

FIGURE 48: HUNTER RIVER ALLUVIUM BORE OH943 pH TREND 2017 TO 2020



Note: Missing data indicates that there was insufficient water to take a sample.

FIGURE 49: HUNTER RIVER ALLUVIUM BORE OH943 EC TREND 2017 TO 2020

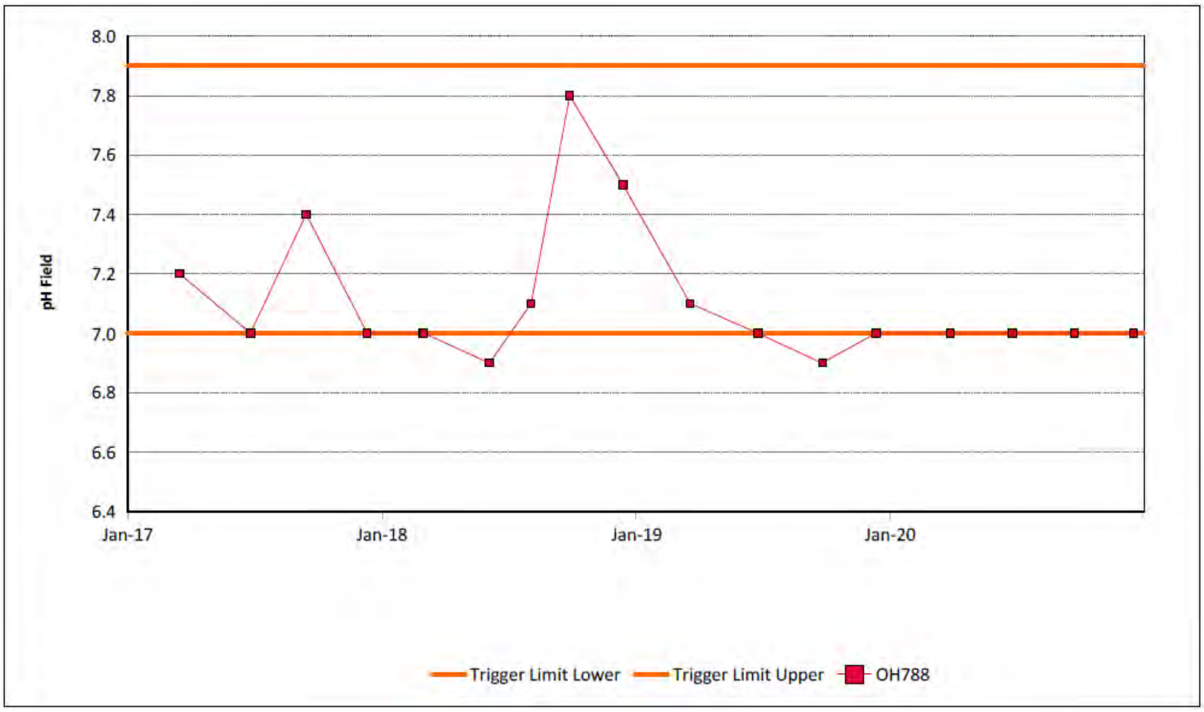


FIGURE 50: HUNTER RIVER ALLUVIUM BORE OH788 PH TREND 2017 TO 2020

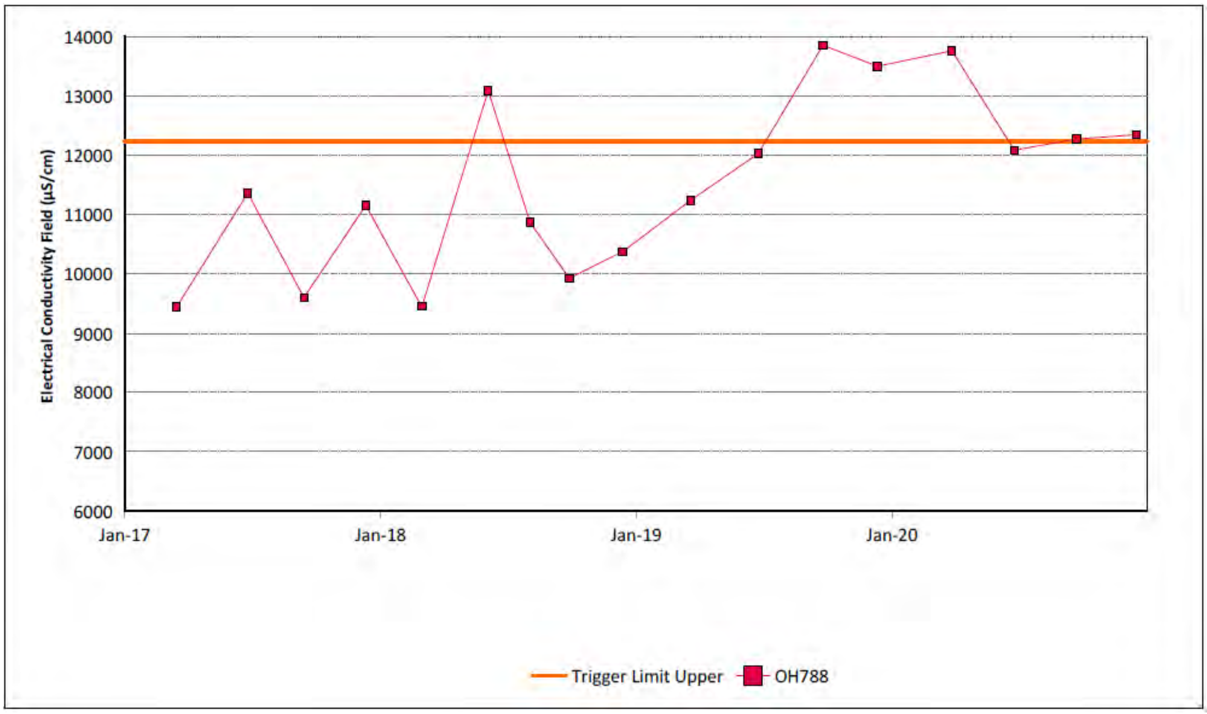


FIGURE 51: HUNTER RIVER ALLUVIUM BORE OH788 EC TREND 2017 TO 2020

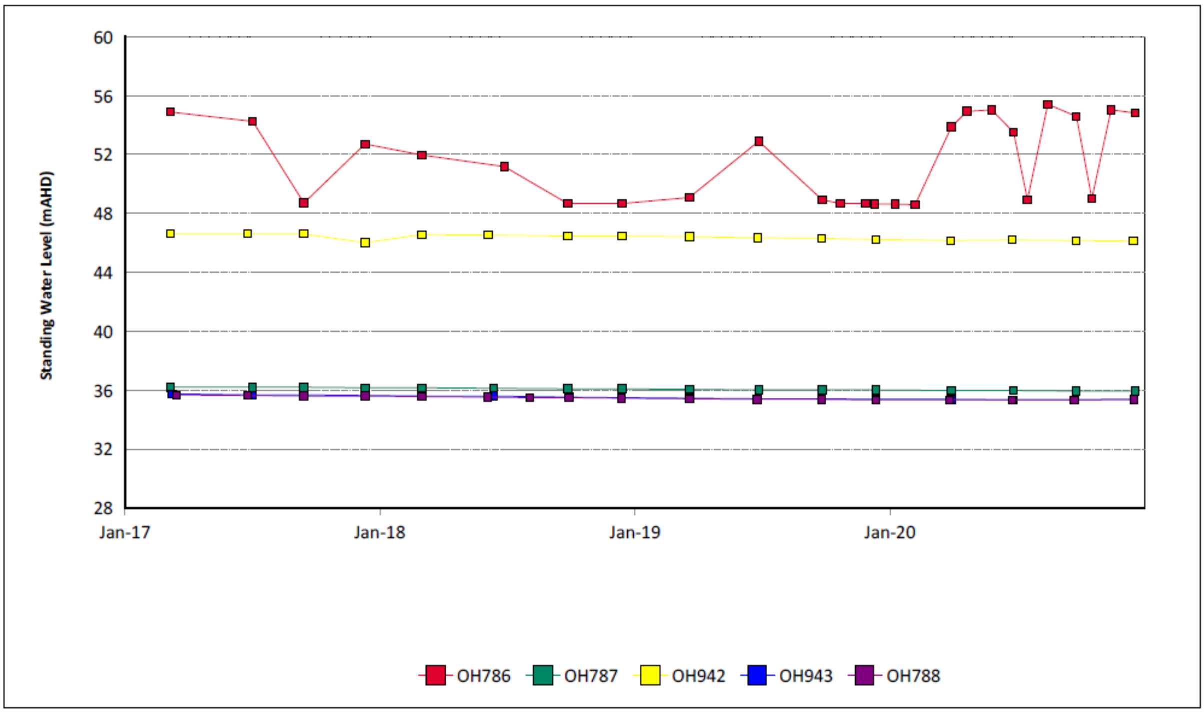


FIGURE 52: HUNTER RIVER ALLUVIUM GROUNDWATER SWL TRENDS 2017 TO 2020

6.7.6.5 Redbank Bores

Groundwater monitoring in the Redbank seam was undertaken from four sites during 2020. A total of 16 samples were collected during the reporting period. The pH, EC and SWL trends for 2017 to 2020 for Redbank seam groundwater bores are shown in **Figure 53**, **Figure 54** and **Figure 55** respectively. Trigger tracking results are shown in **Table 6.21**. Water quality results across the Redbank seam bores were generally consistent with historical values.

A steady declining trend in SWL values at all monitoring sites continued during the reporting period. This was expected/predicted given the close proximity of the bores to MTW's operations at Warkworth which are progressing West. The depressurisation of the groundwater in this area was predicted as a result of mining.

TABLE 6.19 REDBANK SEAM GROUNDWATER 2020 INTERNAL TRIGGER TRACKING

Location	Date	Trigger limit	Action taken in response
WOH2153A	25/02/2020	**pH – 95th Percentile**	Investigation commenced. pH results from bore WOH2153A likely to be attributable to the declining standing water levels recorded in this bore.
	28/05/2020		Investigation commenced. pH results from bore WOH2153A likely to be attributable to the declining standing water levels recorded in this bore.
	25/08/2020		Investigation completed. pH results likely to be attributable to the declining standing water levels recorded in this bore. Monitoring results back within trigger limits for November 2020 sample round.

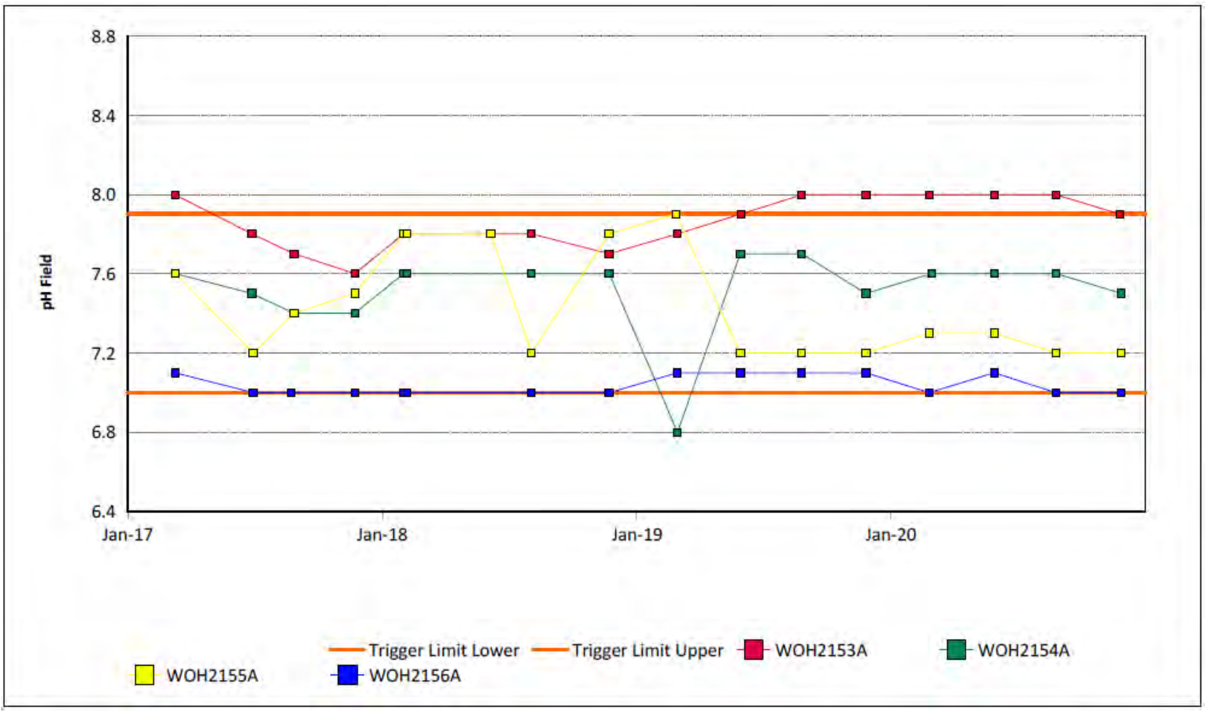


FIGURE 53: REDBANK SEAM GROUNDWATER PH TRENDS 2017 TO 2020

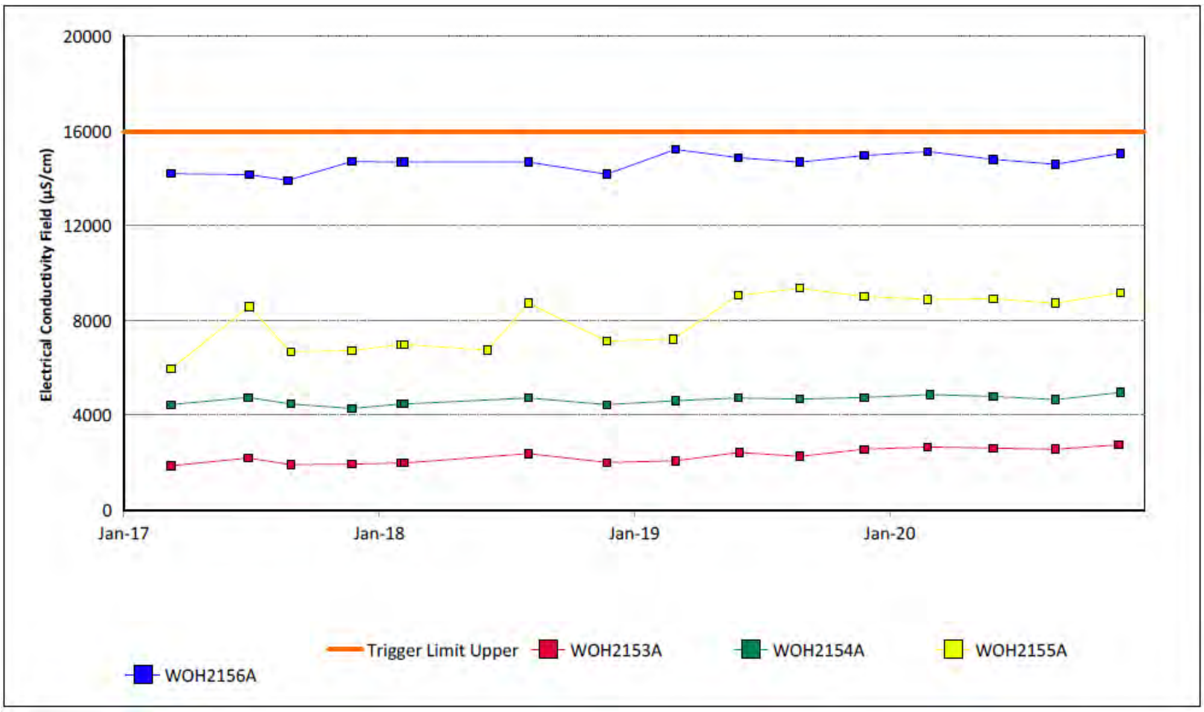


FIGURE 54: REDBANK SEAM GROUNDWATER EC TRENDS 2017 TO 2020

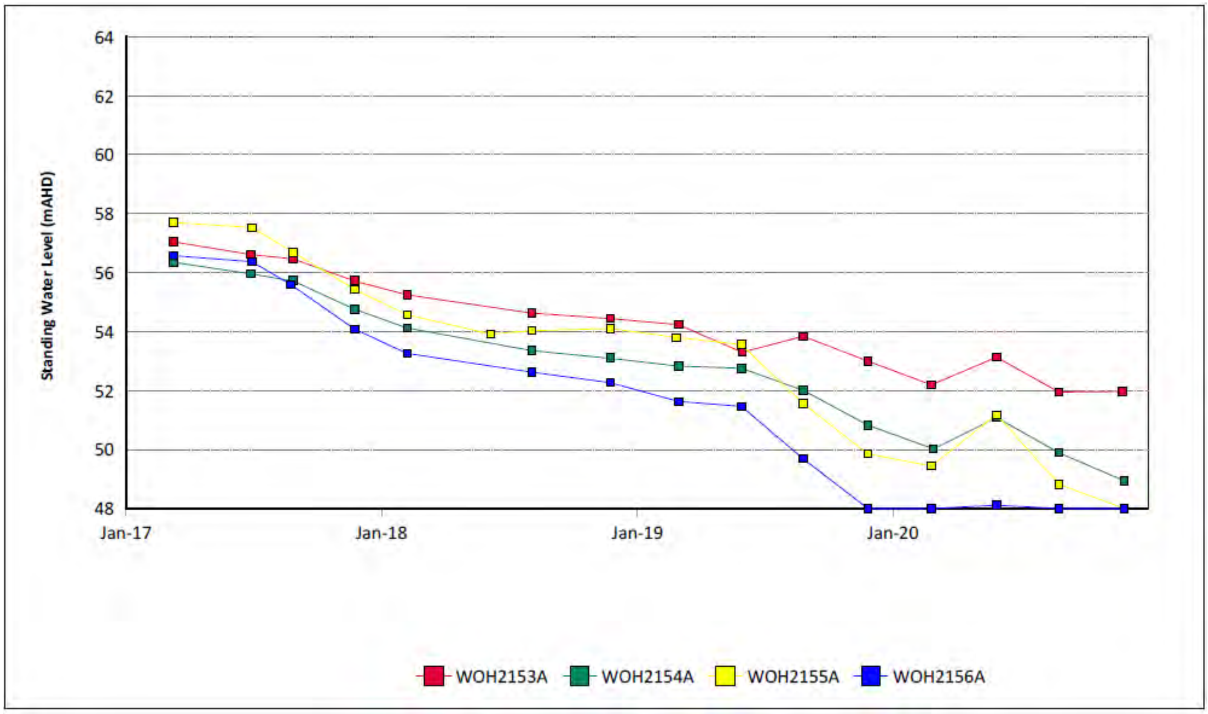


FIGURE 55: REDBANK SEAM GROUNDWATER SWL TRENDS 2017 TO 2020

6.7.6.6 Shallow Overburden Bores

Groundwater monitoring in the Shallow Overburden bores was undertaken from ten sites during 2020. A total of 40 samples were collected during the reporting period. The pH, EC and SWL trends for 2017 to 2020 for Shallow Overburden groundwater bores are shown in **Figure 56**, **Figure 57** and **Figure 58** respectively. Trigger tracking results are shown in **Table 6.22**.

Water levels and water quality were generally in line with historical values across these bores during the reporting period. Groundwater level trends for bores within the shallow overburden material showed stable to slightly declining groundwater levels. The exception to this were bores MTD616P in which slightly increasing groundwater levels were recorded followed by stabilisation and a decline. No land use changes or activities are known to have occurred near the bores that may have caused this rising trend. Further investigation into site conditions around MTD616P will be undertaken to confirm this during the 2021 reporting period.

TABLE 6.20 SHALLOW OVERBURDEN SEAM GROUNDWATER 2020 INTERNAL TRIGGER TRACKING

Location	Date	Trigger limit	Action taken in response
MTD605P	26/02/2020	**EC – 95th percentile**	Watching Brief*
	25/05/2020		Investigation undertaken. Results trending back within trigger levels following recent rainfall.
	24/08/2020		Investigation completed. Data consistent with historical results within bore MTD650P. Trigger limits are established for all bores within the seam. MTD605P, expresses localised variation with data consistent with historical results
MTD616P	25/02/2020	**pH – 5th percentile**	Investigation Undertaken. Historically, fluctuations in pH at this location coincide with changes to the sampling methodology, from quarterly grab sampling to low flow pumping/purging prior to annual comprehensive sampling and analysis. A change to the sampling methodology implemented in 2019 i.e. low flow pumping/purging prior to all sampling and analysis, is considered the cause of the measured drop in pH. pH has returned to within lower pH trigger limit in May 2020 sample event
	23/11/2020		Watching Brief*
MB15MTW01D	27/02/2020	**pH – 5th percentile**	Watching Brief*
	27/05/2020		Investigation Commenced
	26/08/2020		Investigation commenced. A change to the sampling methodology implemented in 2019 i.e. low flow pumping/purging prior to all sampling and analysis, is possibly considered the cause of the measured drop in pH results.
	25/11/2020		Investigation commenced. Consultant engaged to complete bore lithology and confirm aquifer representation. Depending on finding, further investigation maybe required.

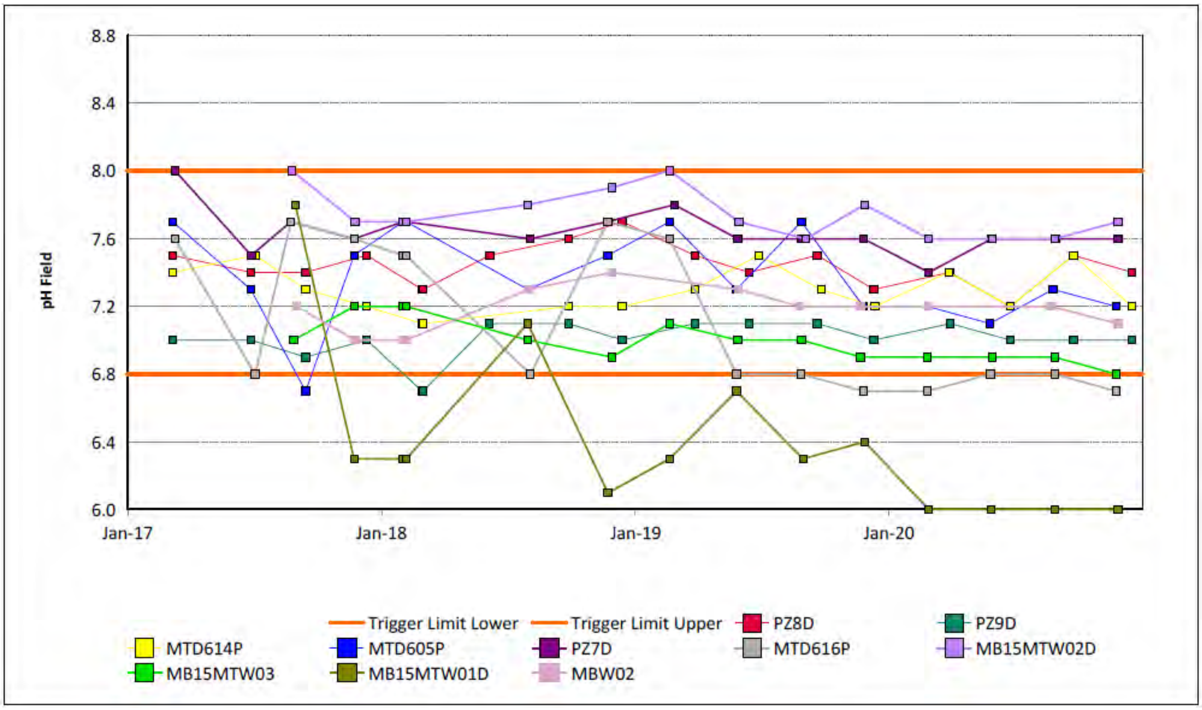


FIGURE 56: SHALLOW OVERBURDEN SEAM GROUNDWATER pH TRENDS 2017 TO 2020

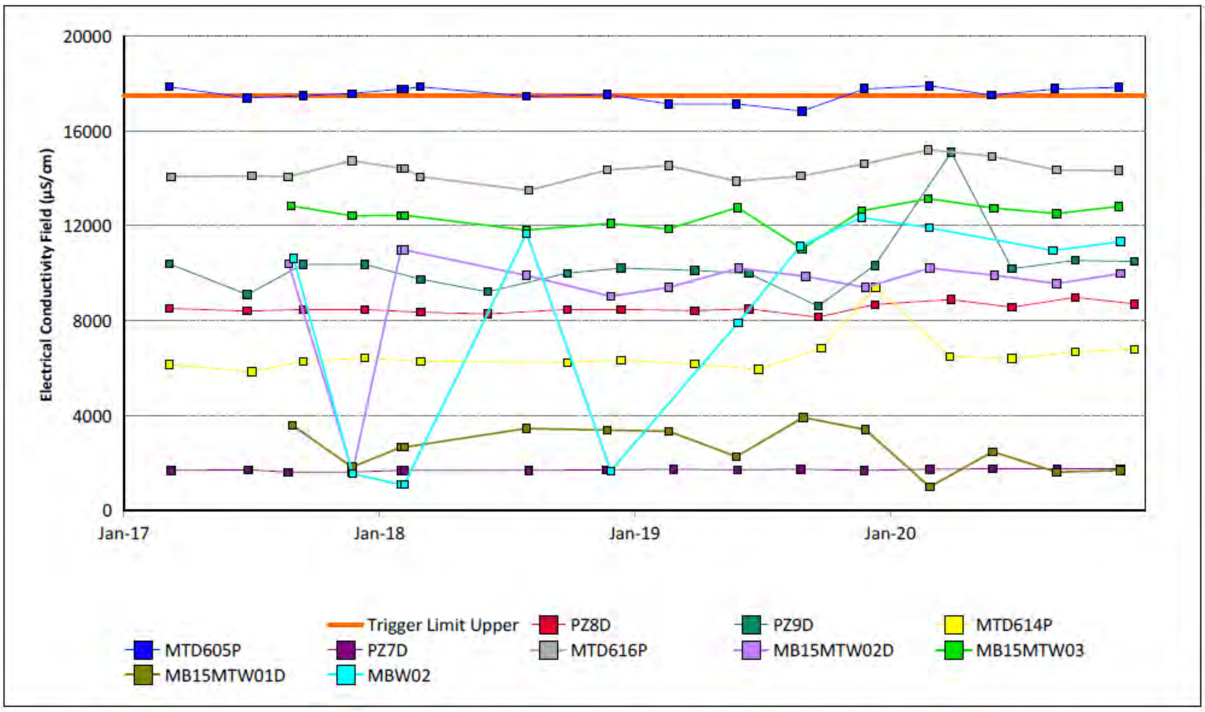


FIGURE 57: SHALLOW OVERBURDEN SEAM GROUNDWATER EC TRENDS 2017 TO 2020

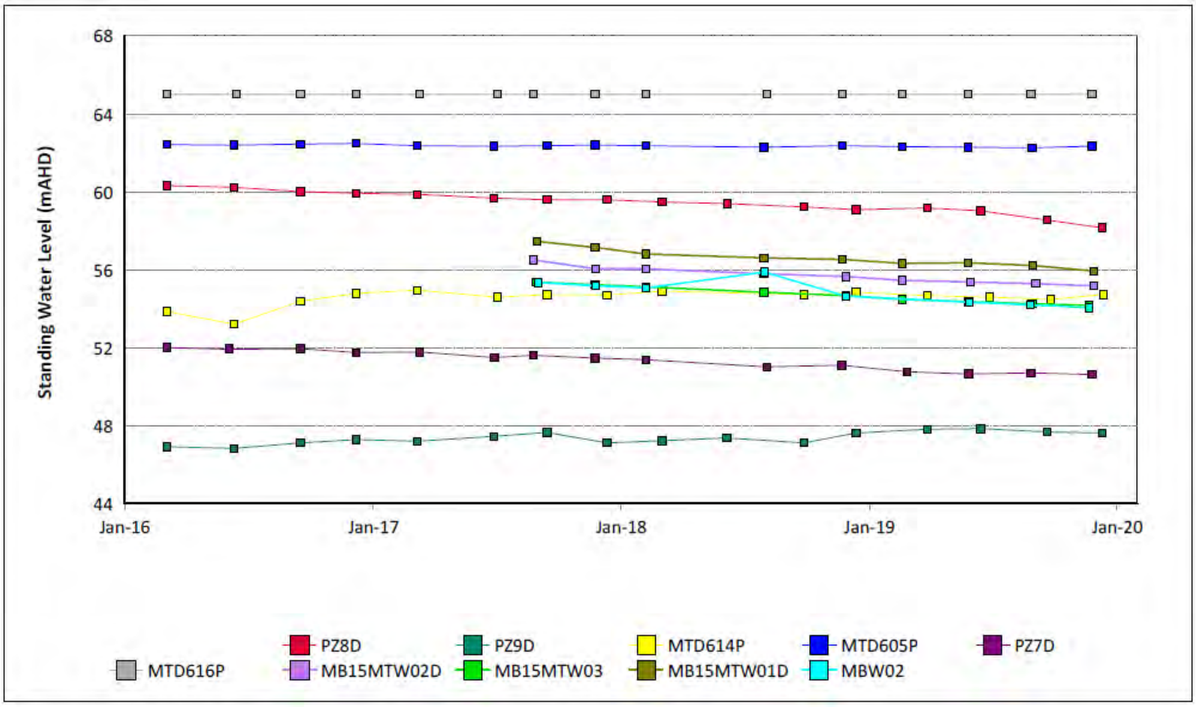


FIGURE 58: SHALLOW OVERBURDEN SEAM GROUNDWATER SWL TRENDS 2017 TO 2020

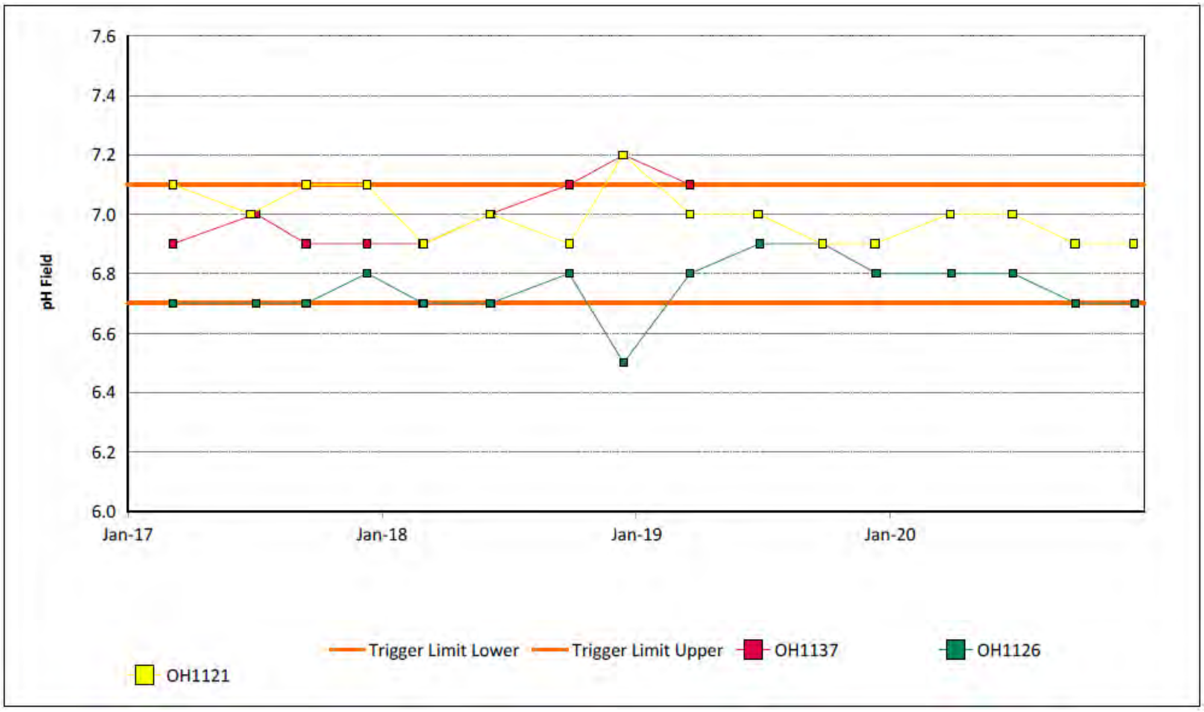
6.7.6.7 Vaux Seam Bores

Groundwater monitoring in the Vaux Seam was undertaken from three sites during 2020; a total of 8 samples were collected. The pH, EC and SWL trends for 2017 to 2020 for Vaux groundwater bores are shown in **Figure 59**, **Figure 60** and **Figure 61** respectively.

Historical groundwater level trends for the Vaux seam bores show that over 2020 groundwater elevations within the Vaux Seam, north of North Pit, (OH1126) ranged between 45.71 mAHD and 46.01 mAHD. OH1137 has remained dry since September 2019 onwards. These trends are similar to trends observed within the Warkworth Seam, which may relate to depressurisation of the coal seams below the actively mined seams at MTW, or due to surrounding mine operations that target the Vaux Seam.

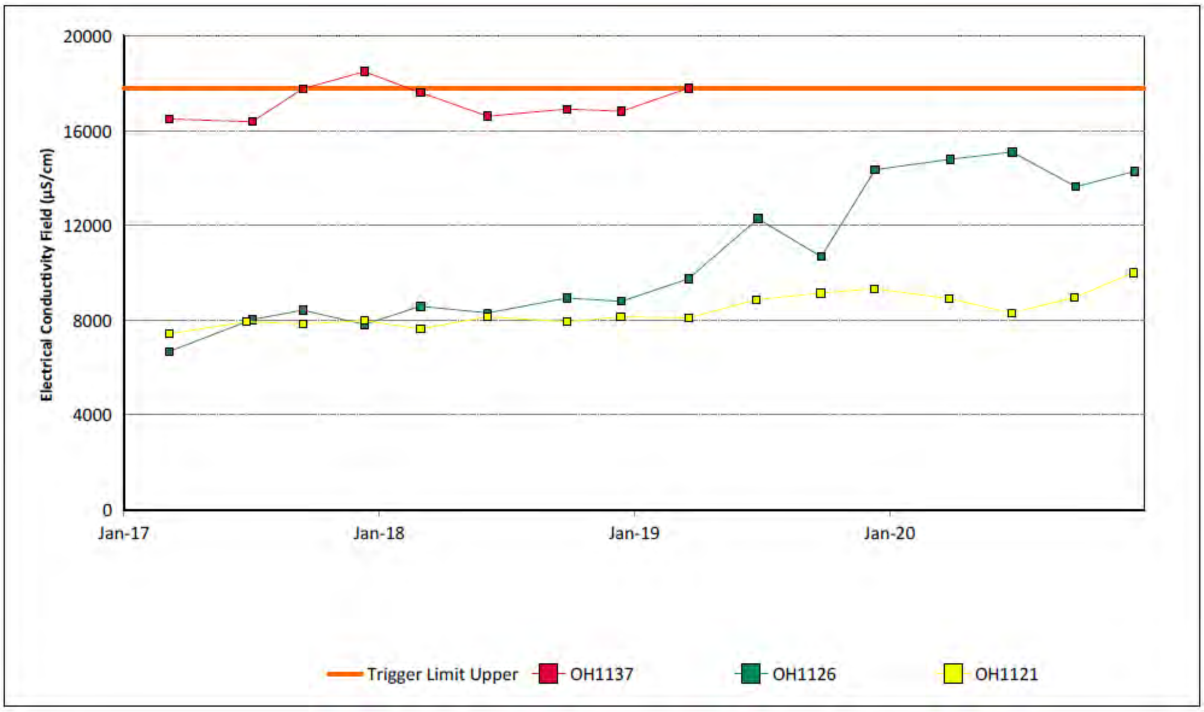
Groundwater levels within bore OH1121 remained stable over 2020.

The bores record a general decline in groundwater levels since 2008, while the model predicted a rise in groundwater levels. This difference may relate to how the model replicates recovery within the rehabilitated spoil at North Pit. The difference may also relate to influence of licenced groundwater abstraction from the Lemington Underground Bore that is not replicated within the model.



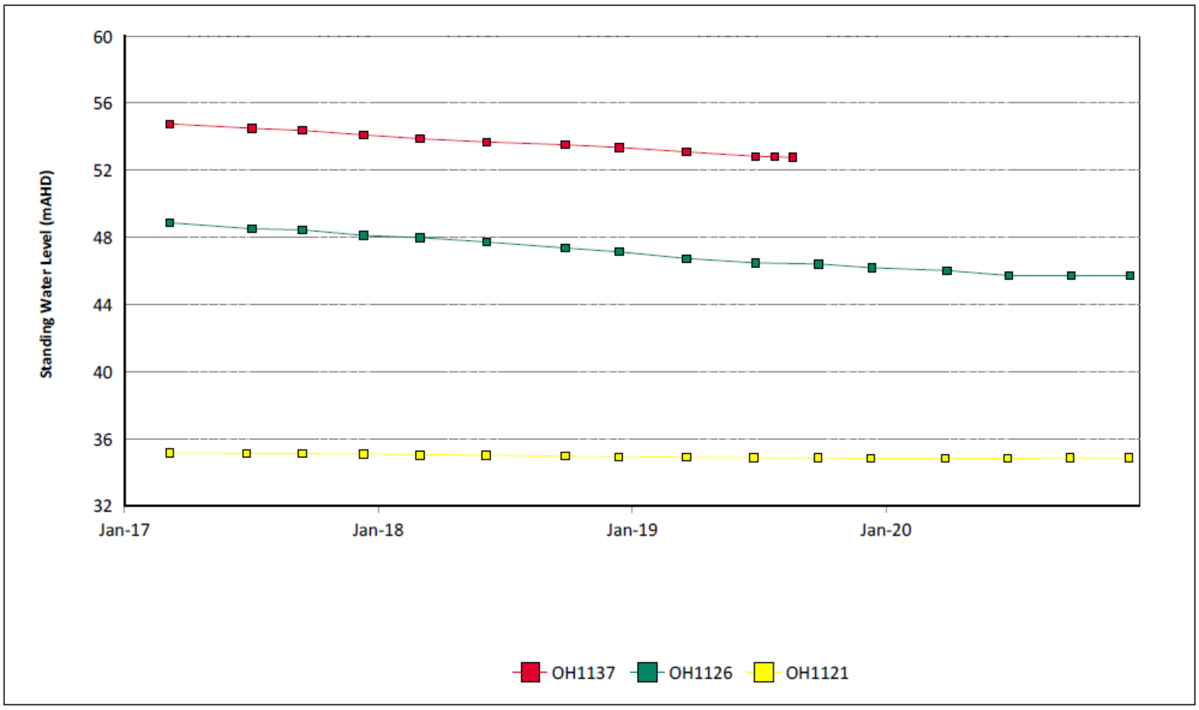
Note: Missing data indicates that there was insufficient water to take a sample.

FIGURE 59: VAUX SEAM GROUNDWATER PH TRENDS 2017 TO 2020



Note: Missing data indicates that there was insufficient water to take a sample.

FIGURE 60: VAUX SEAM GROUNDWATER EC TRENDS 2017 TO 2020



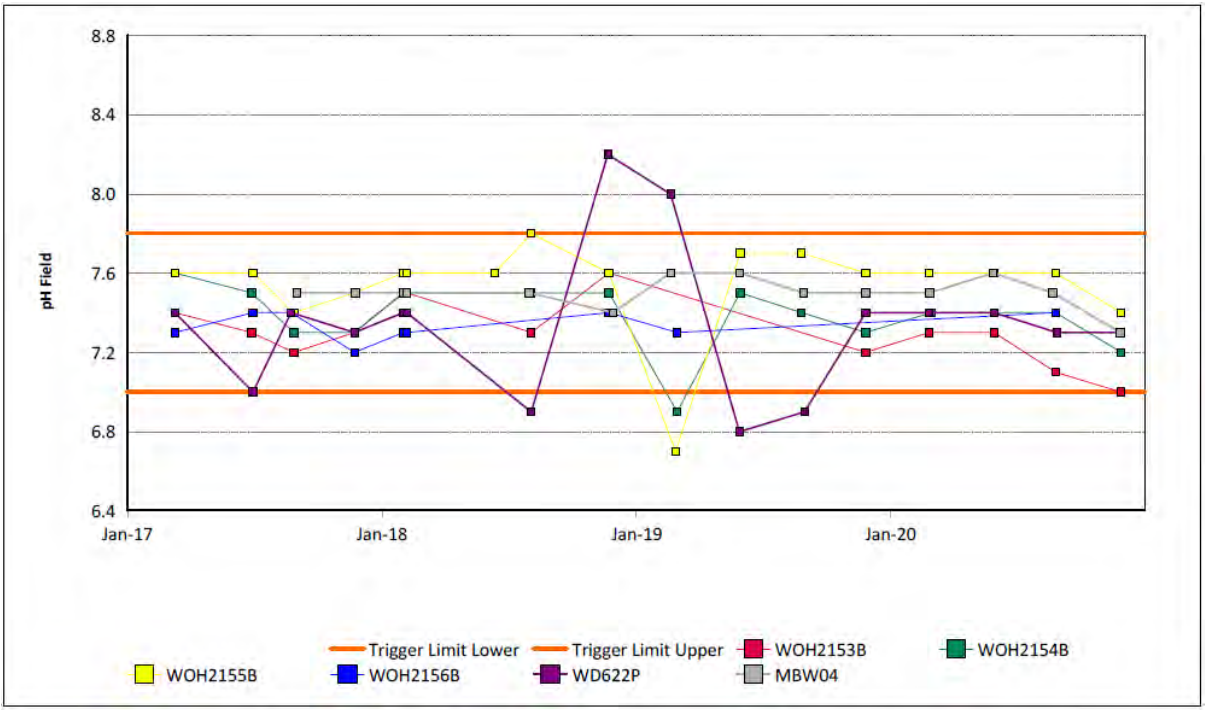
Note: Missing data indicates that there was insufficient water to take a sample.

FIGURE 61: VAUX SEAM GROUNDWATER SWL TRENDS 2017 TO 2020

6.7.6.8 Wambo Seam Bores

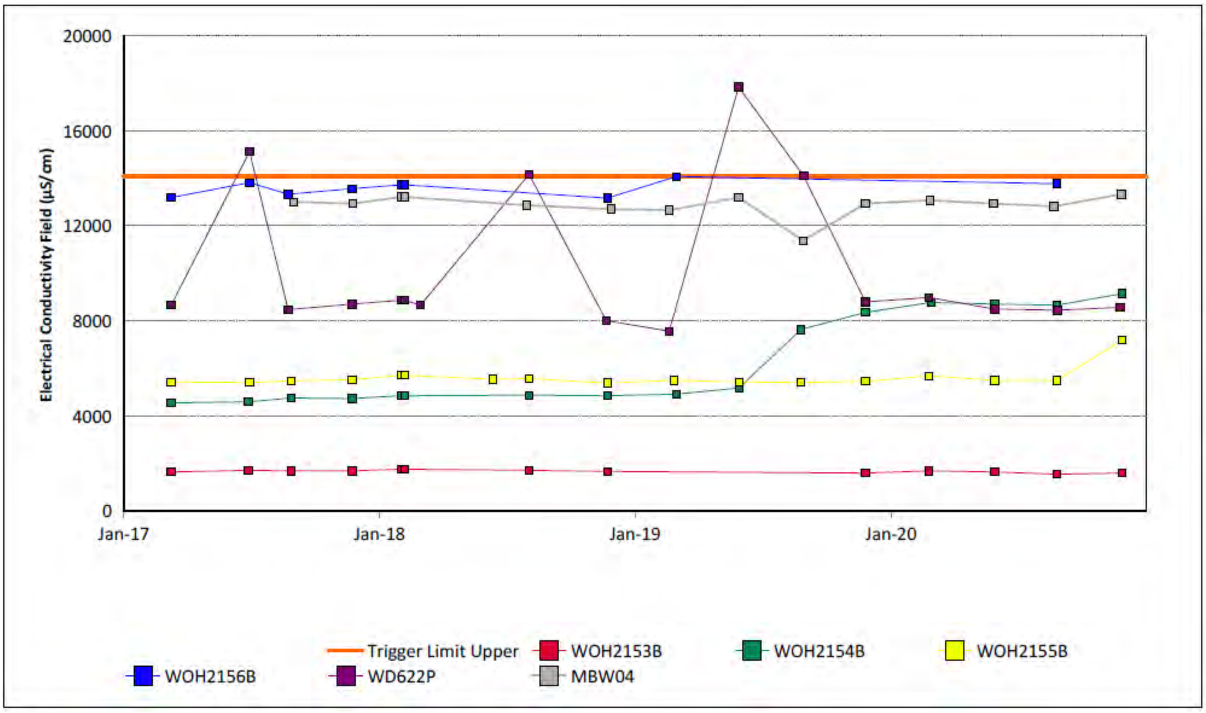
Groundwater monitoring in the Wambo Seam was undertaken from six sites during 2020. A total of 21 samples were collected during the reporting period. The pH, EC and SWL trends for 2017 to 2020 for Wambo Seam groundwater bores are shown in **Figure 62, Figure 63** and **Figure 64** respectively.

Groundwater elevations in the Wambo Seam recovered temporarily following above average rainfall in February and March 2020. Despite this temporary relief, the declining trends continued over the rest of the year as a result of coal seam depressurisation.



Note: Missing data indicates that there was insufficient water to take a sample.

FIGURE 62: WAMBO SEAM GROUNDWATER PH TRENDS 2017 TO 2020



Note: Missing data indicates that there was insufficient water to take a sample.

FIGURE 63: WAMBO SEAM GROUNDWATER EC TRENDS 2017 TO 2020

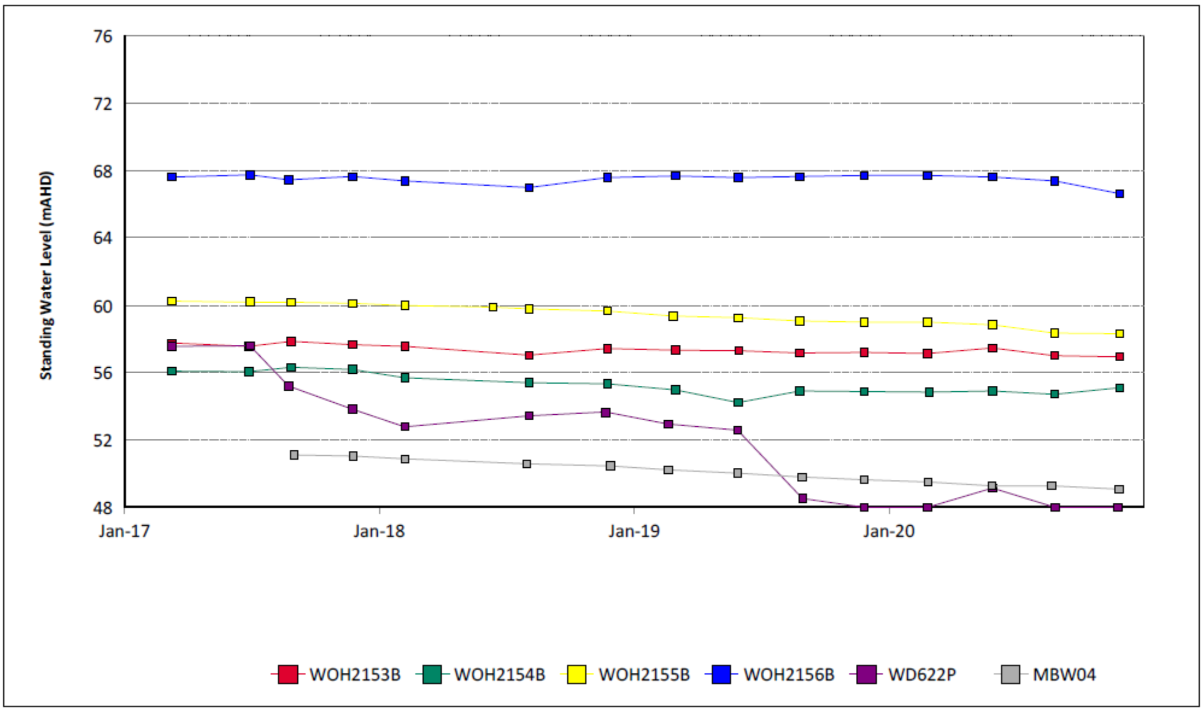


FIGURE 64: WAMBO SEAM GROUNDWATER SWL TRENDS 2017 TO 2020

6.7.6.9 Warkworth Seam Bores

Groundwater monitoring in the Warkworth Seam was undertaken from two sites during 2020; 24 samples were collected. The pH, EC and SWL trends for 2017 to 2020 for Warkworth seam bores are shown in **Figure 65**, **Figure 66** and **Figure 67** respectively. Trigger tracking results are shown in **Table 6.25**. The SWL in both bores reduced gradually over the reporting period in line with historical trends.

Table 6.21 Warkworth Seam Groundwater 2020 Internal Trigger Tracking

Location	Date	Trigger limit	Action taken in response
OH1138(1)	09/01/2020	pH – 5th percentile	Investigation Commenced
	06/02/2020		Investigation Commenced
	23/03/2020		Investigation Completed. As outlined in the MTW 2019 Annual Groundwater Review pH results for monitoring bore OH1138 likely to be attributable to the regional drawdown associated within the active mining in North Pit and the potential influences from the abstraction of water from the Lemington underground workings. Monthly results obtained since March 2020 (April, May and June) have confirmed pH to be back within trigger limits.
	16/07/2020		Watching Brief*
	14/08/2020		Watching Brief* Monitoring results back within trigger limits for September 2020 sample round.
	16/10/2020		Watching Brief*
	13/11/2020		Watching Brief* Monitoring results back within trigger limits for December 2020 sample round.

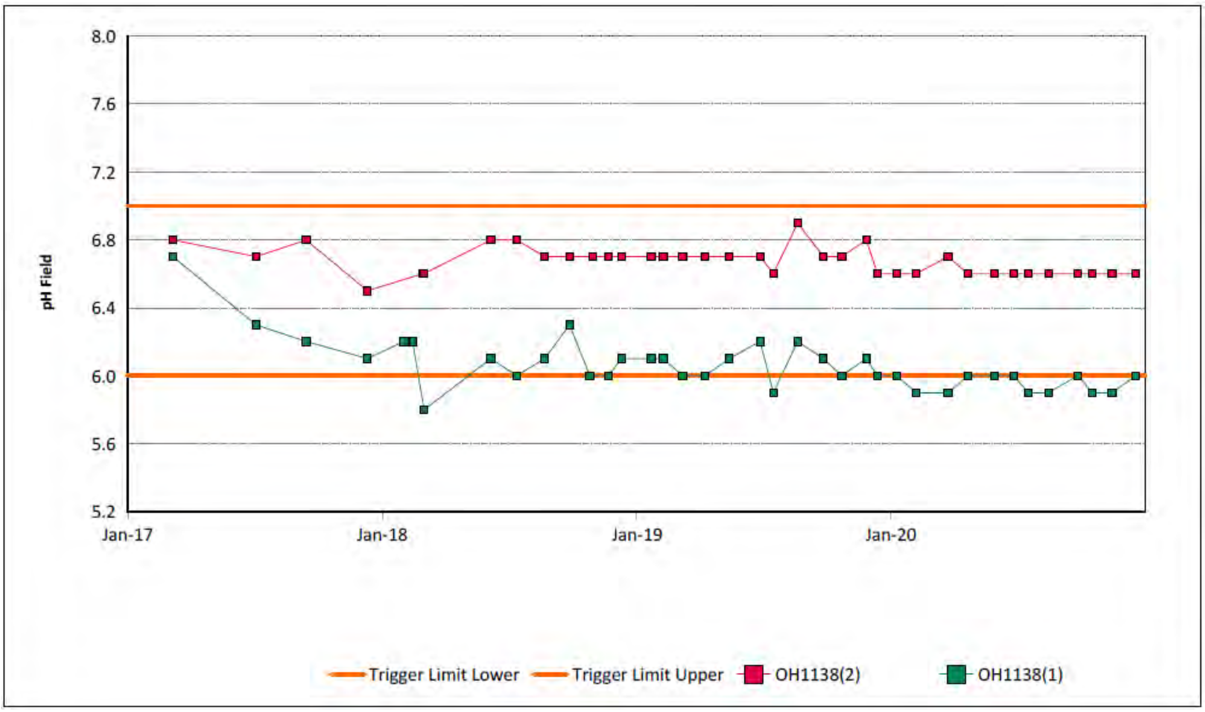


FIGURE 65: WARKWORTH SEAM GROUNDWATER pH TRENDS 2017 TO 2020

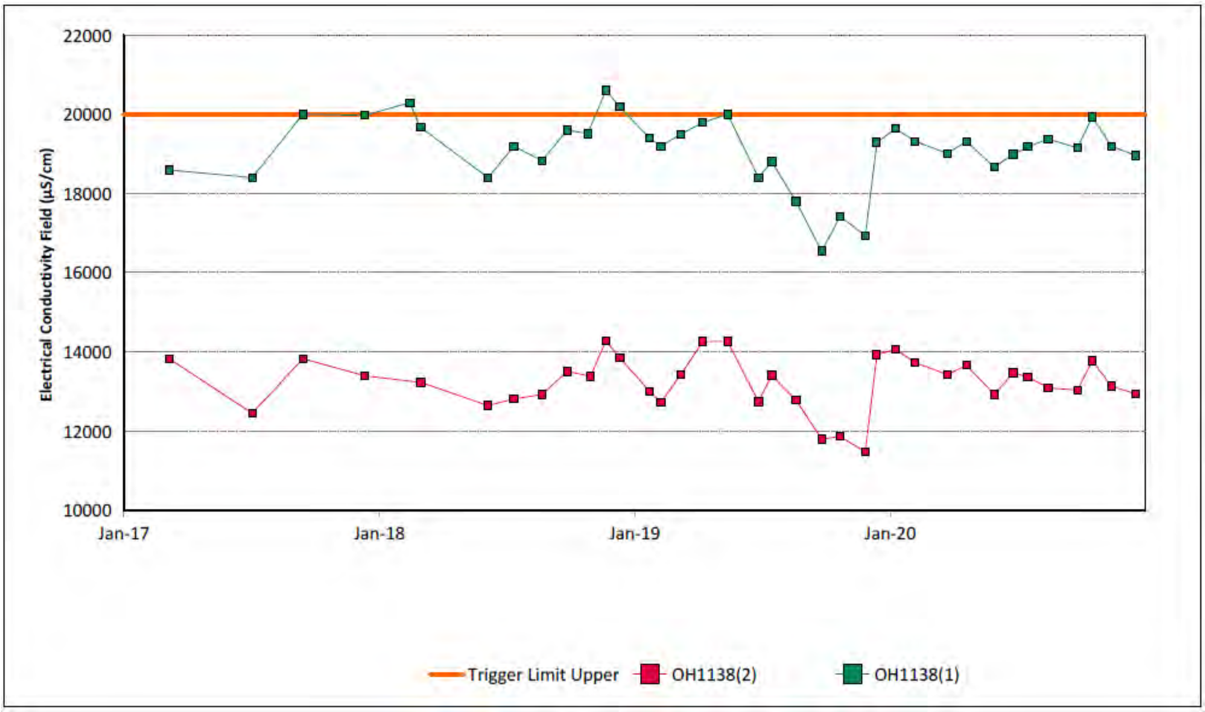


FIGURE 66: WARKWORTH SEAM GROUNDWATER EC TRENDS 2017 TO 2020

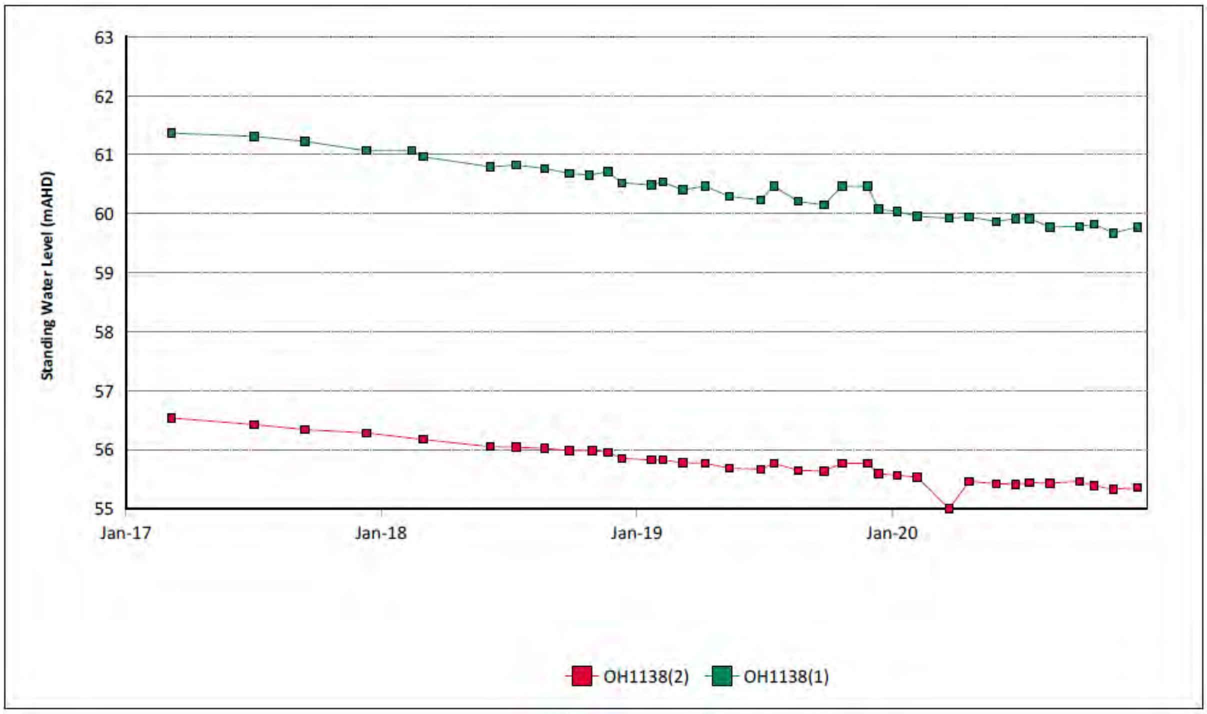


FIGURE 67: WARKWORTH SEAM GROUNDWATER SWL TRENDS 2017 TO 2020

6.7.6.10 Wollombi Brook Alluvium Bores

Groundwater monitoring in the Wollombi Brook Alluvium was undertaken from two sites during 2020; four samples were collected. The pH, EC and SWL trends for 2017 to 2020 are shown in **Figure 68** to **Figure 72** respectively. The trigger tracking result is shown in **Table 6.26**.

Over 2020 the SWL in both bores has steadily increased. The increase in water levels corresponds to the stream flow levels in the Wollombi Brook as a result of increased rainfall over the period. As outlined in **Appendix 4** the spikes in water quality across PZ8S and PZ9S are likely to be related to the bore being dry (at construction depth) and samples being influenced by localised rainwater at the base of each bore.

TABLE 6.22 WOLLOMBI BROOK ALLUVIUM GROUNDWATER 2020 INTERNAL TRIGGER TRACKING

Location	Date	Trigger limit	Action taken in response
PZ8S	22/09/2020	**EC – 95th Percentile**	Watching Brief* Monitoring results back within trigger limits for December 2020 sample round.

FIGURE 68: WOLLOMBI BROOK ALLUVIUM GROUNDWATER PH TRENDS 2017 TO 2020

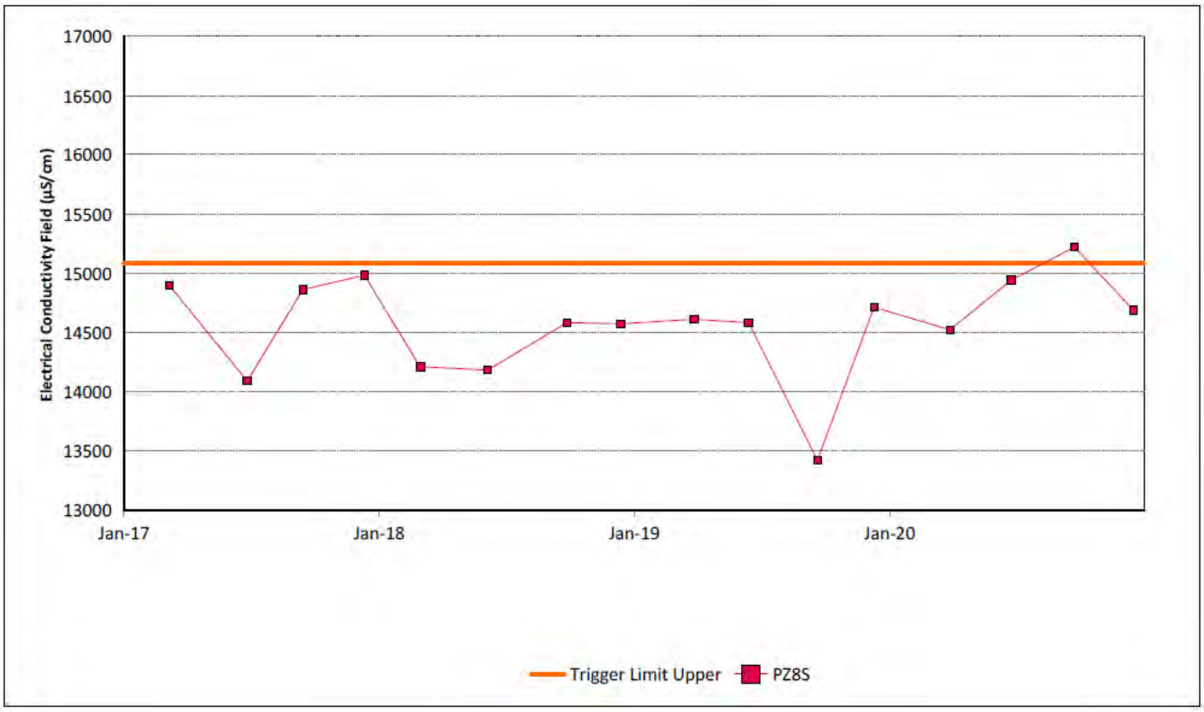
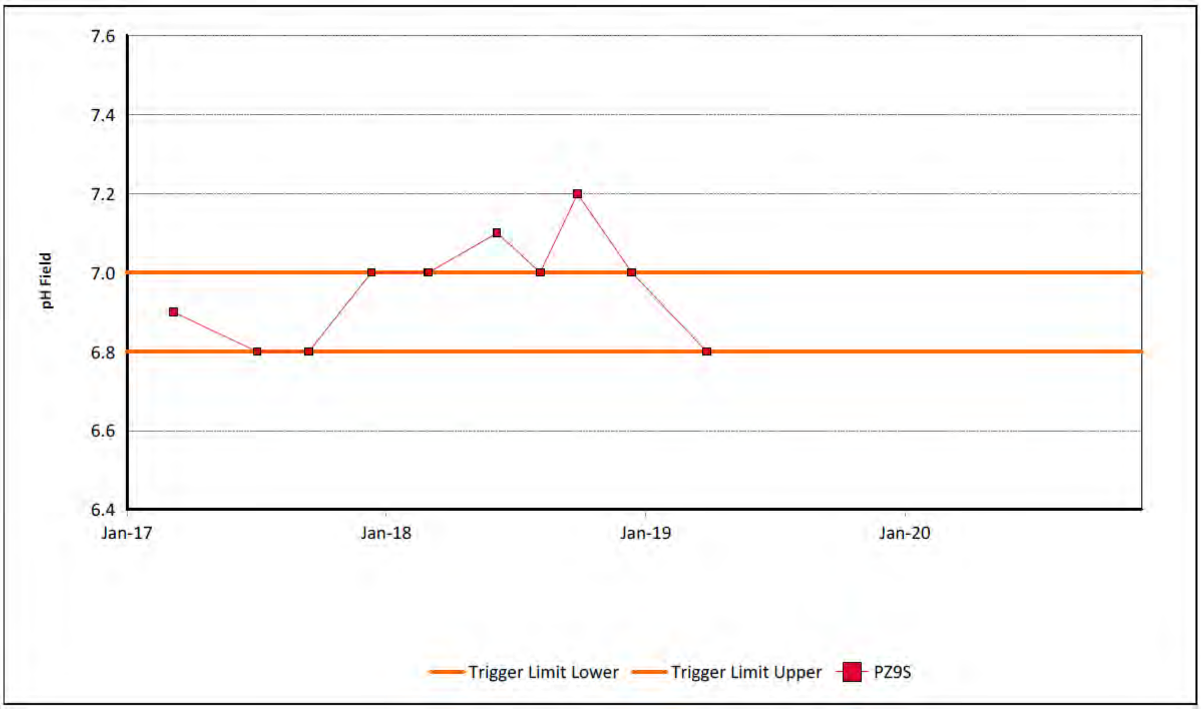


FIGURE 69: WOLLOMBI BROOK ALLUVIUM GROUNDWATER EC TRENDS 2017 TO 2020



Note: Missing data indicates that there was insufficient water to take a sample.

FIGURE 70: WOLLOMBI BROOK ALLUVIUM GROUNDWATER PH TRENDS 2017 TO 2020

Note: Missing data indicates that there was insufficient water to take a sample.

FIGURE 71: WOLLOMBI BROOK ALLUVIUM GROUNDWATER EC TRENDS 2017 TO 2020

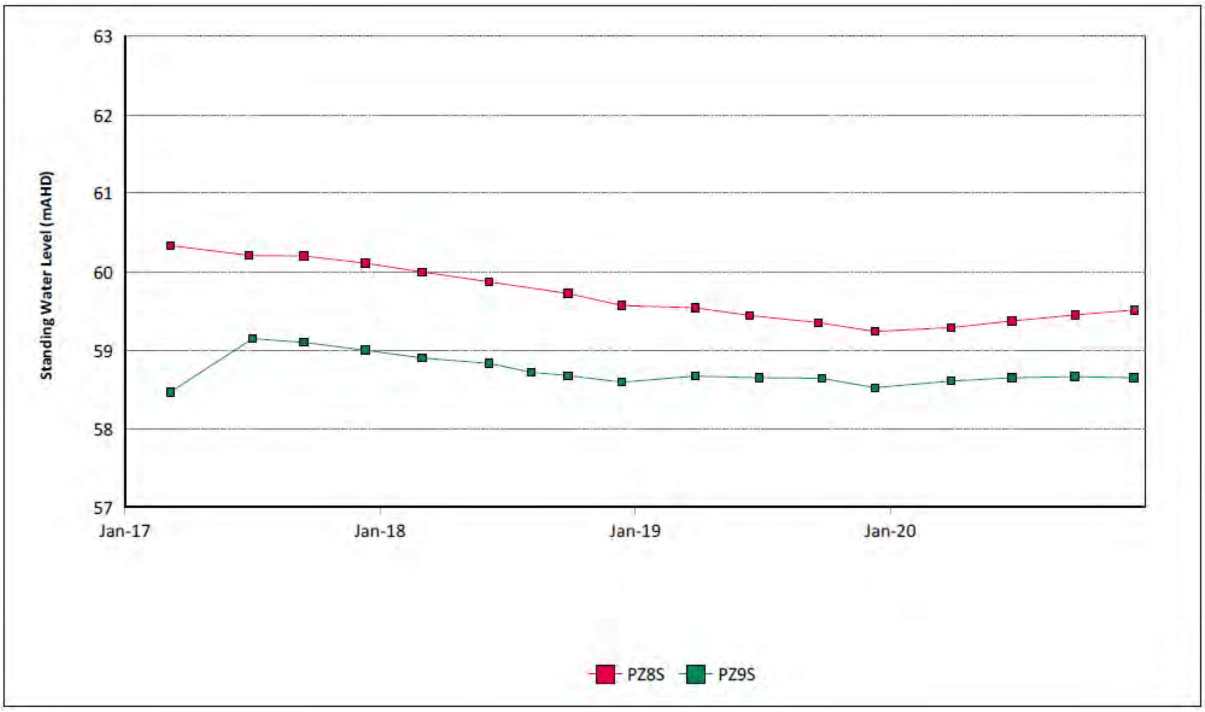


FIGURE 72: WOLLOMBI BROOK ALLUVIUM GROUNDWATER SWL TRENDS 2017 TO 2020

6.7.6.11 Woodlands Hill Seam Bores

Groundwater monitoring in the Woodlands Hill Seam was undertaken from one site during 2020; four samples were collected. The pH, EC and SWL trends for 2017 to 2020 are shown in **Figure 73** to **Figure 75** respectively. The trigger tracking result is shown in **Table 6.27**. An erroneous pH reading (outside of trigger limits) was recorded during Q1 2019. The result was not consistent with historical values and was considered to be related to a field recording error. Groundwater elevations at WD625P remained relatively similar throughout 2019 and 2020. This is likely due to the distance that these bores are from the pit.

TABLE 6.23 WOODLANDS HILL SEAM GROUNDWATER 2020 INTERNAL TRIGGER TRACKING

Location	Date	Trigger limit	Action taken in response
WD625P	28/02/2020	**EC – 95th Percentile**	Watching Brief* EC result from bore WD625P has returned within trigger limits during the June 20 sample round.
	26/11/2020		Watching Brief*

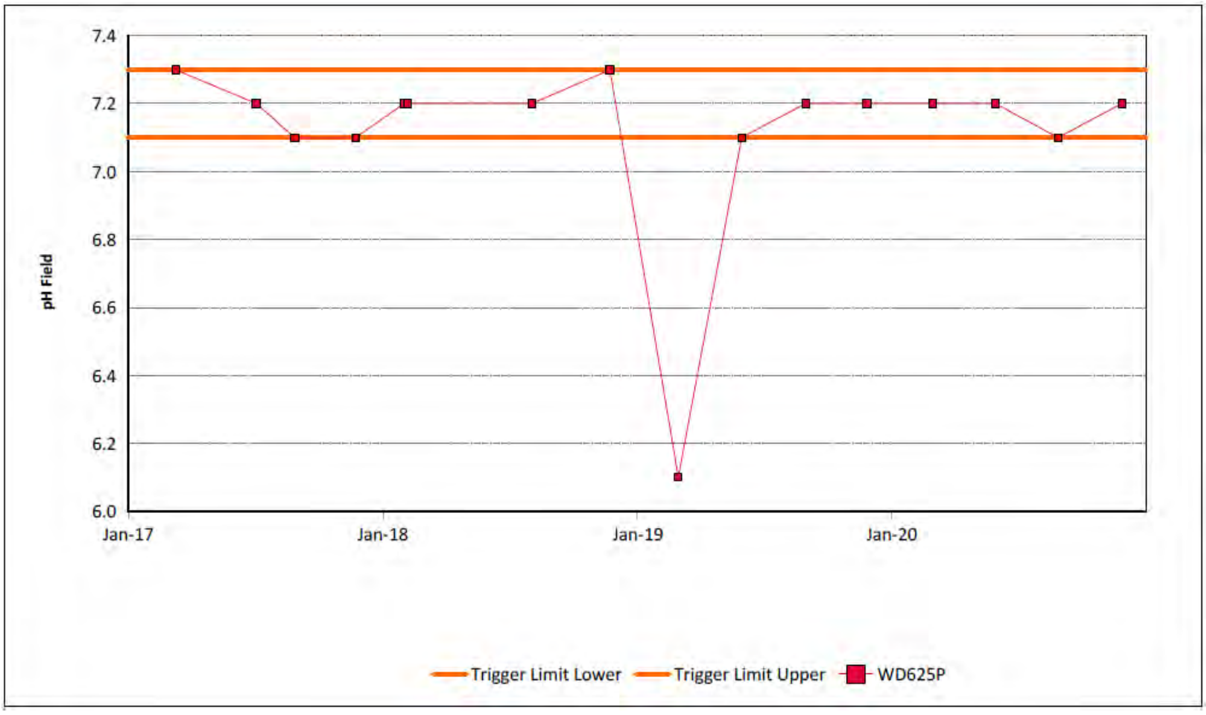


FIGURE 73: WOODLANDS HILL SEAM GROUNDWATER PH TRENDS 2017 TO 2020

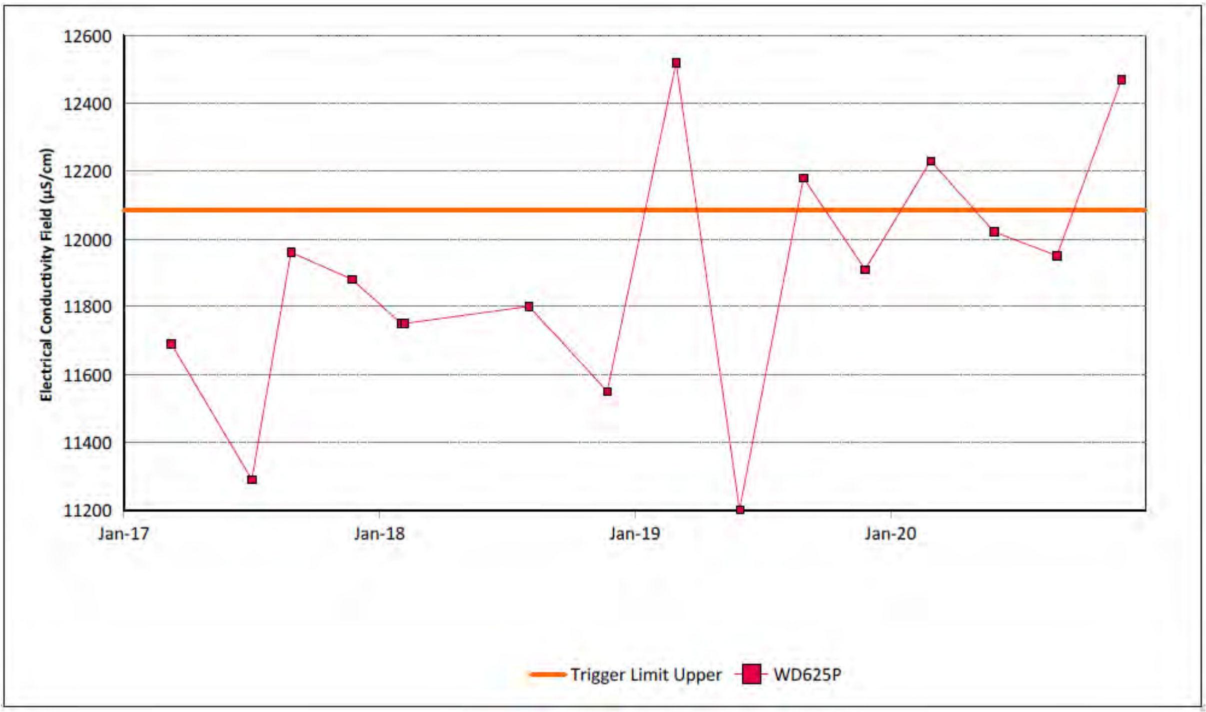


FIGURE 74: WOODLANDS HILL SEAM GROUNDWATER EC TRENDS 2017 TO 2020

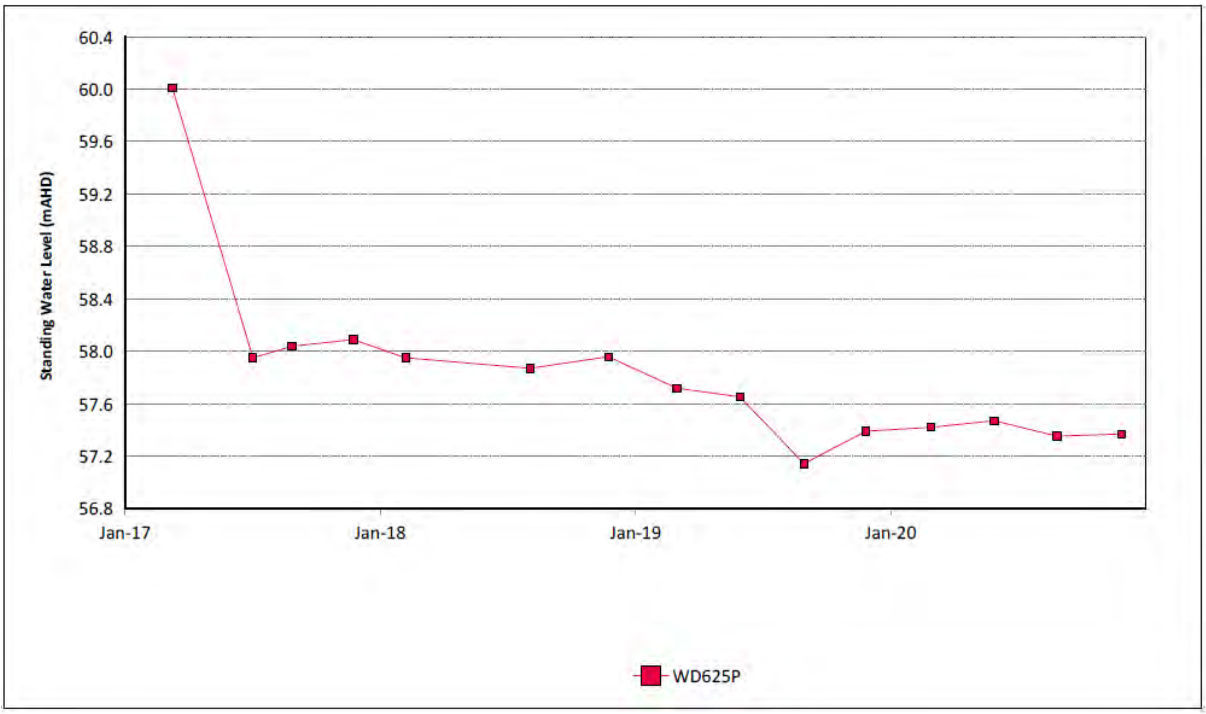


FIGURE 75: WOODLANDS HILL SEAM GROUNDWATER SWL TRENDS 2017 TO 2020

6.7.6.12 Aeolian Warkworth Sands

Groundwater monitoring in the Aeolian Warkworth Sands was undertaken from one site during 2020; a total of four samples were collected. The pH, EC and SWL trends for 2017 to 2020 are shown in **Figure 76**, **Figure 77** and **Figure 78** respectively. Historical water level data for the bore shows a general decline in groundwater levels within the Warkworth Sands. During 2020 groundwater levels within the Warkworth Sands at PZ7S started to recover, likely in response to above average rainfall received in February and March 2020. Further investigation into the local ground conditions, condition of the nested bore and functionality of the bore loggers will be undertaken during the 2021 reporting period, to understand the interaction between the two bore depths.

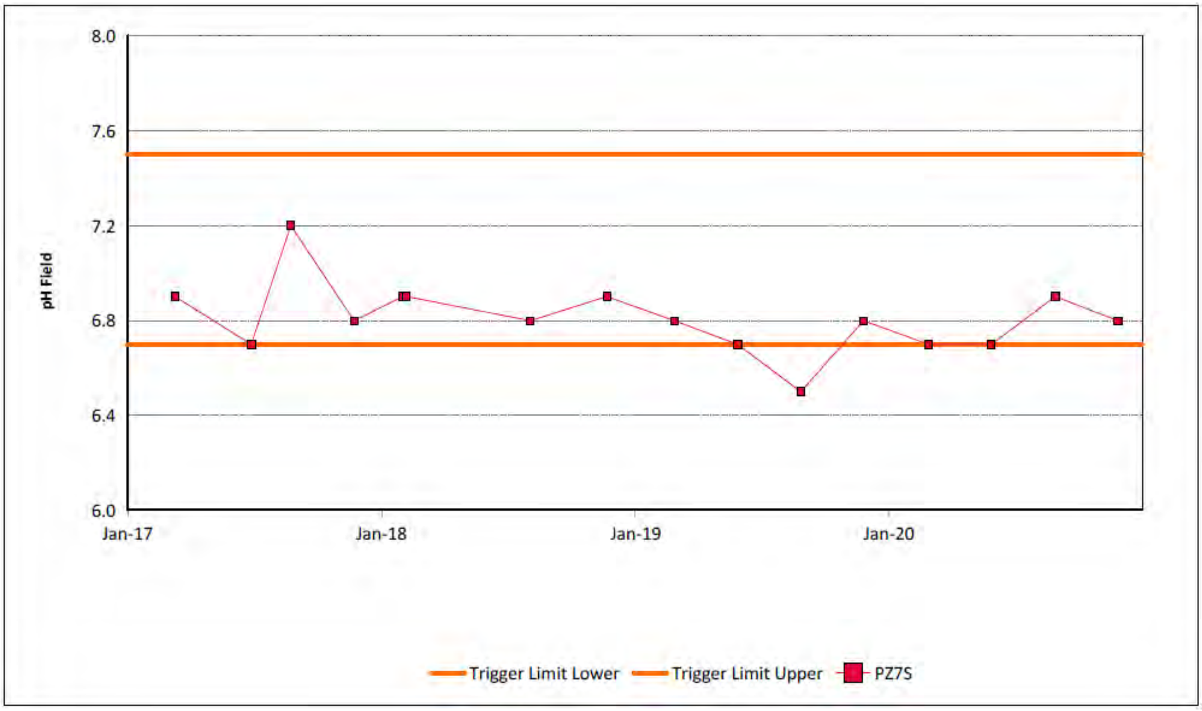


FIGURE 76: AEOLIAN WARKWORTH SANDS GROUNDWATER pH TRENDS 2017 TO 2020

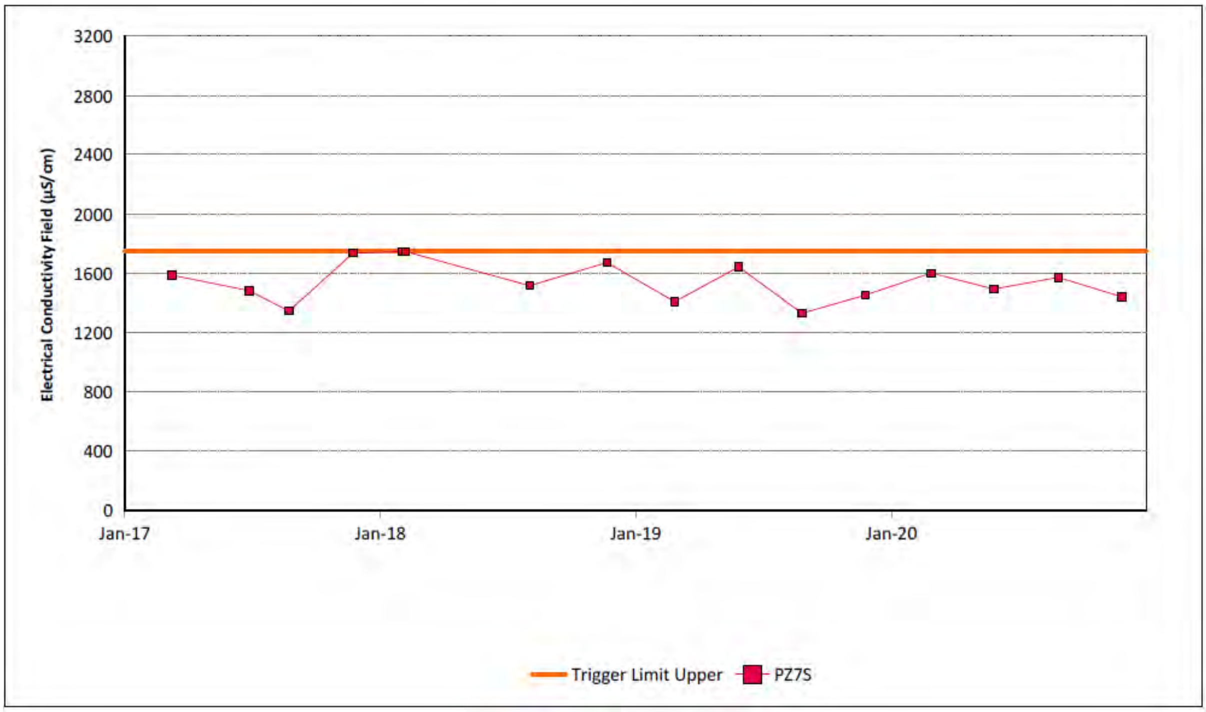


FIGURE 77: AEOLIAN WARKWORTH SANDS GROUNDWATER EC TRENDS 2017 TO 2020

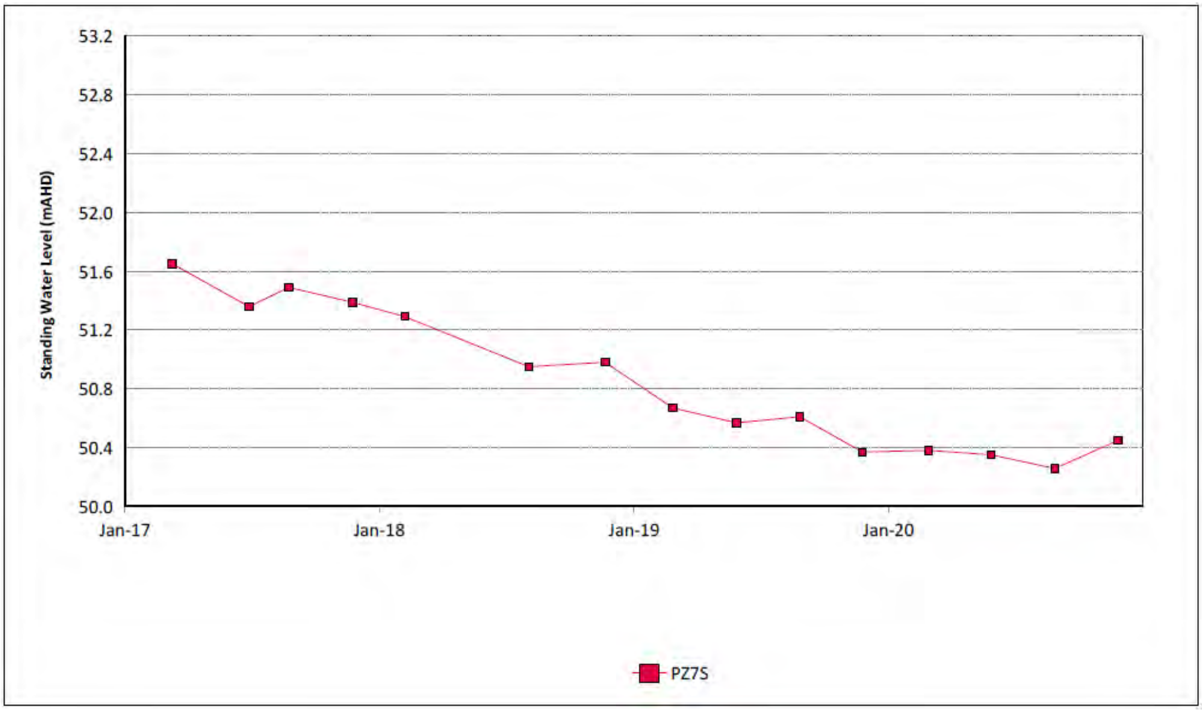


FIGURE 78: AEOLIAN WARKWORTH SANDS GROUNDWATER SWL TRENDS 2017 TO 2020

6.7.7 Audits and Reviews

Groundwater monitoring results are reviewed against the approved trigger limits within MTW's approved Water Management Plan on a quarterly basis by MTW. A comparison of the water quality information across MTW's monitoring bore network is provided graphically in **Figure 33** to **Figure 78.** The approved trigger limits are based on the historical water quality data as shown in the relevant site Environmental Impact Assessments. These trigger limits are updated annually based on collected site data as described in the MTW Water Management Plan. A summary of the management actions taken in response to any exceedances of the trigger limits during the period is provided in **Table 6.18** to **Table 6.28.**

An annual groundwater review was undertaken by an independent groundwater consultant. The scope of the review included an assessment of the water quality and groundwater levels recorded during the 2020 reporting period as well as a review of the historical results against the predictions in the site groundwater model. A copy of the full report is included in **Appendix 4.**

Key findings from the independent groundwater consultant's report were:

- Groundwater monitoring data indicates that, where saturated, water within the alluvium has started trending upwards in line with climate and stream flow trends. Groundwater within the Permian coal measures were mostly declining after exhibiting temporary head increases following above average rainfall events. Where observed, the decreasing elevations are believed to be attributed to depressurisation of the coal seams in relation to mining activities. The groundwater drawdown appears in line with the predicted drawdown with the coal measures around active mine areas.
- The review of the sites groundwater model predictions against the historical site data generally showed that the model appeared to adequately replicate observed changes in groundwater levels during the 2020 reporting period. The review did however highlight some areas for improvement to further validate the current groundwater model, these items are included in the groundwater report in **Appendix 4**.
- Review of water quality results and comparison to trigger levels for EC and pH identified several trigger exceedances over 2020. It was identified that several bores exceeded triggers for EC and pH; however, 2020 readings were mostly in line with historical trends for these bores. It is also noted that MTW changed its sampling methodology during the 2019 reporting period following recommendations in the 2018 review. It is recommended that a review of the trigger limits be undertaken in light of the revised sampling methodology. Groundwater quality trends outside of historical trends were observed for bore OH1138 and WOH2139A, which likely relate to declining groundwater levels. The decline in levels most likely relate to potential movement of groundwater and mixing of different water qualities given the larger hydraulic gradients in the aquifer caused by depressurisation and the groundwater system moving towards a new equilibrium (physically and chemically).
- Over 2020 monitoring of the groundwater bore network was generally conducted in accordance with the Groundwater Monitoring Program outlined within the WMP. Annual

samples were collected in general accordance with relevant standards. The exception to this was generally for cases where the condition of the bores (i.e. 32 mm casing) inhibited the ability to collect representative samples. Grab samples have been taken for monitoring bores WOH1239A, WOH2141A, WOH2153A, WOH1254A, WOH2155A, WOH2156A, WD622P, MBW02 and MBW03 within the network. This approach is not in line with industry standards and may not provide a representative water quality sample. The justification for this methodology should be reviewed to determine if more suitable methods (i.e. full purge or low flow) can be applied. In addition, a review into the requirement of these bores for the collection of water quality data for the WMP should be undertaken. If it is found that the continued collection of water quality data is required from a bore and suitable sampling methods cannot be adopted to obtain a representative sample, then bore rectification works should be considered.

- Quantification of groundwater take was undertaken based on reported volumes estimated for approved operations by AGE (2015) and metered abstraction volumes from bores and surface water pumps. Based on this information, over the 2020 reporting year the total take under the Hunter Regulated water source was estimated at 1,458.7 ML. Total take from Hunter Unregulated water source was estimated at 11 ML and 210 ML from the North Coast Fractured and Porous Rock water source.
- Comparison of observed groundwater levels against predicted levels generated from the numerical groundwater model were made. Overall, the numerical model was found to have adequately replicated observed changes in groundwater levels for 2020. Where modelled and observed values were significantly different, it was largely found that the difference in values could be attributed to differences in actual and predicted site conditions (i.e. climatic conditions, changes to mine progression / activities etc). A number of recommendations therefore related to updating the model including a review of VWP data and construction, better matching of actual mine progression, inclusion of the LUG bore abstraction and current climate and streamflow trends.
- Overall, the current monitoring network and program is generally adequate for satisfying current monitoring requirements of the WMP. There is good spatial of coverage of monitoring locations across the site, with multiple bores and VWP sensors installed into each relevant aquifer unit.

Key recommendations from the independent groundwater consultant’s report include:

- Review the groundwater monitoring network and program to more clearly identify the purpose of each bore based on its location and construction, and align the compliance conditions to this purpose. Including inclusion of newly installed monitoring points and removal or replacement of bores/sensors from the program that have been identified as destroyed/erroneous.
- Check surveyed ground and casing elevations for bores including MBW6A and OH1125 (2).
- Check standpipe stickup measurements for MTD605P, MTD614P and MTD616P.

- Check VWPs and monitoring bore loggers are working correctly (i.e. check/replace batteries and logger depths) and adjust the site barometric logger to log on the hour (i.e. 9am, 10am, 11am etc.).

Recommended VWP sensor investigations and replacements/ removal include:

- WD645 S1 (replace/ remove) and S5 (investigate first);
- WD646R S2 (replace/ remove) and S5 (investigate first);
- MTD605 S2 (investigate first) and S6 (replace/ remove); and
- MTD616 P1 (investigate first – particularly noting the correct naming convention and sensor depth as there have been a range of names for this array of VWPs relating to different depths, e.g. P1, sensor 1, S1, VW1 etc.).
- Investigate ground conditions, bore construction and logger data for nested bore PZ7S and PZ7D.
- Installation of data logger within bore OH786 and replacement of logger for PZ7S.
- Review of logger installation depths for MB15MTW02S as the currently verified depth is not providing accurate water levels compared to manual dipped measurements. The standpipe stickup should also be checked for MB15MTW02S.
- Investigate the condition of the logger in MB15MTW03 and replace logger if it is found to be faulty.
- The monitoring methodology and bore logs should be assessed to devise a suitable method for attaining water quality samples. This is important as the last full water quality suite analysis undertaken for OH786 was in June 2016.
- Review the bore condition and construction records to verify the total bore depth for OH787.
- Review the bore logs for MB15MTW01S and MB15MTW02S to determine whether target geology is alluvium or weathered Permian coal measures.
- Review bore logs for OH1121 to determine if the bore has been installed in the Vaux Seam which according to geology map should not be present at this location.
- Further investigation into site conditions around MTD616P should be undertaken to confirm that no land use changes or activities have caused rising groundwater level trends in this bore.
- Review of groundwater quality triggers to ensure they are reasonable and adequately capture historical trends for bores and account for changing climate conditions.
- Continue to update the numerical groundwater model to account for climate trends and actual mine progression activities that have evolved since the initial model development.

6.8 Waste

6.8.1 Management

The management of waste generated on the MTW site is undertaken in accordance with the site MTW non-mineral waste management strategy which is designed to;

- track and record all wastes leaving the site to meet all regulatory requirements; and
- implement appropriate segregation, collection, handling, transport and disposal of waste in a way which minimises the impacts on the environment.

All waste not suitable for reuse on site is removed by a licensed waste contractor and disposed of or recycled accordingly at licensed waste management facilities within the local Hunter region. Appropriate segregation is implemented across various waste streams at MTW to maximise diversion from landfill and minimise the impact to the environment by recycling or reuse. Some waste categories are processed and disposed of on the MTW site, as per NSW EPA exemption approvals, set out in the MTW Environmental Protection Licenses. The effluent treatment and disposal facilities at MTW consist of sewage treatment plants which treat, disinfect and dispose, or re-use the treated effluent on site. All waste management contractors engaged for waste collection, handling and transportation at MTW are licensed by the NSW Environmental Protection Agency (EPA).

6.8.2 Performance

During the reporting period MTW continued to undertake regular inspections of areas where wastes are generated and stored, to reinforce the principles of a considerate waste management approach including waste stream segregation to increase material recycling and promote diversion from landfill. In 2020 79% of all non-mineral waste generated and removed from MTW was diverted from landfill and processed at licensed recycling and secondary use facilities. The remaining 21% was disposed of as end-of-life waste at a local licensed landfill facility. There were no community complaints or regulatory non-compliance notices receiving in 2020, in relation to waste management during the reporting period.

7 REHABILITATION

7.1 Summary of Rehabilitation

A total of 38.5 ha of new rehabilitation was undertaken during 2020 against a Mining Operations Plan (MOP) target of 43.8 ha. A further 45.6ha of Stage 2 rehabilitation was seeded to the target vegetation community seed mixes in 2020 to reduce the legacy rehabilitation areas that are in the Growth Medium Development phase.

Total disturbance undertaken during 2020 was 50.6 ha, which was slightly lower than the MOP projection of 51.8 ha. The disturbance during 2020 was made up of 46.7 ha of new disturbance and 3.9 ha of disturbance of previously rehabilitated area.

TABLE 7.1 KEY REHABILITATION PERFORMANCE INDICATORS

Mine Area Type	Previous Reporting Period (Actual) Year 2019 (ha)	This Reporting Period (Actual) Year 2020 (ha)	Next Reporting Period (Forecast) Year 2021 (ha)
A. Total mine footprint[1]	3,881.2	3,934.1	3,952.3
B. Total Active Disturbance[2]	2,579.8	2,601.3	2,580.2
C. Land being prepared for rehabilitation[3]	159.1	104.9	20.0
D. Land under active rehabilitation[4]	1,142.3	1,227.9	1,352.1
E. Completed rehabilitation[5]	0	0	0

[1] ***Total mine footprint*** *includes all areas within a mining lease that either have at some point in time or continue to pose a rehabilitation liability due to mining and associated activities. As such it is the sum of total active disturbance, decommissioning, landform establishment, growth medium development, ecosystem establishment, ecosystem development and relinquished lands (as defined in DRE MOP/RMP Guidelines). Please note that subsidence remediation areas are excluded.*

[2] ***Total active disturbance*** *includes all areas ultimately requiring rehabilitation such as: on-lease exploration areas, stripped areas ahead of mining, infrastructure areas, water management infrastructure, sewage treatment facilities, topsoil stockpiles areas, access tracks and haul road, active mining areas, waste emplacements (active/unshaped/in or out-of-pit), and tailings dams (active/unshaped/uncapped).*

[3] ***Land being prepared for rehabilitation*** *– includes the sum of mine disturbed land that is under the following rehabilitation phases – decommissioning, landform establishment and growth medium development (as defined in DRE MOP/RMP Guidelines).*

[4] ***Land under active rehabilitation*** *– includes areas under rehabilitation and being managed to achieve relinquishment – includes the following rehabilitation phases as described in the DRE MOP/RMP Guidelines – "ecosystem and land use establishment" and "ecosystem and land use sustainability" (revegetation assessed as showing signs of trending towards relinquishment OR infrastructure development).*

[5] ***Completed rehabilitation*** *– requires formal sign off by DRE that the area has successfully met the rehabilitation land use objectives and completion criteria.*

7.1.1 Management of Rehabilitation

Performance criteria for each rehabilitation phase is provided in detail in the MOP for MTW. The criteria have been developed so that the rehabilitation success can be quantitatively tracked as it progresses through the phases outlined below:

- Stage 1 – Decommissioning
- Stage 2 – Landform Establishment
- Stage 3 – Growth Medium Development
- Stage 4 – Ecosystem and Land use Establishment
- Stage 5 – Ecosystem and Land use Sustainability
- Stage 6 – Rehabilitation Complete

The performance criteria are objective target levels or values that can be measured to quantitatively demonstrate the progress and ultimate success of a biophysical process. A monitoring methodology has been developed to measure the performance criteria outlined in the MOPs utilising a combination of tools that provide quantitative data to assess changes occurring over time.

The target levels or values have been based on monitoring results from reference sites and were detailed in the MOP Amendment A approved by Resources Regulator in December 2018. The results of the rehabilitation monitoring programme for native vegetation areas are compared against the target levels to determine if rehabilitation has been successful or if additional intervention is needed.

Monitoring of rehabilitated land returned to native vegetation commenced in 2015. The results of this monitoring and monitoring programs conducted in 2017 and 2019 have been presented in previous MTW Annual Environmental Reviews (AER's). Monitoring has been conducted across 12 reference sites within the two target vegetation communities Central Hunter Grey Box-Ironbark Woodland EEC, and Ironbark-Spotted Gum-Grey Box Forest EEC. Previous monitoring programs have established 50 permanent monitoring transects across MTW rehabilitation areas with the majority of these sites having been revisited in successive years to provide information on the progression of sites over time. Sites have been selected to include rehabilitation of varying ages and different rehabilitation methods.

No monitoring of rehabilitated land was undertaken in 2020 due to the MOP performance criteria being changed in response to recommendations from the Independent Review of Rehabilitation Progress prepared at the end of 2019. The MOP performance criteria have been accepted following approval of the MTW MOP Amendment C in November 2020 so the monitoring program will be amended to reflect the new performance criteria and monitoring will restart in Autumn 2021.

The key issues affecting successful rehabilitation at MTW and the control measures implemented to address these issues are listed below:

Issue 1 – Weed competition affecting native vegetation establishment.

Control Measures.

Use of mine spoil as growth medium to avoid use of weedy topsoils in rehabilitation. This technique has proven successful in establishing diverse native vegetation when combined with the use of composts and other ameliorants to improve the physical, chemical and nutritional quality of the mine spoil. Suitable alternative compost products have been sourced and used in 2019 and 2020 in place of the Mixed Waste Compost, which was banned from use by the EPA in 2018.

Weed control on topsoil stockpiles.

Topsoil stockpiles established prior to 2011 were seeded with exotic pasture species to provide a suitable cover for erosion protection. These competitive exotic species are causing weed problems in rehabilitation areas when the soil from these stockpiles is used on areas being returned to native vegetation. MTW has a topsoil stockpile maintenance program in place to spray out the exotic pasture species and sow native species on these old stockpiles. Stockpiles may require a number of weed control passes to adequately reduce weed levels before sowing to native species. New topsoil stockpiles are being treated in much the same way as new rehabilitation areas, in terms of weed control and soil amelioration, before being sown to native species. Establishment of native species on topsoil stockpiles will reduce the presence of weeds and provide a soil seed bank in rehabilitation areas that contains seeds from desirable native species.

Pre- and post-sowing weed control in rehabilitation.

MTW has implemented an extensive weed control program in rehabilitation areas to reduce the amount of weeds and assist the establishment of native vegetation. This program involves the use of boom sprays for both pre-sowing and pre-emergent spray passes to control weeds volunteering from the topsoil. After the native species have germinated, a weed-wiper can be used to control weeds that are taller than the native species. Herbicide can be wiped onto the taller weeds without affecting the emerging native species. Crews using backpack sprays and Quikspray units are also used to selectively control weeds that are growing amongst desirable native species.

Issue 2 – Topsoil/spoils prone to dispersion leading to surface crusting, erosion and poor vegetation establishment.

Control Measures.
Addition of ameliorants to topsoil/spoil. MTW conducts soil testing on the topsoil/spoil material that is used in rehabilitation areas. Based on the results of the soil testing, ameliorants such as compost, gypsum, lime and fertilisers are then used to address the physical, chemical and nutritional deficiencies of the topsoil/spoil. Subsequent applications of ameliorants are undertaken as required to address poor performing rehabilitation areas with continuing soil quality issues.

Issue 3 – Lack of native seed in topsoil seed bank leading to poor vegetation establishment.

Control Measures.
Sourcing of diverse native seed mixes. MTW has generally found that the soil seed bank in topsoils from both stripping areas and topsoil stockpiles cannot be relied on to contain sufficient native seed propagules for successful native vegetation establishment in rehabilitation. MTW has established medium term contracts with seed suppliers to provide some security of supply to suppliers who are then able to collect and store sufficient quantities of seed to meet MTW's future demands. The seed supply contracts include quality assurance controls to ensure the seed being purchased is of suitable quality i.e. satisfactory provenance, correct species, high seed count and viability.

7.2 Decommissioning

Capping of the Interim Tailings Storage Facility continued during 2020 using breaker rock from the South CHPP. A capping of inert spoil will be placed over the breaker rock before rehabilitating the area.

During 2017, capping of Tailings Dam 2 commenced using small contractor-owned equipment to place selected mine spoil in layers across the tailings dam surface. Capping work was suspended during 2017 due to settlement cracking occurring in an area where the tailings surface had low strength. Stage 1 capping work was recommenced during 2020 in areas where geotechnical studies identified that the tailings strength was sufficient to support the capping process. During the reporting period mine equipment has been able to continue capping on some areas where the Stage 1 capping had been finished. The other focus of activity during 2020 has been on pumping activities to keep the surface of the tailings storage facility dry. The aim of this work is to increase the strength of the top layer of the tailings to allow the Stage 1 capping work to continue.

7.3 Rehabilitation Performance

Table 7.2 summarises actual rehabilitation and disturbance completed compared with the rehabilitation commitments in the MTW MOP. **Appendix 5** provides the Annual Rehabilitation Report Form, including rehabilitation progress for each domain through the rehabilitation phases.

The area of new and Stage 2 rehabilitation that was sown during the reporting period was 40.3ha above the MOP target for MTW. The area of rehabilitation disturbance was slightly higher than the MOP target for MTW by 0.9ha, leading to a net rehabilitation result for 2020 that was 39.4ha above the MOP commitment. The net rehabilitation result over the MOP period (2015 to 2020) is 345.1ha versus a MOP commitment of 388.4ha, lagging by 43.3ha. This shortfall will be caught up in 2021 with the Stage 2 seeding that is planned during this period.

The amount of new disturbance undertaken in 2020 was 2.1ha lower than the MOP projections. The cumulative new disturbance over the period of the current MOP is also 2.0ha lower than the projected disturbance.

The 2020 rehabilitation areas for MTW are shown in **Appendix 6.**

TABLE 7.2 REHABILITATION AND DISTURBANCE COMPLETED IN 2020

MOP	Pit Area	2020 Totals (ha)		Cumulative Totals During MOP Period* (ha)	
		Actual	MOP Commitment	Actual	MOP Commitment
Rehabilitation					
MTW	Mt Thorley	35.9[1]	19.8	151.1	174.6
	Warkworth	48.2[2]	24.0	319.5	338.5
	MTW Total	**84.1**	**43.8**	**470.6**	**513.1**
Rehabilitation Disturbance					
MTW	Mt Thorley	0.1	0.0	52.9	52.8
	Warkworth	3.8	3.0	72.6	71.9
	MTW Total	**3.9**	**3.0**	**125.5**	**124.7**
New Disturbance					
MTW	Mt Thorley	8.5	7.3	35.5	67.3
	Warkworth	38.2	41.5	389.1	359.3
	MTW Total	**46.7**	**48.8**	**424.6**	**426.6**
Net Rehabilitation (Rehabilitation minus Rehabilitation Disturbance)					
MTW	Mt Thorley	35.8	19.8	98.2	121.8
	Warkworth	44.4	21.0	246.9	266.6
	MTW Total	**80.2**	**40.8**	**345.1**	**388.4**

Note: Rehabilitation areas relate to areas at or past the phase of Ecosystem and Landuse Establishment.
** MOP Period is 2015 – 2021*
[1] Includes 19.2ha of Stage 2 Seeding
[2] Includes 26.4ha of Stage 2 Seeding

Progressive rehabilitation commitments are outlined in the Warkworth Continuation 2014 and Mt Thorley Operations 2014 Environmental Impact Statements. These documents modelled a total of 1,103 ha of rehabilitation to be completed by the end of 2017, and a further 505.8ha to be completed by the end of 2023. At the end of the reporting period there had been 1,227.9 hectares of rehabilitation completed across MTW, 124.9ha ahead of the EIS forecast for the end of 2017. By the end of 2021 it is predicted there will be 1,352.1ha of rehabilitation completed which will be 256.7ha short of the EIS forecast for the end of 2023. It is considered unlikely that there will be 257ha of rehabilitation available to be completed in the period 2022 to 2023 so the completed rehabilitation at the end of 2023 is expected to be 5 to 10% (80 to 160ha) less than the EIS forecast.

7.4 Rehabilitation Programme Variations

A MOP amendment (Amendment C) was submitted during the reporting period which included the following changes:

- updated Map 3A to 3G to reflect the findings of the Independent Review of Rehabilitation Progress: Mount Thorley-Warkworth Mine in relation to rehabilitation phase classification;
- recommendations from the Independent Review of Rehabilitation Progress: Mount Thorley Warkworth Mine related to performance criteria and seed mix changes;
- revised final landform for filling of the South Pit Void;
- earlier commencement of tailings deposition into the Loders Pit Tailings Storage Facility (TSF) in lieu of raising the embankment height on the Centre Ramp TSF;
- reduced estimates for new rehabilitation to be completed in the period from 2020 to 2021;
- revised Rehabilitation Cost Estimates for Mount Thorley and Warkworth.

7.5 Rehabilitation Trials

During 2018, a trial was undertaken on the CD Dump rehabilitation area of MTW to mainly compare the performance of an inoculated mineral fertiliser against that of Mixed Waste Compost as a soil ameliorant. The trial was conducted on plots that used both topsoil and mine spoil as the growth medium with the various treatments shown in the table below.

Monitoring of this trial will be undertaken during 2021 to determine the relative effects of the various soil ameliorants.

TABLE 7.3 SOIL AMELIORATION TREATMENTS USED FOR 2018 CD DUMP REHABILITATION TRIAL

Plot	Area ha	Growth Medium	Gypsum t/ha	Compost t/ha	Lime kg/ha	Fertiliser kg/ha
A1	0.95	Topsoil	0	50	300	300
A2	0.36	Topsoil	0	50	300	0
A3	0.28	Topsoil	0	50	0	400
A4	0.2	Spoil	0	50	300	0
A5	0.14	Spoil	0	50	300	300
B1	0.46	Topsoil	0	0	0	400
B2	0.29	Topsoil	0	0	300	300
B3	0.23	Topsoil	0	0	300	0
B4	0.2	Spoil	0	0	300	300
B5	0.2	Spoil	0	0	0	400
B6	0.18	Spoil	0	0	300	0
C1	4.31	Topsoil	10	100	0	0
C2	1.01	Spoil	10	100	0	0
Trial Total	**8.81**					

Bettergrow Biomulch Compost was trialled as a replacement for Mixed Waste Compost as a soil ameliorant in rehabilitation during 2019 and 2020. Compost application rates for the Bettergrow Biomulch Compost were reduced to approximately 50t/ha (from 100t/ha used for the Mixed Waste Compost) to offset the increased cost of this compost. Germination and early establishment appears to be adequate even with the reduced application rates.

Trials were also conducted in 2020 to investigate the effect of not adding compost to topsoils. These trials are of particular interest for rehabilitation where topsoil has been used that has a high weed seed load. It is thought that not adding compost to “weedy” topsoils could reduce the growth of competitive weed species and hence result in better establishment of native species. Rehabilitation areas within the trials have received identical treatments apart from the addition of compost to some areas to allow for a comparison of results on composted versus un-composted areas.

7.6 Rehabilitation Maintenance

Management of rehabilitated areas is undertaken as required or when issues are identified through monitoring, auditing or inspections. Rehabilitation maintenance activities are described further in the sections below.

Post rehabilitation broadacre weed control

Broadacre weed treatment within rehabilitation areas is undertaken using agricultural methods comprising boom sprays and wick wipers. In existing rehabilitation areas boom spraying is primarily used to manage cover crop and fallow areas prior to sowing to final native seed mixes. Pre-emergent application of herbicide is occasionally necessary to control emerging weeds in the period between sowing and germination of the desired plants. Wick wiping targets rapidly growing exotic grasses and other erect growing weeds in the period following native germination but while desirable species remain below the wiper target zone. During 2020 areas totalling 66.1ha of existing rehabilitation received boom spray and/or wick wiper treatment.

Hand spraying and manual removal of weeds is also undertaken in rehabilitation areas with establishing native vegetation. During 2020 areas totalling 215.5ha were treated using selective weed control methods (i.e. backpack spray, Quikspray, cut and paint, manual removal). The area of selective weed control has increased significantly again in 2020 (up from 37ha in 2018 and 171.5ha in 2019) in response to the changing rehabilitation methodology to move more quickly to sowing rehabilitation areas with the diverse native seed mixes.

Rehabilitation areas receiving weed control during 2020 are shown in **Figure 79** below. Note some areas may have received a combination of treatments during the reporting period.

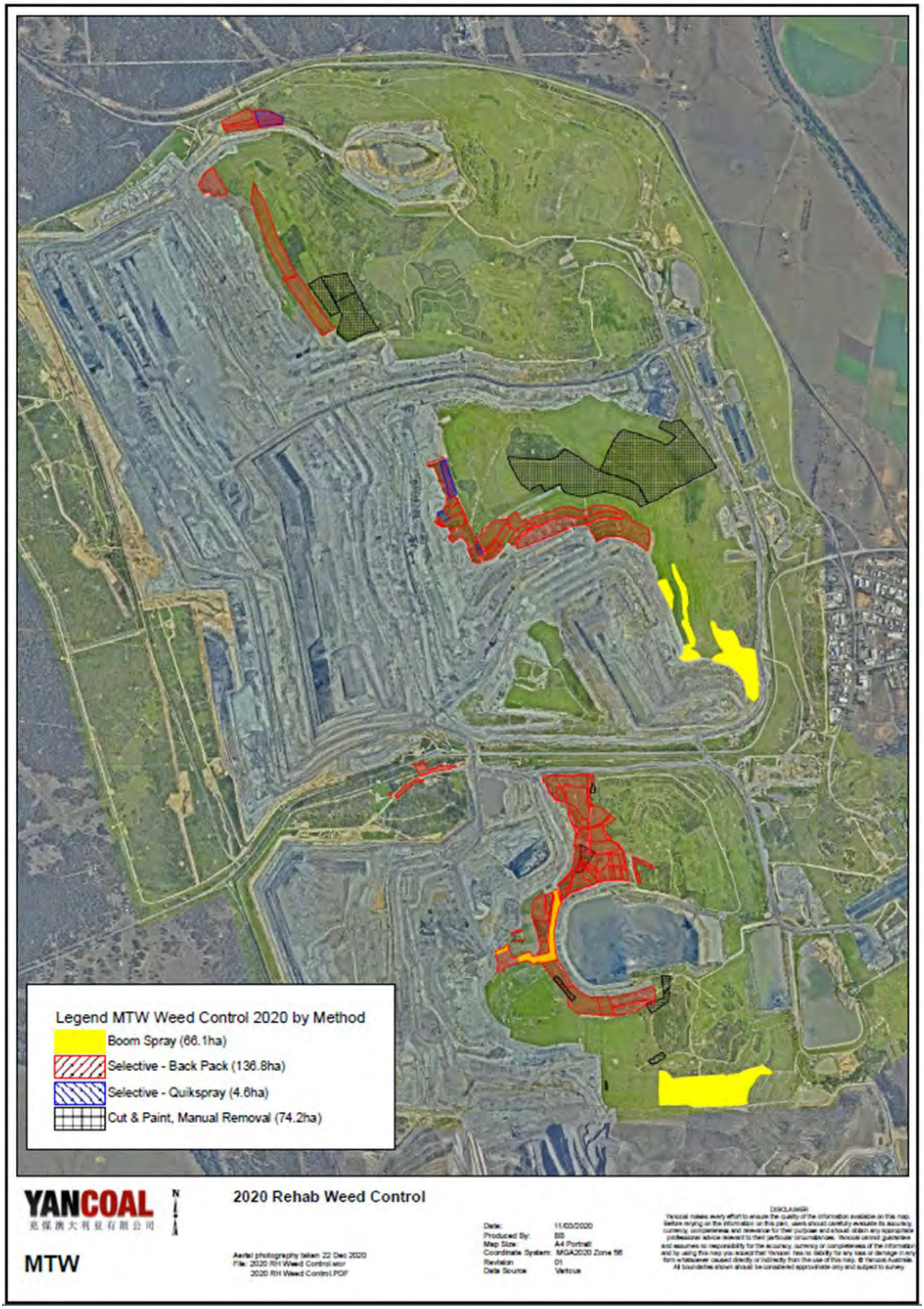


FIGURE 79: 2020 REHABILITATION WEED CONTROL LOCATIONS

7.7 Topsoil Management

Topsoil is managed according to MTW's Disturbance and Rehabilitation procedures. **Table 7.4** outlines the topsoil used and stockpiled during 2020. There was 28.6 ha of rehabilitation top soiled during 2020, using stockpiled and pre-stripped soil resources.

TABLE 7.4 SOIL MANAGEMENT

Soil Used this Period (m^3)	Soil Prestripped this Period (m^3)	Stockpile Inventory to Date (m^3)	Stockpile Inventory Last Report (m^3)
28,600	35,200	666,929	660,357

7.8 Tailings Management

Detail of capping activities on tailings storage facilities at MTW is covered in **Appendix 5**. Minimising the amount of standing water on tailings storage facilities, by managing the decant water, is important during and post tailings deposition to assist with closure of these facilities. Effective removal of decant water enables better consolidation of the tailings material, which in turn facilitates earlier capping and rehabilitation of the storage facility. **Table 7.5** outlines the current state of decant water pumping infrastructure across the active and inactive TSF's at MTW.

TABLE 7.5 TAILINGS MANAGEMENT

Facility	Status	Decant System
Centre Ramp TSF	Active	Decant pumps in place, regular pumping
Abbey Green South	Active	Decant pumps installed as required due to infrequent filling regime.
TD2	Inactive (Capping in progress)	Diesel Pump in place
Interim TSF	Inactive (Capping in progress)	Floating solar pump installed
Ministrip TSF	Active	Diesel Pump in place, pumping as required
Loders Pit TSF	Active	Tailings deposition commenced in January 2021, decant pumps in place, regular pumping

7.9 Weed Control

7.9.1 Weed Treatment

The weeds identified at MTW occur primarily in areas that have been disturbed such as post mining rehabilitation areas, previous civil works areas, soil stockpiles, water management structure surrounds, and general areas of minor ground disturbance. A total of 96 days of weed management work was undertaken on site at MTW during 2020, with 393 ha of land treated, including maintenance of access tracks and 56 environmental monitoring points. The weeds targeted during the 2020 weed management programme were based on the results of the 2019 weed survey. **Figure 80** illustrates the target species and weed treatment areas across MTW. Weed treatment areas are assessed following the completion of periods of work to determine the effectiveness of control works.

The species focussed on during treatment included:

- African boxthorn *(Lycium ferocissimum)*
- Castor oil *(Ricinus communis)*
- Farmers friends *(Bidens pilosa)*
- Galenia *(Galenia pubescens)*
- Green cestrum *(Cestrum parqui)*
- Lantana *(Lantana Camara)*
- Mother of millions *(Bryophyllum delagoense)*
- Narrow leaf cotton bush *(Gomphocarpus fructicosus)*
- Opuntia (Pear) species (Tiger, Prickly and Creeping Pear)
- Saligna *(Acacia saligna)*
- St Johns Wort *(Hypericum perforatum)*
- Various grasses (Various spp)

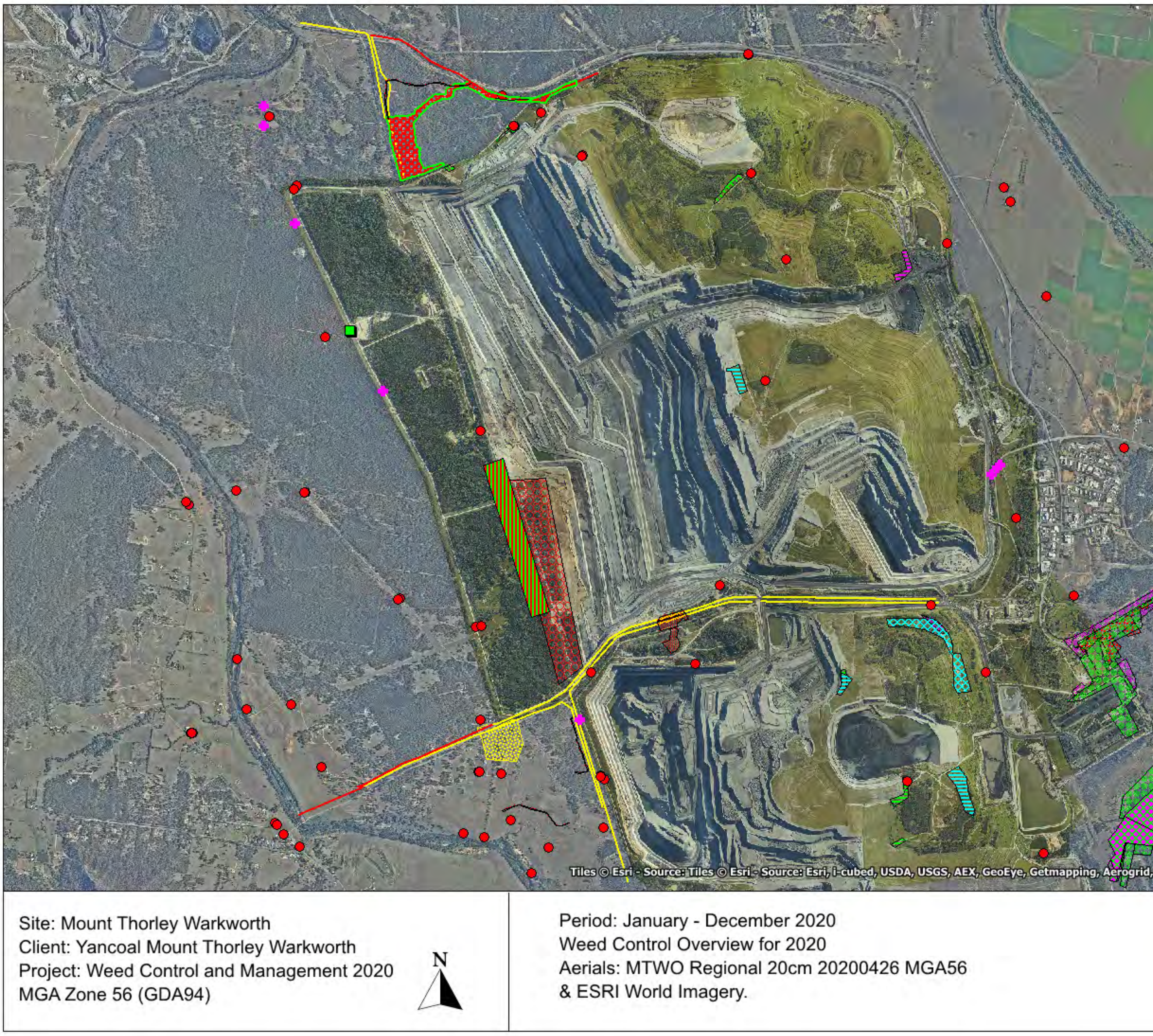


FIGURE 80: ANNUAL WEED CONTROL OVERVIEW FOR 2020

7.9.2 Annual Weed Survey

The management and control of weeds at MTW is governed by the Annual Weed Survey (AWS). The AWS lists Weeds of National Significance (WONS), noxious, environmental and other non-declared weed species identified across MTW and provides a framework to allow for structured weed management and control across operational and non-operational areas of MTW.

The following summarises the results of the weed survey undertaken during December 2020 and is based upon the NSW Biosecurity Act 2015 which came into force from 1 July 2017 and repealed 14 Acts including the Noxious Weeds Act 1993. The new legislation has resulted in the development of the Hunter Regional Strategic Weed Management Plan 2017-2022 which covers the area occupied by MTW.

Eight WONS were identified during the survey, they included:

- African boxthorn *(Lycium ferocissimum)* State – Asset protection
- Bitou bush *(Chrysanthemoides monilifera subspecies rotundata)* State – Containment
- Fireweed *(Scenecio madagascariensis)* State – Asset protection/ Regional – additional species of concern
- Lantana *(Lantana camara)* State – Asset protection

Pear Species:

- Creeping pear *(Opuntia humifusa)* State – Asset protection
- Prickly pear *(Opuntia stricta)* State – Asset protection/ Additional species of concern
- Tiger pear *(Optunia aurantiaca)* State – Asset protection
- Velvety pear tree *(Opuntia tomentosa)* State – Asset protection

Fifteen other priority weeds were identified at MTW during the survey, including:

- African olive *(Olea europea subspecies cuspidae)* Regional – Asset protection
- African lovegrass *(Eragrostis curvulva)* Regional – Additional species of concern
- Balloon vine *(Cardiospermum grandiflorum)* Regional – Additional species of concern
- Blue heliotrope *(Heliotropium amplexicaule)* Regional – Additional species of concern
- Castor oil plant *(Ricinus communis)* General biosecurity duty
- Coolatai grass *(Hyparrhenia hirta)* Regional - Asset protection
- Fleabane *(Conyza bonariensis)* General biosecurity duty
- Galenia *(Galenia pubescens)* Regional – Additional species of concern
- Green cestrum *(Cestrum parqui)* Regional - Asset protection
- Mother of millions *(Bryophyllum delagonese)* Regional - Asset protection
- Pampas grass *(Cortaderia selloana)* Regional - Containment
- Saffron thistle *(Carthamus lanatus)* General biosecurity duty
- St Johns Wort *(Hypericum perforatum)* Regional – Additional species of concern
- Bathurst burr *(Xanthium spinosum)* General biosecurity duty
- Noogoora burr *(Xanthium occidentale)* Regional Additional species of concern

Twelve weeds that are not officially declared or listed were also recorded at MTW including:

- Blackberry nightshade *(Solanum nigram)*
- Century plant *(Agave americana)*
- Golden wreath wattle or Saligna *(Acacia saligna)*
- Inkweed *(Phytolacca octandra)*
- Lambs tongue *(Verbascum Thapsus)*
- Mustard weed *(Sisymbrium sp)*
- Narrow leaved cotton bush *(Gomphocarpus fructicosus)*
- Paddy melon *(Cucumis myriocarpus)*
- Rhodes grass *(Chloris gayana Kunth)*
- Stinking Rodger *(Tangetes minuta)*
- Spiny Rush (Juncas acutus)
- Tree Tobacco (Nicotiana glauca)

Species identified during the 2020 survey will form the basis of ongoing weed management works during 2021.

7.10 Vertebrate Pest Management

As part of MTW's Vertebrate Pest Action Plan a baiting programme is carried out on a seasonal basis. Two 1080 ground baiting programmes consisting of approximately 60 bait sites utilising meat baits and ejector baits were undertaken during autumn and spring to target wild dogs and foxes. Baits were checked over a three-week period and replaced each week when taken. The programmes were undertaken in conjunction with neighbouring landholders where possible.

Table 7.6 summarises the results from the programmes carried out at MTW during 2020 with baiting locations and results for the programmes are illustrated in **Figure 81** and **82**.

TABLE 7.6 VERTEBRATE PEST CONTROL SUMMARY

Season	1080 Baiting			
	Total Lethal Baits Laid	Takes by Wild Dog	Takes by Fox	Takes by Feral Pigs
Autumn	120	27	9	1
Spring	120	60	6	-
Total	**240**	**87**	**15**	**1**

Additional pest management programmes included:

- Feral pig 1080 baiting programme carried out across MTW in winter resulted in 13 feral pigs poisoned. Rabbit 1080 baiting programme carried out at the same time resulted in 400g of poisoned carrots consumed.
- Opportunistic shooting of vertebrate pests; two hare and one deer.

MTW will continue to carry out quarterly vertebrate pest control programmes during 2021 to limit feral pest impacts on landholdings and surrounding neighbours.

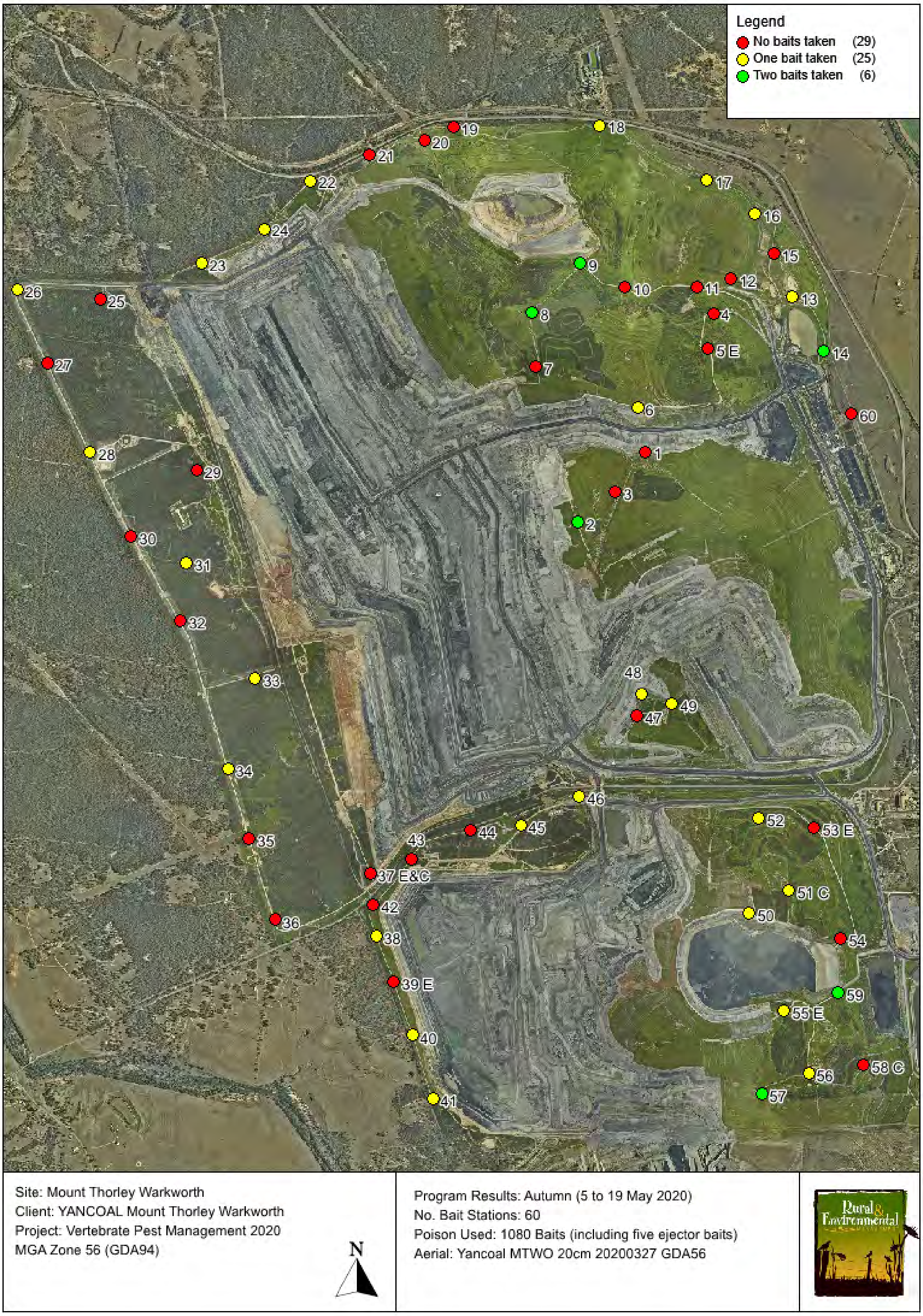


Figure 81: Baiting Station Locations and Results at MTW During Autumn 2020 Vertebrate Pest Management Programme

Site: Mount Thorley Warkworth
Client: YANCOAL Mount Thorley Warkworth
Project: Vertebrate Pest Management 2020
MGA Zone 56 (GDA94)

N

Program results: Spring (13 October to 2 November 2020)
No. Bait Stations: 60
Poison Used: 1080 Baits (including five ejector baits)
Aerial: Yancoal MTWO 20cm 20200327

Figure 82: Baiting Station Locations and Results at MTW During Spring 2020 Vertebrate Pest Management Programme

7.11 Biodiversity Offsets

7.11.1 Management

MTW's impacts on biodiversity values are offset through the protection and management of Biodiversity Areas (BAs). The BA's that are related to MTW illustrated in **Figure 83** and also listed in **Table 7.7** below:

TABLE 7.7 MTW BIODIVERSITY AREAS

Biodiversity Areas	Area (ha)	Environmental Approvals				Offset Feature/s
		State		Federal		
		NSW 2014	NSW 2015	EPBC 2002/629	EPBC 2009/5081	
Southern	986	211	775		94	Warkworth Sands Woodland; Central Hunter Grey Box – Ironbark Woodland; Habitat for Swift Parrot, Regent Honeyeater, Southern Myotis and Large-eared Pied Bat.
Northern	341	39	302		341	Warkworth Sands Woodland; Central Hunter Grey Box – Ironbark Woodland; Habitat for Swift Parrot, Regent Honeyeater, Southern Myotis and Large-eared Pied Bat.
North Rothbury	41		41		41	North Rothbury Persoonia
Goulburn River (MTW Portion)	1,066		1,066	1,066		Central Hunter Valley Eucalypt Forest (CHVEF); Ironbark/Stringybark Communities; Box shrubby/grassy Woodlands; Habitat for Swift Parrot and Regent Honeyeater
Bowditch	602		602	520	82	CHVEF; Ironbark/Stringybark Communities; Habitat for Swift Parrot and Regent Honeyeater
Putty	383				383	CHVEF; Habitat for Swift Parrot and Regent Honeyeater
Seven oaks	519				519	CHVEF; Habitat for Swift Parrot and Regent Honeyeater
Condon View (MTW Portion)	345				345	CHVEF; Habitat for Swift Parrot and Regent Honeyeater

The MTW BA's are managed in accordance with site specific Offset Management Plans (OMPs). All of the OMPs are available on MTW's website.

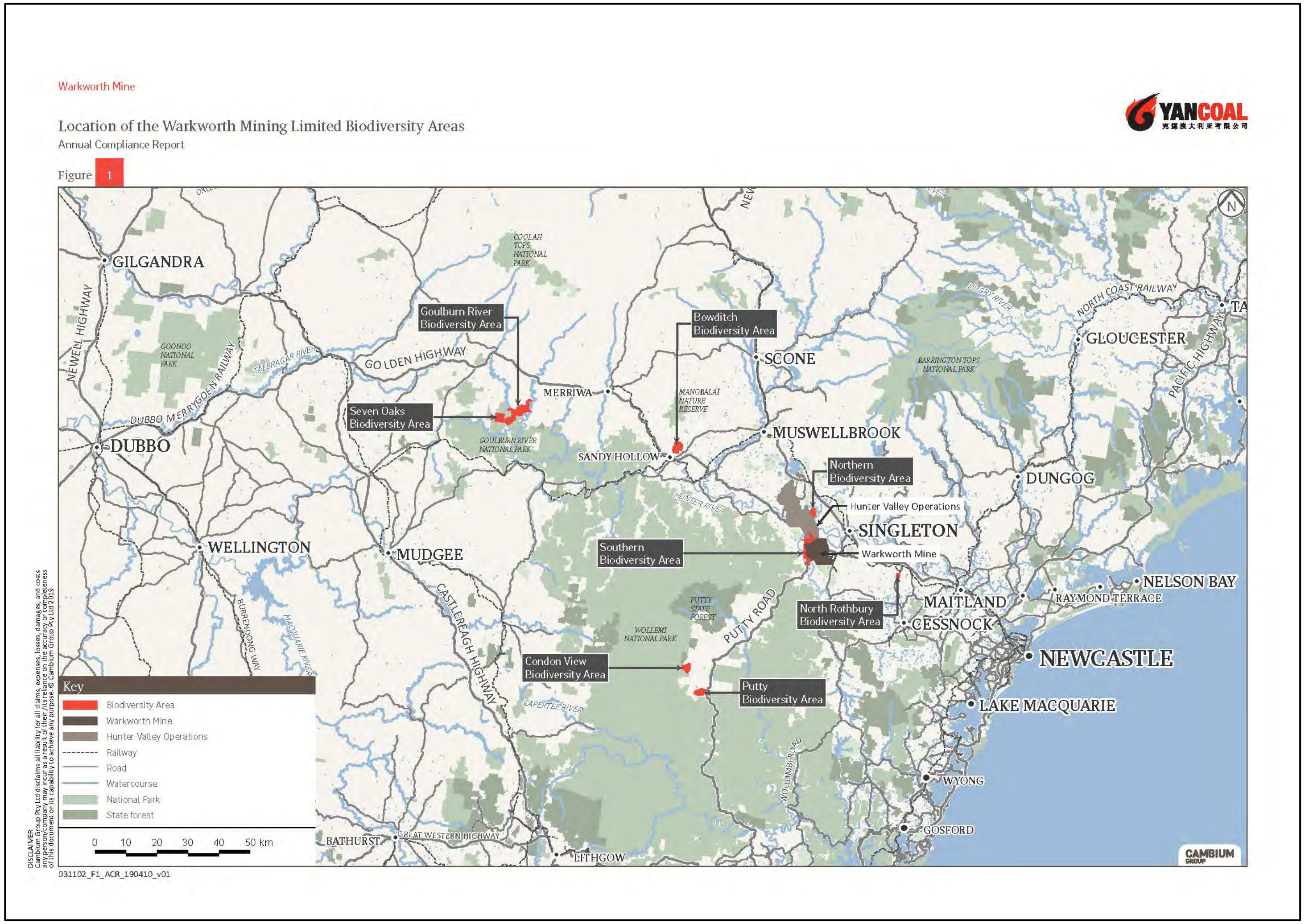


FIGURE 83: MTW BIODIVERSITY OFFSET LOCALITY MAP

7.11.2 Biodiversity Area Management Activities

The OMPs describe the Conservation Management Strategies. The following are the key actions completed throughout 2020 across all the BAs:

7.11.2.1 Weed Control

Weed control at the Local BAs targeted the following species:

- African boxthorn *(Lycium ferocissimum)*
- African lovegrass *(Eragrostis curvulva)*
- African olive *(Olea europaea subsp. Cuspidate)*
- Blue heliotrope *(Heliotropium amplexicaule)*
- Caltrop *(Tribulus terrestris)*
- Castor oil plant *(Ricinus communis)*
- Coolatai grass *(Hyparrhenia hirta)*
- Fat hen *(Chenopodium sp)*
- Farmers friends *(Biden pilosa)*
- Galenia *(Galenia pubescens)*
- Green cestrum *(Cestrum parqui)*
- Lantana *(Lantana camara)*
- Mother of millions *(Bryophyllum delagonese)*
- Paddys Lucerne *(Sida rhombifolia)*
- Paterson's curse *(Echium plantagineum)*
- Prickly pear *(Opuntia stricta)*
- Telegraph weed *(Heterotheca grandiflora)*
- Tiger pear *(Optunia aurantiaca)*

Weed control at the Regional BAs targeted the following species:

- Blackberry *(Rubus fruticosus)*
- Blue heliotrope *(Heliotropium amplexicaule)*
- Bridal creeper *(Asparagus asparagoides)*
- Cat heads *(Emex australis)*
- Caltrop *(Tribulus terrestris)*
- Common Thorn-Apple *(Datura stramonium)*
- Farmers friends *(Bidens pilosa)*
- Fireweed *(Scenecio madagascariensis)*
- Green cestrum *(Cestrum parqui)*
- Lantana *(Lantana camara)*
- Lamb's tongue *(Verbascum thapsus)*
- Lavender scallops *(Bryophyllum fedtschenkoi)*
- Mallow *(Malva parviflora)*

- Mexican Poppy *(Argemone ochroleuca)*
- Mustard weed *(Sisymbrium officinale)*
- Narrow leaf cotton bush *(Gomphocarpus fructicosus)*
- Noogoora burr *(Xanthium occidentale)*
- Paddy's lucene *(Sida rhombifolia)*
- Paterson's curse *(Echium plantagineum)*
- Prickly pear *(Opuntia stricta)*
- Scotch thistle *(Onopordum acanthium)*
- St John's wort *(Hypericum perforatum)*
- Stinking roger *(Tangetes minuta)*
- Tiger Pear *(Optunia aurantiaca)*
- Tree of heaven *(Ailanthus altissima)*
- Variegated thistle *(Silybum marianum)*

7.11.2.2 Infrastructure Management and Improvement

In 2020 fence repairs were undertaken at the Southern, Northern, North Rothbury, Putty, Condon View and Bowditch BAs. A new 1.4 km section of boundary fence was installed at the Goulburn River BA. All tracks were maintained to reduce encroaching vegetation and improve access. Regular property inspections were undertaken on all BAs.

7.11.2.3 Fire Management

The MTW Biodiversity Area Bushfire Management Plan was reviewed in 2020. Slashing of fire breaks was undertaken on the Southern and Goulburn River BAs. Overall fuel load assessments were undertaken on the Local and Regional BAs to identify the current exposure to bushfire fuel hazard and implement a bushfire fuel hazard reduction programme. A Hazard Reduction Burn for North Rothbury BA was approved however weather conditions were outside the prescribed limits, so the burn has been rescheduled for autumn 2021.

7.11.2.4 Strategic Grazing

No strategic grazing was undertaken in the BAs in 2020.

7.11.2.5 Vertebrate Pest Management

Two 1080 ground baiting programmes were undertaken across the Biodiversity Areas targeting wild dogs and foxes in 2020. Baits were checked over a three-week period and replaced each week when taken. Baiting was carried out in autumn and spring and was undertaken in conjunction with neighbouring landholders where possible. **Table 7.8** summarises the results from the programmes during 2020.

TABLE 7.8 SUMMARY OF VERTEBRATE PEST MANAGEMENT 2020

Season	1080 Baiting				
	Total Lethal Baits Laid	Takes by Wild Dog	Takes by Fox	Takes by Feral Pigs	Takes by other/unknown
Autumn (Local BAs)	120	29	12	2	3
Spring (Local BAs)	120	50	5	2	12
Autumn (Regional BAs)	184	45	31	11	12
Spring (Regional BAs)	174	38	22	30	36
Total	**598**	**162**	**70**	**45**	**63**

Additional pest management programmes included:

- Noisy Miner ground shoot at the Goulburn River BA to assist the survivability of the Regent Honeyeater: 212 Noisy Miners controlled over a seven-day programme under Licence to Harm Protected Animals (Biodiversity Conservation Act 2016). This is the fourth consecutive year of this programme making this the longest running and most successful noisy miner management programme in the country. The 2020 programme expanded the treatment area to include the whole BA and monitoring results conclude that ongoing noisy miner management is successfully suppressing noisy miner numbers at the Goulburn River Biodiversity Area.
- Opportunistic shooting of other vertebrate pests included two feral pigs.
- Aerial shoot conducted by NPWS controlled 14 feral pigs at the Goulburn River BA in October.
- The Professional Wild Dog Controller Programme has trapped and euthanised more than 360 problem wild dogs in the three years it has been running. This is a four-year programme with the primary goal to reduce the impacts of wild dog predation on livestock production, the social wellbeing of livestock producers, and native fauna, through professional and targeted control of problem dogs in the Upper Hunter district. A total of 19 wild dogs have been controlled on Yancoal land since July 2017.

Vertebrate pest management programmes will continue to be carried out during 2021 to limit feral pest impacts on landholdings and surrounding neighbours.

7.11.2.6 Seed Collection

Seed collection was undertaken by contractors in the Northern and Southern BAs during 2020, focussing on the WSW, River Oak Forest and Ironbark vegetation community. Seed collection was also undertaken on the Goulburn River BA for Yellow Box – Grey Box – Red Gum grassy woodland and River Oak riparian woodland. Tube stock for 2021 plantings is currently being propagated from the seed collected.

7.11.2.7 Revegetation

MTW has committed to restoring the Endangered Ecological Communities of Warkworth Sands Woodland and Central Hunter Grey Box – Ironbark Woodland in the Southern and Northern Biodiversity Areas. Work commenced in 2014 and overall there is more than 500 hectares of grassland area to be planted and managed over 15 years to restore these Endangered Ecological Communities.

In 2020, restoration work included infill planting Central Hunter Grey Box – Ironbark Woodland and River Oak Forest in the Southern BA and with 7,000 tube stock planted into rip lines. Infill of 2,000 tube stock was planted into Warkworth Sands Woodland plots in the Southern BA. Warkworth Sands Woodland planting progressed at the Northern BA with 9,112m^3 of WSW sand stripped ahead of mining at MTW and hauled to the Northern Biodiversity Area. 5,480m^3 of this WSW sand was spread into strips and seeded with native grasses to increase the groundcover diversity then planted with 4,500 tubestock. The additional sand was stockpiled and will be spread into strips and seeded with native grass and planted with tubestock in 2021.

Infill planting at the Goulburn River Biodiversity area to increase the suitability of habitat for the Regent Honeyeater continued with 12,000 tube stock planted into the cleared areas of Yellow Box – Grey Box – Red Gum Grassy Woodland and riparian woodland areas. Access to the site was restricted during 2020 due to high river levels, which meant that not all areas could be accessed for infill planting in 2020. Supplementary infill planting will continue in 2021.

The next round of planting is planned for autumn 2021 and will include 11,000 Warkworth Sands Woodland tubestock in the Northern BA and 4,400 in the Southern BA. Additional infill of the Central Hunter Grey Box – Ironbark Woodland and River Oak Forest planting areas at the Southern BA will continue as required.

Figure 84: Drone Image of Northern Biodiversity Planting Area

Figure 85: Warkworth Sand Woodlands Planting Strip Northern Biodiversity Area

7.11.2.8 Bird Assemblage Monitoring

Bird assemblage monitoring is undertaken every two years as part of the ecological monitoring requirements to assess changes in the condition and extent of the woodland habitats within the BAs and the ongoing usage of these habitats by woodland birds.

A total of 204 two-hectare 20-minute bird surveys were conducted during the winter and early spring period, to cover the period when swift parrots and regent honeyeaters are most likely to be present on site. A total of 124 species of birds were recorded throughout the eight Biodiversity Areas (BAs). Bird species richness has increased by eight species on 2016 data and by two species on 2018 data.

Three regent honeyeaters - two males and a female- were detected at the Putty BA. This is the first confirmed record of regent honeyeater utilising habitat within the Putty BA. A single male regent honeyeater was also detected on the Goulburn River BA, though not during formal bird monitoring surveys and not within an established monitoring site. No swift parrots were detected occupying any of the Biodiversity Areas. Overall bird activity was likely affected by lagged effects of drought, namely a lack of eucalypt blossom and vegetation dieback.

FIGURE 86: REGENT HONEYEATER AT PUTTY ©LIAM MURPHY.

7.11.2.9 Habitat Restoration Monitoring

The habitat restoration monitoring programme assesses the changes in key attributes within the BA through time as grassland communities are restored to woodland. Monitoring was undertaken across all BAs in Spring 2020 and demonstrated that exotic cover had increased across all properties except the North Rothbury and Bowditch BAs.

The North Rothbury and Bowditch BAs had most key attributes close to or within benchmark indicating a high potential for regeneration across the site. Seven Oaks, Condon View and Putty BAs had some key attributes within benchmark values demonstrating that previously disturbed areas show potential for successful regeneration and overall restoration.

Some monitoring sites at the Goulburn River BA were inaccessible due to high river levels and these have not been included in the 2020 monitoring programme. The Goulburn River BA showed that regenerating woodland areas are in a good condition with most key attributes meeting or close to benchmark. The cleared grassland areas were however well below benchmark. Infill planting to increase the suitability of habitat for the Regent Honeyeater was undertaken in 2019 and 2020 with tube stock planted into the cleared areas of Yellow Box – Grey Box – Red Gum Grassy Woodland and riparian woodland areas. Weather conditions during this time have impacted the survival rates so additional supplementary planting has been scheduled for 2021.

The Northern and Southern BAs had a high level or variability in the condition of the grassland areas. Additional planting of woodland species has been scheduled for 2021. The woodland areas were near benchmark condition.

7.11.2.10 Rapid Condition Assessments

The Rapid Condition Assessment technique is used a preliminary assessment of woodland condition within the BA. Each year the sites in mature and regrowth vegetation are revisited to record the presence or absence of key habitat components and threatening processes. The results of the Rapid Condition Assessment, together with property inspection and plot reference points will be used to monitor woodland condition and identify emerging threats.

7.12 Audits and Reviews

The NSW Resources Regulator undertook a Targeted Assessment Program (TAP) at MTW on 26 June 2020 which focused on soils and materials management in relation to rehabilitation activities. The TAP program has been introduced ahead of rehabilitation reforms that are expected to be introduced as regulation in 2021. During the TAP, MTW was assessed on its preparedness to implement the requirements of the proposed rehabilitation reforms. The opportunities for improvement identified in the TAP report will be included in a Rehabilitation Management Plan that will be prepared in accordance with the guidelines proposed under the rehabilitation reforms; and implemented during 2021.

An Independent Environmental Audit (IEA) was conducted at MTW during 2020. A summary of progress for implementation of the IEA recommendations has been included in **Appendix 7**.

8 COMMUNITY

8.1 Complaints

A total of 235 complaints were recorded during the reporting period, with a decrease of approximately 39% compared to 2019. The 235 complaints were registered by approximately 39 people (some complainants remained anonymous), with just over 71% of complaints received from 7 individuals. Most complaints were received from residents in the Bulga area. A breakdown of complaints by type is shown in **Table 8.1**.

Noise remains of key concern for near neighbours. There has been a trending decrease (overall 42.7%) in noise complaints from 2018. The decrease experienced from 2018 is considered partially attributed to increased noise measurements undertaken by the Community Response Officers from 2018 to 2020 and corresponding mitigating actions taken where required.

Dust has reduced as a key concern for the community. 2020 showed a significant decrease of complaints regarding dust by ~79% in comparison to 2019. The decrease from 2019 may be attributed to the above average rainfall conditions in 2020 (828 mm) in comparison to the below average rainfall in 2019 (304 mm) and 2018 (457 mm).

The average annual rainfall recorded at MTW's Charlton Ridge Meteorological station is 646mm, as calculated from 2007 to 2020 annual totals.

Lighting has emerged as a key concern for the community. 2020 showed an increase of complaints regarding lighting by 33% in comparison to 2019. This increase from 2019 may be partially attributed to the progression of mining in the Warkworth Pit, which is progressively removing natural topographical shielding, as well as normal dumping activity on elevated dumps.

In summary:

- 43% reduction in noise complaints;
- 79% reduction in dust complaints;
- Blasting, Water and Other related complaint numbers have remained fairly consistent since 2018, although lighting related complaints were higher than in 2019.;
- Complaints in the "Other" category decreased from 2019. Complaints in this category were in relation to odour.

TABLE 8.1 SUMMARY OF COMPLAINTS BY TYPE FOR 2018 TO 2020

Complaint type	2020	2019	2018
Noise	98	112	171
Blasting	68	94	69
Dust	30	146	76
Lighting	36	27	32
Water	0	0	0
Other	3	6	3
Total	235	385	351

8.2 Review of Community Engagement

8.2.1 Communication

Members of the community are encouraged to contact MTW and engage in a way that suits them. Communication avenues in place to support MTW include:

- MTW free call Community Information Line (1800 727 745), which is advertised regularly in local newspapers and community newsletters;
- Online, via MTW's website (www.insite.yancoal.com.au) with information about MTW including approvals documents, public reports, environmental monitoring results, blasting and road closures, and information about the MTW Community Consultative Committee (CCC) including the minutes of CCC meetings;
- MTW maintains a 24 hour freecall environmental hotline (1800 656 892), which allows community members to register a concern or complaint at any time of the day or night, 365 days a year. The hotline is advertised in telephone directories, on the MTW website, regularly in local newspapers, and in MTW publications;
- MTW maintains a Blast Information Line (1800 099 669) which provides information on blasts and road closures;
- Near neighbour engagement, including proactive visits to neighbours surrounding MTW; and
- MTW also issues correspondence to specific community members who may be affected by certain changes, to inform of upcoming consultation activities and as a feedback mechanism.

A range of consultation and engagement activities have continued in 2020, which included:

- The MTW Social Impact Management Plan was implemented. This plan collates together all commitments that were part of the Environmental Assessment for MTW's Continuation Project process and identifies where the company will undertake actions to mitigate some of the potential impacts in the area. The main topics include:-
    - Voluntary Planning Agreement;

- Property Agreements Strategy, around acquisition and mitigation rights in the area.
- Management of properties in and around Bulga that MTW has had to acquire.
- Conservation funds and how MTW operate these.
- Support for local Schools
- Scholarships and Apprenticeships;
- Acquisition of Commercial Facilities, for example the Bulga Tavern where MTW has worked to upgrade this facility to support the business sustainability;
- Ongoing Community Support Program; and
- the MTW CCC, which is identified as one of the primary communication areas where the company reports back through the CCC on how their business is performing.

- Engagement and consultation with near neighbours to provide project updates at key project milestones and activities, and in response to concerns/queries raised by individual near neighbours;
- MTW are supportive of the Upper Hunter Mining Dialogue School Tours program. Over two weeks in September, primary school children from St Catherine's Catholic College visited MTW to tour the operation.

8.2.2 Community Consultation Committee

The MTW CCC met on a quarterly basis to discuss our operations. The Committee is comprised of MTW representatives, community members and other key external stakeholders, including Singleton Council. The MTW CCC minutes were made available on the MTW website (www. insite.yancoal.com.au). The community is invited to visit the MTW website to learn more about the MTW CCC, as well as other aspects of MTW operations and projects.

MTW advertised for new members to join the CCC over a period between 27 November 2019 to 17 January 2020. Advertisements were placed in the Singleton Argus Newspaper, in local businesses in Bulga, and at the Singleton Council offices. In addition, the local community near MTW were directly sent a letter advising that an opportunity to apply to join the MTW CCC was available. MTW's Independent Chair accepted the applications and gained DPIE Secretary approval for new members and alternate members on 23 March 2020.

During the reporting period the CCC members were:

- Dr Col Gellatly - Independent Chair
- Cr Hollee Jenkins - Singleton Council Representative
- Mr Adrian Gallagher – Community Representative
- Mr Ian Hedley – Community Representative
- Mr Stewart Mitchell – Community Representative
- Ms Antoinette Silk – Community Representative (DPIE endorsed 23/3/2020)
- Mrs Barb Brown – Community Representative (DPIE endorsed 23/3/2020)
- Mr John Lamb – Community Representative (DPIE endorsed 23/3/2020, resigned 25/11/2020)

- Mr Neville Hodkinson – Stakeholder Representative - Singleton Shire Healthy Environment Group (DPIE endorsed 23/3/2020)
- Mr Graeme O'Brien – Community Representative (Alternate - DPIE endorsed 23/3/2020)
- Mr Denis Maizey – Community Representative (Alternate - DPIE endorsed 23/3/2020)

Company representatives attending the CCC included:

- Mr Jason McCallum - MTW General Manager
- Mr Gary Mulhearn – MTW Environment & Community Manager
- Mr David Bennett – MTW Mining Manager (and Acting General Manager)
- Mr John Campbell – MTW Technical Services Manager
- Ms Olivia Lane – MTW Environment & Community Coordinator
- Ms Claire Bennis – MTW Community Response Officer

8.2.3 Community Support and Development

In 2020, MTW continued its focus on ensuring the long-term sustainability of the communities in which it operates, through the facilitation of community development programmes such as:

- Voluntary Planning Agreement
- Mount Thorley Warkworth Community Support Program

8.2.3.1 Voluntary Planning Agreement

In 2020, MTW continued contributions to the voluntary planning agreement funds required by development consents SSD-6464 and SSD-6465, and as agreed with Singleton Council. During 2020, MTW contributed a further $800,000 excluding GST, bringing total VPA contributions at end of 2020 to $5.2M of the total commitment value of $11M.

Singleton Council operates the Mount Thorley Warkworth VPA Community Committee which discusses the Bulga Community Project Fund component of the VPA funds. During 2020, the committee was chaired by Mayor Sue Moore and includes senior staff from Council, community representatives, and a Yancoal representative. Pleasingly, there have been several projects approved in the Bulga area from the Bulga Community Project Fund which includes:

- Bulga Recreation Grounds improvements and exercise equipment (which officially opened on 19 March 2020);
- Bulga Hall improvements (new media system, ceiling upgrade, verandah/store room upgrade);
- Old Bulga School restoration;
- Electronic message board; and
- Bulga Stock Reserve ongoing developments (including development of plan of management).

8.2.3.2 MTW Community Support Program

In 2020 MTW continued implementation of the Yancoal Community Support Program (CSP). The CSP intends to make a genuine positive difference to the communities in which Yancoal operates. Applications for CSP partnerships are formally received once per funding year, closing 4 November 2019 for the 2020 funding year. MTW considers and supports applications for local donations and sponsorships that have a clear community benefit and are aligned with the CSP guidelines.

In 2020, many events being supported had to postpone their timing into 2021 due to COVID-19 restrictions. In 2020, MTW proposed to support the following local projects and initiatives:

- University of Newcastle Scholarship Program
- University of Newcastle Upper Hunter Science and Engineering Challenge (COVID19 – Support held for 2021)
- Rotary Club of Singleton on Hunter – 2020 Singleton Art Prize (COVID19 – Support held for 2021)
- Singleton Schools Learning Community – Visible Wellbeing Project (VWB techniques help teachers to use the learning process itself as a delivery mechanism to build student wellbeing - for teachers and students in all Singleton schools)
- Singleton Business Chamber – 2020 Singleton Business Excellence Awards (COVID19 – Support held for event – planned for November 2021)
- Westpac Rescue Helicopter Service – Hunter Valley Mining Charity Rugby League Competition 2020 – (COVID-19 - Support held for event in March 2021)
- Newcastle & Hunter Combined Schools ANZAC Service – 2020 Singleton ANZAC Service (COVID-19 – support held for 2021 event)
- Singleton Theatrical Society – 2020 Annual Musical (COVID19 – Support held for 2021)
- United Elizabeth Gates Village Auxillary – Shower Commode Chair
- Glennies Creek Rural Fire Service –Genfo Knapsacks
- Singleton District Girl Guides – Camping Kitchen Supplies
- Howes Valley Rural Fire Service – Whitegoods for RFS station kitchen update
- Singleton Golf Club Lady Members – Annual Ladies Day Open 2020
- Wildlife Aid Inc - Support for Wildlife care and rescue
- Northern Agriculture Association Inc - 2020 Singleton Show (cancelled due to COVID-19)
- Samaritans Foundation – Christmas Lunch in Singleton 2020

MTW also advertised the opportunity for 2021 CSP funding during 2020. Applications closed 6 November 2020 and progress with community support program initiatives will be provided in the next reporting period.

9 INDEPENDENT ENVIRONMENTAL AUDIT

An Independent Environmental Audit (IEA) of MTW was conducted in April 2020 to satisfy Schedule 5, Condition 9 of both the Warkworth Mining Limited (SSD-6464) and Mount Thorley Operations (SSD-6465) Development Consents, which require an IEA to be undertaken "*within 1 year of the commencement of development under this consent, and every 3 years thereafter*", and an audit report submitted "*within 6 weeks of the completion of this audit*.".

The audit focused on the site's compliance with the conditions of; Development Consent's, Environmental Protection Licences, Coal and Mining Leases and supporting documents including management plans, covering the period 5 May 2017 to 30 April 2020.

This IEA identified some non-compliances against conditions of Development Consent SSD 6464 and SSD 6565, and other licences and approvals. Of the 28 non-compliances against a condition of a licence or approval identified, 13 were low risk and eight were identified as administrative in nature. The remaining seven non compliances were assessed to be medium risk. No high risk findings were identified in the audit.

At the time of the audit, MTW were aware of the identified non-compliances against conditions, licences and approvals and were actively working to address a number of the issues identified in the audit report. An update of progress against the Action Plan developed in response to the 2020 Independent Environmental Audit is included in **Appendix 7**.

The environmental audit report and MTW's response to recommendations are available in full on the company website (https://insite.yancoal.com.au/document-library/audits-mtw).

The next MTW Independent Environmental Audit is due in 2023.

10 INCIDENTS AND NON-COMPLIANCE

A summary of the environmental incidents reported during 2020 are provided in **Table 10.1** below

TABLE 10.1 ENVIRONMENTAL INCIDENT SUMMARY 2020

Date	Incident Details	Follow up Actions
9 February 2020	Discharge from two boundary dams at Warkworth (Dam 50N and Dam 53N) as a result of a greater than design rainfall event. A total of 91.4mm of rainfall was recorded during the incident period from 6 February to 9 February 2020. Notifications to the relevant regulatory authorities was undertaken, in accordance with the MTW Pollution Incident Response Management Plan (PIRMP).	Investigation undertaken by MTW into both discharges. MTW submitted an incident report to EPA and DPIE associated with the discharge event. Dewatering of Dams 50N and Dam 53N continued throughout the duration and post the rainfall event to the sites mine water management system to dewater both dams to their lowest operating levels. Water samples were also collected from monitoring sites during the event and analysis results obtained. MTW utilised the boundary dam monitoring system, installed in 2019, to assist with management of the sites remote boundary dams.
14 May 2020	Discharge from one boundary dam at Mount Thorley (Dam 9S) via spillway to Loders Creek. The overtopping event occurred as a result of a fault of a level sensor which caused the automatic valve between Dam 6S and Dam 9S to remain open, permitting Dam 9S to fill and overtop. Notifications to the relevant regulatory authorities was undertaken, in accordance with the MTW Pollution Incident Response Management Plan (PIRMP).	Containment actions were implemented immediately to cease the overflow. Dam 9S levels were lowered. Automated decant infrastructure between Dam 6S and Dam 9S was placed into manual mode. An external investigation was undertaken to determine the cause and contributing factors of the overtopping incident. The corrective actions and recommendations from the external investigation report are being implemented to prevent reoccurrence. The incident report was provided to the Department of Planning, Industry and Environment, to the EPA and to the Resources Regulator on 21 May 2020.

On the 17 December 2019 the EPA conducted drone surveillance of WML regarding dust generation at the premise, this included haul truck generated dust. The EPA issued a Show Cause notice in relation to their observations on the 3 March 2020. WML received an Official Caution on 26 May 2020 in relation to wheel-generated dust from haul trucks operating at WML. The Official Caution was in relation to Condition O3.2 of Environmental Protection Licence 1376.

MTO received an Official Caution from the EPA in October 2020 in relation to the water discharge (Dam 9S) incident reported to the EPA and DPIE on 14 May 2020. Details of the incident are provided above in **Table 10.1**. The Official Caution was in relation to section 120 of the Protection of the Environment Operations Act (POEO) 1997.

11 ACTIVITIES TO BE COMPLETED IN THE NEXT REPORTING PERIOD

Yancoal will endeavour to carry out the following activities during the 2021 reporting period at Mount Thorley Warkworth, as outlined in **Table 11.1**.

Table 11.1 Proposed Activities for 2021 Reporting Period

ID	Performance Area	Activities Proposed
1	Noise	• Maintain and continue sound power level testing of attenuated fleet; • Continue undertaking noise management and monitoring actions in accordance with the MTW Noise Management Plan • Undertake quarterly comparison of real time and external noise monitoring to validate real time monitoring results.
2	Blasting	• Review and revise the MTW Blast Management Plan for operational changes at MTW. • Implementation of a real time model, which will use real time meteorological data from weather stations throughout the Hunter Valley to better determine the effect of possible overpressure enhancement
3	Air Quality	• Engage an air quality consultant to clarify whether extrapolation from the current air quality monitoring network data provides representative data to inform tenants of the particulate emissions at their residence or if additional monitoring is required. Any outcomes will be assessed and implemented where required.

ID	Performance Area	Activities Proposed
4	Aboriginal Cultural Heritage	• Ongoing Aboriginal archaeological and cultural heritage management activities will occur in 2021 in accordance with current management plans, to inform ongoing land management and development planning. This will include the relocation of the Site M grinding grooves from the Putty Road Storage facility to the WBACHCA & the salvage of those Aboriginal artefact sites located within the ACHMP Area in areas required for mine development. Condition monitoring of those sites peripheral to authorised disturbance areas will be conducted annually to ensure operational compliance with the ACHMP. • Conservation Agreements for the Wollombi Brook and Loders Creek Aboriginal Cultural Heritage Conservation Areas will be progressed in 2021. • Relocation of the three cultural scar trees from the active mining area will be undertaken in consultation with the relevant stakeholders. • In accordance with the AHMP MTW has engaged a consultant to complete a reconciliation of aboriginal cultural heritage data during the 2021 reporting period. • The WBACHCA PMIG meetings are planned to commence during the 2021 reporting period to begin actioning the WBACHCA plan of implementation.
5	Historic Heritage	• Implementing the MTW complex-wide HHMP developed in accordance with the conditions of the Warkworth & Mount Thorley Development Consents, which will guide the management of historic heritage. • MTW has engaged a contractor to undertake quarterly grounds maintenance at Springwood and Red Brick historic heritage houses. • Treatment of the cat claw creeper vine will be commenced during the 2021 reporting period at Springwood followed by a structural building inspection. • Replacing window and door sheeting and any loose roofing is planned for completion at the Red Brick house during the 2021 reporting period. • Track maintenance into the RAAF Mess Hall is planned for completion during the 2021 reporting period to allow access for future works. During the 2021 reporting period tree lopping, asbestos removal and a structural building inspection are targeted for completion.

ID	Performance Area	Activities Proposed
6	Water	• Improving the general capacity of the site's water resources via construction and/or upgrades of approved tailings storage and water storage facilities (NOOP and Loders Pit TSF). • Implementation of actions/recommendations from the annual groundwater review. • Develop an action plan to address the findings of the annual stream health assessment for Loders Creek. • Construct NPN water management infrastructure to reduce risks associated with stormwater management in this zone. • Completion of sediment control water management infrastructure ahead of mining pre-strip area. • Improve the separation of water classifications (mine, sediment, clean) on site to reduce risks associated with stormwater management. • Install additional boundary dam monitoring equipment on the Warkworth sediment dams. • Update the operational site water balance and model.
7	Rehabilitation	• The rehabilitation monitoring programme will continue in 2021 for native vegetation rehabilitation areas. The monitoring program will be varied to align with changes to MOP performance criteria resulting from Independent Rehabilitation Review (Emergent Ecology 2019) recommendations. • Maintenance activities are planned to result in approximately 87ha of rehabilitation, currently in the initial stage of cover cropping, being seeded with the full native seed mixes. Weed spraying (boom and spot spraying) and weed wiping will be conducted in establishing rehabilitation areas as required to control both noxious and environmental weeds that are likely to impact on successful rehabilitation being achieved. It is planned that 35ha of new rehabilitation will be undertaken at MTW during 2021. • Habitat augmentation measures, such as the construction of habitat ponds and the placement of salvaged logs in rehabilitation areas. • Capping of Tailings Dam 2 will be progressed during 2021 in accordance with the revised capping methodology developed by Australian Tailings Consultants. The capping method being utilised on TD2 was reviewed and updated following settlement cracking of the capping layer in an area of TD2 in 2017. • Capping of the Interim TSF will continue during 2021 using breaker rock from the South CHPP as the initial capping layer.

ID	Performance Area	Activities Proposed
8	Biodiversity Management	• Planting works will continue to restore Warkworth Sands Woodland and Central Hunter Grey Box – Ironbark Woodland in the Northern and Southern BAs. Supplementary planting to re-establish the cleared land in the Yellow Box – Grey Box – Red Gum Grassy Woodland to a Box Gum Grassy Woodland community and increase the suitability of habitat for the Regent Honeyeater in the River Oak riparian woodland will continue at the Goulburn River Biodiversity Area. • Conservation management actions will be undertaken across the BAs in 2021 in accordance with the Offset Management Plans, these will include weed management in autumn and spring. Vertebrate pest management including 1080 ground baiting programmes to target wild dogs and foxes scheduled for autumn and spring across all BAs, 1080 baiting targeting feral pigs at the Goulburn River BA and a noisy miner control in the regent honeyeater breeding area at the Goulburn River BA. Rapid Condition Assessments, Overall Fuel Load Assessments and property inspections will be undertaken across all BAs. The hazard reduction burn for North Rothbury has been scheduled for autumn. Fence and waste removal will be undertaken at the Northern and Condon View BAs. Infrastructure improvement including fence repairs and track maintenance will be undertaken as required. • Progress the securing of biodiversity offset areas using the methods detailed in the relevant state and federal biodiversity approvals.
9	Community Engagement	• Continued operation of the Community Consultation Committee. • Implementation of the MTW Social Impact Management Plan (which outlines specific and general stakeholder engagement and consultation requirements).
10	Community Development	• Implementation of the Yancoal Community Support Program (CSP) during 2021 after closing date in November 2020 and seeking applications from the local community for 2021 funding. The CSP program will provide an opportunity for multiple site or group-wide investment in larger, long-term, capacity building projects that make a positive difference. Focus areas include health, social and community, environment, education and training.

Appendix 1:

Aboriginal Heritage Management Plan Compliance Inspection Report

Mount Thorley Warkworth

Aboriginal Heritage Management Plan 2020 Compliance Audit Inspection

Report prepared for

Yancoal Australia, Mount Thorley Warkworth

February 2021

Joel Deacon

ARROW HERITAGE SOLUTIONS

Introduction

Yancoal Australia (Yancoal) manage the Mount Thorley Warkworth (MTW) mining complex located in the Hunter Valley, approximately 8km south-west of Singleton. Approval for the continuation & expansion of the mine was granted on 26th November 2015 under two separate project approvals: the Warkworth Continuation Project Approval (SSD-6464) & the Mount Thorley Operations Project Approval (SSD-6465).

Pursuant to Condition 43 of the Warkworth Continuation Project Approval, & Condition 28 of the Mount Thorley Operations Project Approval, Yancoal developed a MTW Aboriginal Heritage Management Plan (AHMP) to cover both mining operations, which was originally approved by the Department of Planning & Environment on 29th May 2017. This AHMP sets out the principles, processes & measures through which Aboriginal cultural heritage (ACH) will be managed within the AHMP Area. This includes a commitment (Provision 24) to conduct annual AHMP compliance inspections with members of the Aboriginal community, through the auspices of the MTW Aboriginal Cultural Heritage Working Group (CHWG), throughout the life of operations. The purpose of the compliance inspections is to afford the Aboriginal stakeholders & MTW:

- the opportunity to visit mine operations and mine areas to inspect the operational compliance with AHMP provisions & Ground Disturbance Permit procedures;
- to inspect and monitor the condition and management of various sites over time; and
- to review the effectiveness and performance of AHMP provisions in the management of cultural heritage at the mine.

These compliance inspections are conducted at least annually. Due to the number of ACH sites within the AHMP area & the time foreseen to inspect all sites, it is not feasible to inspect every site during the same field trip. Therefore, a regular, rolling program of compliance inspections has been implemented that will visit all sites at each location periodically. A record will be kept of each compliance inspection against each Aboriginal cultural heritage site, so that it can be ensured that each site is inspected regularly.

Proposed Activity and Project Brief

The compliance inspections involved the following elements:

- A number of ACH sites (39) were visited and AHMP compliance inspection proformas were completed for each noting the outcomes of the inspections including evidence of compliance and non-compliance with AHMP provisions, recommendations on modifications and improvements to management provisions, recommendations on corrective actions, and other comments associated with AHMP provisions; and
- A photographic record was completed for the inspected ACH sites.

Timing & Personnel

The 2020 MTW AHMP compliance inspection program was conducted on Tuesday and Wednesday 22/23 December 2020. The personnel involved in these inspections were:

Name	**Position/Organisation**
Joel Deacon	Archaeologist, Arrow Heritage Solutions
Alarna Bristow	Environment and Community Coordinator, MTW
Georgina Berry	CHWG representative
Aden Perry	CHWG representative

Arrow Heritage Solutions were engaged as independent heritage consultants to conduct the AHMP compliance inspections, and Joel Deacon acted as technical advisor and author of this report. MTW's Environment and Communities Co-ordinator Alarna Bristow arranged the compliance inspection programs and escorted the field team. Representatives of the Upper Hunter Wonnarua Council and Culturally Aware participated in the field work program.

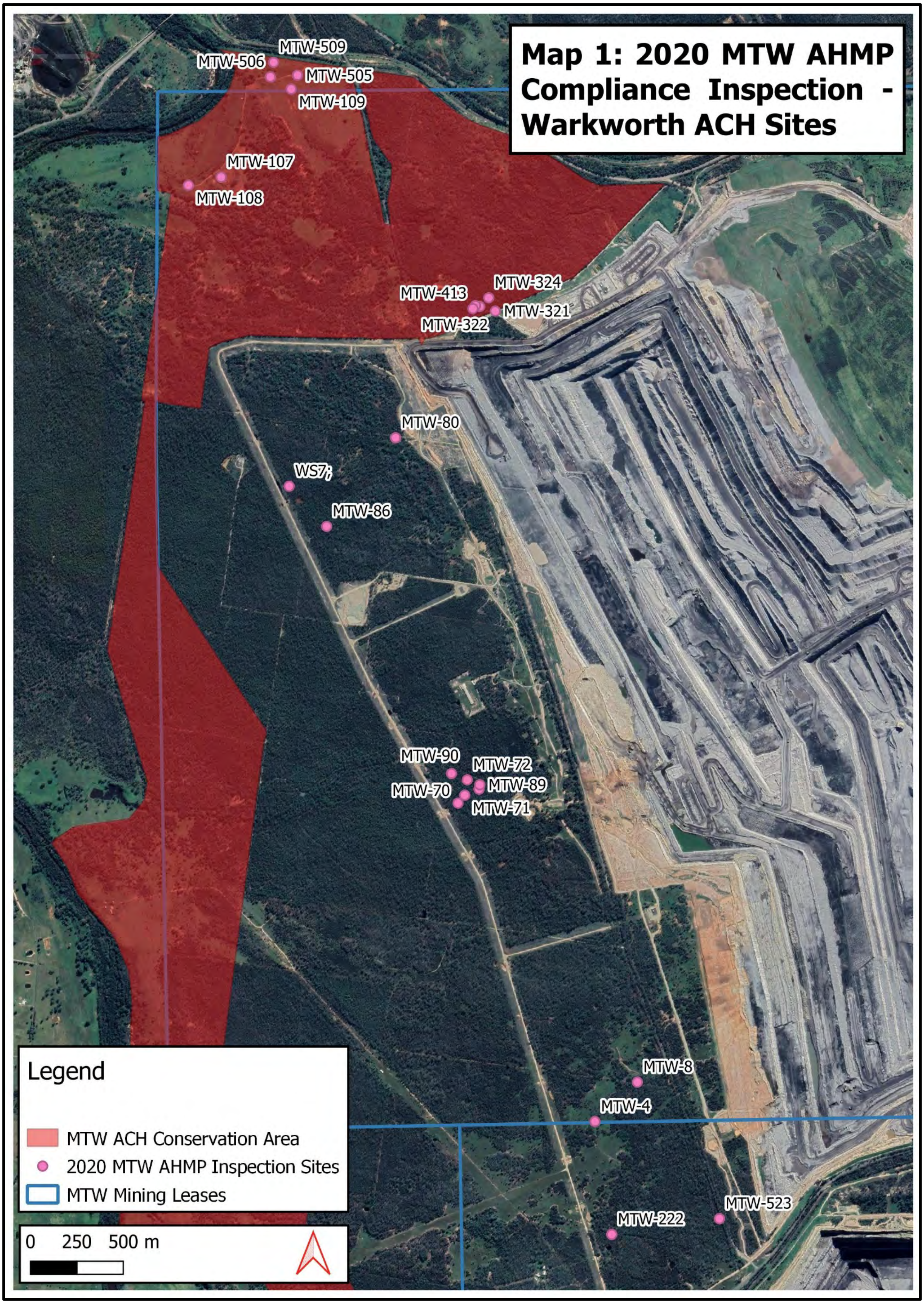
MTW AHMP Compliance Inspection

A total of 39 ACH sites were inspected across both the Warkworth and the Mount Thorley operations (see Maps 1 and 2). The area at Warkworth was selected for inspection as this is adjacent to current development areas and is being frequently accessed for a variety of activities. A sample of sites from within the Wollombi Brook ACH Conservation Area (WBACHCA) were also inspected to ensure they were being managed effectively and not subject to any natural disturbance (i.e. erosion). Sites inspected at Mount Thorley are located in the vicinity of sediment dams and a water discharge point, or in proximity to the Rail Loading

Facility. Both these areas, although not constantly actively accessed, are adjacent to development and possible ground disturbing activities.

Results

Table 1 summarises the results of the 2020 MTW compliance inspection and summarises the information recorded on the individual proforma inspection sheets. Using a mobile mapper pre-loaded with the GIS co-ordinates for each ACH site, the field team travelled to each location and attempted to re-locate each site. Sometimes this was not possible due to poor ground surface visibility, a result which in itself was not overly significant as long as it was determined that the vicinity had not been inadvertently disturbed. The presence and condition of barricading or fencing was noted, as well as the presence and nature of various potential site disturbing factors (e.g. erosion, animal, human). General observations of each site were made if necessary, and, based on information provided for all the above factors, management recommendations were discussed and agreed by the field team for each site.


Map 1: 2020 MTW AHMP Compliance Inspection - Warkworth ACH Sites
MTW-509
MTW-506
MTW-505
MTW-109
MTW-107
MTW-108
MTW-324
MTW-413
MTW-321
MTW-322
MTW-80
WS7;
MTW-86
MTW-90
MTW-72
MTW-89
MTW-70
MTW-71
MTW-8
MTW-4
MTW-523
MTW-222
Legend
MTW ACH Conservation Area
2020 MTW AHMP Inspection Sites
MTW Mining Leases
0 250 500 m


Map 2: 2020 MTW AHMP Compliance Inspection - Mt Thorley ACH Sites
Short 2 (Bulga)
Site 3
Site 2
MTW-664
MTW-663
AG-PAD-2
MTW-545
MTW-546
MTW-547
MTW-539
MTW-535
MTW-548
MTW-550
MTW-524
Legend
MTW ACH Conservation Area
2020 MTW AHMP Inspection Sites
MTW Mining Leases
0
250
500 m

Site Name	Date	Mine	Site re-identified?	Site intact?	Site fenced/ barricaded?	Fencing/ barricading intact?	Natural erosion	Livestock damage	Human disturbance	Animal disturbance	Pests & weeds	General observations	Management recommendations
AG-PAD-2	22/12/20	MTO	Yes	Yes	No	-	No	No	No	No	Lots of weeds	Recorded as a PAD so no artefacts to see on surface	
MTW-107	22/12/20	WML	No	Yes	Yes	No	No	No	No	No	No	Within WBACHCA	Consider rebarricading if ground disturbance activities are planned in this area in the future.
MTW-108	22/12/20	WML	Yes	Yes	Yes	No	No	No	No	No	No	Track through site has been re-routed and site is revegetating	Rebarricade site
MTW-109	22/12/20	WML	Yes	Yes	Yes	No	No	No	No	No	No	Site has been delineated with pickets only	Consider barricading if ground disturbance activities are planned in this area in the future.
MTW-222	23/12/20	WML	Yes	Yes	Yes	Yes	No	No	Near old track	No	No	-	
MTW-321	23/12/20	WML	Yes	Yes	Yes	Yes	No	No	No	No	No	Tree in good health	
MTW-322	23/12/20	WML	Yes	Yes	Yes	Yes	No	No	No	No	No	Within WBACHCA	
MTW-323	23/12/20	WML	Yes	Yes	Yes	Yes	No	No	No	No	No	Within WBACHCA	
MTW-324	23/12/20	WML	Yes	Yes	Yes	Yes	No	No	No	No	No	Within WBACHCA	
MTW-4	23/12/20	WML	No	Yes	Yes	Yes	No	No	No	No	No	Very low visibility	Spray with herbicide and salvage
MTW-413	23/12/20	WML	Yes	Yes	Yes	Yes	No	No	No	No	No	Within WBACHCA	
MTW-505	22/12/20	WML	Yes	Yes	Yes	Yes	No	No	No	No	No	Within WBACHCA	
MTW-506	22/12/20	WML	Yes	Yes	Yes	No	Yes	No	No	No	No	Within WBACHCA	Rebarricade site
MTW-509	22/12/20	WML	Yes	Yes	No	-	Sheet wash	No	Old borrow area	No	No	Within WBACHCA, near track to Springwood	Barricade site
MTW-523	23/12/20	WML	Yes	Yes	Yes	Yes	No	No	No	No	No	Fallen scarred tree in very deteriorated state	Relocation to be attempted in consultation with CHWG
MTW-524	22/12/20	MTO	Yes	Yes	No	-	Sheet wash	No	No	No	No	-	-
MTW-535	22/12/20	MTO	Yes	Yes	Yes	Yes	No	No	No	No	No	-	
MTW-538	22/12/20	MTO	Yes	Yes	Yes	Yes	Some	No	No	No	No	Additional artefact located at 321876e 6385400n	Rebarricade to include additional artefact
MTW-539	22/12/20	MTO	Yes	Yes	Yes	Yes	No	No	No	No	No		
MTW-545	22/12/20	MTO	Yes	Yes	No	-	No	No	No	No	No	Heavy leaf litter	

Site Name	Date	Mine	Site re-identified?	Site intact?	Site fenced/ barricaded?	Fencing/ barricading intact?	Natural erosion	Livestock damage	Human disturbance	Animal disturbance	Pests & weeds	General observations	Management recommendations
MTW-546	22/12/20	MTO	Yes	Yes	No	-	No	No	No	No	No	Heavy leaf litter	
MTW-547	22/12/20	MTO	Yes	Yes	No	-	Quite severe	No	No	No	No	AHIP is in place over area	Consider salvaging site to prevent loss through erosion
MTW-548	22/12/20	MTO	No	Yes	No	-	Sheet wash	No	Dam construction	No	No	AHIP is in place over area. Site was recorded after dam construction	Consider salvaging site to prevent loss through erosion
MTW-550	22/12/20	MTO	Yes	Yes	No	-	No	No	No	No	No	-	
MTW-663	22/12/20	MTO	No	Yes	No	-	Some	No	Likely disturbance during powerline maintenance	No	No	In powerline easement	Barricade site to prevent disturbance during powerline maintenance
MTW-664	22/12/20	MTO	No	Yes	No	-	Some	No	Likely disturbance during powerline maintenance	No	No	In powerline easement	Barricade site to prevent disturbance during powerline maintenance
MTW-69	23/12/20	WML	No	Yes	Yes	Yes	No	No	No	No	No	-	Salvage when required
MTW-70	23/12/20	WML	Yes	Yes	Yes	Yes	No	No	No	No	No	-	Have arborist assess for removal options
MTW-71	23/12/20	WML	Yes	Yes	Yes	Yes	No	No	No	No	No	-	Salvage when required
MTW-72	23/12/20	WML	No	Yes	Yes	Yes	No	No	Yes – on old track	No	No	On disused track	Salvage when required
MTW-8	23/12/20	WML	Yes	Yes	Yes	Yes	No	No	No	No	No	Scarred tree in very deteriorated state. Track has been diverted as avoidance buffer	Relocation to be attempted in consultation with CHWG
MTW-80	23/12/20	WML	Yes	Yes	Yes	Yes	No	No	No	No	No	Tree in good health	Relocate in consultation with CHWG
MTW-86	23/12/20	WML	No	Yes	Yes	No	No	No	No	No	No	Very poor GSV	Re-barricade and salvage when required
MTW-89	23/12/20	WML	Yes	Yes	Yes	Yes	No	No	Yes – on old track	No	No	-	Salvage when required
MTW-90	23/12/20	WML	No	Yes	Yes	Yes	No	No	Yes – on old track	No	No	-	Salvage when required
Short 2 (Bulga)	22/12/20	MTO	No	Yes	No	-	No	No	No	No	No	Poor visibility	

Site Name	Date	Mine	Site re-identified?	Site intact?	Site fenced/ barricaded?	Fencing/ barricading intact?	Natural erosion	Livestock damage	Human disturbance	Animal disturbance	Pests & weeds	General observations	Management recommendations
Site 2	22/12/20	MTO	Yes	Yes	Yes	No	Sheet wash	No	No	No	No	In rail loop	Rebarricade site
Site 3	22/12/20	MTO	Yes	Yes	Yes	No	No	No	No	No	No	In rail loop	Rebarricade site
WS7	23/12/20	WML	No	Yes	Yes	Yes	No	No	No	No	No	-	Salvage when required

Table 1: Results of 2020 MTW AHMP Compliance Inspection

Aboriginal Site Management Recommendations

All ACH site locations visited during the AHMP compliance inspection were found to be intact with no recent damage or unauthorised disturbance noted. Not all ACH sites were able to be re-identified, however, in all cases this was due to thick vegetation cover obscuring the ground surface rather than due to inadvertent destruction.

Management recommendations were provided for the majority of the ACH sites visited during the 2020 compliance inspection. The nature of these recommendations are described below.

Install or reinstall/repair barricade, wire and/or signage

Sites: MTW-86, 108, 506, 509, 538, 663, 664, Site 2 and Site 3

As a general observation, most of the barricading, where installed at ACH sites, was in a good state of repair. Some new barricading has been recommended as a protective measure for sites located in proximity to access or activity areas. Barricading should consist of hi-vis string line and signage delineating the area as an ACH site to be avoided.

Example of dilapidated barricading (at MTW-506)

Consider rebarricading if activity increases in the area

Sites: MTW-107 and 109

These sites are located within the WBACHCA where access and disturbance activity is limited. These sites have previously been delineated, however, this barricading has now deteriorated, although the star pickets remain in place. As these areas are already afforded a high degree of protection by virtue of them being inside the WBACHCA, rebarricading is not necessary at this point in time. However, it is recommended that the star pickets remain in place so that barricading could be reinstalled if activities increase in the area in the future.

Salvage in consultation with CHWG

Sites: MTW-4, 69, 71, 72, 86, 89, 90, 547, 548 and WS7

There are a number of sites that are located within future planned disturbance areas or are already in close proximity to work areas. These sites should be salvaged prior to works in the area to prevent inadvertent disturbance. There were no objections raised to this recommendation by the RAPs in the field, and further planning and salvage should be done in conjunction with the CHWG.

The two sites located at Mount Thorley (MTW-547 and 548) are located on the banks of Loders Creek and are at risk of being washed away by sheet wash and erosion. Their condition should be discussed with the CHWG with a view to salvaging them prior to them being lost to erosion.

Sheet wash erosion at MTW-548

Remove and relocate scarred trees

Sites: MTW-8; 70; 80; 523

Four scarred trees are located within the approved future mining area at MTW. With the exception of MTW-70, these trees have been assessed by an arborist regarding the best method of removal and relocation. MTW-70 should also be assessed for removal and relocation. These scarred trees have been visited by RAPs during this compliance inspection and during other inspections and assessments. Their removal and the arborist's plans should be discussed with the CHWG, as well as the location to where they will be relocated – the WBACHCA has been suggested. The three dead trees (MTW-8, 70 and 523) are in a poor condition however and may not be able to be successfully relocated.

Scarred tree MTW-8

Scarred tree MTW-70

Scarred tree MTW-80

Scarred tree MTW-523

Conclusions and Recommendations

The 2020 AHMP compliance inspection has been conducted as per the procedures outlined in the AHMP. No unauthorised site disturbances or AHMP non-compliances were observed during the inspection, and no issues were raised by the CHWG representatives present. A number of recommendations have been made to enhance or assist with the management of ACH at MTW:

1. **Install or reinstall/repair barricade, wire and/or signage at sites MTW-86, 108, 506, 509, 538, 663, 664, Site 2 and Site 3;**
2. **Consider rebarricading if activity increases in the area at sites MTW-107 and 109;**
3. **Discuss and plan the salvage with CHWG of sites MTW-4, 69, 71, 72, 86, 89, 90, 547, 548 and WS7; and**
4. **In consultation with the CHWG and an arborist, remove and relocate scarred trees MTW-8; 70; 80; and 523, considering the Wollombi Brook ACH Conservation Area as a relocation destination.**

Appendix 2:

Historic Heritage Management Plan Compliance Inspection Report

Mount Thorley Warkworth Historic Heritage Management Plan 2020 Compliance Audit Inspection

Report prepared for

Yancoal Australia, Mount Thorley Warkworth

January 2021

Joel Deacon

ARROW HERITAGE SOLUTIONS

Introduction

Yancoal Australia (Yancoal) manage the Mount Thorley Warkworth (MTW) mining complex located in the Hunter Valley, approximately 8km south-west of Singleton. Approval for the continuation & expansion of the mine was granted on 26 November 2015 under two separate project approvals: the Warkworth Continuation Project Approval (SSD-6464) & the Mount Thorley Operations Project Approval (SSD-6465).

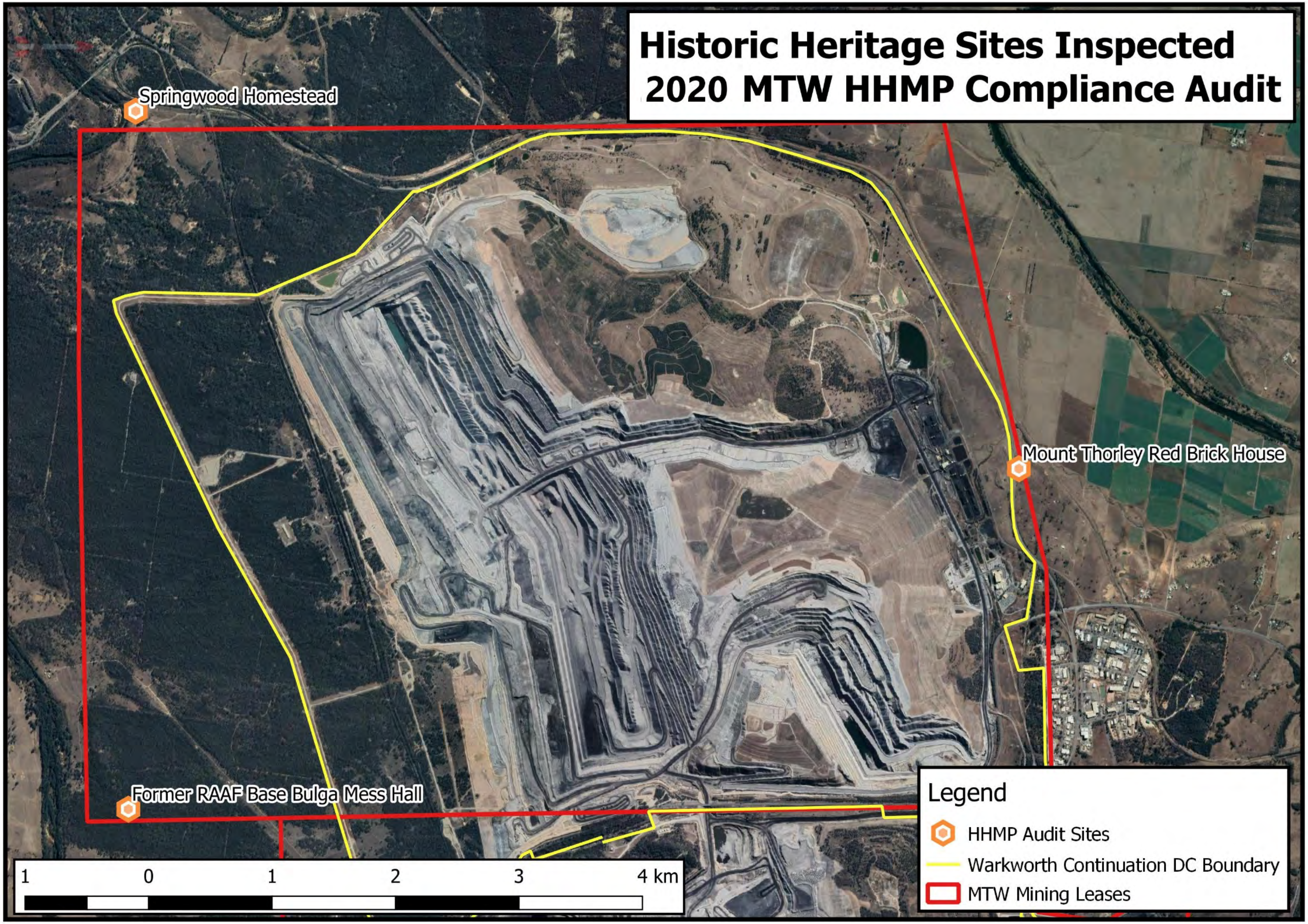
Pursuant to Condition 46 of the Warkworth Continuation Project Approval, Yancoal have developed an MTW Historic Heritage Management Plan (HHMP) that covers the whole MTW mining complex. The MTW HHMP was approved by the Department of Planning & Environment on 11 October 2017 and sets out the principles, processes & measures through which historic heritage will be managed within the HHMP Area. This includes the commitment (Provision 19) to conduct annual HHMP compliance inspections with members of the community through the auspices of the Community Heritage Advisory Group (CHAG). The purpose of the HHMP compliance inspections is to:

a. inspect areas and sites to assess compliance with the provisions of the HHMP;
b. inspect and monitor the condition and management of various sites; and
c. review the effectiveness and performance of the HHMP provisions in the management of historic heritage at MTW.

Proposed Activity and Project Brief

The following historic sites (shown in the map below) within the MTW HHMP area were to be inspected to assess compliance with actions listed in the HHMP and specific Conservation Management Plans (CMP), and a detailed photographic record for each site was collated to add to the previous photographic data:

- Former RAAF Base Bulga Mess Hall
- Springwood Homestead
- Mount Thorley Brick Farm House


Historic Heritage Sites Inspected
2020 MTW HHMP Compliance Audit
Springwood Homestead
Mount Thorley Red Brick House
Former RAAF Base Bulga Mess Hall
Legend
HHMP Audit Sites
Warkworth Continuation DC Boundary
MTW Mining Leases
1
0
1
2
3
4 km

Timing & Personnel

The 2020 MTW HHMP compliance inspection was conducted on Monday 21 December 2020. The personnel involved in this inspection were:

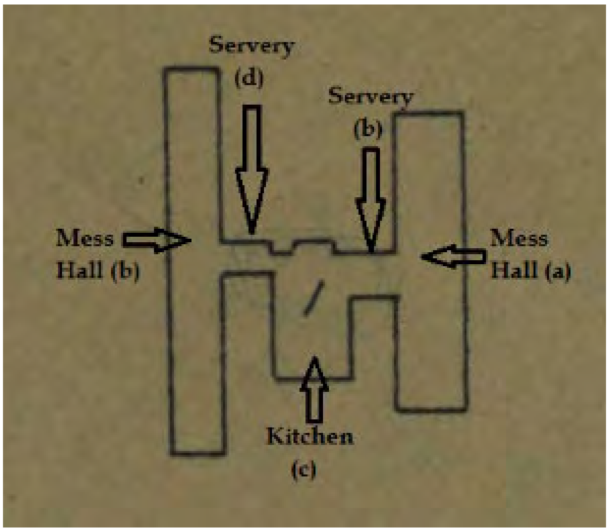
Name	Position/Organisation
Joel Deacon	Archaeologist, Arrow Heritage Solutions
Alarna Bristow	Environment and Community Coordinator, MTW
Neville Hodkinson	CHAG representative
Stewart Mitchell	CHAG representative
Wesley Warren	CHAG representative
Michael Young	CHAG representative
Lyn MacBain	CHAG representative

Arrow Heritage Solutions were engaged as independent heritage consultants to conduct the HHMP compliance inspection, and Joel Deacon acted as technical advisor and author of this report. MTW's Environment and Community Coordinator arranged the compliance inspection program and escorted the field team. Neville Hodkinson, Stewart Mitchell, Lyn MacBain, Michael Young and Wesley Warren participated in the inspection as representatives of the CHAG forum.

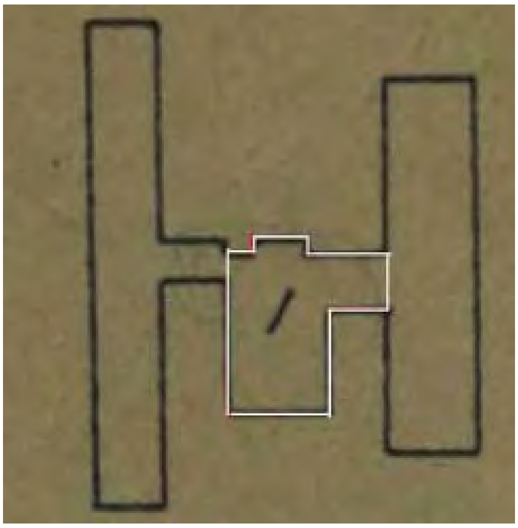
Former RAAF Base Bulga Mess Hall

Following the Japanese attack on Pearl Harbour in December 1941, plans were approved to expand existing RAAF bases and establish new ones, including a number of sites in the Hunter Valley. Bulga was identified as a potential site for an operational base and the area was officially taken over by the RAAF on 12 June 1942 for use as a relief landing strip. By July 1943 the site was completed, including the kitchen and mess hall, however, by January 1944 the use of the site was limited due to the decreasing threat of attack. A 1946 condition report noted this building as deteriorating. In January 1953, the building was noted as missing a few sheets of iron and windows.

The building sits in the former camp area west of the north-south runway. It was originally irregular in plan comprising a central kitchen area measuring 13.4 x 8.8m, with long rectangular mess halls to the east and west, connected by a servery on either side. The remnant structure today comprises the kitchen building and the foundation of one of the serveries (see below).



Original layout of building



Remaining structure

The remnant building is "L" shaped in plan with brick and concrete footings. During the original assessment conducted by ERM in November 2012 (which informed the CMP) the building was noted as being in poor condition with trees physically impacting on the building fabric, and some minor settlement issues resulting in cracking and failing brickwork. The western section of the building was the most intact part, retaining the original timber frame, corrugated asbestos cement roof sheeting and walls clad with corrugated iron sheeting.

The building is currently structurally unsound, with a large tree impacting on the roof and a number of timber elements either missing or in a deteriorated state. Corrugated asbestos roof sheeting is also missing in some places, and damaged and in poor condition where it remains. Much of the corrugated iron sheeting is corroded. Brickwork is also cracking in a number of locations resulting in significant movement outward, loss of mortar and loss of bricks along the southern and eastern elevations.

View to mess from south-east (2012)

Remnant kitchen area (2012)

As a result, a number of structural recommendations were outlined by ERM in the CMP developed for the site in 2012. These recommendations were not intended to return the building to a serviceable state, rather they seek to do the minimum required to allow safe access to the building to prevent significant damage, and also allow safe access for asbestos removal and internal inspection of the building in the short to medium term.

CMP Requirements

Short to medium term structural recommendations included:

a) **Remove fallen tree branch.** The tree branch impacting on the roof of the building should be removed, using an external mobile elevated platform or boom lift;

b) **Temporary propping.** The building should be temporarily propped and supported as per Bligh Tanner plans SK 1.0 A and SK 2.0 A (contained within the CMP) to allow for safe access into the building and more detailed inspection of the structure.

c) **Asbestos Removal.** Asbestos removal should be completed by a licensed asbestos removal specialist, include the roof sheeting, all asbestos dust and fibres, and loose fragments that are known to exist in the remaining area.

d) **Stabilise framework and replace roof.** Any structural roof members that are destabilized once the roof sheeting is removed are to be secured as required. Side walls which lose stiffness once the roof sheeting has been removed are to be propped temporarily until the new roof has been replaced.

e) **Archaeological clean-up.** Asbestos removal and clean-up should be supervised by a historical archaeologist to ensure any identified items of significance are retained.

f) **Further building inspection.** A structural engineer should complete a building inspection to identify structural repairs and stability requirements with four weeks of the building being cleaned up and decontaminated from asbestos.

Following the internal inspection of the building noted in (f) above, further advice may be provided regarding medium to long term recommendations. Due to the lack of integrity of the building, recommendations are unlikely to be directed at restoration of the building, but more towards retaining the remnant structure in a safe environment and reducing further deterioration. Repair drawings have been provided in the CMP to remedy any major cracking in the brickwork or where sections of brickwork have either partially collapsed or broken away from the wall.

Photographic Comparison 2012 – 2018 – 2020 (March) – 2020 (December)

During the inspection of the Former RAAF Base Bulga Mess Hall for this report, a number of photographs were taken from the same angles and of the same features as were taken during the ERM 2012 assessment and archival recording as well as during the 2018 and March 2020 HHMP compliance inspections. These photographs provide a visual baseline condition assessment of the building, and also allow a comparative analysis of the deterioration, or maintenance, levels over the last six to eight years. These photographs are set out below, along with comments pertinent to management recommendations.

<table>
<tr><th>2012</th><th>2018</th><th>2020 (Mar)</th><th>2020 (Dec)</th></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="4">East elevation
2012-18: no discernible change – note fallen branch from tree on western side.
2018-20 (Mar): no discernible change – fallen branch has moved.
Mar 2020 – Dec 2020: no discernible change.</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="4">View to north-east elevation
2012-18: roof over open kitchen area has deteriorated, causing severe lean on far wall.
2018-20 (Mar): top of far wall now collapsed.
Mar 2020 – Dec 2020: no discernible change.</td></tr>
</table>

2012	2018	2020 (Mar)	2020 (Dec)
			
South-east elevation **2012-18:** evidence of increased bow to southern wall. **2018-20 (Mar):** bow in wall appears to have increased. **Mar 2020 – Dec 2020:** bow in wall continues to increase.			
			
South elevation **2012-18:** evidence of increased bow to southern wall and missing panel above entry. **2018-20 (Mar):** increased bow to southern wall. **Mar 2020 – Dec 2020:** increased bowing on southern wall.			

2012	2018	2020 (Mar)	2020 (Dec)
			
West elevation **2012-18:** shows deterioration of roofing members above open kitchen area and leaning north wall, and further collapse of asbestos roof due to fallen dead tree. **2018-20 (Mar):** top of north wall now collapsed, further damage to roof with branch now fallen to ground. **Mar 2020 – Dec 2020:** no discernible change.			
			
North elevation **2012-18:** no discernible change. **2018-20 (Mar):** top of north wall now collapsed. **Mar 2020 – Dec 2020:** no discernible change.			

2012	2018	2020 (Mar)	2020 (Dec)
			
North-east elevation **2012-18:** difficult to discern change. **2018-20 (Mar):** difficult to discern change. **Mar 2020 – Dec 2020:** no discernible change.			
			
Concrete and brick foundation at east side of building **2012-18:** difficult to discern change. **2018-20 (Mar):** no discernible change. **Mar 2020 – Dec 2020:** no discernible change.			

2012	2018	2020 (Mar)	2020 (Dec)
			
View to building interior from north-east **2012-18:** shows collapse of remnant roofing members above open kitchen area. **2018-20 (Mar):** further minor deterioration of asbestos sheeting panelling. **Mar 2020 – Dec 2020:** no discernible change.			
			
Grease trap at south end of building **2012-18:** shows bow to south wall. **2018-20 (Mar):** shows increased bow to south wall. **Mar 2020 – Dec 2020:** shows increasing bowing of south wall, and example of new termite monitoring system in bottom right of picture.			

2012	2018	2020 (Mar)	2020 (Dec)
			
Storage area at south end of building **2012-18:** further slight collapse of storage area. **2018-20 (Mar):** shows loosening of corrugated iron wall sheeting due to bowing in wall. **Mar 2020 – Dec 2020:** no discernible change.			
			
Windows and entry at west elevation **2012-18:** shows large trunk/branch portions of tree collapsed on roof, which has destroyed roof ventilator. **2018-20 (Mar):** shows majority of branches fallen from roof, leaving increased damage to sheeting. **Mar 2020 – Dec 2020:** no discernible change.			

2012	2018	2020 (Mar)	2020 (Dec)
			
Timber window detail, west elevation **2012-18:** no discernible change. **2018-20 (Mar):** no discernible change. **Mar 2020 – Dec 2020:** no discernible change.			
			
Showing cylindrical ventilator and damage to roof, view from west **2012-18:** shows significant roof damage from fallen dead tree, including to ventilator. **2018-20 (Mar):** shows increased damage to roof edge sheeting from fallen branch. **Mar 2020 – Dec 2020:** no discernible change.			

<table>
<tr><th>2012</th><th>2018</th><th>2020 (Mar)</th><th>2020 (Dec)</th></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="4">Detail of north-west elevation
2012-18: shows increased collapse over open kitchen area, as well as new damage to brick foundation at north-west corner.
2018-20 (Mar): shows fallen top of north wall plus increased (animal?) damage to brick foundation at north-western corner.
Mar 2020 – Dec 2020: no discernible change.</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="4">Showing interior damage at kitchen at north end of building
2012-18: shows increased collapse over and accumulation of debris within open kitchen area. Note also severe lean to north wall.
2018-20 (Mar): shows collapsed top of north wall and collapse of remaining full cross-beam.
Mar 2020 – Dec 2020: no discernible change.</td></tr>
</table>

2012	2018	2020 (Mar)	2020 (Dec)
			
Showing interior damage at kitchen at north end of building **2012-18:** shows increased collapse over and accumulation of debris within open kitchen area. Note also severe lean to north wall. **2018-20 (Mar):** shows collapsed top of north wall and collapse of remaining full cross-beam. **Mar 2020 – Dec 2020:** no discernible change.			
			
View to interior of south end of building, view from east **2012-18:** shows increased collapse over open kitchen area. **2018-20 (Mar):** shows further minor deterioration of asbestos panelling. **Mar 2020 – Dec 2020:** no discernible change.			

2012	2018	2020 (Mar)	2020 (Dec)
			
Showing stove at kitchen at north end **2012-18:** note the remaining two stove doors have become unhinged and build up of debris from collapsed roof. **2018-20 (Mar):** stove now obscured by collapsed north wall. **Mar 2020 – Dec 2020:** no discernible change.			

2012	2018	2020 (Mar)	2020 (Dec)
			
View to interior, showing west entry to building **2012-18:** no discernible change. **2018-20 (Mar):** no discernible change. **Mar 2020 – Dec 2020:** no discernible change.			
			
Showing west interior space **2012-18:** no discernible change. **2018-20 (Mar):** no discernible change. **Mar 2020 – Dec 2020:** no discernible change.			

2012	2018	2020 (Mar)	2020 (Dec)
			

Damaged brick foundation at south-east corner
2012-18: no discernible increase to cracked brick foundation.
2018-20 (Mar): further cracking of foundation (to left of shot) and some slumping of corner bricks.
Mar 2020 – Dec 2020: some slight potential further movement in cracked section (also note termite management system in bottom right hand corner of photograph.

2012	2018	2020 (Mar)	2020 (Dec)
			

Detail of damaged brick foundation
2012-18: some further collapse of concrete/cement above brick foundation.
2018-20 (Mar): some slumping outwards of corner brick foundation.
Mar 2020 – Dec 2020: no discernible change.

2012	2018	2020 (Mar)	2020 (Dec)
			
View to interior of building, looking north from south entry **2012-18:** no discernible change. **2018-20 (Mar):** no discernible interior change, but shows collapsed north wall. **Mar 2020 – Dec 2020:** no discernible change.			
			
View to interior of building from entry at west **2012-18:** no discernible change. **2018-20 (Mar):** no discernible change. **Mar 2020 – Dec 2020:** no discernible change.			

2012	2018	2020 (Mar)	2020 (Dec)
			

Showing interior of building, viewed from north-west corner
2012-18: shows collapsed roofing members above open kitchen area and accumulation of debris.
2018-20 (Mar): shows collapsed north wall across stove and additional fallen roof member.
Mar 2020 – Dec 2020: no discernible change.

Showing interior of building, viewed from north-west corner
2012-18: shows collapsed roofing members above open kitchen area and accumulation of debris.
2018-20 (Mar): shows additional collapsed roofing member.
Mar 2020 – Dec 2020: no discernible change.

The comparative photographs above show the changes at the building over the past eight years. Although no great change was noted between the current and the last inspection, no structural maintenance has occurred either. During this time it can be expected that the underlying causes of deterioration, such as the degeneration of wooden framework and metal panelling, and animal burrowing underneath the structure has continued. Therefore, the more significant changes and priority actions identified during the last inspection remain of importance and, if anything, their need of remediation has increased in urgency. Previous recommendations remain valid and the key issues remain:

- Damaged roof sheeting and roofing members, as well as increasing structural instability of bowing southern wall;
- Due to the complete collapse of remaining roofing members over the open kitchen area the top portion of the northern wall has now failed and fallen inside the building footprint; and
- Increased damage to brick foundation in north-west corner, and new slumping of south-west foundation corner.

It should be noted, however, that a termite management regime has been implemented around the site, which is a positive action and will assist in the arrest of the deterioration of the wooden aspects of the building. In addition, aerial drone photography of the site as recommended at the previous audit has been conducted and can be added to the site records.

Recommendations

High Priority Actions

1. If not already conducted, have an asbestos expert assess and develop a clean up and disposal plan to deal with both the broken fragments and intact asbestos sheeting;
2. Remove any remaining tree branches from the roof. In addition, to prevent similar damage in the future, serious consideration should be given to removing or lopping those trees that are located close enough to the building that they may cause damage if they fall or drop large branches;

High Priority Actions to Follow Actions 1 & 2

3. Pending the results of the asbestos assessment, the building and surrounds should be thoroughly cleaned of asbestos and other rubbish material. An archaeologist should be present to collect any items of historic importance or that relate to the original fabric

of the building. These can be stored inside the building and potentially re-used during further stabilization programs;

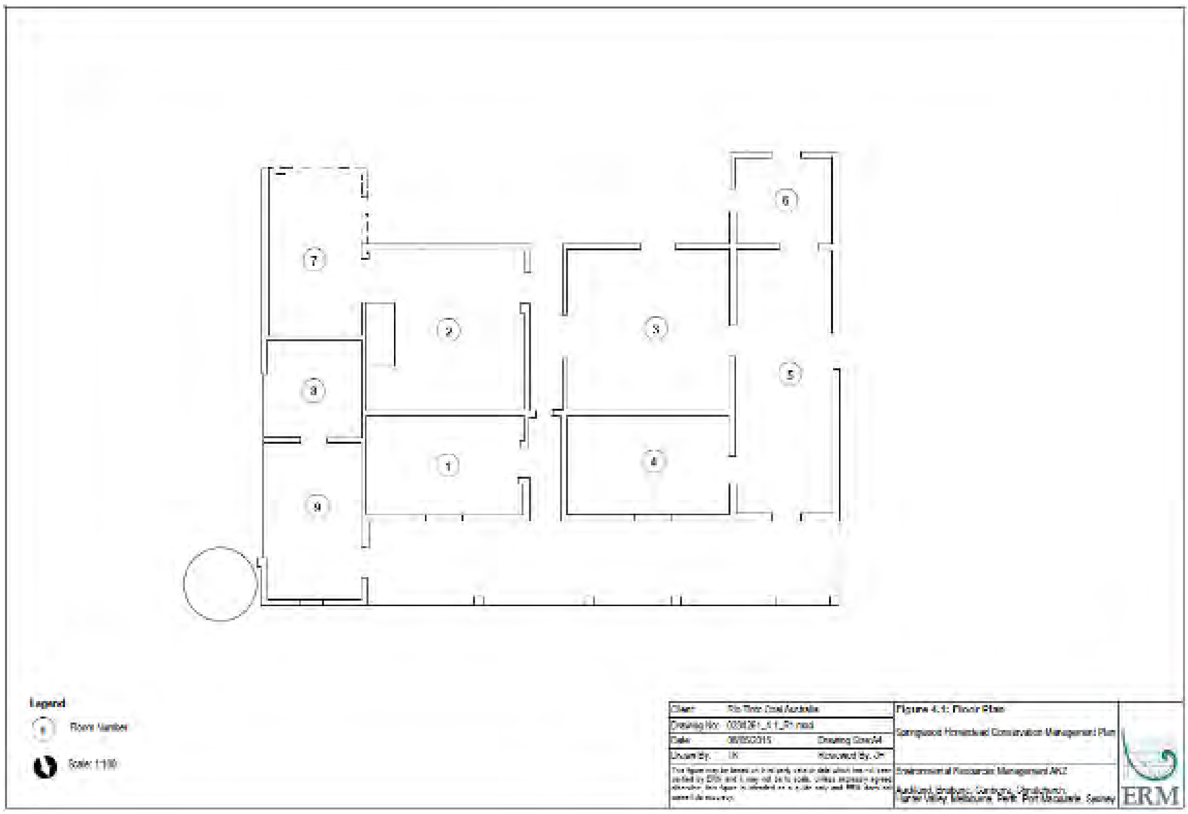
4. Pending the results of the asbestos assessment, any parts of the building framework, such as roofing members of walls should be stabilized and propped, using the Bligh Tanner plans as a guide;
5. A structural engineer should then inspect the building before any further works are commenced to make further recommendations on stability requirements and structural repairs. These further works should aim to reduce the likelihood and extent of any further deterioration at the site rather than seek to rebuild or renovate as it is unlikely that there would be any valid or appropriate option to re-use the site; and

Ongoing

6. Continue with the recently implemented termite monitoring regime.

Springwood Homestead

Based on historical research, Springwood Homestead is likely to have been constructed c.1860, and displays many characteristics of late Old Colonial Georgian and Victorian Georgian architecture, including an original shingle broken-backed roof, fanlights or transom lights, panelled doors and under-roof verandahs. The homestead is low-set, constructed in vertical timber slabs and built around a four room square core, as shown in the plan below (taken from ERM's 2015 CMP).



Given that Springwood Homestead is timber framed and in direct contact with the ground, it is remarkable that it is still standing and in a generally stable condition, with most roof rafters appearing to be still in place. Although the building fabric is generally intact there are a number of areas where the level of structural damage to the roof, wall and flooring members is high. The majority of the damage has occurred from termites and fungal decay, resulting in localised collapse of outer external walls and roof structures. Recently, vandalism has also been an issue, with many vertical timber slabs having been pilfered. Within the CMP developed for the site by ERM in 2015, a number of stabilisation measures have been recommended that will assist to reduce the extent of damage, however a return to a habitable state is not planned.

Springwood Homestead in 2012

CMP Recommendations

Although many recommendations are made within the CMP, the more important management measures have been incorporated within a conservation works schedule that covers the following issues:

- Drainage and weatherproofing;
- Asbestos;
- Vegetation;
- Termites and vermin;
- Building fabric; and
- Structural capacity and wind loads.

The works schedule prioritises the required conservation works and are presented with technical specifications from a structural engineer. Those measures that attend to the buildings structural integrity are the focus of the schedule.

High Priority

a) Remove debris from roof using a cherry picker or similar;
b) Remove tree from eastern elevation and stabilize building in this location;
c) Remove vine from eastern wall using combination of pruning and herbicide;

d) Remove tree from south-west corner and stabilize building in this location;
e) Prune all overhanging branches and maintain regular maintenance program; and
f) Reinstate southern verandah and roof to match northern elevation.

Moderate to Low Priority

g) Place treated plywood sheeting over door openings;
h) Prune trees, spray weeds and slash grass;
i) Clean up of site surrounds, overseen by archaeologist;
j) Clean up of building interior, overseen by archaeologist;
k) Refix loose ceiling boards, retaining evidence of fabric if unable to fix;
l) Refix loose and dislodged slabs and plates; and
m) Place treated plywood sheeting over openings and undertake repairs to windows.

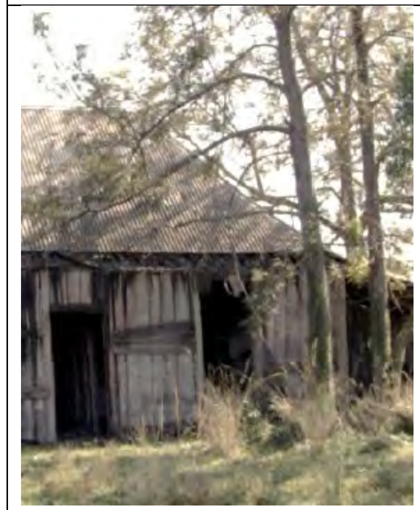
Photographic Comparison 2014 – 2018 – 2020 (March) – 2020 (December)

During the inspection of Springwood Homestead for this report, a number of photographs were taken from the same angles and of the same features as were taken during the 2018 and March 2020 HHMP compliance inspections, and the ERM 2014 assessment that informed the 2015 CMP. These photographs provide a visual baseline condition assessment of the building, and also allow a comparative analysis of the changes over the last six to eight years. These photographs are set out below, along with comments pertinent to management recommendations.

2014	2018	2020 (Mar)	2020 (Dec)
			
Eastern elevation **2014-8:** no discernible change. **2018-20 (Mar):** roof slumping appears to have increased. **Mar 2020-Dec 2020:** heavy leaf litter on roof persists. Positively, vegetation surrounding the house is occurring regularly.			
			
Looking towards south-west corner from south-west **2014-8:** no discernible change to tree impact, but note missing vertical slabs from southern wall. **2018-20 (Mar):** no discernible change, but vine still growing. **Mar 2020-Dec 2020:** no discernible change.			

2014	2018	2020 (Mar)	2020 (Dec)
			

Southern elevation
2014-8: vertical timber slabs have been removed from southern wall.
2018-20 (Mar): possible deterioration of shingles at roof edge, and missing panels from above back door.
Mar 2020-Dec 2020: no discernible change.

Southern elevation
2014-8: vertical timber slabs have been removed from southern wall.
2018-20 (Mar): possible deterioration of shingles at roof edge, and missing panels from above back door.
Mar 2020-Dec 2020: no discernible change.

<table>
<tr><th>2014</th><th>2018</th><th>2020 (Mar)</th><th>2020 (Dec)</th></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="4">Southern elevation doorway
2014-8: door has been removed.
2018-20 (Mar): no discernible change.
Mar 2020-Dec 2020: no discernible change.</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="4">South-eastern corner
2014-8: vertical slabs have been removed causing further collapse of roof.
2018-20 (Mar): further deterioration of eastern wall.
Mar 2020-Dec 2020: heavy leaf litter on roof persists.</td></tr>
</table>

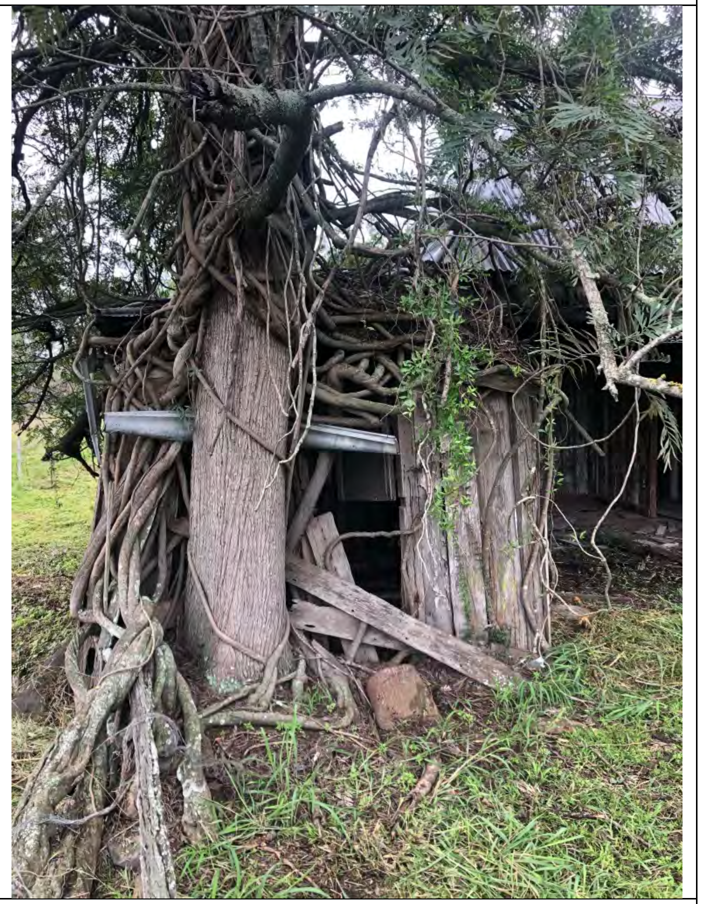
2014	2018	2020 (Mar)	2020 (Dec)
			
Eastern side **2014-8:** debris has been cleaned and stored and a weed removal program conducted. The house area has also been fenced. **2018-20 (Mar):** further deterioration of eastern wall and regrowth of weeds. **Mar 2020-Dec 2020:** no discernible change.			
			
Room 2 interior **2014-8:** increased debris caused by removal of southern wall. **2018-20 (Mar):** no discernible change. **Mar 2020-Dec 2020:** no discernible change.			

2014	2018	2020 (Mar)	2020 (Dec)
			
South-west corner **2014-8:** shows removal of vertical slabs from southern wall. **2018-20 (Mar):** no discernible change. **Mar 2020-Dec 2020:** no discernible change.			
			
Northern elevation **2014-8:** further deterioration of weatherboard panelling. **2018-20 (Mar):** no discernible change, though termite activity present. **Mar 2020-Dec 2020:** grass/weed growth encroaching over verandah floor.			

2014	2018	2020 (Mar)	2020 (Dec)
			
South-east corner **2014-8:** shows removal of vertical slabs from southern wall, and some from eastern wall, and further collapse of roof. **2018-20 (Mar):** further roof slumping and deterioration of eastern wall. **Mar 2020-Dec 2020:** no discernible change.			
			
Eastern elevation **2014-8:** possible further collapse of crossbeam and guttering. **2018-20 (Mar):** tree continues to impact eastern roof line. **Mar 2020-Dec 2020:** increased impact on roofline by tree branches.			

2014	2018	2020 (Mar)	2020 (Dec)
			

Northern elevation
2014-8: slumping of verandah along edge beam.
2018-20 (Mar): no discernible change.
Mar 2020-Dec 2020: grass/weed growth encroaching over verandah floor.

View of south-west corner from south
2014-8: shows removal of vertical slabs from southern wall as well as some increase in vegetation growth.
2018-20 (Mar): no discernible change but continuing vegetation impacts.
Mar 2020-Dec 2020: Apparent increased vine growth.

The comparative photographs above show the changes at the building over the past seven years. Although no great change was noted between the current and the last inspection, no structural maintenance has occurred either. During this time it can be expected that the underlying causes of deterioration, such as the degeneration of wooden framework, impacts caused by adjacent trees and the effects of weather entering the unsealed building has continued. Therefore, the more significant changes and priority actions identified during the last inspection remain of importance and, if anything, their need of remediation has increased in urgency. Previous recommendations remain valid and the key issues remain:

- The removal of all of the vertical timber slabs from the southern wall continue to have a negative impact on the structural integrity of this side of the building, allowing weather and the associated adverse impacts into the building; and
- The continued growth of trees and vines are also having impacts on structural stability in the south-western corner and along the eastern roof line;

It should be noted, however, that a termite management regime has been implemented around the site, which is a positive action and will assist in the arrest of the deterioration of the wooden aspects of the building. Also, a vegetation management regime is in place that sees regular maintenance within the fenced compound. In addition, aerial drone photography of the site as recommended at the previous audit has been conducted and can be added to the site records.

Recommendations

Management recommendations have been prioritised as high or moderate importance, and high priority recommendations should be actioned as soon as possible, after which the conservation works schedule within the CMP can be re-evaluated and amended by a structural engineer prior to further works being commenced.

High Priority

1. Remove the trees and vines currently impacting the building at the eastern elevation and south-west corner and treat to prevent regrowth. Coincident with this removal, acrow props should be installed where appropriate, i.e. where the trees themselves have been supporting the building structure, and as per the structural engineer's instructions at Annex B of the CMP;
2. Once vegetation has been removed, clean all debris from the roof and prune (or consider the removal of) all other trees in close vicinity of the building with potential to drop leaf/branch litter on roof;

3. Clear the surroundings of the building of rubbish, overgrowth and weeds in the accompaniment of an archaeologist to ensure any items of historical relevance are salvaged and stored within the homestead; and
4. Due to the damage caused by the removal of the vertical slabs, once the items above are complete, a structural engineer should then re-inspect the building before any further works are commenced to make further recommendations on stability requirements and structural repairs.

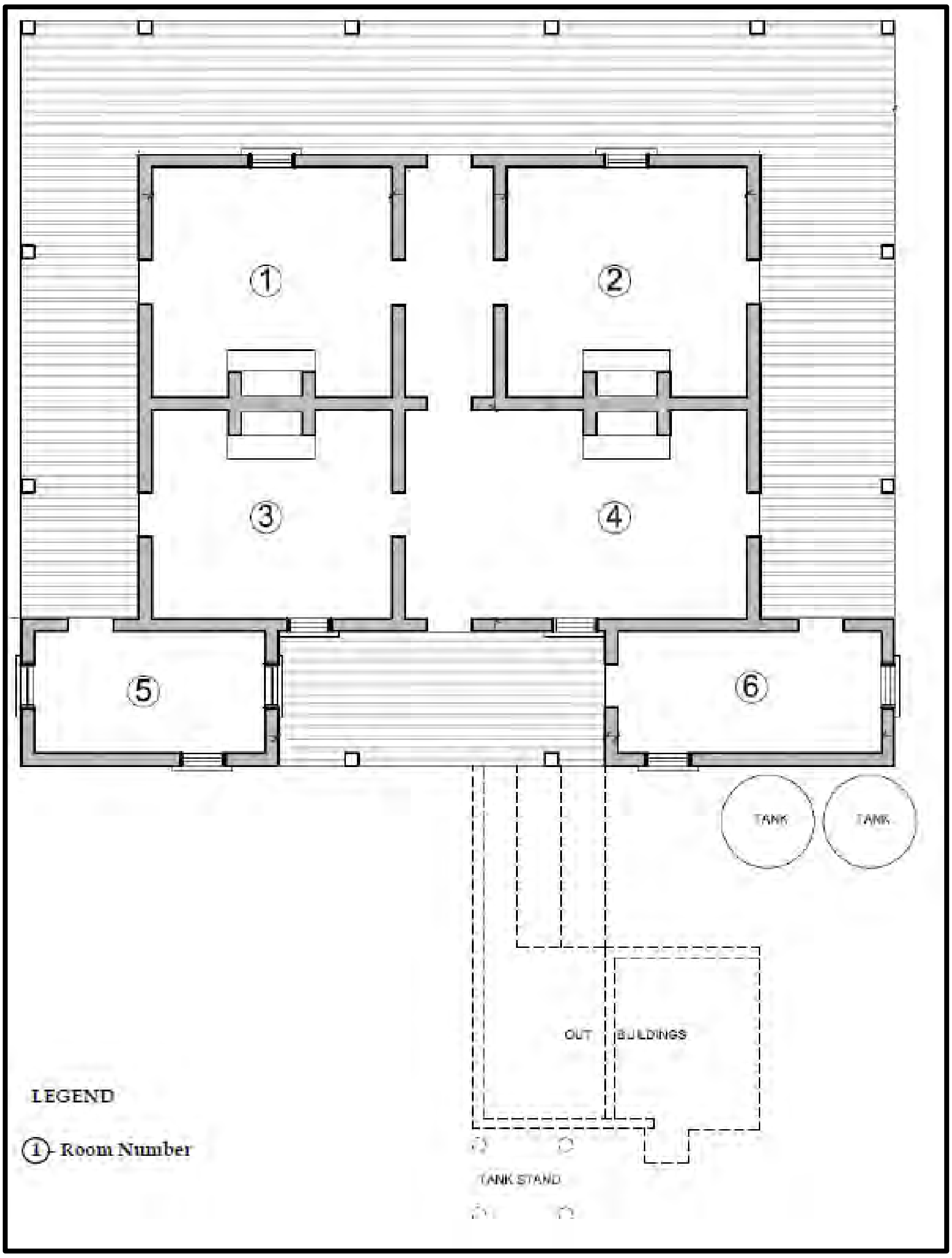
Moderate Priority

Once the high priority recommendations have been attended to, the structural engineer may recommend different or additional measures than originally put forward. Notwithstanding these, the following moderate priority measures are recommended to attain compliance with the CMP and enhance the condition of the homestead:

1. Due to their propensity to harbour termites and transfer infestation to the building, remove all peppercorn trees from around the building;
2. Future condition inspections should photograph the building using the photograph views and locations presented above so that any changes to the building can be documented in subsequent inspections;
3. Maintain the regular vegetation maintenance program;
4. Pending structural engineer's advice, reinstate southern wall, verandah and roof to match northern elevation.
5. Pending reconstruction of southern wall, place treated plywood sheeting over door and window openings;
6. Clean up of building interior, overseen by archaeologist;
7. Pending structural engineer's advice, refix loose ceiling boards and loose and dislodged wall slabs and plates, retaining evidence of fabric if unable to fix;
8. Ensure the minor recommendations and 'policies' listed throughout Section 7 of the CMP are considered in the future management of the homestead; and
9. Give consideration to an archaeological excavation and research program at the site, with possible community involvement, to explore the areas of archaeological potential identified in the CMP.
10. Maintain the termite and pest control regime at the building.

Mount Thorley Brick Farm House

The Mount Thorley Brick Farm House is located off the Golden Highway opposite the MTW coal handling and preparation plant, c.10km south-west of Singleton. The portion of land on which the house sits was purchased by Eliza Glass in 1870 and the physical attributes of the house, which display characteristics of Victorian Georgian architecture, suggest that it was constructed during the following decade. The building is roughly square in plan, with four principal rooms flanking a central hallway.



Floor plan of Mount Thorley Brick Farm House, north up (from ERM 2015 CMP)

The masonry structure of the building is sound, however, it was noted as being in poor physical condition in 2015 (when a CMP was developed for the site by ERM), with a collapsed verandah roof, missing or loose roof sheeting, missing or collapsed verandah posts, and floorboards and areas affected by termites. The conservation works schedule within the CMP considered the following issues at Mount Thorley Brick Farm House:

- Drainage and weather-proofing;
- Asbestos;
- Vegetation;
- Termites and vermin;
- Building fabric; and
- Structural capacity and wind loads.

Recommendations were made within the CMP's conservation works schedule to address the elements above, a number of which have completed by the proponent. These works included:

- Removal and safe storage of verandah;
- Initial vegetation clearing;
- Sheeting and sealing of all window and door openings;
- Clean up of scattered debris surrounding building; and
- Repair of loose roof sheeting and patching of holes.

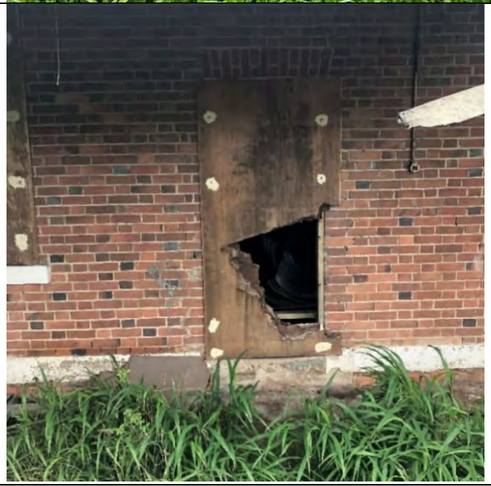
Monitoring and maintenance of these repaired items is an ongoing requirement to ensure they provide continual protection to the building.

Mount Thorley Brick Farm House (2012)

Photographic Comparison 2015 – 2018 – 2020 (March) – 2020 (December)

During the inspection of the Mount Thorley Brick Farm House for this report, a number of photographs were taken from the same angles and of the same features as were taken during previous HHMP compliance inspections as well as the ERM 2015 assessment that informed the CMP. These photographs provide a visual baseline condition assessment of the building, and also allow a comparative analysis of the changes over the last five years. These photographs are set out below, along with comments pertinent to management recommendations.

<table>
<tr><th>2015</th><th>2018</th><th>2020 (Mar)</th><th>2020 (Dec)</th></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="4">View of north-west side
2015-8: verandah removed and stored inside building, vegetation has been managed
2018-20 (Mar): vegetation has regrown around building
Mar 2020-Dec 2020: vegetation again under control, panel above boarded door requires refixing.</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="4">View of north-west roof corner (focus on damaged roof)
2015-8: roofing sheets have been replaced and holes patched
2018-20 (Mar): some minor roof holes and lifted sheeting noted
Mar 2020-Dec 2020: some verandah flashing fallen, panel above door requires refixing.</td></tr>
</table>

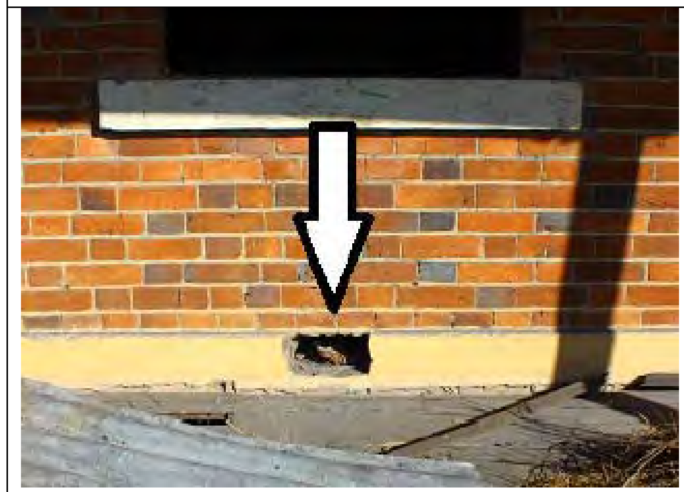
2015	2018	2020 (Mar)	2020 (Dec)
			
			
View of door and window panelling **2015-8:** sheeting installed on all openings, however some repair required **2018-20 (Mar):** some repair of panelling required **Mar 2020-Dec 2020:** Front door panel requires reinstallation. Broken panel remains unrepaired			
			
View of rear of building (view south) **2015-8:** debris has been cleared and stacked **2018-20 (Mar):** vegetation has regrown around building and stacked debris **Mar 2020-Dec 2020:** vegetation cleared and debris restacked			

2015	2018	2020 (Mar)	2020 (Dec)
			
View of rear of building (view north) **2015-8:** debris has been cleared and stacked **2018-20 (Mar):** vegetation has regrown around building and stacked debris **Mar 2020-Dec 2020:** vegetation cleared and debris restacked			

2015	2018	2020 (Mar)	2020 (Dec)
			
			
View of eastern verandah (focus on verandah floor) **2015-8:** posts and sheeting removed, damaged boards remain exposed **2018-20 (Mar):** damaged boards remain and vegetation growth throughout **Mar 2020-Dec 2020:** damaged boards remain and vegetation growth throughout			

2015	2018	2020 (Mar)	2020 (Dec)
			
View of rear of building (focus on roof) **2015-8:** skillion roof, guttering and rafters have collapsed; main roof holes repaired **2018-20 (Mar):** no discernible change **Mar 2020-Dec 2020:** some minor holes in roofing require repair			
			
View of north-east of building **2015-8:** wall element has collapsed (bricks stacked under window); roof framing, sheeting and guttering has collapsed **2018-20 (Mar):** no discernible change **Mar 2020-Dec 2020:** no discernible change			

2015	2018	2020 (Mar)	2020 (Dec)
			
View of north-east corner of building (focus wall below window) **2015-8:** bricks from roof above stacked in front of required repointing, window sheeting removed **2018-20 (Mar):** no discernible change **Mar 2020-Dec 2020:** repointing requirements remain			
			
View of south-east of building (focus on top of wall) **2015-8:** no discernible change **2018-20 (Mar):** no discernible change **Mar 2020-Dec 2020:** no discernible change			

2015	2018	2020 (Mar)	2020 (Dec)
			
View of eastern verandah (focus on dwarf wall wall) **2015-8:** debris cleared from verandah, no change to dwarf wall **2018-20 (Mar):** no discernible change **Mar 2020-Dec 2020:** cracking to wall evident			
			
View of ventilation grilles **2015-8:** grilles not replaced **2018-20 (Mar):** no discernible change **Mar 2020-Dec 2020:** grilles remain open			

2015	2018	2020 (Mar)	2020 (Dec)
			
View of southern chimney **2015-8:** no discernible change **2018-20 (Mar):** no discernible change **Mar 2020-Dec 2020:** no discernible change			

Recommendations

The comparative photographs above show the changes at the building over the past six years. As with the other two buildings, although no great change was noted between the current and the last inspection, no structural maintenance has occurred either. During this time it can be expected that the underlying causes of deterioration, such as the degeneration of wooden framework and the effects of weather entering through unsealed sections has continued. Therefore, the more significant changes and priority actions identified during the last inspection remain of importance and, if anything, their need of remediation has increased in urgency. Previous recommendations remain valid and the key issues remain:

- Considerable damage and exposure to the rear of the building;
- Loose, damaged and removed window and door sheeting; and
- Some new roof holes and loose sheeting.

It should be noted, however, that, like Springwood Homestead, a termite management regime has been implemented around the site, which is a positive action and will assist in the arrest of the deterioration of the wooden aspects of the building. Also, a vegetation management regime is in place that sees regular maintenance around the building. In addition, aerial drone photography of the site as recommended at the previous audit has been conducted and can be added to the site records.

While many of the high and moderate priority recommended actions within the CMP conservation works schedule have been completed in the past, the 2020 inspection has identified that some items need renewed attention. The recommendations outlined below are required to minimise the risk of further deterioration in the building structure.

High Priority

1. Replace any damaged plywood door/window coverings and ensure all coverings are tightly attached;
2. Patch fix any new damage to roofing sheets;
3. If any asbestos or fibrous cement sheeting remains at the property, engage an asbestos removalist to remove as required;

Moderate Priority

4. Check that all debris surrounding the house has been removed. If this has not occurred, remove all debris, ensuring an archaeologist is on hand to identify and catalogue any early architectural fittings or rare pieces of joinery that should be retained for future restoration purposes;
5. Reinstall verandah, including verandah decking and northern brick dwarf wall, re-using original material where possible, as per recommendations M5, M6 and L1 in the CMP conservation works schedule;
6. As the roof above Room 6 has collapsed, salvage any reusable masonry or timber and set aside within room. Engage a structural engineer to advise on feasibility of reconstructing the roof. (NB. Recommendation M9 in the CMP conservation works schedule erroneously refers to Room 5 rather than Room 6 as shown in the photograph);
7. Replace gutters around the house to match existing materials and ogee profile. Install new down-pipes and ensure they are discharging away from the building.
8. Repoint mortar joints with lime based mortar on brickwork below Room 6 eastern elevation window sill, on northern wall of room 5 and all chimneys;
9. Install new ventilation grilles to existing ground level openings; and
10. Maintain the termite and pest control regime at the building.
11. Maintain the vegetation management program.

Appendix 3:

Annual Stream Health and Stability Report

2020 STREAM HEALTH AND STABILITY REPORT

Mount Thorley Warkworth

SLR Ref: 630.30119-R01
Version No: -v0.2
February 2021

PREPARED BY

SLR Consulting Australia Pty Ltd
ABN 29 001 584 612
2 Lincoln Street
Lane Cove NSW 2066 Australia
(PO Box 176 Lane Cove NSW 1595 Australia)
T: +61 2 9427 8100
E: sydney@slrconsulting.com   www.slrconsulting.com

BASIS OF REPORT

DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
630.30119-R01-v0.1	28 January 2021	Stephane Peignelin / Samuel McDonald	Paul Delaney	Paul Delaney
630.30119-R01-v0.2	25 February 2021	Stephane Peignelin / Samuel McDonald	Paul Delaney	Paul Delaney

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APPENDICES

1 Introduction

SLR Consulting Australia Pty Ltd (SLR) was initially engaged in December 2017 by Bulga Surface Operations (BSO) and Mount Thorley Warkworth (MTW) to conduct channel stability and stream health monitoring of creeks adjacent to the mine sites. An integrated channel monitoring program was developed as both mines discharge into the same drainage lines (e.g. Loders Creek). The monitoring program includes channel stability and stream health assessments at six specific monitoring points (two of which are only specific to BSO and one point which is only specific to MTW). In addition it also includes a visual inspection of Loders Creek from the Hunter River to the MTW discharge point to identify any areas of increased erosion.

SLR has subsequently carried out the 2018, 2019 and 2020 annual channel stability and stream health monitoring to identify any changes to the creeks including any new erosion features in accordance with regulatory requirements. This report has been specifically prepared for the MTW monitoring points and should be read in conjunction with the 2017, 2018 and 2019 reports for better understanding.

MTW has advised there have been nil licenced discharge events from the MTW discharge point between the 2019 stream health monitoring event and the 2020 monitoring event. There has been 958 mm of rainfall recorded within the on-site rainfall gauge for the period October 2019 to Mid-January 2021. In comparison, the Bureau of Meteorology shows 974 mm of rainfall recorded at Singleton (Singleton Defence AWS 61430) for the same period. Overall, this round of monitoring was subjected to a significantly wetter year than the previous rounds of monitoring and that was reflected by an increase in vegetation growth.

2 METHODOLOGY

In accordance with the accepted scope of works the following procedure was undertaken at each monitoring site:

1. Documenting locations and dimensions of significant erosive or depositional features;
2. Photographs upstream, downstream and at both banks;
3. Rating the site with the Ephemeral Stream Assessment protocol developed by the CSIRO to assess the erosional state of the creek at the monitoring location (a measure of channel stability);
4. Rating the site with the Rapid Appraisal of Riparian Condition protocol developed by Land & Water Australia. This assesses the ecological condition of riparian habitats using indicators that reflect functional aspects of the physical, community and landscape features of the riparian zone (a measure of stream health); and
5. Taking measurements of the channel cross-sections (transects) for comparison purposes for any future monitoring.

2.1 Rapid Appraisal of Riparian Condition (RARC)

The RARC is an assessment method incorporating indicators of geophysical and biological properties and processes which are likely to provide reliable estimates of ecological condition in riverine ecosystems (Land & Water Australia, 2005). The RARC index is made up of five sub-indices, each with a number of indicator variables which can be seen in **Table 1** below.

Table 1 Summary table of indicators, functions and components assessed in the RARC (Land and Water Australia, 2005)

Functions of the riparian zone at different levels of organisation	Components of the riparian ecosystem that perform those functions	Indicators of the functions used in the RARC
Physical:		
Reduction of erosion of banks	Roots, ground cover	Vegetation cover*
Sediment trapping	Roots, fallen logs, ground cover	Canopy cover, fallen logs, ground cover vegetation, leaf litter cover
Controlling stream microclimate/ discharge/water temperatures	Riparian forest	Canopy cover
Filtering of nutrients from upslope	Vegetation, leaf litter	Ground cover vegetation, leaf litter cover
Community:		
Provision of organic matter to aquatic food chains	Vegetation	Vegetation cover*, leaf litter cover
Retention of plant propagules	Fallen logs, leaf litter	Fallen logs, leaf litter cover
Maintenance of plant diversity	Regeneration of dominant species, presence of important species, dominance of natives *versus* exotics	Native canopy and shrub regeneration, grazing damage to regeneration, reeds, native vegetation cover*
Provision of habitat for aquatic and terrestrial fauna	Fallen logs, leaf litter, standing dead trees/hollows, riparian forest, habitat complexity	Fallen logs, leaf litter cover, standing dead trees, hollows, vegetation cover*, number of vegetation layers
Landscape:		
Provision of biological connections in the landscape	Riparian forest (cover, width, connectedness)	Vegetation cover*, width of riparian vegetation, longitudinal continuity of riparian vegetation, proximity to other habitat
Provision of refuge in droughts	Riparian forest	Vegetation cover*

* Vegetation cover = canopy, understorey and ground cover

In accordance with previous annual stream health surveys undertaken at the site, classifications have been assigned based on the total score as assessed by the RARC methodology. It is useful to compare this total score over time to see how the biodiversity and functionality of the riparian zone is progressing at each of the monitoring points. **Table 2** below outlines these classifications.

Table 2 Summary RARC Classification System

RARC Total Score	Classification
40-50	Excellent
35-39	Good

RARC Total Score	Classification
30-34	Average
25-29	Poor
<25	Very Poor

2.2 CSIRO Ephemeral Stream Assessment

The CSIRO *Ephemeral Stream Assessment* procedures (CSIRO, date unknown) were used to assess the channel stability of Loders Creek in the vicinity of the MTW Mine. The assessment uses four main classes of indicators to evaluate the degree of stream-bed condition:

1. The type and condition of the vegetation present, if any;
2. The shape and profile of the drainage line and type of materials on the drainage line floor;
3. The nature of the drainage line wall materials; and
4. The nature of the stream bank bordering flats and/or slopes and regulation of lateral flow into the drainage line.

The indicators produce a rating based on a scoring system, and the combined total of the indicators rank each location from very actively eroding through to very stable as shown in **Table 3.** This enables an assessment to be made as to whether the section of creek has changed since previous rounds of annual monitoring.

Table 3 Classification of different drainage line states (CSIRO)

Activity Rating (%)	Classification	Discussion of Classification
80 +	Very Stable	Drainage line is very stable and likely to be in original form. It is able to withstand all flow velocities that have previously occurred in this area and only minimal monitoring is required, predominantly after high flow events, to ensure condition does not deteriorate.
70-80	Stable	Drainage line is stable. It is important to assess this zone in relation to the other classifications and define whether this zone is moving from potentially stabilising to a more stable form, or if it is deteriorating from a very stable form. The nature of this relationship will identify the type of monitoring required.
60-69	Potentially Stabilising	Drainage line is potentially stabilising. Ongoing monitoring is required while rehabilitation works are not needed in the immediate future.
50-59	Active	Drainage line is actively eroding and remedial actions are required. It is important to classify if erosion is caused primarily by upstream flows, lateral flows or unstable wall materials so that appropriate rehabilitation can be carried out.

Activity Rating (%)	Classification	Discussion of Classification
< 50	Very Active	Drainage line is very actively eroding and immediate remedial actions are required. It is important to classify if erosion is caused primarily by upstream flows, lateral flows or unstable wall materials so that appropriate rehabilitation can be carried out.

Table Source: CSIRO Ephemeral Stream Assessment (CSIRO, date unknown)

2.3 Transects at Monitoring Points

Transect data is collected at the monitoring points to provide a representation of the drainage line profile. The transect assessment allows for simple identification of any deposition of sediments within the channel bed or scouring of the banks by comparison with profile measurements on a yearly basis.

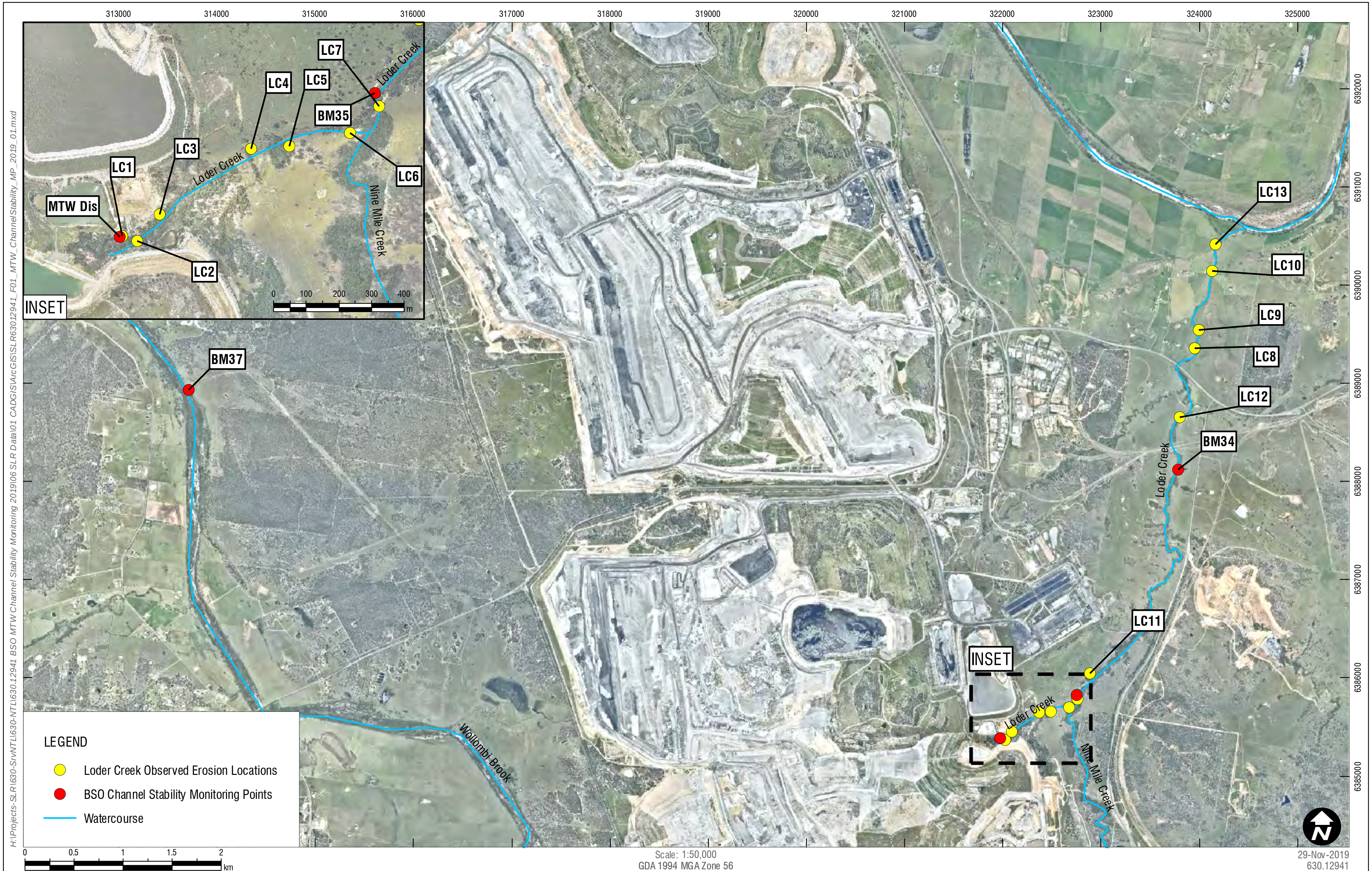
The transect assessment is undertaken by extending a tape measure laterally across the drainage line to two permanently fixed posts which are located within the riparian zone. A survey staff is then used to measure the vertical distance between the tape and the ground surface at approximately 0.5 m increments or at points which capture any sudden changes in channel geometry (e.g. steep channel banks).

2.4 Visual Assessment of Loders Creek

A visual inspection of Loders Creek from the Hunter River to the MTW discharge point was undertaken to identify any areas of increased erosion. Where erosion was observed within this reach of Loders Creek the following were recorded:

- Documented locations and dimensions of notable erosive or depositional features;
- Photos so that comparisons could be made in future surveys; and
- Rating the site with the *Ephemeral Stream Assessment* protocol developed by the CSIRO to assess the erosional state of the creek at the monitoring location.

Any visible changes that occurred since the preceding inspection will be documented by comparison to the photos taken during the previous surveys.



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MTW Channel Stability Monitoring Points - 2020

FIGURE 1

3 Results

3.1 Channel Stability / Stream Health Monitoring Site Results

3.1.1 MTW Discharge Point (321966 E 6385379 N)

This monitoring point is located at the Mount Thorley discharge point (MTW Dis). This section of creek has been upgraded and now includes rock armouring of the creek bed as well as jute mesh and seeding of both banks. Overall, the creek stability at this location has improved from the previous monitoring cycle and is now stabilising.

The banks are characterised by patches of scattered eucalypts with Bull Oak (*Allocasuarina luehmannii*) and Swamp Oak (*Casuarina glauca*) dominating the canopy. The understorey is sparse consisting mainly of Acacia shrubs scattered on the bank. An increase in groundcover was observed on either side of the rock armoured area likely due to recent rainfalls. While there was an increase in exotic grass (and some prickly pear), regeneration of canopy species was observed. It should be noted while there is still very little diversity in either canopy or groundcover species the diversity of canopy and groundcover species appears to be increasing. Both banks of the creek contain an almost continuous band of riparian vegetation in widths less than 40m wide, with the exception of the cleared area where the discharge construction works occurred. Exotic grass and bare soil (mine workings and vehicle tracks) surround riparian vegetation. Debris such as leaf litter and fallen logs are evident as well as standing dead trees. Linkage to larger areas of native vegetation is absent. The channel of the creek line contained dense native *Juncus* spp.

RARC Stream Health Assessment Classification – **Average**

CSIRO Ephemeral Stream Assessment Classification – **Potentially Stabilising**

Photos taken at the established photo points for this monitoring point are shown in Plate 1 to Plate 4.

Plate 1 Right Bank

Plate 2 Upstream

Plate 3 Downstream

Plate 4 Left Bank

For the purpose of monitoring any changes to the creek, a creek line transect was established. The transect is shown in **Figure 2** and was taken from left to right looking downstream. It can be seen from this transect that the channel hasn't changed significantly since the previous monitoring cycle. It should also be noted that as part of the upgrade works, the peg on the left bank was removed which explains why this round of monitoring shows a shorter length of transect. Difference in the data appears to be within the expected transect accuracy tolerances, it is not possible to discern if there has been bed erosion across at transect location.

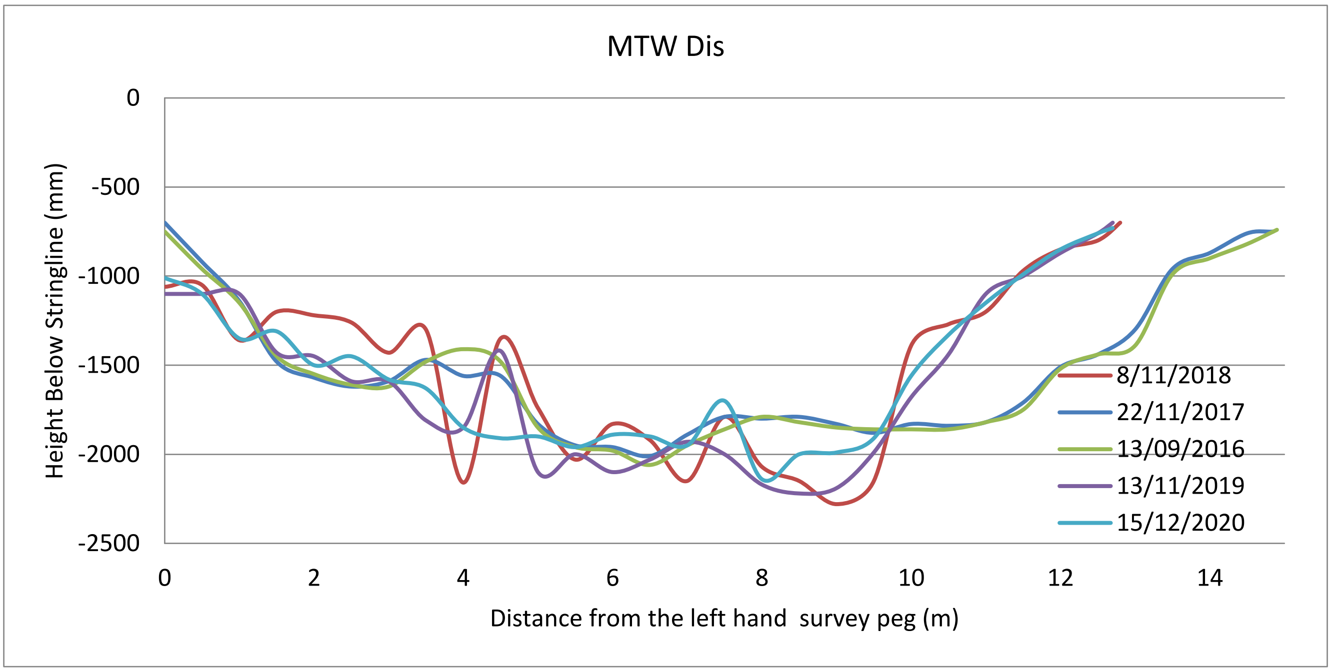

Figure 2 MTW Dis Transect Results

3.1.2 BM35 (322746 E 6385819 N)

The channel at this location was observed to have a good coverage of long grass across the bed. The left bank also appears stable with good grass coverage. The right bank contains some lateral erosion (approximately 0.5m high) at the top of the bank. The lateral erosion is forming some rill/gully erosion down this bank, however the rest of the right bank appears to be stable with good grass coverage. Overall, this location shows similar conditions to the previous monitoring cycle.

The creek banks are characterised by Swamp Oak (*Casuarina glauca*) with scattered eucalypts upslope. Both banks of the creek contained an almost continuous band of riparian vegetation in widths mostly around 15m wide with one patch downstream extending to 40m wide. The understory consisted of weeds including Paddy's Lucerne and Rhodes Grass. Exotic pastures surrounded riparian vegetation and linkage to other areas of native vegetation was absent. The channel of the creek line contained dense native *Typha* spp. with exotic grasses. Regenerating canopy tree (mostly *Casuarina glauca*) species were abundant. There has been no noticeable change since the last monitoring period.

RARC Stream Health Assessment Classification – **Poor**

CSIRO Ephemeral Stream Assessment Classification – **Active**

Photos taken at the established photo points for this monitoring point are shown in Plates 5 to 9.

Plate 5 Right Bank

Plate 6 Upstream

Plate 7 Downstream

Plate 8 Left Bank

Plate 9 Erosion (top of right bank)

For the purpose of monitoring any changes of the creek, a creek line transect was established. The transect is shown in **Figure 3** and was taken from left to right looking downstream. It suggests that no significant scouring has occurred on the banks or creek bed since the previous monitoring cycles. A slight dip in the 2020 data at the 2m mark was caused by tussock vegetation and any other difference in the data appears to be within the expected transect accuracy tolerances.

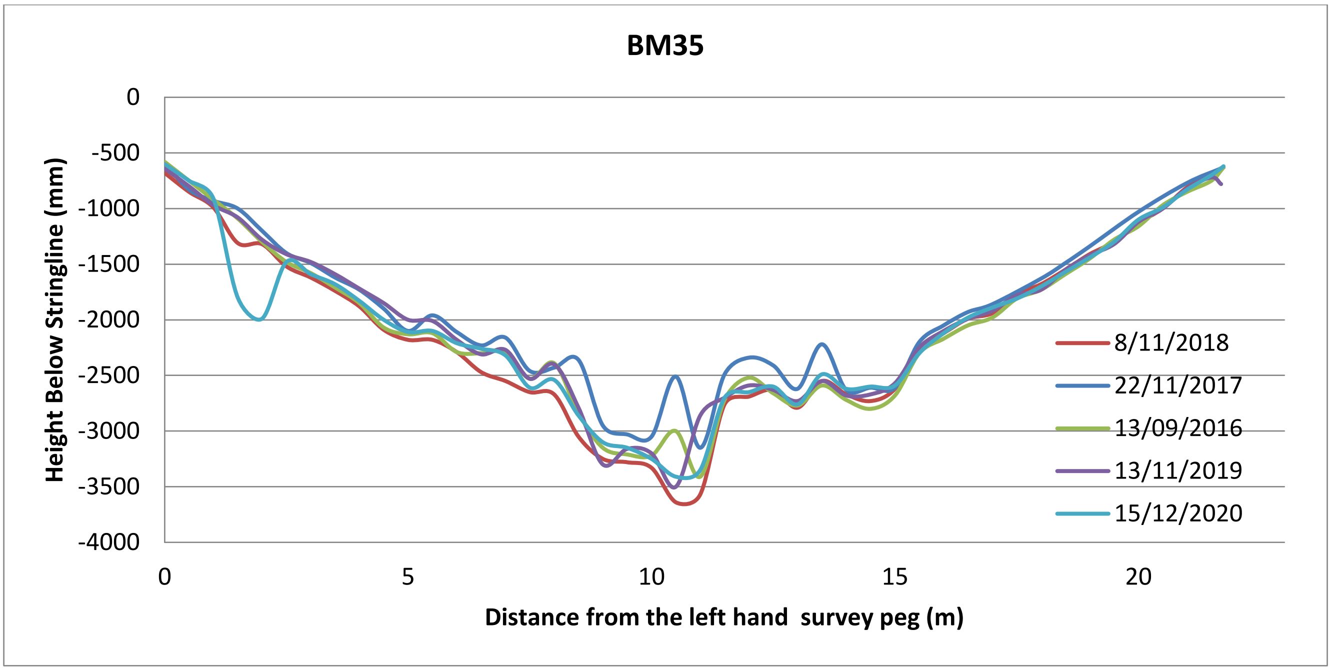

Figure 3 BM35 Transect Results

3.1.3 BM34 (323779 E 6388119 N)

The creek bed at this monitoring point is covered by reeds and is stable. Both the left and right banks have good grass coverage and appear to be stable with gentle-moderate slopes. The creek upstream and downstream of the monitoring point also appears to be stable. The creek has a very slight meander at this monitoring point. Overall, this location has remained the same as the previous monitoring cycle conditions.

The banks were characterised by dense Swamp Oak (*Casuarina glauca*), tall River Oak *(Casuarina cunninghamia)* with scattered eucalypts. The creek is congested with *Juncus spp* and *Phragmites australis.* The understory contained high levels of weed infestation. Paddy's Lucerne and in particular African Boxthorn were abundant below the canopy particularly upstream of the monitoring point. An increase in blackberry nightshade was also observed on the upper slope of the banks. It should be noted that Lantana had been significantly reduced since the last monitoring period due to recent weed works. Native Weeping Grass (*Microlaena stipoides*) was present in small patches beneath the denser canopy areas. Both banks of the creek contained an almost continuous band of riparian vegetation in widths less than 30m wide. Exotic pastures surrounded riparian vegetation and linkage to other areas of native vegetation was absent. Regenerating canopy tree (mostly *Casuarina glauca*) species were abundant. The generally revealed vegetation growth since the last monitoring period especially in the stream bed where *Juncus spp* and *Phragmites australis* has continued to grow during favourable climatic conditions. However overall, there was very little observable change in vegetation structure.

RARC Stream Health Assessment Classification – **Average**

CSIRO Ephemeral Stream Assessment Classification – **Stable**

Photos taken at the established photo points for this monitoring point are shown in Plates 10 to 13.

Plate 10 Right Bank

Plate 11 Upstream

Plate 12 Downstream

Plate 13 Left Bank

For the purpose of monitoring any changes of the creek, a creek line transect was established. The transect is shown in **Figure 4** and was taken from left to right looking downstream for previous rounds of monitoring. Due to flowing water in the creek, SLR was unable to undertake the 2020 transect. Visual inspection of the monitoring location suggested that the creek cross section hasn't changed since the 2019 monitoring cycle.

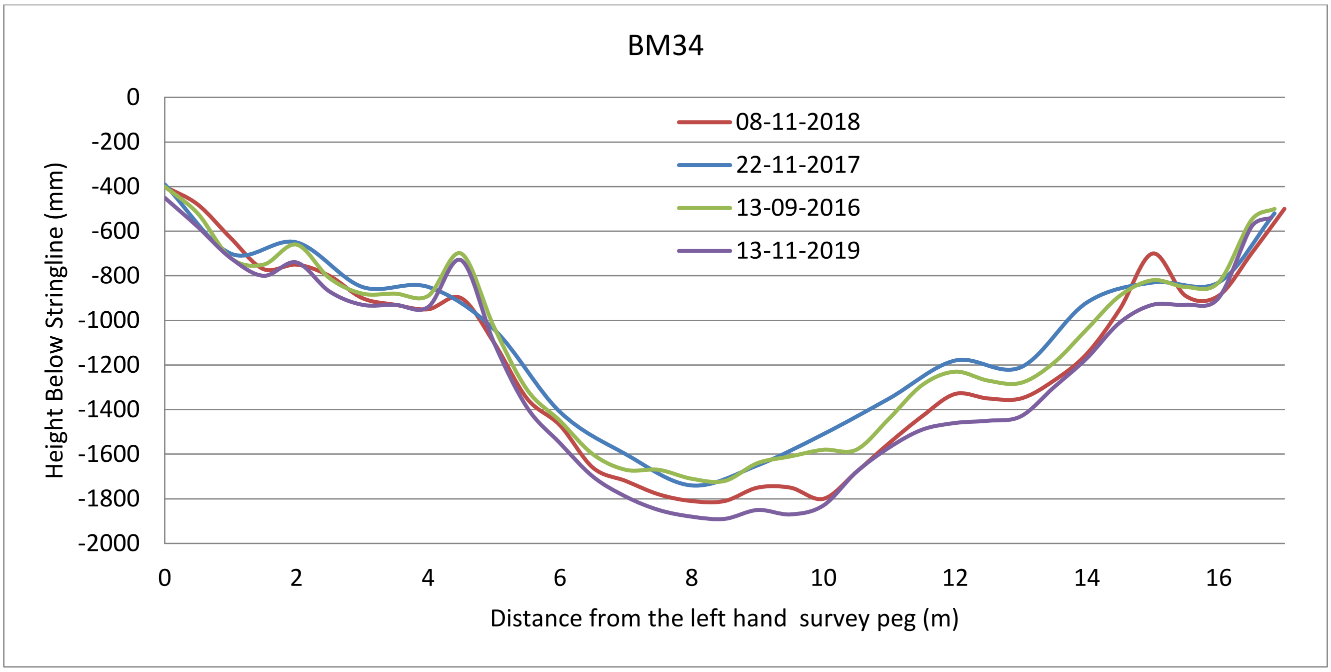

Figure 4 BM34 Transect Results

3.1.4 BM37 (313709 E 6388933 N)

Monitoring point BM37 is the only monitoring point that is located on Wollombi Brook. Wollombi Brook is a large tributary of the Hunter River, with channel widths ranging from 10m to 60m. Generally, Wollombi Brook has flowing water in it except during extreme drought periods. Water was observed to be flowing at the time of the inspection. Both the left and right banks appeared to be generally stable with both banks containing trees. The right bank is steeper than the left bank with a moderate slope and a height of approximately 2m. A pipe outlet exists immediately downstream of the monitoring point on the eastern bank and has scoured out the bank slightly with some exposed moderately dispersive soils (approximately 0.3m high). Some wombat holes were also observed on the eastern bank. Overall, this location has remained the same as the previous monitoring cycle conditions.

At sample site BM37, only the eastern side of Wollombi Brook was surveyed, as the width and depth of the stream prevented transects extending across the full width of the stream. Riparian vegetation along a 280 meter reach of the stream was surveyed, with four parallel transects established across the riparian zone upstream and downstream of the sample site (marker point). Generally, only a thin band (of between 5m to 15m in width) of native riparian forest exists along the banks of the stream. The innermost parts of the riparian zone, extending over a series of steep terraced banks, comprise of a narrow band of modified open forest of mainly Swamp Oak (*Casuarina glauca*), River Oak (*Casuarina cunninghamiana*) and occasional Cabbage Gum *Eucalyptus amplifolia*. The lower bank edges contain patches of dense reeds, including *Typha orientalis*, *Phragmites australis* and the exotic *Juncus acutus*. Patches of Parramatta Green Wattle *Acacia parramattensis*, as well as juvenile (or early mature) eucalypts and casuarinas, form a mid-canopy in places; however, generally the vegetation lacks a shrub layer. Leaf litter, as well as exotic grasses and herbs, dominates the ground layer, with common species being Paddy's Lucerne *Sida rhombifolia*, Panic Veldt Grass *Ehrharta erecta* and Common Sowthistle *Sonchus oleraceus*. The native Weeping Grass (*Microlaena stipoides*) occurs occasionally in shaded bank areas.

Upslope of this vegetation, extending to the outer parts of the riparian zone, the forest canopy gives way to cleared land comprising with exotic pasture grass, supporting a range of common exotic grasses and herbs, including African Lovegrass *Eragrostis curvula*, Narrow-leafed Carpet Grass *Axonopus fissifolius*, Couch *Cynodon dactylon* and several other species. A dramatic increase in groundcover was observed on the flat sections of the bank including large blankets of ***Typha orientalis*** and patches of Sowthistle *Sonchus oleraceus.* The canopy layer appeared to be denser than the previous monitoring event which was likely due to the recent climatic conditions favourable for vegetation growth.

RARC Stream Health Assessment Classification – **Poor**

CSIRO Ephemeral Stream Assessment Classification – **Potentially Stabilising**

Photos taken at the established photo points for this monitoring point are shown in Plates 14 to 19.

Plate 14 Right Bank

Plate 15 Upstream

Plate 16 Downstream

Plate 17 Left Bank

Plate 18 Erosion

Plate 19 Erosion

3.2 Loders Creek Erosion Visual Assessment

3.2.1 LC1 (321974 E 6385382 N)

The erosion at LC1 has been remediated as part of upgrade work on the Mount Thorley discharge point. The works undertaken at this erosion site included rock armouring of the creek bed as well as jute mesh and seeding of both banks. Overall, this location has improved greatly and is now considered stable.

CSIRO Ephemeral Stream Assessment Classification – **Stable**

Photos taken at the established photo points for this monitoring point are shown in Plates 20 to 23.

Plate 20 Right Bank

Plate 21 Upstream

Plate 22 Downstream

Plate 23 Left Bank

3.2.2 LC2 (322019 E 6385367 N)

The erosion observed at LC2 included a steep near vertical section of exposed dispersive material (approximately 2m high) on the right bank. This area appeared to be actively eroding including some areas immediately downstream. The erosion at this monitoring location appears to be similar to what was observed in the 2018 survey. A tree was observed to have fallen over at this section of the exposed creek bank. The creek bed and left bank appear to be stable at this location.

CSIRO Ephemeral Stream Assessment Classification – **Active**

Photos taken at the established photo points for this monitoring point are shown in Plates 24 to 26.

Plate 24 Upstream

Plate 25 Downstream

Plate 26 Erosion

3.2.3 LC3 (322087 E 6385446 N)

This location is positioned at a small channel entry point to Loders Creek (on the left bank). The channel appears to be stable, however the confluence point has some significant erosion with some slight undercutting and tunnelling of the dispersive soil. Overall, this monitoring location appears very similar to the previous monitoring cycle.

CSIRO Ephemeral Stream Assessment Classification – **Very Active**

Photos taken at the established photo points for this monitoring point are shown in Plates 27 to 30.

Plate 27 Upstream

Plate 28 Downstream

Plate 29 Erosion

Plate 30 Tunnel Erosion

3.2.4 LC4 (322367 E 6385647 N)

LC4 is located under a powerline in an area where it appears that vegetation has been maintained within the powerline easement. The near vertical left bank on the outside of the creek meander is about 4-5m high and has some exposed dispersive material (approximately 1m high) near the top of the bank however this erosion has shown signs of potentially stabilising. The right bank is much flatter and appears to be stable, as does the creek bed. Overall, this monitoring location has shown similar conditions to the previous monitoring cycle.

CSIRO Ephemeral Stream Assessment Classification – **Potentially Stabilising**

Photos taken at the established photo points for this monitoring point are shown in Plates 31 to 33.

Plate 31 Right Bank

Plate 32 Left Bank

Plate 33 Downstream

3.2.5 LC5 (322484 E 6385655 N)

LC5 is located in a historic diversion of Loders Creek. The erosion observed at LC5 included erosion extending up the right bank approximately 20-30m. The area has 0.5-1.0m high steep exposed walls surrounding 5m of exposed soil. The creek bed and left bank appear to be stable. Overall, this monitoring location has shown similar conditions to the previous monitoring cycle.

CSIRO Ephemeral Stream Assessment Classification – **Active**

Photos taken at the established photo points for this monitoring point are shown in Plates 34 to 37.

Plate 34 Right Bank

Plate 35 Upstream

Plate 36 Downstream

Plate 37 Erosion (top of right bank)

3.2.6 LC6 (322670 E 6385697 N)

The erosion observed at LC6 included significant lateral erosion near the top of the right bank. This erosion was approximately 1m high with an alluvial fan extending approximately 2m from the near vertical bank. The rest of the right bank appears to stable as does the creek bed and the left bank. Overall, this monitoring location appears similar to the previous monitoring cycle. The active erosion appears to be primarily the result of a historic disturbance of the top of the right bank which has exposed the highly dispersive soils at this location.

CSIRO Ephemeral Stream Assessment Classification – **Active**

Photos taken at the established photo points for this monitoring point are shown in Plates 38 to 40.

Plate 38 Right Bank

Plate 39 Erosion

Plate 40 Erosion

3.2.7 LC7 (322759 E 6385778 N)

The erosion observed at LC7 included an area of active erosion of a steep comprising exposed dispersive clay material (approximately 0.8m high) on the right bank, however this erosion is not laterally extensive. The erosion appears to have been caused by lateral flow across the bare banks in the area. The right bank appears to be stable downslope of the eroded area, as does the creek bed and the left bank. Overall, this monitoring location has shown similar conditions to the previous monitoring cycle.

CSIRO Ephemeral Stream Assessment Classification – **Active**

Photos taken at the established photo points for this monitoring point are shown in Plates 41 to 43.

Plate 41 Right Bank

Plate 42 Upstream

Plate 43 Erosion

3.2.8 LC8 (323948 E 6389351 N)

The erosion observed at LC8 included significant erosion of the left bank (approximately 1m high with the overall bank at approximately 2.5m high) at a location with a slight meander in the creek. The erosion has some minor undercutting with a section of vertical banks partly stabilised by tree roots. Vegetation growth at this location appears to have increased since the last round of monitoring. This is most likely linked to the alluvial nature of the soil as well as the continuous rainfall observed in the region in the last few months. Trees at this location are at risk of falling over due to loss of support. The creek bed and right bank appear to be stable. Overall, this monitoring location has shown similar conditions to the previous monitoring cycle.

CSIRO Ephemeral Stream Assessment Classification – **Potentially Stabilising**

Photos taken at the established photo points for this monitoring point are shown in Plates 44 to 47.

Plate 44 Right Bank

Plate 45 Upstream

Plate 46 Downstream

Plate 47 Left Bank

3.2.9 LC9 (323996 E 6389540 N)

The erosion observed at LC9 included some loss of exposed slightly dispersive material on the right bank which may have been caused by livestock in the area. This bank is about 2m high and has about 0.8m of exposed soil. The area appears to be stabilising and this round of monitoring has shown an increase in vegetation growth. This is most likely linked to the continuous rainfall observed in the region in the last few months. The creek bed and the left bank appear to be stable. Overall, this monitoring location has shown similar conditions to the previous monitoring cycle.

CSIRO Ephemeral Stream Assessment Classification – **Potentially Stabilising**

Photos taken at the established photo points for this monitoring point are shown in Plates 48 to 51.

Plate 48 Right Bank

Plate 49 Upstream

Plate 50 Downstream

Plate 51 Left Bank

3.2.10 LC10 (324131 E 6390142 N)

The erosion observed at LC10 is located immediately downstream of a concrete lined chute. The soil is alluvial and non-dispersive. The erosion has been created from scouring of the right bank during large flow events with the upstream chute increasing the velocity of the water to this downstream section of channel. This scouring has exposed some tree roots of some of the trees that line the creek bank. The creek has steep slopes on both banks (approximately 3m high) and was observed flowing at the time of monitoring. The creek is generally stable upstream and downstream except for some cattle tracks immediately upstream on the right bank. Overall, this monitoring location has shown similar conditions to the previous monitoring cycle.

CSIRO Ephemeral Stream Assessment Classification – **Active**

Photos taken at the established photo points for this monitoring point are shown in Plates 52 to 55.

Plate 52 Right Bank

Plate 53 Upstream

Plate 54 Downstream

Plate 55 Left Bank

3.2.11 LC11 (322881 E 6386043 N)

The erosion observed at LC11 includes some significant tunnelling and active erosion on the left bank with exposed vertical dispersive soil. Potential causes for this erosion include wombat holes as well as the presence of a contour bank overflow (which is located immediately upslope of the erosion). Trees were observed on both banks and creek bed. The creek bed and the right bank both show stable conditions. Overall, this monitoring location has shown similar conditions to the previous monitoring cycle.

CSIRO Ephemeral Stream Assessment Classification – **Active**

Photos taken at the established photo points for this monitoring point are shown in Plates 56 to 59.

Plate 56 Upstream

Plate 57 Right Bank

Plate 58 Erosion

Plate 59 Erosion

3.2.12 LC12 (323802 E 6388650 N)

The erosion observed at LC12 includes some erosion (approximately 2m high) on the left bank. It is likely that this erosion was at least partially caused by a fallen tree at the monitoring point location. The 2020 monitoring cycle shows this erosion partially vegetated. This is most likely linked to the continuous rainfall observed in the region in the last few months. The left bank at the monitoring point is significantly higher than the right bank. The creek bed and the right bank both show stable conditions.

CSIRO Ephemeral Stream Assessment Classification – **Potentially Stabilising**

Photos taken at the established photo points for this monitoring point are shown in Plates 60 to 63.

Plate 60 Right Bank

Plate 61 Upstream

Plate 62 Downstream

Plate 63 Left Bank

3.2.13 LC13 (324160 E 6390408 N)

LC13 includes some erosion extending for approximately 5m on the steep left bank with exposed soil which doesn't appear to be highly dispersive. This erosion was most likely caused by livestock tracks observed upstream and downstream of the monitoring location or a localised slope failure. Other than more vegetation as a result of continuous rainfall in the region, this monitoring location has shown similar conditions to the previous monitoring cycle.

CSIRO Ephemeral Stream Assessment Classification – **Potentially Stabilising**

Photos taken at the established photo points for this monitoring point are shown in Plates 64 to 67.

Plate 64 Right Bank

Plate 65 Upstream

Plate 66 Downstream

Plate 67 Left Bank

4 Summary of Results

Site	RARC Stream Heath Assessment Classification				CSIRO Ephemeral Stream Assessment Classification				Primary Cause of Erosion
	2017	2018	2019	2020	2017	2018	2019	2020	
MTW Dis	Poor	Poor	Poor	Average	Active	Potentially Stabilising	Potentially Stabilising	Potentially Stabilising	Lateral Inflows
BM35	Poor	Poor	Poor	Poor	Active	Active	Active	Active	Unstable Wall Materials
BM34	Poor	Poor	Average	Average	Very Stable	Stable	Stable	Stable	NA
BM37	Average	Poor	Poor	Poor	Stable	Stable	Potentially Stabilising	Potentially Stabilising	NA
LC1	NA	NA	NA	NA	Active	Stable	Stable	Stable	NA
LC2	NA	NA	NA	NA	Active	Active	Active	Active	Unstable Wall Materials
LC3	NA	NA	NA	NA	Very Active	Very Active	Very Active	Very Active	Upstream Flows
LC4	NA	NA	NA	NA	Potentially Stabilising	Potentially Stabilising	Potentially Stabilising	Potentially Stabilising	Unstable Wall Materials
LC5	NA	NA	NA	NA	Potentially Stabilising	Active	Active	Active	Unstable Wall Materials
LC6	NA	NA	NA	NA	Active	Active	Active	Active	Unstable Wall Materials
LC7	NA	NA	NA	NA	Active	Active	Active	Active	Lateral Inflows

Site	RARC Stream Heath Assessment Classification				CSIRO Ephemeral Stream Assessment Classification				Primary Cause of Erosion
	2017	2018	2019	2020	2017	2018	2019	2020	
LC8	NA	NA	NA	NA	Potentially Stabilising	Potentially Stabilising	Potentially Stabilising	Potentially Stabilising	Upstream Flows
LC9	NA	NA	NA	NA	Potentially Stabilising	Potentially Stabilising	Potentially Stabilising	Potentially Stabilising	Unstable Wall Materials
LC10	NA	NA	NA	NA	Potentially Stabilising	Active	Potentially Stabilising	Active	Upstream Flows
LC11	NA	NA	NA	NA	Active	Active	Active	Active	Wombat Activity, Contour Bank Overflows
LC12	NA	NA	NA	NA	Active	Active	Potentially Stabilising	Potentially Stabilising	Fallen Tree
LC13	NA	NA	NA	NA	Active	Active	Active	Potentially Stabilising	Livestock Tracks

5 Conclusion and Recommendations

MTW advise there have been nil licenced discharge events from the MTW discharge point between the 2019 stream health monitoring event and the 2020 monitoring event. There has been 958 mm of rainfall recorded within the on-site rainfall gauge for the period October 2019 to Mid-January 2021. In comparison, the Bureau of Meteorology shows 974 mm of rainfall recorded at Singleton (Singleton Defence AWS 61430) for the same period. Overall, this round of monitoring was subjected to a significantly wetter year than the previous rounds of monitoring and that was reflected by an increase in vegetation growth.

The results of this monitoring survey indicate that both stream health and channel stability fluctuate over different sections of Loders Creek. The survey identified that some sections of Loders Creek are currently eroding and are vulnerable to further erosion with areas of significant erosion observed. These areas are generally associated with exposed dispersive sub-soils, which hamper vegetation establishment by the development of a hard surface crust when the soil is dry, and the 'melting' nature of the soil when wet.

The survey identified that the majority of Loders Creek displayed stable environments. Generally, the monitoring identified that the creeks have not significantly changed from what was observed during the 2019 survey. Many sections of the creek experience active erosion as a result of natural influences. Improvements were also identified during the 2020 survey, resulting from both natural occurrences as well as man-made upgrade works undertaken in 2018 at MTW Discharge Point.

The CSIRO rating has upgraded for LC13 while downgraded for LC10 from what was observed during the 2019 inspection although the observed conditions were similar. This is largely related to the subjectivity using the methodology proposed by CSIRO and therefore is subjected to change where there is a change in assessor.

The RARC stream health assessment identified that the monitoring points on Loders Creek were classified as poor and average. It should be noted that MTW Discharge Point situated on Loders Creek increased from the upper range of 'poor' to the lower range of 'average' due to an increase in debris such as leaf litter as well as standing dead trees. The single monitoring point on Wollombi Brook (BM37) was classed as poor with little change observed since monitoring in 2019 with the exception of groundcover growth. Due to the consistent rainfall over the spring/ summer months a noticeable increase in vegetation mass was identified across all sites.

It is recommended that MTW adopt a risk-based approach to determine whether mitigation measures and/or improvement works are required at the monitoring points where erosion was observed. Different remediation measures may be utilised depending on the type of erosion that has occurred (as listed in **Section 4**).

For example, erosion caused by lateral flows and unstable wall materials may be remediated by re-grading the batter slope (as required) to a maximum gradient of 3(H):1(V), ripping the soil and then seeding with a suitable vegetation species. Gypsum may also be used as a soil ameliorant and applied at a rate of 1kg/m^2. Bunding may also be used to control upslope lateral flows. Creek erosion caused by the shear stresses associated with the upstream flows may be remediated by armouring of the creek bed / banks (i.e. rock, jute mesh, erosion blanket etc), as was observed to have been implemented by MTW at location MTW Discharge Point during the 2018 survey.

6 References

Land & Water Australia (2005), Rapid Appraisal Of Riparian Condition – Version Two (River and Riparian Technical Guideline No. 4a)

Commonwealth Scientific and Research Organisation (CSIRO) (date unknown) - Ephemeral Stream Assessment, date accessed 14/09/09,

http://www.cse.csiro.au/research/ras/efa/resources/ephemeraldrainagelineassessment.pdf

APPENDIX A

Rapid Appraisal of Riparian Conditions

Rapid Appraisal of Riparian Condition

Site Number: **BM34**

Site:	**Loders Creek**	**GPS start:**	**see figure**
Date:	**14-01-2021** **Observer:** **SM**	**GPS end:**	

Longitudinal continuity of riparian canopy vegetation (>5m wide)

Map	Score
	4

0 = <50%, 1 = 50-64%, 2 = 65-79%, 3 = 80-94%, 4 = ≥95% vegetated bank;

with ½ point subtracted for each significant discontinuity (>50m long)

Width of riparian canopy vegetation

Transect	Channel Width (CW)	Vegetation Width (VW)	Score
1	6	25	3
2	6	20	3
3	6	15	2
4	6	15	2
Average			2.5

Channel ≤10m wide: 0 = VW <5m, 1 = VW 5-9m , 2 = VW 10-19m, 3 = VW 20-39m, 4 = VW ≥40m

Channel >10m wide: 0 = VW/CW <0.5, 1 = VW/CW 0.5-0.9, 2 = VW/CW 1-1.9, 3 = VW/CW 2-3.9, 4 = VW/CW ≥4

Proximity

Score
2

Nearest patch of native vegetation >10ha:

0 = >1km, 1 = 200m-1km, 2 = contiguous,

3 = contiguous with patch >50ha

Vegetation cover: Canopy >5m, Understorey 1-5m, Ground cover <1m

Transect	Canopy	Native canopy	Understorey	Native understorey	Ground cover	Native ground cover	# layers
1	1	1	2	0	3	2	3
2	1	1	2	0	3	2	3
3	3	3	2	0	3	2	3
4	3	3	2	0	3	2	3
Average	2	2	2	0	3	2	3

Canopy and ground cover: 0 = none, 1 = 1-30%, 2 = 31-60%, 3 = >60%

Understorey cover: 0 = none, 1 = 1-5%, 2 = 6-30%, 3 = >30%

Debris

Transect	Leaf litter	Native leaf litter	Standing dead trees	Hollow-bearing trees	Fallen logs
1	1	1	0	0	1
2	1	1	0	0	1
3	1	1	0	0	1
4	1	1	0	0	1
Average	1	1	0	0	1

Leaf litter & native leaf litter cover: 0 = none, 1 = 1-30%, 2 = 31-60%, 3 = >60%

Standing dead trees (>20cm dbh) & hollow-bearing trees: 0 = absent, 1 = present

Fallen logs (>10cm diameter): 0 = none, 1 = small quantities, 2 = abundant

Features

Transect	Native canopy species regeneration	Native understorey regeneration	Large native tussock grasses	Reeds
1	1	1	2	2
2	1	1	2	2
3	1	1	2	2
4	1	1	2	2
Average	1	1	2	2

Regeneration <1m tall: 0 = none, 1 = scattered, and 2 = abundant, with ½ point subtracted for grazing damage

Reeds & large tussock grasses: 0 = none, 1 = scattered, and 2 = abundant

Calculation of scores

Site Number:	BM34

Longitudinal continuity of riparian canopy vegetation

Score
4

Width of riparian canopy vegetation

Average	2.5

Proximity

Score
2

Vegetation cover

	Canopy	Native canopy	Understorey	Native understorey	Ground cover	Native ground cover	# layers
Average	2	2.5	2	0	3	2	3

Debris

	Leaf litter	Native leaf litter	Standing dead trees	Hollow-bearing trees	Fallen logs
Average	1	1	0	0	0

Features

	Native canopy species regeneration	Native understorey regeneration	Large native tussock grasses	Reeds
Average	1	1	1	2

TOTALS

Site:	Habitat	Cover	Natives	Debris	Features	**Total**
(out of)	11	12	9	10	8	50
	8.5	10	4.5	2	5	30

Rapid Appraisal of Riparian Condition

Site Number: **BM35**

Site:	**Loders Creek**	**GPS start:**	**See figure**
Date:	**14-01-2021** **Observer:** **SM**	**GPS end:**	

Longitudinal continuity of riparian canopy vegetation (>5m wide)

Map	Score
	3

0 = <50%, 1 = 50-64%, 2 = 65-79%, 3 = 80-94%, 4 = >95% vegetated bank;

with ½ point subtracted for each significant discontinuity (>50m long)

Width of riparian canopy vegetation

Transect	Channel Width (CW)	Vegetation Width (VW)	Score
1	5	18	2
2	5	25	3
3	5	30	3
4	5	60	4
Average			3

Channel <10m wide: 0 = VW <5m, 1 = VW 5-9m , 2 = VW 10-19m, 3 = VW 20-39m, 4 = VW >40m

Channel >10m wide: 0 = VW/CW <0.5, 1 = VW/CW 0.5-0.9, 2 = VW/CW 1-1.9, 3 = VW/CW 2-3.9, 4 = VW/CW >4

Proximity

Score
1

Nearest patch of native vegetation >10ha:

0 = >1km, 1 = 200m-1km, 2 = contiguous,

3 = contiguous with patch >50ha

Vegetation cover: Canopy >5m, Understorey 1-5m, Ground cover <1m

Transect	Canopy	Native canopy	Understorey	Native understorey	Ground cover	Native ground cover	# layers
1	3	3	2	0	3	0	3
2	3	3	2	0	3	0	3
3	3	3	2	0	3	0	3
4	3	3	2	0	1	0	3
Average	3	3	2	0	2.5	0	3

Canopy and ground cover: 0 = none, 1 = 1-30%, 2 = 31-60%, 3 = >60%

Understorey cover: 0 = none, 1 = 1-5%, 2 = 6-30%, 3 = >30%

Debris

Transect	Leaf litter	Native leaf litter	Standing dead trees	Hollow-bearing trees	Fallen logs
1	3	3	0	0	1
2	3	3	0	0	1
3	3	3	0	0	0
4	3	3	0	0	0
Average	3	3	0	0	0.5

Leaf litter & native leaf litter cover: 0 = none, 1 = 1-30%, 2 = 31-60%, 3 = >60%

Standing dead trees (>20cm dbh) & hollow-bearing trees: 0 = absent, 1 = present

Fallen logs (>10cm diameter): 0 = none, 1 = small quantities, 2 = abundant

Features

Transect	Native canopy species regeneration	Native understorey regeneration	Large native tussock grasses	Reeds
1	1	1	2	2
2	1	1	2	2
3	1	1	2	2
4	1	1	2	2
Average	1	1	2	2

Regeneration <1m tall: 0 = none, 1 = scattered, and 2 = abundant, with ½ point subtracted for grazing damage

Reeds & large tussock grasses: 0 = none, 1 = scattered, and 2 = abundant

Calculation of scores

Site Number:	BCC01

Longitudinal continuity of riparian canopy vegetation

Score
3

Width of riparian canopy vegetation

Average	3

Proximity

Score
1

Vegetation cover

	Canopy	Native canopy	Understorey	Native understorey	Ground cover	Native ground cover	# layers
Average	2.25	2.25	2	0	2	0	3

Debris

	Leaf litter	Native leaf litter	Standing dead trees	Hollow-bearing trees	Fallen logs
Average	3	3	0	0	0

Features

	Native canopy species regeneration	Native understorey regeneration	Large native tussock grasses	Reeds
Average	1	1	1	2

TOTALS

Site:	Habitat	Cover	Natives	Debris	Features	**Total**
(out of)	11	12	9	10	8	50
	7	9.25	2.25	6	5	29.5

Rapid Appraisal of Riparian Condition

Site Number: **BM37**

Site:	**Wollomi Brook**	**GPS start:**	**See figure**
Date:	**15-12-2020** **Observer:** **SM**	**GPS end:**	

Longitudinal continuity of riparian canopy vegetation (>5m wide)

Map	Score
	3

0 = <50%, 1 = 50-64%, 2 = 65-79%, 3 = 80-94%, 4 = >95% vegetated bank;

with ½ point subtracted for each significant discontinuity (>50m long)

Width of riparian canopy vegetation

Transect	Channel Width (CW)	Vegetation Width (VW)	Score
1	20	15	1
2	10	17	2
3	20	20	4
4	10	35	3
Average			2.5

Channel <10m wide: 0 = VW <5m, 1 = VW 5-9m , 2 = VW 10-19m, 3 = VW 20-39m, 4 = VW >40m

Channel >10m wide: 0 = VW/CW <0.5, 1 = VW/CW 0.5-0.9, 2 = VW/CW 1-1.9, 3 = VW/CW 2-3.9, 4 = VW/CW >4

Proximity

Score
2

Nearest patch of native vegetation >10ha:

0 = >1km, 1 = 200m-1km, 2 = contiguous,

3 = contiguous with patch >50ha

Vegetation cover: Canopy >5m, Understorey 1-5m, Ground cover <1m

Transect	Canopy	Native canopy	Understorey	Native understorey	Ground cover	Native ground cover	# layers
1	3	3	2	1	3	1	3
2	3	3	2	1	3	1	3
3	3	3	2	1	3	1	3
4	3	3	2	1	3	1	3
Average	3	3	2	1	3	1	3

Canopy and ground cover: 0 = none, 1 = 1-30%, 2 = 31-60%, 3 = >60%

Understorey cover: 0 = none, 1 = 1-5%, 2 = 6-30%, 3 = >30%

Debris

Transect	Leaf litter	Native leaf litter	Standing dead trees	Hollow-bearing trees	Fallen logs
1	2	2	0	0	0
2	2	2	0	0	0
3	2	2	0	0	0
4	2	2	0	0	0
Average	2	2	0	0	0

Leaf litter & native leaf litter cover: 0 = none, 1 = 1-30%, 2 = 31-60%, 3 = >60%

Standing dead trees (>20cm dbh) & hollow-bearing trees: 0 = absent, 1 = present

Fallen logs (>10cm diameter): 0 = none, 1 = small quantities, 2 = abundant

Features

Transect	Native canopy species regeneration	Native understorey regeneration	Large native tussock grasses	Reeds
1	0	0	1	2
2	0	0	1	2
3	0	0	1	2
4	0	0	1	2
Average	0	0	1	2

Regeneration <1m tall: 0 = none, 1 = scattered, and 2 = abundant, with ½ point subtracted for grazing damage

Reeds & large tussock grasses: 0 = none, 1 = scattered, and 2 = abundant

Calculation of scores

Site Number:	BM37

Longitudinal continuity of riparian canopy vegetation

Score
3

Width of riparian canopy vegetation

Average	2.5

Proximity

Score
2

Vegetation cover

	Canopy	Native canopy	Understorey	Native understorey	Ground cover	Native ground cover	# layers
Average	2	2	2	1	3	1	3

Debris

	Leaf litter	Native leaf litter	Standing dead trees	Hollow-bearing trees	Fallen logs
Average	2	2	0	0	0.5

Features

	Native canopy species regeneration	Native understorey regeneration	Large native tussock grasses	Reeds
Average	0	0	1	2

TOTALS

Site:	Habitat	Cover	Natives	Debris	Features	**Total**
(out of)	11	12	9	10	8	50
	7.5	10	4	4.5	3	29

Rapid Appraisal of Riparian Condition

Site Number: **MTW DIS**

Site:	**Mount Thorley Warkworth Discharge Point (MTW DIS PT)**	**GPS start:**	
	See figure		
Date:	**14-01-2021** **Observer:** **SM**	**GPS end:**	

Longitudinal continuity of riparian canopy vegetation (>5m wide)

Map	Score
	2

0 = <50%, 1 = 50-64%, 2 = 65-79%, 3 = 80-94%, 4 = ≥95% vegetated bank;

with ½ point subtracted for each significant discontinuity (>50m long)

Width of riparian canopy vegetation

Transect	Channel Width (CW)	Vegetation Width (VW)	Score
1	3	75	4
2	3	15	2
3	5	45	4
4	7	55	4
Average			3.5

Channel ≤10m wide: 0 = VW <5m, 1 = VW 5-9m , 2 = VW 10-19m, 3 = VW 20-39m, 4 = VW ≥40m

Channel >10m wide: 0 = VW/CW <0.5, 1 = VW/CW 0.5-0.9, 2 = VW/CW 1-1.9, 3 = VW/CW 2-3.9, 4 = VW/CW ≥4

Proximity

Score
1

Nearest patch of native vegetation >10ha:

0 = >1km, 1 = 200m-1km, 2 = contiguous,

3 = contiguous with patch >50ha

Vegetation cover: Canopy >5m, Understorey 1-5m, Ground cover <1m

Transect	Canopy	Native canopy	Understorey	Native understorey	Ground cover	Native ground cover	# layers
1	3	3	1	1	2	1	3
2	3	3	0	0	2	1	3
3	2	2	1	1	3	1	3
4	3	3	1	1	2	1	3
Average	2.75	2.75	0.75	0.75	2.25	1	3

Canopy and ground cover: 0 = none, 1 = 1-30%, 2 = 31-60%, 3 = >60%

Understorey cover: 0 = none, 1 = 1-5%, 2 = 6-30%, 3 = >30%

Debris

Transect	Leaf litter	Native leaf litter	Standing dead trees	Hollow-bearing trees	Fallen logs
1	3	3	1	1	1
2	3	3	0	0	1
3	3	3	0	0	0
4	3	3	0	0	0
Average	3	3	0.25	0.25	0.5

Leaf litter & native leaf litter cover: 0 = none, 1 = 1-30%, 2 = 31-60%, 3 = >60%

Standing dead trees (>20cm dbh) & hollow-bearing trees: 0 = absent, 1 = present

Fallen logs (>10cm diameter): 0 = none, 1 = small quantities, 2 = abundant

Features

Transect	Native canopy species regeneration	Native understorey regeneration	Large native tussock grasses	Reeds
1	1	0	1	2
2	1	0	1	2
3	1	0	1	2
4	1	0	1	2
Average	1	0	1	2

Regeneration <1m tall: 0 = none, 1 = scattered, and 2 = abundant, with ½ point subtracted for grazing damage

Reeds & large tussock grasses: 0 = none, 1 = scattered, and 2 = abundant

Calculation of scores

Site Number:	MTW DIS PT

Longitudinal continuity of riparian canopy vegetation

Score
2

Width of riparian canopy vegetation

Average	3.5

Proximity

Score
1

Vegetation cover

	Canopy	Native canopy	Understorey	Native understorey	Ground cover	Native ground cover	# layers
Average	2.75	2.25	0.75	0.75	2.25	1	3

Debris

	Leaf litter	Native leaf litter	Standing dead trees	Hollow-bearing trees	Fallen logs
Average	3	3	0.25	0	0.5

Features

	Native canopy species regeneration	Native understorey regeneration	Large native tussock grasses	Reeds
Average	1	0	1	2

TOTALS

Site:	Habitat	Cover	Natives	Debris	Features	**Total**
(out of)	11	12	9	10	8	50
	6.5	8.75	4	6.75	4	30

APPENDIX B

CSIRO Ephemeral Stream Assessment Database

MTW CSIRO Ephemeral Stream Assessment Database

Site Number	Distance US/DS from Survey Peg (m)	Date of Monitoring	Nov-18	Nov-19	Dec-20
		Assessor	SLR	SLR	SLR
		Channel Characteristic	**Rating**	**Rating**	**Rating**
		Vegetation on D/L Floor	3	3	3
		Vegetation on D/L Walls	3	3	3
		Shape of D/L Cross-Section	3	3	3
		Longitudinal Morphology	3	3	3
		Particle Size of Materials on Floor	1	1	1
LC1	0m (At Survey Peg)	Nature of D/L Wall Materials	3	3	3
		Nature and Shape of Bank Edge	4	4	4
		Nature of Lateral Flow Regulation	3	3	3
		Sum of Ratings	**23**	**23**	**23**
		Activity Rating	**72**	**72**	**72**
		Classification	**Stable**	**Stable**	**Stable**
		Vegetation on D/L Floor	3	3	3
		Vegetation on D/L Walls	1	1	1
		Shape of D/L Cross-Section	2	2	2
		Longitudinal Morphology	2	2	2
		Particle Size of Materials on Floor	1	1	1
LC2	0m (At Survey Peg)	Nature of D/L Wall Materials	1	1	1
		Nature and Shape of Bank Edge	4	4	4
		Nature of Lateral Flow Regulation	4	4	4
		Sum of Ratings	**18**	**18**	**18**
		Activity Rating	**56**	**56**	**56**
		Classification	**Active**	**Active**	**Active**
		Vegetation on D/L Floor	3	3	3
		Vegetation on D/L Walls	1	1	1
		Shape of D/L Cross-Section	2	1	1
		Longitudinal Morphology	2	1	1
		Particle Size of Materials on Floor	1	1	1
LC3	0m (At Survey Peg)	Nature of D/L Wall Materials	1	1	1
		Nature and Shape of Bank Edge	3	3	3
		Nature of Lateral Flow Regulation	2	2	2
		Sum of Ratings	**15**	**13**	**13**
		Activity Rating	**47**	**41**	**41**
		Classification	**Very Active**	**Very Active**	**Very Active**
		Vegetation on D/L Floor	3	3	3
		Vegetation on D/L Walls	3	3	3
		Shape of D/L Cross-Section	3	2	3
		Longitudinal Morphology	3	3	3
		Particle Size of Materials on Floor	1	1	1
LC4	0m (At Survey Peg)	Nature of D/L Wall Materials	1	1	1
		Nature and Shape of Bank Edge	4	4	4
		Nature of Lateral Flow Regulation	4	4	4
		Sum of Ratings	**22**	**21**	**22**
		Activity Rating	**69**	**66**	**69**
		Classification	**Potentially Stabilising**	**Potentially Stabilising**	**Potentially Stabilising**
		Vegetation on D/L Floor	3	3	3
		Vegetation on D/L Walls	2	2	2
		Shape of D/L Cross-Section	2	2	2
		Longitudinal Morphology	2	2	2
		Particle Size of Materials on Floor	1	1	1
LC5	0m (At Survey Peg)	Nature of D/L Wall Materials	2	2	2
		Nature and Shape of Bank Edge	3	3	3
		Nature of Lateral Flow Regulation	4	4	4
		Sum of Ratings	**19**	**19**	**19**
		Activity Rating	**59**	**59**	**59**
		Classification	**Active**	**Active**	**Active**
		Vegetation on D/L Floor	3	3	3
		Vegetation on D/L Walls	2	2	2
		Shape of D/L Cross-Section	2	2	2
		Longitudinal Morphology	2	2	2
		Particle Size of Materials on Floor	1	1	1
LC6	0m (At Survey Peg)	Nature of D/L Wall Materials	1	1	1
		Nature and Shape of Bank Edge	3	3	3
		Nature of Lateral Flow Regulation	3	3	3
		Sum of Ratings	**17**	**17**	**17**
		Activity Rating	**53**	**53**	**53**
		Classification	**Active**	**Active**	**Active**
		Vegetation on D/L Floor	3	3	3
		Vegetation on D/L Walls	1	1	1
		Shape of D/L Cross-Section	2	2	2
		Longitudinal Morphology	2	2	2
		Particle Size of Materials on Floor	1	1	1
LC7	0m (At Survey Peg)	Nature of D/L Wall Materials	2	2	2
		Nature and Shape of Bank Edge	4	4	4
		Nature of Lateral Flow Regulation	2	2	2
		Sum of Ratings	**17**	**17**	**17**
		Activity Rating	**53**	**53**	**53**
		Classification	**Active**	**Active**	**Active**
		Vegetation on D/L Floor	2	2	2
		Vegetation on D/L Walls	1	1	3
		Shape of D/L Cross-Section	3	3	3
		Longitudinal Morphology	3	3	3
		Particle Size of Materials on Floor	1	1	1
LC8	0m (At Survey Peg)	Nature of D/L Wall Materials	2	2	2
		Nature and Shape of Bank Edge	4	4	4
		Nature of Lateral Flow Regulation	4	4	4
		Sum of Ratings	**20**	**20**	**22**
		Activity Rating	**63**	**63**	**69**
		Classification	**Potentially Stabilising**	**Potentially Stabilising**	**Potentially Stabilising**
		Vegetation on D/L Floor	3	3	3
		Vegetation on D/L Walls	3	3	3
		Shape of D/L Cross-Section	3	3	3
		Longitudinal Morphology	2	2	2
		Particle Size of Materials on Floor	1	1	1

MTW CSIRO Ephemeral Stream Assessment Database

Site Number	Distance US/DS from Survey Peg (m)	Date of Monitoring Assessor Channel Characteristic	Nov-18 SLR Rating	Nov-19 SLR Rating	Dec-20 SLR Rating
LC9	0m (At Survey Peg)	Nature of D/L Wall Materials	3	2	2
		Nature and Shape of Bank Edge	3	4	3
		Nature of Lateral Flow Regulation	4	4	4
		Sum of Ratings	**22**	**22**	**21**
		Activity Rating	**69**	**69**	**66**
		Classification	**Potentially Stabilising**	**Potentially Stabilising**	**Potentially Stabilising**
LC10	0m (At Survey Peg)	Vegetation on D/L Floor	1	1	1
		Vegetation on D/L Walls	1	1	1
		Shape of D/L Cross-Section	2	2	2
		Longitudinal Morphology	2	1	2
		Particle Size of Materials on Floor	1	3	1
		Nature of D/L Wall Materials	4	4	4
		Nature and Shape of Bank Edge	4	4	4
		Nature of Lateral Flow Regulation	4	4	4
		Sum of Ratings	**19**	**20**	**19**
		Activity Rating	**59**	**63**	**59**
		Classification	**Active**	**Potentially Stabilising**	**Active**
LC11	0m (At Survey Peg)	Vegetation on D/L Floor	3	2	2
		Vegetation on D/L Walls	1	2	2
		Shape of D/L Cross-Section	2	3	3
		Longitudinal Morphology	2	2	2
		Particle Size of Materials on Floor	1	1	1
		Nature of D/L Wall Materials	1	2	2
		Nature and Shape of Bank Edge	3	3	3
		Nature of Lateral Flow Regulation	4	4	4
		Sum of Ratings	**17**	**19**	**19**
		Activity Rating	**53**	**59**	**59**
		Classification	**Active**	**Active**	**Active**
LC12	0m (At Survey Peg)	Vegetation on D/L Floor	2	2	2
		Vegetation on D/L Walls	2	2	3
		Shape of D/L Cross-Section	3	3	3
		Longitudinal Morphology	2	3	2
		Particle Size of Materials on Floor	1	1	1
		Nature of D/L Wall Materials	2	2	2
		Nature and Shape of Bank Edge	3	3	3
		Nature of Lateral Flow Regulation	4	4	4
		Sum of Ratings	**19**	**20**	**20**
		Activity Rating	**59**	**63**	**63**
		Classification	**Active**	**Potentially Stabilising**	**Potentially Stabilising**
LC13	0m (At Survey Peg)	Vegetation on D/L Floor	1	1	1
		Vegetation on D/L Walls	2	1	2
		Shape of D/L Cross-Section	3	2	3
		Longitudinal Morphology	2	2	2
		Particle Size of Materials on Floor	1	1	1
		Nature of D/L Wall Materials	2	3	3
		Nature and Shape of Bank Edge	4	4	4
		Nature of Lateral Flow Regulation	4	4	4
		Sum of Ratings	**19**	**18**	**20**
		Activity Rating	**59**	**56**	**63**
		Classification	**Active**	**Active**	**Potentially Stabilising**
MTW Dis	0m (At Survey Peg)	Vegetation on D/L Floor	1	1	1
		Vegetation on D/L Walls	2	2	2
		Shape of D/L Cross-Section	3	3	3
		Longitudinal Morphology	2	2	2
		Particle Size of Materials on Floor	3	3	3
		Nature of D/L Wall Materials	3	3	3
		Nature and Shape of Bank Edge	4	4	4
		Nature of Lateral Flow Regulation	2	2	2
		Sum of Ratings	**20**	**20**	**20**
		Activity Rating	**63**	**63**	**63**
		Classification	**Potentially Stabilising**	**Potentially Stabilising**	**Potentially Stabilising**
BM34	0m (At Survey Peg)	Vegetation on D/L Floor	3	3	3
		Vegetation on D/L Walls	3	3	3
		Shape of D/L Cross-Section	5	5	5
		Longitudinal Morphology	3	3	3
		Particle Size of Materials on Floor	1	1	1
		Nature of D/L Wall Materials	3	3	3
		Nature and Shape of Bank Edge	3	3	3
		Nature of Lateral Flow Regulation	4	4	4
		Sum of Ratings	**25**	**25**	**25**
		Activity Rating	**78**	**78**	**78**
		Classification	**Stable**	**Stable**	**Stable**
BM35	0m (At Survey Peg)	Vegetation on D/L Floor	3	3	3
		Vegetation on D/L Walls	2	2	2
		Shape of D/L Cross-Section	2	2	2
		Longitudinal Morphology	2	2	2
		Particle Size of Materials on Floor	1	1	1
		Nature of D/L Wall Materials	2	2	2
		Nature and Shape of Bank Edge	3	3	3
		Nature of Lateral Flow Regulation	3	3	3
		Sum of Ratings	**18**	**18**	**18**
		Activity Rating	**56**	**56**	**56**
		Classification	**Active**	**Active**	**Active**
BM37	0m (At Survey Peg)	Vegetation on D/L Floor	1	1	1
		Vegetation on D/L Walls	3	3	3
		Shape of D/L Cross-Section	4	4	3
		Longitudinal Morphology	3	3	4
		Particle Size of Materials on Floor	1	1	1
		Nature of D/L Wall Materials	3	2	2
		Nature and Shape of Bank Edge	4	4	4
		Nature of Lateral Flow Regulation	4	4	4
		Sum of Ratings	**23**	**22**	**22**
		Activity Rating	**72**	**69**	**69**

MTW CSIRO Ephemeral Stream Assessment Database					
Site Number	Distance US/DS from Survey Peg (m)	Date of Monitoring	Nov-18	Nov-19	Dec-20
		Assessor	SLR	SLR	SLR
		Channel Characteristic	Rating	Rating	Rating
		Classification	Stable	Potentially Stabilising	Potentially Stabilising

ASIA PACIFIC OFFICES

BRISBANE
Level 2, 15 Astor Terrace
Spring Hill QLD 4000
Australia
T: +61 7 3858 4800
F: +61 7 3858 4801

CANBERRA
GPO 410
Canberra ACT 2600
Australia
T: +61 2 6287 0800
F: +61 2 9427 8200

DARWIN
5 Foelsche Street
Darwin NT 0800
Australia
T: +61 8 8998 0100
F: +61 2 9427 8200

GOLD COAST
Ground Floor, 194 Varsity Parade
Varsity Lakes QLD 4227
Australia
M: +61 438 763 516

MACKAY
21 River Street
Mackay QLD 4740
Australia
T: +61 7 3181 3300

MELBOURNE
Suite 2, 2 Domville Avenue
Hawthorn VIC 3122
Australia
T: +61 3 9249 9400
F: +61 3 9249 9499

NEWCASTLE
10 Kings Road
New Lambton NSW 2305
Australia
T: +61 2 4037 3200
F: +61 2 4037 3201

PERTH
Ground Floor, 503 Murray Street
Perth WA 6000
Australia
T: +61 8 9422 5900
F: +61 8 9422 5901

ROCKHAMPTON
rockhampton@slrconsulting.com
M: +61 407 810 417

SYDNEY
2 Lincoln Street
Lane Cove NSW 2066
Australia
T: +61 2 9427 8100
F: +61 2 9427 8200

TAMWORTH
PO Box 11034
Tamworth NSW 2340
Australia
M: +61 408 474 248
F: +61 2 9427 8200

TOWNSVILLE
Level 1, 514 Sturt Street
Townsville QLD 4810
Australia
T: +61 7 4722 8000
F: +61 7 4722 8001

AUCKLAND
68 Beach Road
Auckland 1010
New Zealand
T: +64 27 441 7849

NELSON
5 Duncan Street
Port Nelson 7010
New Zealand
T: +64 274 898 628

NEW PLYMOUTH
Level 2, 10 Devon Street East
New Plymouth 4310
New Zealand
T: +64 0800 757 695

Appendix 4:

Annual Ground Water Review Report

MOUNT THORLEY WARKWORTH

2020 Annual Groundwater Review

Prepared for:

Yancoal Mount Thorley Warkworth Australia
PO Box 267
SINGLETON NSW 2330

SLR Ref: 620.30305.00000-R01
Version No: -v2.0
March 2021

PREPARED BY

SLR Consulting Australia Pty Ltd
ABN 29 001 584 612
Level 2, 15 Astor Terrace
Spring Hill QLD 4000 Australia
(PO Box 26 Spring Hill QLD 4004)
T: +61 7 3858 4800
E: brisbane@slrconsulting.com www.slrconsulting.com

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 Yancoal Mount Thorley Warkworth Australia (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
620.30305.00000-R01-v2.0	18 March 2021	Duncan Dawson	Angus McFarlane	Angus McFarlane
620.30305.00000-R01-v1.0	11 March 2021	Stephen Lee, Duncan Dawson and Tingting Liu	Angus McFarlane	Angus McFarlane

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APPENDICES

1 Introduction

1.1 Overview

The Mount Thorley Warkworth (MTW) mining complex is located approximately 15 km south-west of Singleton, NSW. As part of compliance with mine approval conditions, routine groundwater monitoring is conducted across MTW, and the data reviewed and analysed on an annual basis. The annual groundwater review is required for:

- Warkworth Mine in accordance with Condition 25 of the Warkworth Consent (SSD 6464) Statement of Commitments; and
- Mt Thorley Mine in accordance with Condition 27 of Development Consent (SSD 6465)

MTW commissioned SLR Consulting Pty Ltd (SLR) to review the groundwater monitoring data for the 2020 calendar year. This report presents groundwater monitoring data collected at the MTW complex and discusses the impact of mining on the groundwater regime.

1.2 Scope

The scope of work for this review included analysis of monitoring data and reporting. This report presents:

- Site background:
  - Legislative requirements and conditions relevant to groundwater;
  - Mine activities over reporting period;
  - Hydrogeological regime; and
  - Groundwater monitoring network and program.
- Data review:
  - Review and illustration (i.e. hydrographs) of groundwater level trends;
  - Review and illustration (i.e. hydrographs) of groundwater quality trends; and
  - Comparison of water level and quality trends to relevant trigger levels and natural trends (i.e. surface water levels and rainfall).
- Review of numerical groundwater model predictions and comparison to observed groundwater levels.
- Discussion of groundwater impacts and compliance over the reporting period and provision of recommendations (where required).

2 MTW Complex

The following section provides a summary of known activities conducted across the complex that relate to the annual groundwater review. The general site layout is presented in **Figure 2-1**.

2.1 Mine Operations

Table 2-1 presents a summary of mine areas across MTW and activities conducted during 2020.

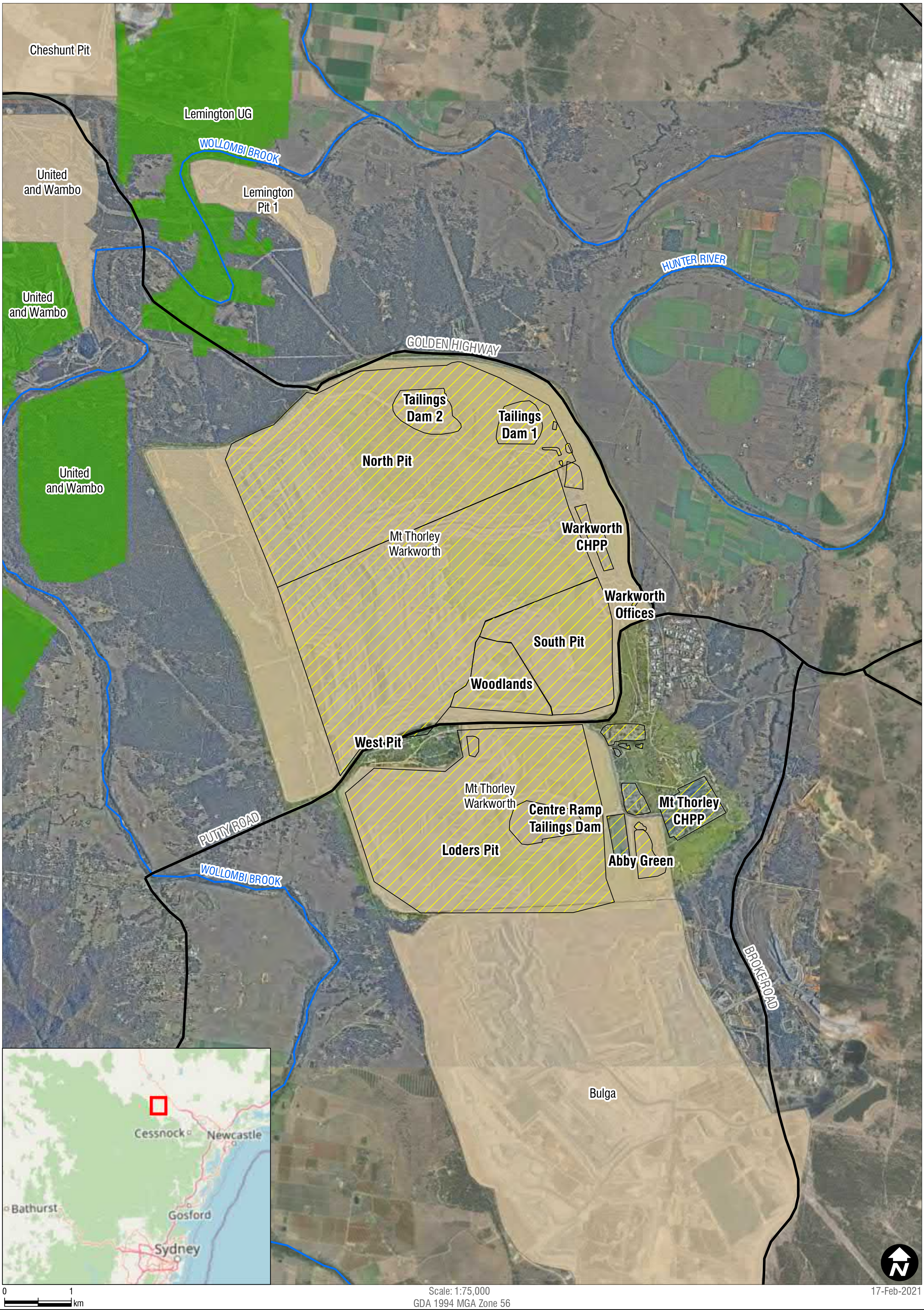
Table 2-1 Summary of MTW Activities

Mine Area	Site	2020 Activities
North Pit	Warkworth	Rehabilitation works appear to have been undertaken on eastern portion of pit footprint (according to aerial imagery).
West Pit	Warkworth	Rehabilitation works appear to have been undertaken on eastern portion of pit footprint
South Pit	Warkworth	No active mining, rehabilitation works in place.
Loders Pit	Mt Thorley	Rehabilitation works appear to have been undertaken on eastern portion of pit footprint
Abby Green Pit	Mt Thorley	No mining active, rehabilitation works in place.

A range of tailings storage facilities (TSF) are present across MTW, as summarised in **Table 2-2**.

Table 2-2 Summary of approved tailings storage facilitates at MTW

Area	Location	Status
Tailings Dam 1 (Dam 32N)	North Pit – Warkworth. Tailings dam located overlying spoil, within backfilled pit.	Inactive, tailings dam rehabilitated.
Tailings Dam 2 (Dam 33N)	North Pit – Warkworth. Tailings dam located overlying spoil, within backfilled pit.	Inactive, excess standing water actively decanted in 2017 and rehabilitation commenced. Capping of the tailings dam continued during the period.
Centre Ramp Tailings Dam (Dam 17S)	Loders Pit – Mt Thorley. Tailings dam located overlying spoil, within backfilled pit.	Active
Abbey Green Tailings Dam (Dam 4S)	Abbey Green – Mt Thorley. Tailings dam located overlying spoil, within backfilled pit.	Active
Mini-strip Tailings Dam	Loders Pit – Mt Thorley. Tailings dam located overlying spoil, within backfilled pit.	Active
Loders Pit North	Loders Pit- Mount Thorley. Tailings dam located in-pit.	In development – infrastructure set up over 2020 with deposition to commence in 2021



Main road
Major watercourses
MTW Infrastructure
Mine Areas
Open Cut
Underground

Sheet Size : A4

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Mt Thorley Warkworth
2020 Annual Groundwater Review
Locality Map

Figure 2-1

2.2 Groundwater Impacts

Groundwater impacts associated with the approved operations are presented within the:

- Warkworth Mine Modification Groundwater Impact Assessment (AGE, 2013);
- Warkworth Continuation 2014 Groundwater Assessment (AGE, 2014a);
- Mount Thorley Operations 2014 Groundwater Assessment (AGE, 2014b);
- Mount Thorley and Warkworth Mines, Long Term Approvals Model Update (AGE, 2015).

The most recent groundwater assessment that captures operations across MTW was the Long Term Approvals Model Update (AGE, 2015). The groundwater assessment involved updating the numerical groundwater model developed in 2014 as part of the continuation projects. Updates included recalibration of the model to site observations and updating the mine plans. AGE (2015) reported on predicted impacts associated with approved operations. The approved operations included mining at North Pit, West Pit and Loders Pit until 2035, as well as surrounding non-MTW mining operations (i.e. Wambo Coal). Groundwater conditions and groundwater response to approved mining, as reported by AGE (2015), indicated:

- Groundwater within the hard rock units (i.e. Whittingham Coal Measures) is directly intercepted by approved operations at MTW, with a peak take of 275 ML/year predicted for Warkworth and 298 ML/year predicted for Mt Thorley;
- Groundwater within the confined to semi-confined Permian coal measures became depressurised around the area of active mining;
- There is no direct interception of groundwater within the 'highly productive' alluvium for active mine operations at MTW;
- With depressurisation of the coal measures, the model predicted a reduction in upward seepage to the 'highly productive' alluvium along the Hunter River and Wollombi Brook, referred to as 'indirect take'. Peak indirect take:
  - From the Wollombi Brook alluvium (Hunter Unregulated) was predicted to be 16.7 ML/year for Warkworth and 11.3 ML/year for Mt Thorley;
  - From the Hunter River alluvium (Hunter Regulated) was predicted to be 3.5 ML/year for Warkworth and 0.6 ML/year for Mt Thorley;

Groundwater licenses have been obtained for the approved operations, as discussed in **Section 2.3**. Management and monitoring requirements of potential groundwater related impacts from approved operations are captured within the development consent conditions. These conditions are addressed within the site Water Management Plan (WMP), which was revised in April 2020. Further discussion on the monitoring and management requirements is included within **Section 5.**

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 MTW are outlined in **Table 2-3**. Water licence details have been obtained from the WMP which was revised on 30th April 2020.

Table 2-3 MTW Groundwater Licenses

Licence Number	Description	WSP	Water Source - Management Zone	Approved Extraction (ML)
40464 20AL218784	Mt Thorley Excavations	North Coast Fractured and Porous Rock	Permian Coal Seams	180
40465 20AL218785	Warkworth Excavations			750
18558 20AL208627	-	Hunter Unregulated and Alluvial Water Sources	Lower Wollombi Brook Water Source	50
18469 20AL218784	-			245
19022 20AL209903	Sandy Hollow Creek		Singleton Water Source	60
10543 20AL201239	To Oakhampton Rail Bridge	Hunter River Regulated Water Source	Zone 2b Hunter River from Wollombi Brook Junction to downstream extent of the Hunter Regulated River	1,009
963 20AL201242	Warkworth Farm – Hunter River Pump			243
971 20AL201258				270
1008 20AL201341				243
995 20AL201302	Appledale Farm – Hunter River Pump			243
1009 20AL201343				435

2.4 Groundwater Conditions

In accordance with the development consent approval conditions and statement of commitments (SOC) to the 2014 continuation project approval, Yancoal are required to prepare and implement a WMP to the satisfaction of the Director-General. **Table 2-4** presents a summary of the relevant groundwater conditions and SOC's from the 2020 WMP. The table identifies where the conditions relating to routine groundwater monitoring for 2020 have been addressed.

Table 2-4 Groundwater Conditions within WMP

Condition	Details	Where Addressed
Sch. 3, Cond. 24 for Mt Thorley (SSD-6465) Sch. 3, Cond. 26 for Warkworth (SSD-6464)	Design, install and maintain emplacements to prevent offsite migration of saline groundwater seepage	See **Section 6** for discussion of groundwater quality. WMP and surface water review
Sch. 3, Cond. 25(b) for Mt Thorley (SSD-6465) Sch. 3, Cond. 27(b) for Warkworth (SSD-6464)	Groundwater Management Plan, which includes detailed baseline data on groundwater levels, yield and quality in the region, and privately-owned groundwater bores, that could be affected by the development	See WMP. As per WMP, no privately-owned groundwater bores on non-mine owned land were identified as having groundwater levels decline by over 2 m due to the approved operations.
Sch. 3, Cond. 25(b) for Mt Thorley (SSD-6465) Sch. 3, Cond. 27(b) for Warkworth (SSD-6464)	Groundwater Management Plan, which includes groundwater assessment criteria, including trigger levels for investigating any potentially adverse groundwater impacts	See **Section 5.3** for triggers and **Section 6.4** for discussion on site water quality results against trigger levels.
Sch. 3, Cond. 25(b) for Mt Thorley (SSD-6465) Sch. 3, Cond. 27(b) for Warkworth (SSD-6464)	Groundwater Management Plan which includes a program to monitor and report on:	
	Groundwater inflows to the open cut pits;	See WMP
	The seepage/leachate from water storages, emplacements, backfilled voids and final voids;	See WMP and surface water review and see **Section 6** for discussion of groundwater quality.
	The impacts of the development on: • regional and local (including alluvial) aquifers; • groundwater supply of potentially affected landowners; • groundwater dependent ecosystems and riparian vegetation; • base flows to Loders Creek (Mt Thorley) and Wollombi Brook (Warkworth);	See **Section 6** for discussion on groundwater monitoring results for 2019. As per WMP, no privately-owned bores identified as potentially impacted. See ecology review for discussion on ecosystems and vegetation.

Condition	Details	Where Addressed
Sch. 3, Cond. 25(b) for Mt Thorley (SSD-6465) Sch. 3, Cond. 27(b) for Warkworth (SSD-6464)	Groundwater Management Plan which includes a plan to respond to any exceedances of the groundwater assessment criteria;	Trigger exceedances are discussed in **Section 6.**
Sch. 3, Cond. 25(b) for Mt Thorley (SSD-6465) Sch. 3, Cond. 27(b) for Warkworth (SSD-6464)	Groundwater Management Plan which includes a program to validate the groundwater model for the development, including an independent review of the model with every independent environmental audit, and compare the monitoring results with modelled predictions.	Numerical model last updated in 2015 as discussed in **Section 2.2**. Comparison between observed and modelled groundwater levels undertaken in **Section 6.6.**.
SOC Warkworth Continuation 2014 EIS Table 22.1 Groundwater	Updates to current groundwater monitoring programme: • installation of nested monitoring bores along the Wollombi Brook (PZ10, PZ11, PZ12); and • installation of monitoring bores with the Warkworth Sands system as part of an update to the existing Warkworth Sands Ephemeral Perched Aquifer Management Plan within the MTW WMP.	Bores installed in 2016, see **Section 5** for details on the monitoring program.
	Mine seepage monitoring programme: • recording of the time, location and estimated volume of any unexpected increased groundwater outflow from the highwall and endwall; • measurement of water pumped from the mine, preferably using flow meters or other suitable gauging apparatus; • correlation of rainfall records with mine seepage records so groundwater and surface water can be separated;	See mine water balance and surface water review.
	Data management and reporting: • establishment of trigger levels; • quarterly review of groundwater levels and field water quality against trigger levels, with site-specific investigations initiated; • formal review of depressurisation of coal measures and alluvium would be undertaken annually by a suitably qualified hydrogeologist; • annual reporting (including all water level and water quality data); and • all groundwater data being stored in a database customised for MTW with suitable QA/QC controls.	Quarterly reviews conducted as part of routine groundwater monitoring by external contractors AECOM. Review of groundwater level and quality changes presented in **Section 6**. Data stored within database held by Yancoal.
	Future model iterations: • assess the validity of the model predictions every three years; and • incorporate into the model and revise predictions, if required.	Model predictions assessed in **Section 6.6.**
	Licensing: • retain and obtain appropriate water licences, as required, to account for modelled take.	**Section 2.3** and **Section 6.5**

Condition	Details	Where Addressed
SOC Mount Thorley Operations 2014 EIS Table 21.1 Groundwater	A site specific investigation into trigger level exceedance would be undertaken if: • professional judgement determines that the single deviation or a developing trend could result in environmental harm; or • three consecutive measurements exceed trigger values.	See **Section 6.4** for discussion on site water quality results against trigger levels.
	Data management and reporting: • establishment of trigger levels; • quarterly review of groundwater levels and field water quality against trigger levels, with site specific investigations initiated; and • all groundwater data being stored in a database customised for MTW with suitable QA/QC controls.	Trigger levels presented in **Section 5.3**. Quarterly reviews conducted as part of routine groundwater monitoring by external contractors AECOM. Data stored within database held by Yancoal.
	Licensing: • retain and obtain appropriate water licences, as required, to account for modelled take.	**Section 2.3**

Groundwater monitoring is to be conducted in accordance with the Groundwater Monitoring Program (GMP) outlined within Appendix C of the WMP. The program outlines groundwater monitoring frequency, parameters to be tested and groundwater triggers for electrical conductivity (EC) and pH. Further discussion on the GMP and triggers is included in **Section 5**.

3 Hydrogeological Setting

This section presents a brief summary of the hydrogeological setting for MTW. 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 MTW region can be classed as temperate and is characterised by hot summers and mild dry winters. Rainfall data from the Bureau of Meteorology (BoM) Station 61191 Bulga (South Wambo) was used as this provides the longest record of data in the area from 1959 to present. **Table 3-1** shows the average monthly rainfall calculated since 1959 and for the year 2020.

Table 3-1 Long Term Average and 2020 Climate Data

Rainfall (mm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Average Historical	87.0	86.1	67.7	45.9	39.9	43.9	30.6	34.3	38.6	55.0	61.5	73.5	**664.0**
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**

A cumulative rainfall departure (CRD) plot is provided as **Figure 3-1** to illustrate long term climate trends in the MTW area, based on average monthly rainfall data. The CRD graphically shows trends in recorded rainfall compared to long-term averages (1959 to 2020 inclusive) 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.

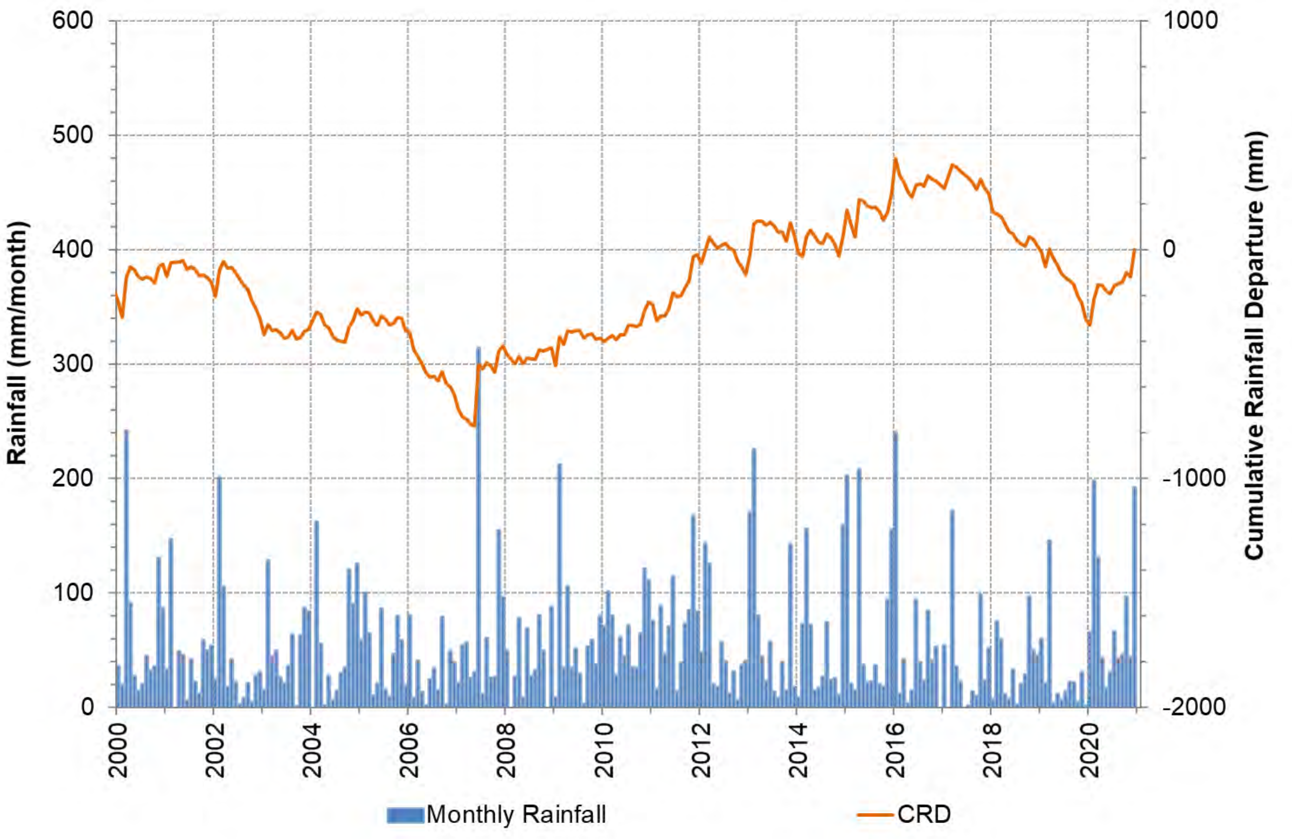


Figure 3-1 Cumulative Rainfall Departure and Monthly Rainfall

As shown in **Figure 3-1**, the region has generally experienced below average rainfall from 2017 to the end of 2019. During 2020, significant above average monthly rainfall was received in February to March and December, leading to increases in the CRD.

3.1.2 Terrain and Drainage

Ground elevations at MTW range between 35 m Australian Height Datum (mAHD) along the Hunter River alluvial plains and 100 mAHD west of MTW. Minor ephemeral drainage features are also present around MTW (i.e. Loders Creek, Sandy Hollow Creek, Doctors Creek), draining into the Hunter River.

Real time stream flow data is monitored along the Hunter River and Wollombi Brook at NSW Department of Primary Industries (DPI) Water gauging stations via the Hunter Integrated Telemetry System (HITS). Time series river water elevations (mean level above zero gauge elevation) is presented in **Figure 3-2** for three HITS stations (Hunter River @ Mason Dieu, Hunter River @ Long Point and Wollombi Brook @ Warkworth).

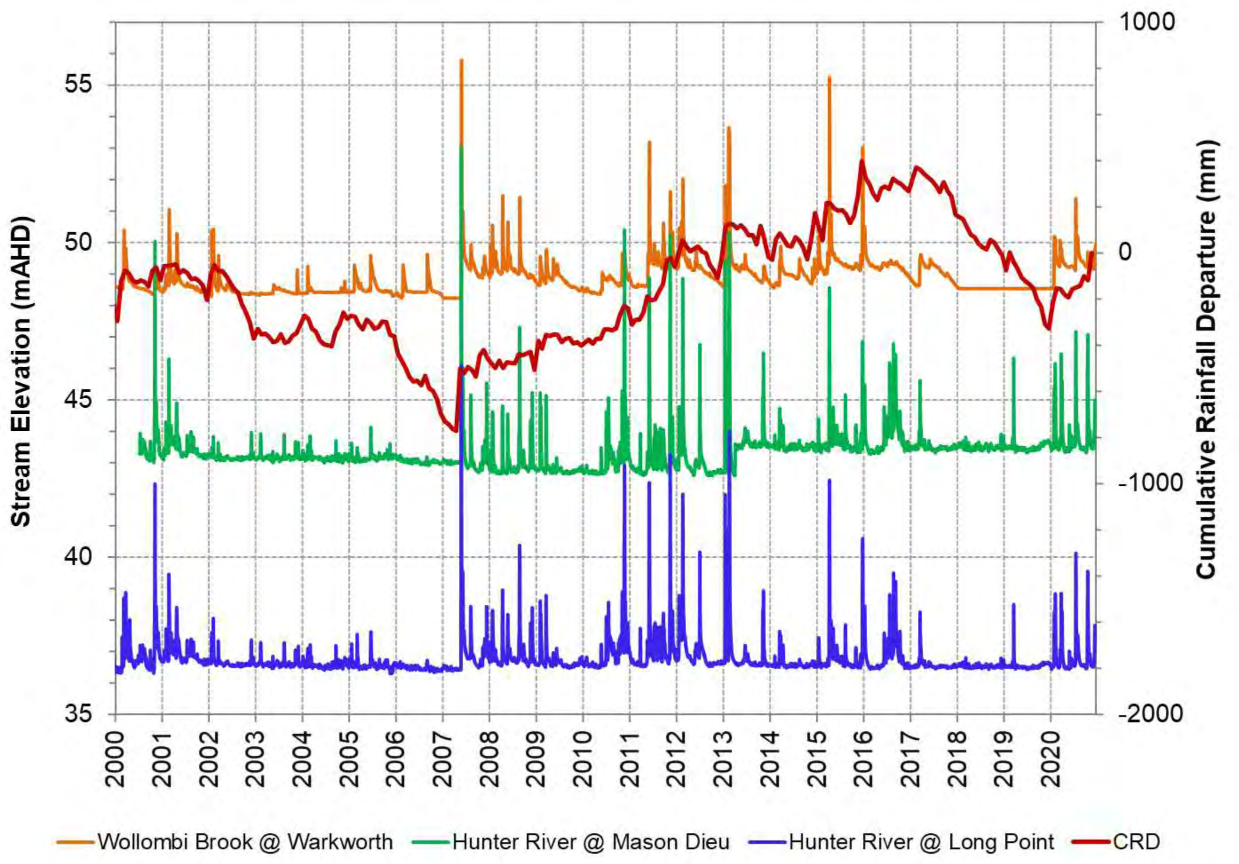


Figure 3-2 Surface Water Levels

As shown in **Figure 3-2**, during 2020 stream elevations within the Hunter River remained generally stable (approximately 36.4 mAHD at Long Point; 43.3 mAHD at Mason Dieu) with the exception of seasonal fluctuations (up to approximately 40.0 mAHD at Long Point and 47.0 mAHD at Mason Dieu) in response to rainfall events. Glenbawn Dam is located approximately 135 km upstream of the project area. Daily regulated releases of the dam storage are undertaken to maintain flow and environmental quality of the Hunter River.

Figure 3-2 shows that during 2020, stream elevations within Wollombi Brook fluctuated within a range from approximately 48.5 mAHD to 51.0 mAHD. The zero gauge for Warkworth station (Station 210004) is set at 47.755 mAHD, meaning that water levels were recorded mostly from 1-3 m above the zero gauge in 2020. In contrast to the previous year where no flows were recorded in the Wollombi Brook, stream discharges were recorded from May to December 2020. Time series data of total rainfall against discharge volumes for Wollombi Brook is presented in **Figure 3-3**. A delay in Wollombi Brook discharge can be seen in May 2020 despite the significant rainfall received from January to March 2020. This delayed response is likely related to initial recharge to the lowered water table in the alluvium occurring before any significant stream flow can follow.

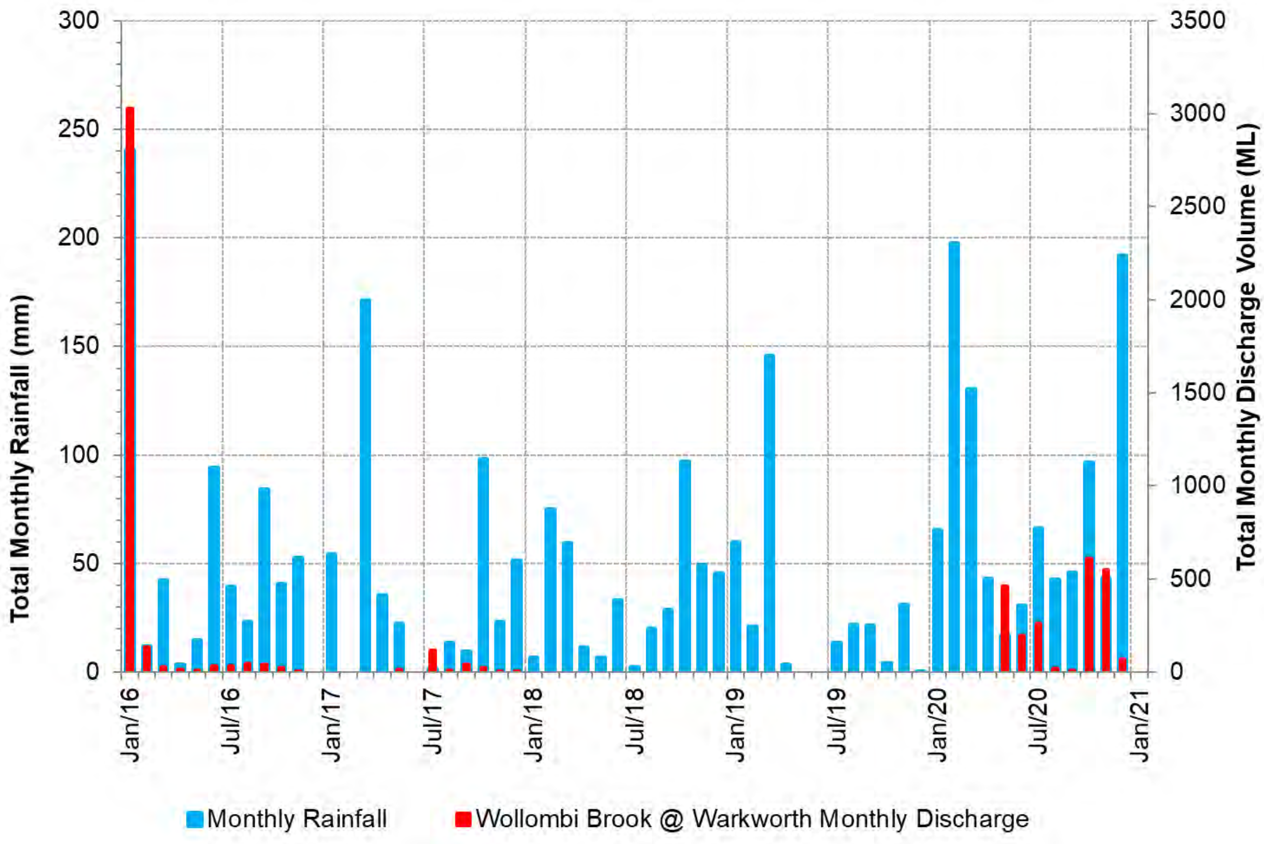


Figure 3-3 Wollombi Brook Monthly Surface Water Flow Volumes vs Monthly Rainfall

3.2 Geology

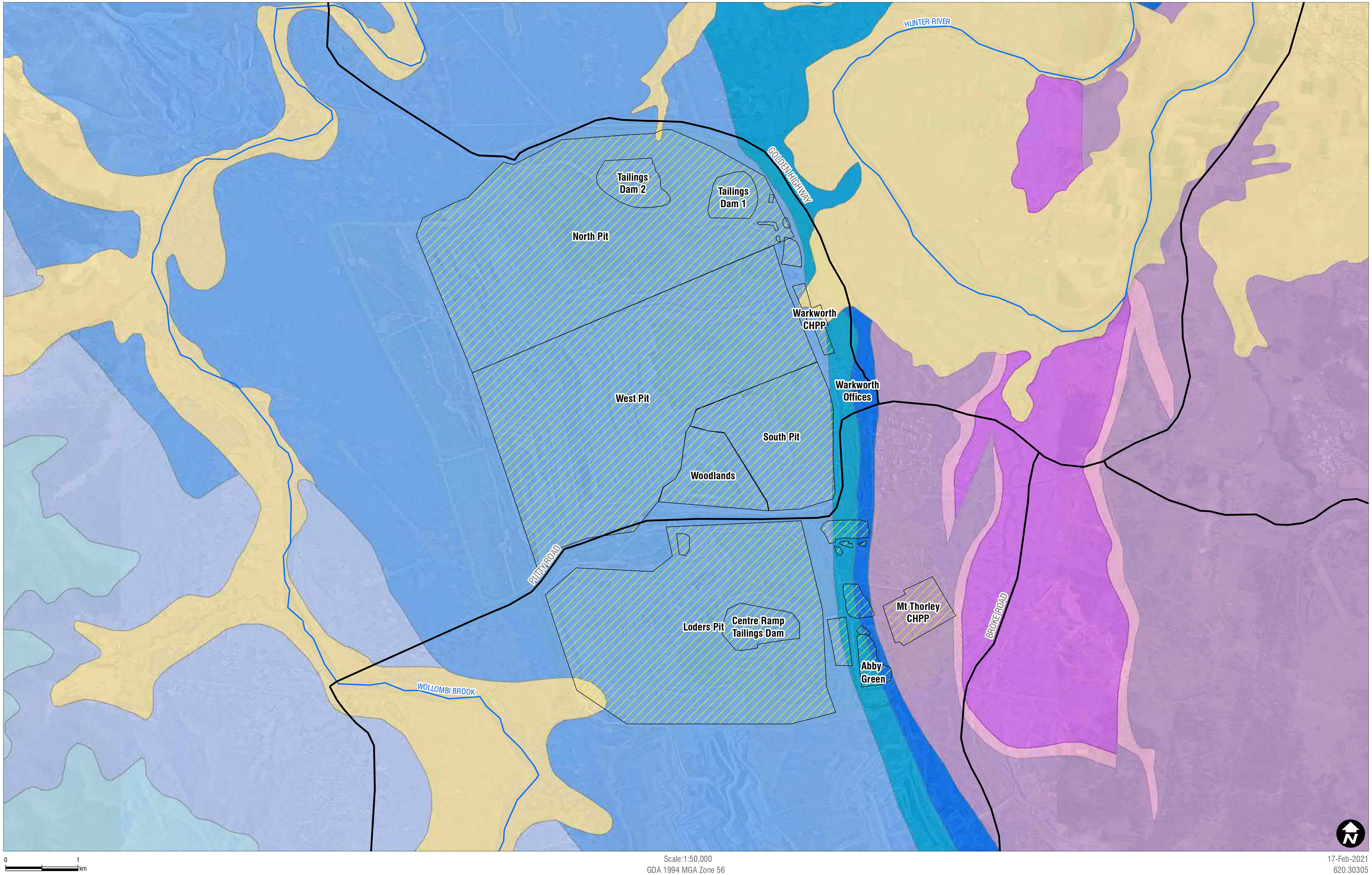
MTW lies within the Hunter Coalfields, which are dominated by the Permian aged Whittingham Coal Measures of the Sydney Basin. The Whittingham Coal Measures are made up of the Jerrys Plains Sub-group and Vane Sub-group. These units comprise economic coal seams along with overburden and interburden consisting of sandstone, siltstone, tuffaceous mudstone and conglomerate. The Whittingham Coal Measures are truncated to the east by the Hunter-Mooki Thrust Fault and occur at MTW as stratified (layered) sequences that dip at a shallow angle (2° to 5°) to the south-west. The coal seams subcrop to the east of MTW.

Along the Hunter River and Wollombi Brook thin Quaternary alluvial deposits unconformably overlie the Permian strata. The alluvial deposits comprise surficial fine-grained sediments (i.e. silts and clays). Along major watercourses (i.e. Hunter River and Wollombi Brook) the surficial sediments overlie basal sands and gravels.

Table 3-2 presents a summary of site geology and **Figure 3-4** presents a map of the geology of the MTW site and surrounds.

Table 3-2 MTW Generalized 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.
		Archerfield Sandstone	Lithic sandstone marker bed.
		Vane Sub-group (Pswv)	Coal bearing sequences interbedded with sandstone and siltstone. Coal seams (youngest to oldest) include Lemington Seam, Pikes Gully Seam, Arties Seam, Liddell Seam, Barrett Seam and Hebden Seam.



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GDA 1994 MGA Zone 56

17-Feb-2021
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Main road
Major watercourses
MTW Infrastructure

Hunter Coalfields 100k Geology

- Qa - Quaternary Alluvium
- Rn - Narrabean Group
- Psl - Newcastle Coal Measures
- Pswj - Jerrys Plains Subgroup
- Pms - Muree Sandstone
- Pswv - Archerfield Ss. Vane Subgroup
- Pswc - Saltwater Creek Formation
- Pmm - Mulbring Siltstone
- Pmb - Branxton Formation

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Figure 3-4

4 Groundwater Units

The principal groundwater units at MTW and its immediate surrounds are the productive alluvium associated with the Hunter River and Wollombi Brook, the Permian coal seams of the Whittingham Coal Measures and associated regolith material. Description of the groundwater units was derived from historical groundwater assessment reports, discussed in **Section 2.2**.

4.1 Regolith

Regolith material has been identified in the east of the project area overlying the Permian coal measures to depths of around 5 m. The material is clay rich comprising clays, sandy clays and minor clayey sands with permeability ranging from approximately 3.3×10^{-5} m/day to 9.5×10^{-3} m/day. The material has previously been categorised as alluvium. The regolith is recharged by rainfall infiltration and potential seepage from mine infrastructure.

4.2 Alluvium

The Quaternary alluvium is an unconfined groundwater system that is recharged by rainfall infiltration, streamflow and upward leakage from the underlying stratigraphy, particularly in undisturbed areas (i.e. away from active mining). The potentiometric surface and flow direction within the alluvium is a subdued reflection of topography. Groundwater within the Hunter River alluvium flows in a southerly direction, while water within the Wollombi Brook alluvium flows in a north to north-easterly direction towards the Hunter River.

Regionally, the Hunter River and Wollombi Brook are predominantly gaining water from the surrounding alluvium, as well as from rainfall and regulated flow (i.e. dam releases). However, there are also areas where the rivers recharge the underlying alluvium. These losing conditions can occur around areas of active mining, where the hydraulic gradient is increased due to depressurisation of the underlying coal measures. Losing conditions also occur within the more topographically elevated tributaries of the main water courses, where the water table is deeper and not connected directly to the streams.

While “less productive” groundwater within the surficial alluvium (Qhb **Table 3-2**) does not meet the ANZECC & ARMCANZ (2000) water quality guidelines for stock water supply, the “highly productive” alluvium (basal sands and gravels (Qha **Table 3-2**)) is considered suitable for stock water supply from a water quality perspective. However, most agricultural producers (crop and cattle) utilise surface water resources (Hunter River and Wollombi Brook) in preference to alluvial groundwater.

Aeolian sands referred to as the Warkworth Sands are present north to north-west of North Pit, and within a small area to the south-west of Loders Pit. The Warkworth Sands comprise fine-grained sands to a thickness of approximately 3 m. The unit overlies clay rich regolith material, which apparently forms a perched aquifer recharged from rainfall infiltration (AGE, 2014a). The Warkworth Sands supports woodland (Warkworth Sands Woodland), which is classified as an Endangered Ecological Community (EEC) under the *Threatened Species Conservation Act* 1995 and Critically Endangered (CE) under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

4.3 Permian Coal Measures

The Whittingham Coal Measures outcrop across the north to east of MTW. The coal measures form unconfined groundwater systems at outcrop, becoming semi-confined to confined as they dip towards the south-west.

Recharge occurs from direct rainfall to the ground surface, infiltrating into the formations through the thin soil cover and weathered profile. The coal measures also occur at subcrop in localised zones beneath alluvium associated with the Hunter River and Wollombi Brook, where the unit is recharged by downward seepage where gradients promote this flow.

The coal seams are typically moderately to slightly permeable, whilst the hydraulic conductivity of the interburden material is generally less than coal seams but is more variable, depending on the predominance of fractures in the rock mass. The hydraulic conductivity of the coal seams generally decreases with depth due to the closure of the cleats with increasing stratigraphic pressure. Conglomerates and weathered sandstone can be present to depths of around 16 m, with hydraulic conductivity of approximately 1.2×10^{-3} m/day to 9.5×10^{-2} m/day.

The direction of groundwater flow for the Whittingham Coal Measures is influenced by the local geomorphology and structural geology, as well as the long history of mining within the region which has significantly altered groundwater flow paths within the Permian units. Groundwater flow in the Permian aquifers on a regional scale follows the regional topography, flowing in a north-easterly direction. However, on a local scale groundwater levels show drawdown impacts associated with the extensive active mining areas. Groundwater discharge from the Whittingham Coal Measures currently occurs as discharge to active mining and abstraction bores, as well as upward seepage to the Quaternary alluvium where hydraulic gradients promote this flow.

There is no significant usage of groundwater from the Permian coal measures, likely due to:

- Poor water quality that generally exceeds ANZECC & ARMCANZ (2000) water quality guidelines for stock supply;
- The presence of perennial surface water flows (Hunter River and Wollombi Brook); and
- The more productive alluvial aquifer.

5 Groundwater Monitoring

5.1 Groundwater Monitoring Program

Groundwater monitoring is conducted at MTW in accordance with the MTW WMP. The monitoring results are used to establish and monitor trends in physical and geochemical parameters of surrounding groundwater potentially influenced by mining.

The monitoring program at MTW measures the Standing Water Level (SWL) in monitoring bores, reported as groundwater elevations (mAHD). The data is compared against background data, EIS predictions and historical trends as a means of assessing MTW related impacts to the quantity of groundwater in the various aquifers. The monitoring program at MTW also assesses the quality of groundwater against background data and historical trends. Groundwater quality is evaluated through the parameters of pH and EC. On a periodic basis (nominally once per annum) a comprehensive suite of analytes is measured, including major anions, cations and metals. Prior to sampling for comprehensive analysis, bore purging is undertaken to ensure a representative sample is collected.

Groundwater quality monitoring data is reviewed on a quarterly basis. The review involves a comparison of measured pH and EC results against internal trigger values which have been derived from the historical data set. Trigger limits are calculated as the 95th percentile maximum value (EC and pH) and the 5th percentile minimum value (pH only) from data collected since 2011. Trigger levels have been set based on target stratigraphy. A site specific investigation will be initiated where three consecutive measurements of EC or pH exceed trigger values or where professional judgement determines that a single deviation or a developing trend could result in environmental harm.

The groundwater monitoring network has been installed progressively over the life of the operations at MTW and acquired through land purchase. In relation to the WMP the groundwater monitoring network at MTW comprises 60 open standpipe bores installed into various geologic units. As outlined within the WMP, bores are grouped based on geology, as summarised below:

- Regolith;
- Hunter River alluvium;
- Wollombi Brook alluvium;
- Aeolian Warkworth Sands;
- Whittingham Coal Measures:
    - Redbank Seam;
    - Wambo Seam;
    - Blakefield Seam;
    - Woodlands Hill Seam;
    - Bowfield Seam;
    - Warkworth Seam;
    - Vaux Seam; and
    - Bayswater Seam.

- Shallow Overburden

In addition, 20 vibrating wire piezometers (VWPs) with a total of 80 sensors are present across the site. Only 10 of the 20 VWPs are listed in Table 1 of the groundwater monitoring programme. However, based on discussion with site personnel and review of the data it is understood some of the VWP sensors may not be fully operational due to a range of factors (i.e. batteries and age). Details of each of the MTW monitoring bores as well as each bore's respective monitoring program are provided in **Appendix A** and the location of the bores are presented in **Figure 5-1**.

In Q4 2019 and Q1 2020 an additional four VWPs were installed at MTW as part of ongoing site investigations. These bores are not included within the compliance network within the WMP, but details on the bores are presented in **Table 5-1** below for background reference. It is recommended that new VWPs should be reviewed and added to the WMP compliance network where appropriate.

Table 5-1 2020 VWP Construction Details Summary

Bore ID	Easting(s) GDA94 z56	Northing(s) GDA94 z56	Ground RL (m AHD)	Sensor Depth (m bTOC)	Target Aquifer	Comments
WD660_P1	314483	6388918	67.09	508.98	Bayswater Floor	Installed on 15th November 2019. P2 - Gradual increase in pressure from December 2019 onwards. Pressure drop prior to December 2019 likely due to cement grout curing/setting. Groundwater pressures in P2 slowly building up to equilibrium.
WD660_P2				476.98	Bayswater Seam	
WD660_P3				434.98	Vaux / Broonie Interburden	
WD660_P4				407.98	Vaux Seam	
WD660_P5				363.98	Mt Arthur Seam	
WD660_P6				245.49	Woodlands Hill Seam	
WD660_P7				121.99	Wambo Seam	
WD662_P1	315437	6387859	72.65	495.99	Bayswater Floor	Installed 19th January 2020. P4 – Gradual increase in pressure from 20th February 2020 but now stable. Significant decrease in pressure since October 2020. P7 – Failed shortly after installation.
WD662_P2				475.99	Bayswater Seam	
WD662_P3				457.49	Broonie / Bayswater Interburden	
WD662_P4				401.49	Vaux Seam	
WD662_P5				384.99	Mt Arthur / Piercefield Interburden	
WD662_P6				351.49	Warkworth Seam	
WD662_P7				89.5	Overburden	
WD663_P1	314343	6391971	83.85	432.602	Bayswater Floor	Installed on 31st January 2020. All sensors working.
WD663_P2				416.634	Bayswater Seam	
WD663_P3				389.698	Broonie / Bayswater Interburden	
WD663_P4				346.818	Vaux Seam	
WD663_P5				324.427	Piercefield / Vaux Interburden	
WD663_P6				306.5375	Mt Arthur Seam	

Bore ID	Easting(s) GDA94 z56	Northing(s) GDA94 z56	Ground RL (m AHD)	Sensor Depth (m bTOC)	Target Aquifer	Comments
WD663_P7				266.285	Mt Arthur / Warkworth Interburden	
WD663_P8				236.412	Warkworth Seam	

As outlined in **Appendix A**, full laboratory water quality analysis is required to be conducted for 60 bores, on an annual basis. The full water quality analysis includes:

- Total dissolved solids (TDS);
- Major ions (Ca, Cl, K, Na, SO_4 (or S), CO_3);
- Total alkalinity, bicarbonate alkalinity, carbonate alkalinity, hydroxide alkalinity; and
- Total metals (Al, As, B, Cd, Cu, Hg, Mg, Ni, Pb, Se, and Zn).

Six of the 60 bores are also analysed for total metals Mo, V and Cr, as shown in **Appendix A.** Discussion on the groundwater monitoring network is presented in **Section 6**.

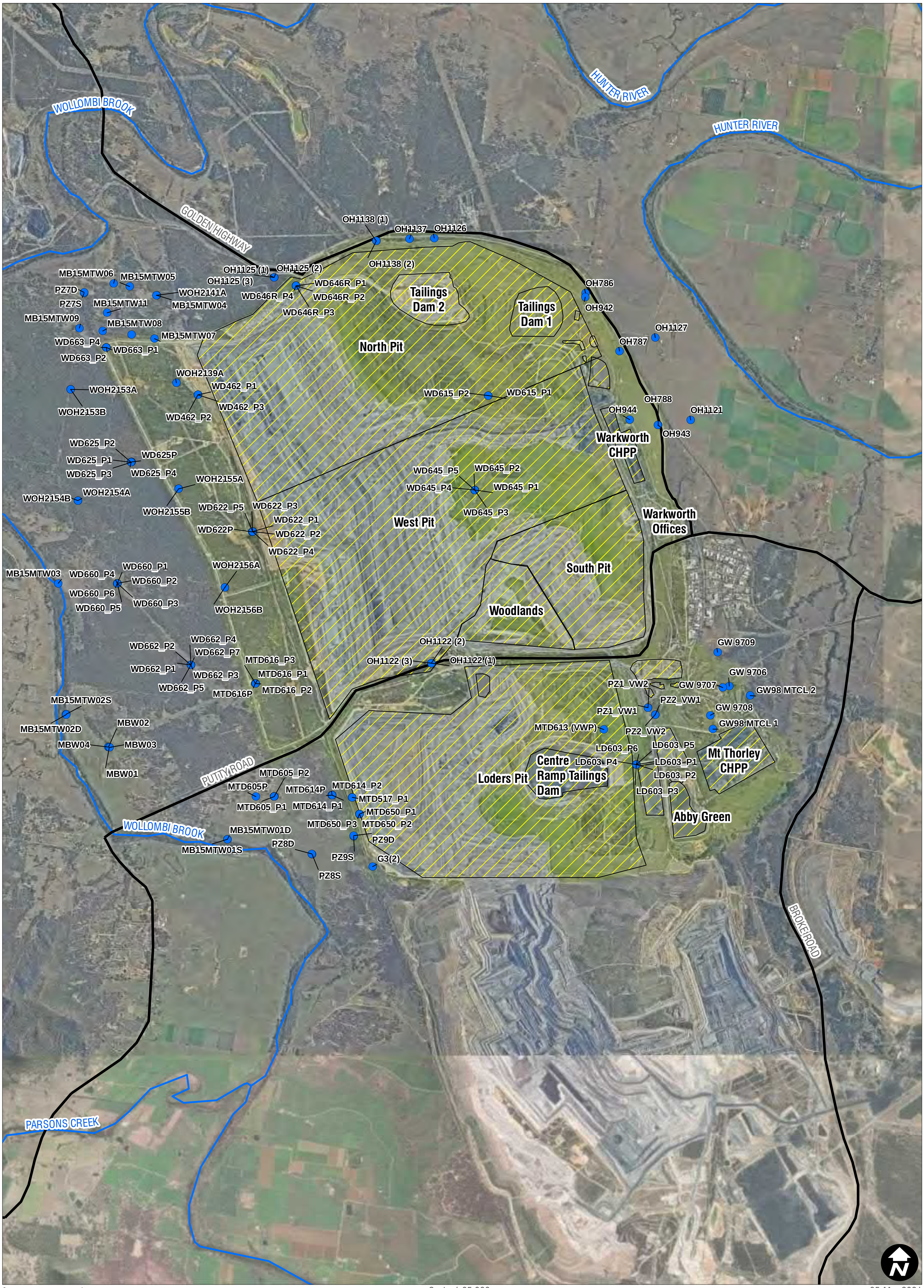
5.2 Groundwater Monitoring Methodology

MTW engages field contractors AECOM to carry out sampling and analysis. Sampling is required to be undertaken in accordance with relevant Australian Standards and other regulatory guidelines. Samples are analysed by laboratories that are National Association of Testing Authorities (NATA) accredited or equivalent for the parameters being analysed.

The WMP states that sampling is to be undertaken in accordance with AS 5667.1:-1998, *Guidance on the Design of Sampling Programs, Sampling Techniques and the Preservation and Handling of Samples and AS 5667.11-1998, Guidance on Sampling of Groundwaters*. Groundwater bores are purged prior to sample extraction for all samples requiring comprehensive laboratory analysis.

From review of the contractors sampling field sheets, it is understood that the quarterly and annual groundwater samples for the majority of bores are collected following purging either by using a Solinist low flow pump or bailer (3x casing volumes where possible) and water levels and field parameters (i.e. EC and pH) monitored. This approach is considered consistent with *AS 5667.1:-1998.* For bores with 25 mm and 32 mm casing, it is understood that the sample is collected following the purging using a bailer with a one-way check valve at the bottom of the bailer. Bores are purged until the field parameters stabilise and then they are sampled.

For the remaining bores (WOH1239A, WOH2141A, WOH2153A, WOH1254A, WOH2155A, WOH2156A, WD622P, MBW02 and MBW03) it is understood that the quarterly and annual groundwater samples are collected as grab samples using a disposable bailer. As outlined within *AS 5667.11-1998*, mineral material can accumulate within boreholes. Therefore, to collect representative groundwater samples the bore should be purged (4 to 6 times the well volume) and water quality parameters stabilised before sampling.



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- Groundwater Monitoring Points
- Main Roads
- Major Watercourses
- MTW_Pits

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2020 Annual Groundwater Review
Groundwater Monitoring Network

Figure 5-1

5.3 Groundwater Triggers

The WMP includes groundwater assessment criteria, including water quality trigger levels for investigating potentially adverse groundwater impacts. Trigger levels were initially revised in the March 2016 version of the WMP and were established based on the 95th percentile of baseline data for EC and based on the 5th and 95th percentiles for pH. The trigger levels as presented in the 2020 revised WMP are summarised in **Table 5-2**.

Groundwater quality measurements from the site monitoring bores have been compared to the relevant trigger levels in **Section 6.4**.

Table 5-2 Groundwater Quality Triggers Based on Monitoring Location

Location	Target Seam/ Stratigraphy	EC (95th) µS/cm	pH (5th)	pH (95th)
OH786	Regolith*	1,311	6.7	7.7
OH787	Regolith*	18,467	7.2	7.7
OH788	Hunter River Alluvium	12,234	7.0	7.9
OH942	Regolith*	25,435	6.5	6.9
OH943	Hunter River Alluvium	8,395	7.1	7.6
PZ7S	Aeolian Warkworth Sands	1,749	6.7	7.5
PZ8S	Wollombi Brook Alluvium	15,086	6.5	7.0
PZ9S	Wollombi Brook Alluvium	16,197	6.8	7.0
PZ7D	Shallow Overburden	17,488	6.8	8.0
PZ8D	Shallow Overburden	17,488	6.8	8.0
PZ9D	Shallow Overburden	17,488	6.8	8.0
MTD616P	Shallow Overburden	17,488	6.8	8.0
MTD614P	Shallow Overburden	17,488	6.8	8.0
MBW02	Shallow Overburden	17,488	6.8	8.0
MB15MTW01D	Shallow Overburden	17,488	6.8	8.0
MTD605P	Shallow Overburden	17,488	6.8	8.0
MB15MTW02D	Shallow Overburden	17,488	6.8	8.0
MB15MTW03	Shallow Overburden	17,488	6.8	8.0
WD625P	Woodlands Hill / Whybrow	12,086	7.1	7.3
WOH2153A	Redbank	15,948	7.0	7.9
WOH2154A	Redbank	15,948	7.0	7.9
WOH2155A	Redbank	15,948	7.0	7.9
WOH2156A	Redbank	15,948	7.0	7.9
WOH2153B	Wambo	14,080	7.0	7.8
WOH2154B	Wambo	14,080	7.0	7.8
WOH2155B	Wambo	14,080	7.0	7.8
WOH2156B	Wambo	14,080	7.0	7.8
WD622P	Wambo	14,080	7.0	7.8

Location	Target Seam/ Stratigraphy	EC (95th) µS/cm	pH (5th)	pH (95th)
MBW04	Wambo	14,080	7.0	7.8
WOH2139A	Blakefield	15,106	6.6	7.9
OH1122 (1)	Blakefield	15,106	6.6	7.9
OH1125 (1)	Blakefield	15,106	6.6	7.9
OH1125 (3)	Bowfield	14,656	6.6	6.9
OH1138 (1)	Warkworth	19,995	6.0	7.0
OH1138 (2)	Warkworth	19,995	6.0	7.0
OH1121	Vane Subgroup†	17,765	6.7	7.1
OH1126	Vaux	17,765	6.7	7.1
OH1137	Vaux	17,765	6.7	7.1
OH1127	Vane Subgroup†	23,000	6.6	7.5
GW 9706	Bayswater	23,000	6.6	7.5
GW 9707	Bayswater	23,000	6.6	7.5
GW 9708	Bayswater	23,000	6.6	7.5
GW 9709	Bayswater	23,000	6.6	7.5
GW98MTCL1	Bayswater	23,000	6.6	7.5
GW98MTCL2	Bayswater	23,000	6.6	7.5
WOH2141A	Whynot Seam	10,527	7.5	7.8

Note: ** Bore located outside extent of mapped alluvium and bore logs and site geology shows the bore actually intersects regolith material not Hunter River Alluvium as categorised within WMP*

† Bore located outside extent of mapped Jerry's Plains Subgroup and likely intersects underlying Vane Subgroup as per 1:25k geological mapping

5.4 Trigger Investigations

No formal trigger investigations were completed in 2020. A review of the monitoring network is however currently being completed In response to recommendations made within the annual review however for 2019, SLR (2020).

6 Monitoring Results

6.1 Data Recovery

6.1.1 Standpipe monitoring bores

Over 2020, groundwater monitoring was carried out at 60 standpipe monitoring bores across MTW. No water level or quality data was collected from ten of the monitoring bores during 2020 due to them being dry. The bores and sites with a data capture rate of less than 100 per cent are outlined in **Table 6-1**.

Table 6-1 Groundwater Monitoring Data Recovery for standpipe bores

Location	Type	Data Recovery	Comments
OH943	WQ	0%	Insufficient water for field test and lab sample – March, June, September and December 2020
OH944	WL and WQ	0%	Bore dry during 2020
PZ9S	WQ	0%	Insufficient water for field test and lab sample – March, June, September and December 2020
MB15MTW04	WL and WQ	0%	Bore dry during 2020
MB15MTW05	WL and WQ	0%	Bore dry during 2020
MB15MTW06	WL and WQ	0%	Bore dry during 2020
MB15MTW07	WL and WQ	0%	Bore dry during 2020
MB15MTW08	WL and WQ	0%	Bore dry during 2020
MB15MTW09	WL and WQ	0%	Bore dry during 2020
MB15MTW10	WL and WQ	0%	Bore dry during 2020
MB15MTW11	WL and WQ	0%	Bore dry during 2020
OH1125 (2)	WL and WQ	0 %	Bore dry during 2020
OH1137	WL and WQ	0%	Bore dry during 2020
WOH2156B	WQ	25%	Insufficient water for lab sample and field test – February, May, and November 2020

6.1.2 VWPs and data loggers

Groundwater levels are recorded by site VWPs and data loggers installed in select monitoring bores. Level data was successfully downloaded from 20 of the VWP sites and 19 of the loggers. Sites where data collection issues have been encountered are outlined in **Table 6-2** and **Table 6-3** for data loggers and VWPs, respectively. Further work to check the VWPs and monitoring bore loggers are working correctly (i.e. check / replacing batteries and logger depths) is ongoing.

Table 6-2 Logger Data Recovery

Bore ID	Serial Number	Comments
PZ8S	2118429	New logger installed in June 2020. No issues so far.

Bore ID	Serial Number	Comments
PZ8D	2118425	New logger installed in June 2020. No issues so far.
PZ9S	2053704	Water level was below base of logger in 2019. Logger appears to have been lowered (previous wire length was 6.26 m – currently at 6.80 m).
PZ7S	2016488	Errors in readings from May 2020 onwards, likely faulty logger. Recommend replacing logger.
PZ7D	2053695	2019 data did not match manual dip measurements. It was suspected that the logger install depth may be different to the reported depth – further investigation confirmed wire length of 10.80 m matches records. Manual dip measurements matches logger data in 2020.
MB15MTW02S	2053694	2019 data did not match manual dip measurements. It was suspected that the logger install depth may be different to the reported depth – further investigation confirmed wire length of 10.04 m does not match 9.90 m on record; however, a logger install depth of 9.71 m provides the most accurate match for 2020 data when applied to 21 November 2019 onwards.
MB15MTW02D	2039901	Erroneous data from old logger from June 2018 to February 2020. New logger installed on 17 March 2020. Appears to be working fine with manual dips matching.

Table 6-3 VWP Data Recovery

Location	Sensor (s)	Comments
WD622	1 to 5	Data erroneous prior to June 2020. VWP interface replaced on 25 June 2020 and all sensors now logging.
PZ2	1 & 2	No longer exists.
MTD605	5 & 6	Sensor 5 data erroneous from January 2020 – otherwise rest of 2020 data is fine. Sensor 6 data erroneous from 23/06/19 – potential sensor failure. Recommend replacement.
MTD613	2	No data from sensor 2. Investigate if sensor 2 has ever been installed.
MTD614	3 to 5	Data erroneous – potential sensor failure.
MTD650	1 to 5	Frequent erroneous data records for all sensors. No access to site in November 2020 as too close to high wall, so data until April 2020.
WD609A	1	Pre-2019 data appears highly fluctuating. Some erroneous trends and fluctuations until 2019. 2020 data mostly appears fine but gradual declining trend observed.
WD645	1 & 5	Frequent data errors from March 2020 onwards. Recommend replacement/ removal of sensor 1 and further investigation and possible replacement/ removal of sensor 5.
WD646R	2 & 5	Frequent erroneous data since installation in sensor 2. Recommend replacement/ removal. Frequent errors were observed in sensor 5 prior to September 2020, but only occasional error after this date – further investigation recommended.
WD662	7	Sensor 7 failed shortly after installation. Recommend replacement/ removal.
WD462	1 to 3	Sensor data does not appear to be collected anymore.
PZ1	1 & 2	Sensor 2 logger replaced in June 2019. Sensor 1 and 2 depths and calibration details unknown

6.2 Monitoring network review

Overall, the current monitoring network and program is generally adequate for satisfying current monitoring requirements of the WMP. There is good spatial coverage of monitoring locations across the site, with multiple bores and VWP sensors installed into each relevant aquifer unit when taken into account the installation of additional VWPs in 2019 and 2020. It is recommended that the Groundwater Management Plan be updated to incorporate these additional VWPs, remove destroyed/erroneous monitoring points and to more clearly identify the purpose of each bore based on its location and construction. Compliance conditions should also be updated to align with the revised network and identified purpose of bores.

6.3 Water Levels

A summary of the water level results is provided for each of the main water bearing units (regolith, alluvium and Permian coal measures) below. Routine water level readings for 2020 are presented in **Appendix B**.

6.3.1 Regolith

In the 2018 annual environmental monitoring report (SLR, 2019) a review of the construction depths for bores previously identified as intersecting the Hunter River Alluvium in the WMP was undertaken. The review found that three bores (OH786, OH787 and OH942) are in fact screened within regolith material, i.e. surficial clays and shallow, deeply-weathered Permian coal measures.

Over 2020, groundwater within the regolith bores occurred at depths of between 0.27 m and 14.03 m below top of casing (mbTOC). **Figure 6-3** presents the historical groundwater levels for all three regolith bores, along with rainfall trends (CRD) and stream elevations recorded at the Hunter River stream gauges at Mason Dieu and Long Point.

The greatest fluctuations in groundwater elevation were recorded for bore OH786 with a total bore depth of 7.1 m bgl, which intersects the shallow regolith east of TD1 and Dam 1N. Groundwater elevations within OH786 have fluctuated over time but generally show a decline since 2016. This may relate to climate trends and reduced rainfall recharge, or potentially relate to cessation of storage within TD1 from 2012 and water storage in Dam 1N. Historical water levels in this bore have indicated that in periods of above average rainfall, the magnitude of fluctuations is less (e.g. 2007 to 2012). After 2012, although the CRD slopes upwards, the period from 2012 to 2016 was not as wet as the previous 6 years – degree of fluctuation in groundwater levels became larger – indicating insufficient recharge to the bore. OH786 appears to have been dry most of the time from 2017 to 2019 which corresponded to the negative slope in CRD (i.e. drought). Groundwater elevations have rebounded during 2020; however, there is still consistently insufficient water in the bore after purging to sample for the full suite of analytes. The last full suite analysis was undertaken in June 2016. It is therefore recommended that the monitoring methodology be reviewed along with bore logs to devise the most appropriate method for attaining water quality samples. It is also recommended that a data logger be deployed to better understand groundwater level fluctuations in the regolith and potential influences from surface water and water storages.

OH787 exhibited a decreasing trend in groundwater elevation during 2020, despite the above average rainfall received early and later in the year. There appears to be historical influence from pumping of nearby bores (large drawdown fluctuations from 2007 to 2010) and a lack of response or delayed response to rainfall. This is possibly due to the lack of connection with alluvium and low permeability of the weathered material in which this bore is screened (identified in SLR, 2019).

Similar to OH787, OH942 has declined in water level over the long term (since 2014), with minor seasonal fluctuations as a delayed response to recharge. Over 2020, despite the above average rainfall, only a 2 cm rise in groundwater level occurred between March 2020 and June 2020, before a decline in groundwater level continued (an additional 9 cm of decrease from June to December 2020).

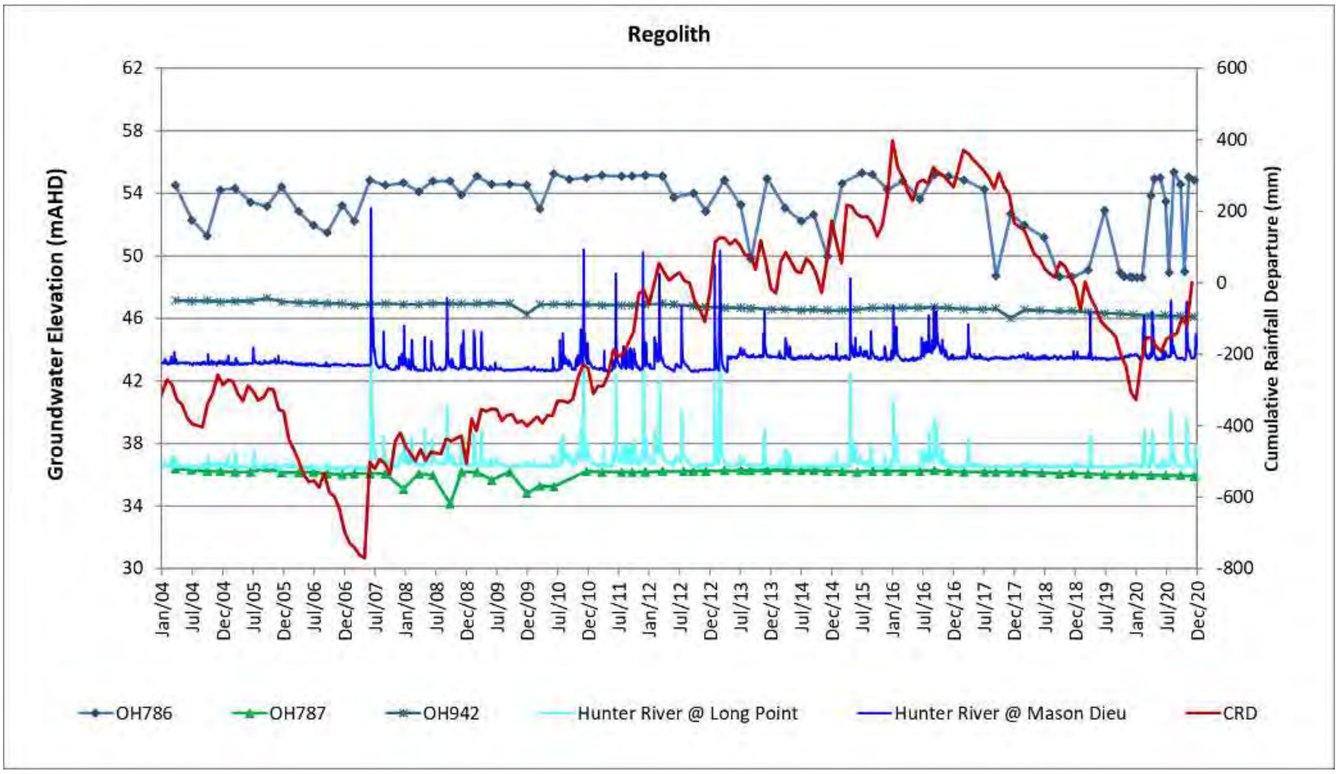

Figure 6-1 Groundwater Levels – Regolith

6.3.2 Alluvium

Groundwater level trends are discussed below for the Warkworth Sands, alluvium along the Hunter River and alluvium along Wollombi Brook.

6.3.2.1 Warkworth Sands

Bores within the Warkworth Sands include PZ7S and MB15MTW04 to MB15MTW11. All bores within the Warkworth Sands are equipped with dataloggers that are set to record groundwater levels on a four-hourly basis with the exception of PZ7S which is six-hourly. Levels recorded using loggers were compensated using barometric levels recorded at the MTW site at hourly intervals. The hourly readings are currently not taken 'on the hour', e.g. at 3:45:31am. It is recommended to set these readings to match all other loggers. It is worth noting that barometric levels used to compensate the 2018 data was sourced from the neighbouring Bulga Mine which resulted in a degree of 'noise' in the readings.

Bore PZ7 is a nested bore of two separate standpipes, with PZ7S constructed within the Warkworth Sands to 11.1 m depth bgl (screened internal unknown), and PZ7D constructed within the shallow overburden material to a total depth of 30.5 m bgl (screened interval unknown). Historical water level data for the bores is presented in **Figure 6-2**. **Figure 6-2** shows that groundwater elevations within the coal measures at PZ7D have historically been slightly higher than levels in the overlying Warkworth Sands, indicating a potential upward gradient. Between 2016 and 2019 this gradient has reduced, with levels within the Warkworth Sands and shallow overburden showing similar elevations and longer-term declining trends. **Figure 6-2** shows that during 2020 groundwater levels within the Warkworth Sands and shallow overburden material at PZ7S and PZ7D, respectively started to recover, likely in response to above average rainfall received in February and March 2020. A delayed recovery response is seen in the manually measured water level at PZ7S. The data collected by the logger in PZ7S was erroneous from June 2020 onwards; therefore, the short-term water level response to rainfall was not able to be examined. As recommended in the previous annual review, further investigation into the local ground conditions bore construction details and condition of the nested bore should be undertaken, to understand the interaction between the two bore depths. The logger in PZ7S should be replaced with an operating logger.

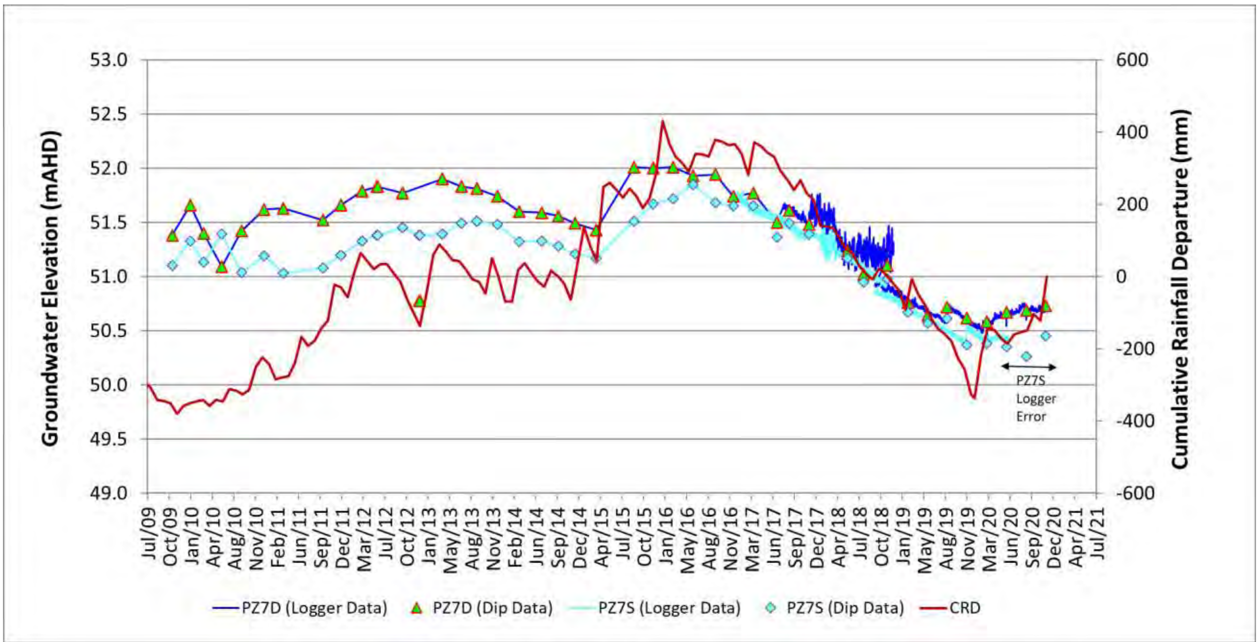

Figure 6-2 Groundwater Levels – Warkworth Sands Bore PZ7S and PZ7D

Bores MB15MTW04 to MB15MTW11 were generally recorded as dry since construction in 2016, as such no hydrographs have been created. An exception to this was bore MB15MTW06, which has historically shown a groundwater level response to rainfall events. Bore MB15MTW06 was recorded as dry throughout 2019 and 2020, which generally corresponds with the below average rainfall recorded between 2016 and 2019. With likely above average rainfall conditions following those observed in 2020, MB15MTW06 may yield water again. Close monitoring of this bore should be maintained.

6.3.2.2 Hunter River Alluvium

Three bores within the monitoring network intersect alluvium along the Hunter River, including OH788, OH943 and OH944. During 2020, bore OH944 was dry, with water levels recorded at or below the base of the bore. According to available bore construction details, bore OH944 is 8.2 m deep and historical monitoring records indicate that the bore has often been dry or had insufficient water present to sample since 2011.

Of the bores with water present, alluvial groundwater levels were measured at depths of between 9.65 m and 10.06 mbTOC during 2020. **Figure 6-3** presents the historical groundwater elevations for all three Hunter River alluvium bores, along with rainfall trends (CRD) and stream elevations recorded at the Hunter River stream gauges at Mason Dieu and Long Point. As shown in **Figure 6-3**, groundwater levels have remained relatively stable at bores OH788 and OH943 since monitoring commenced in 2004, with less than 0.5 m variation in levels recorded. The very slight decline in water level observed between early 2017 and late 2019 for both bores has been attributed to below average rainfall received in the same period. This declining trend appears to have stabilised as a result of above average rainfall received in 2020 and water levels are beginning to recover since December 2020. There appears to be minor correlation between CRD and water levels in MB15MTW01S and MB15MTW02S – especially when assessed together with river elevations. Higher frequency of above average rainfall (seen as a steeper positive trending CRD) and frequent river flows correlate well with periods of peak groundwater levels (e.g. March 2012 and June 2013). Less frequent above average rainfall (seen as a gradual positive trending CRD) and less frequent river flows result in lower magnitude of groundwater rise (e.g. March 2016). As recommended in the previous annual review, the construction and geology at the two bores should be reviewed to verify whether their target geology is alluvium or weathered Permian coal measures.

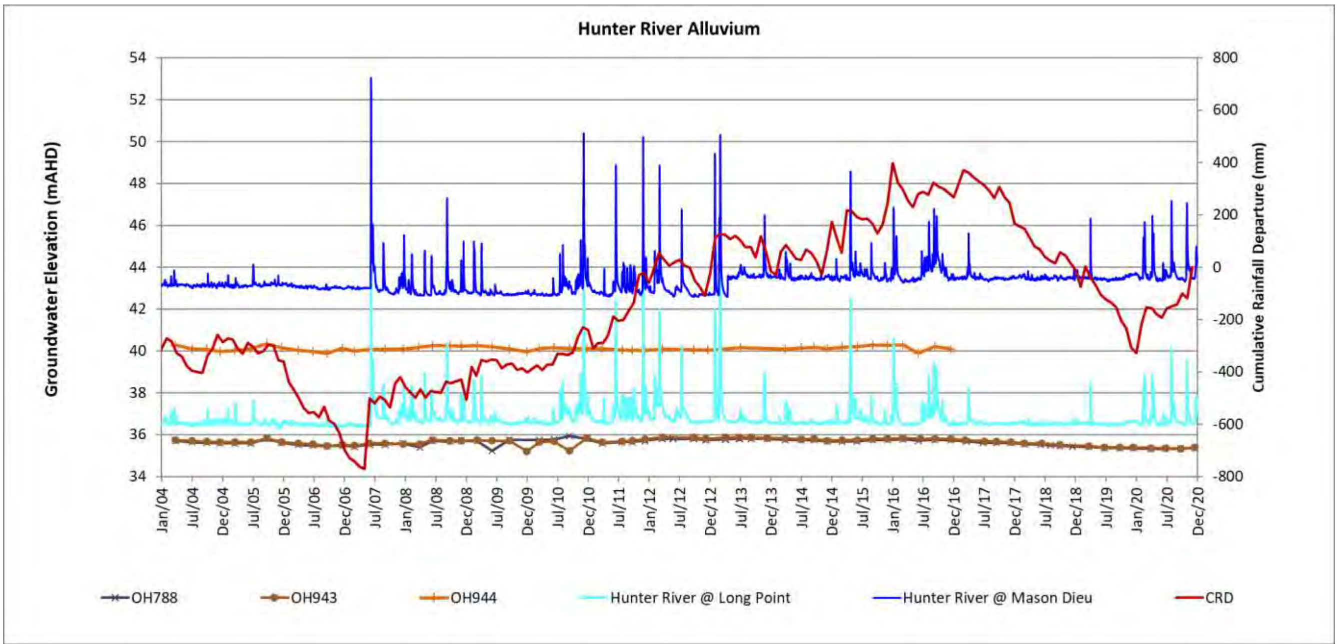

Figure 6-3 Groundwater Levels – Hunter River Alluvium

6.3.2.3 Wollombi Brook Alluvium

Five bores intersect the alluvium along the Wollombi Brook: G3, PZ8S, PZ9S, MB15MTW01S, and MB15MTW02S. Each of these bores are nested sites with two separate standpipes in separate boreholes, the shallower screened in the alluvium, the deeper in the underlying overburden material of the Permian coal measures.

Groundwater elevation trends for bores west of MTW (MB15MTW01 and MB15MTW02) are presented in **Figure 6-4,** which includes rainfall trends (CRD) and stream elevations for Wollombi Brook as recorded at Bulga. Groundwater levels at the two locations are recorded with data loggers and manual dip readings. It should be noted that due to data logger failure, groundwater elevation data for MB15MTW02D between June 2018 and March 2020 is inaccurate and has not been included in **Figure 6-4**. Manual dip readings should be used during this period instead, to provide a basic indication of changes to groundwater levels. Logger data from May to September 2020 had multiple error readings; hence, has not been included in this assessment. Furthermore, the logger in MB15MTW03 was not able to be downloaded during Q4 of 2020. Further investigation into the condition of this logger should be undertaken and the logger replaced if found to be faulty. Manual water levels have been included in **Figure 6-4** and any other discussion.

Prior to 2020, groundwater levels in the Wollombi Brook Alluvium bores were gradually declining along with decreasing CRD due to ongoing below average rainfall. Over 150 mm of rainfall was received in February and March 2020 combined, resulting in flows in Wollombi Brook. River level fluctuations in the Wollombi Brook at Bulga appears closely mirrored by groundwater levels. The largest fluctuations as a result of recharge occur in MB15MTW02S and is followed by MB15MTW01S, both screened in the Wollombi Brook Alluvium and are located adjacent to Wollombi Brook.

Figure 6-4 shows that during 2020, alluvial groundwater elevations along Wollombi Brook are below stream elevations most of the time for the Wollombi Brook alluvial bores (e.g. MB15MTW02S) with the exception of MB15MTW01S in periods of high rainfall and peak surface water levels (e.g. during February and April 2020) – indicating losing conditions during theses times. Groundwater levels steadily increased following the peaks in stream elevation, indicating recharge to groundwater. Discharge of groundwater or baseflow is likely occurring when groundwater levels are above stream elevations, e.g. from April to July 2020. It should be noted that groundwater elevations in MB15MTW01S and MB15MTW01D are very close and suggest that for most of 2020 there was either a very slight upwards flow gradient at this location or no gradient. A slight downwards gradient only occurs after significant rainfall and during peak stream flow. An example of this is seen at the end of July 2020 which lasts no more than five days and resulted in approximately 2 cm of head difference between the alluvium and underlying shallow overburden.

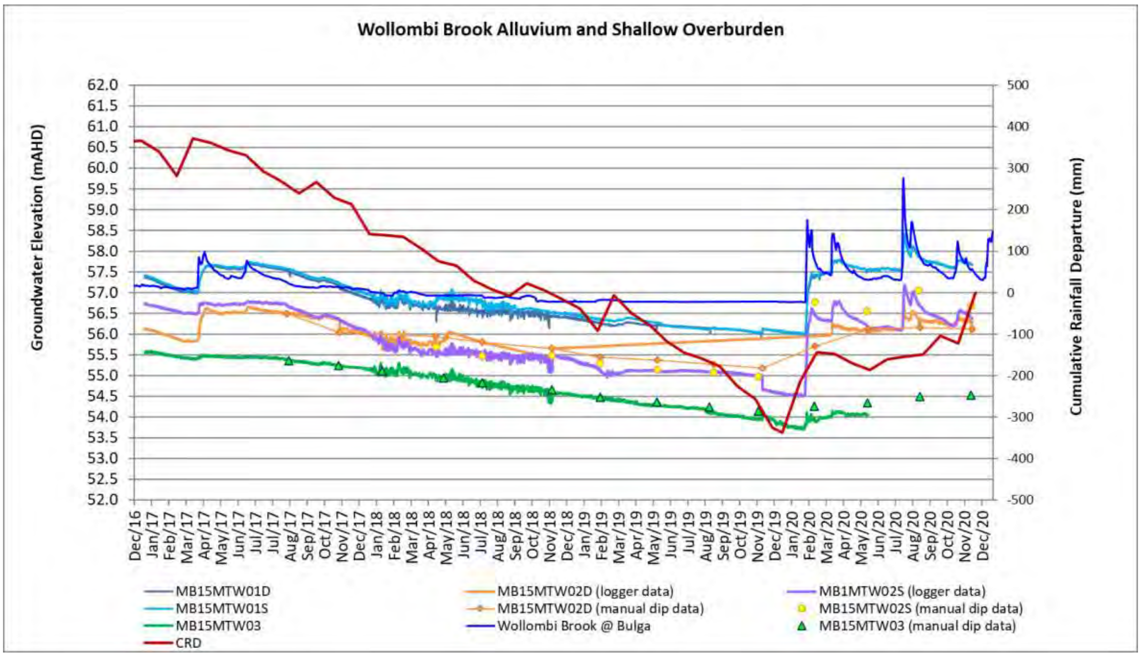

Figure 6-4 Groundwater Levels – Wollombi Brook Alluvium MB15MTW01 and MB15MTW02

Figure 6-4 Error! Reference source not found. shows that alluvial groundwater elevations have generally been higher than the groundwater levels in underlying overburden material, indicating a downward flow gradient. The exception to this is bore site MB15MTW02 where the alluvial groundwater elevations have been marginally lower than the underlying overburden material, indicating a potential upward flow gradient. During 2020, in response to above average rainfall, groundwater elevations in MB15MTW02S have largely remained above MB15MT02D, leading to a potential downwards flow gradient, and likely recharge to the underlying overburden material via the alluvium. A slight and gradual increase in groundwater elevation of no more than 0.5 m occurred during 2020 at MB15MTW02S, which is significantly lower than that at MB15MTW01S, despite both being screened in the Wollombi Brook Alluvium and similarly distanced from the Wollombi Brook.

Trends between the alluvium and underlying shallow overburden material follow similar trends along Wollombi Brook. This contrasts with observations further away from the Wollombi Brook, as discussed below.

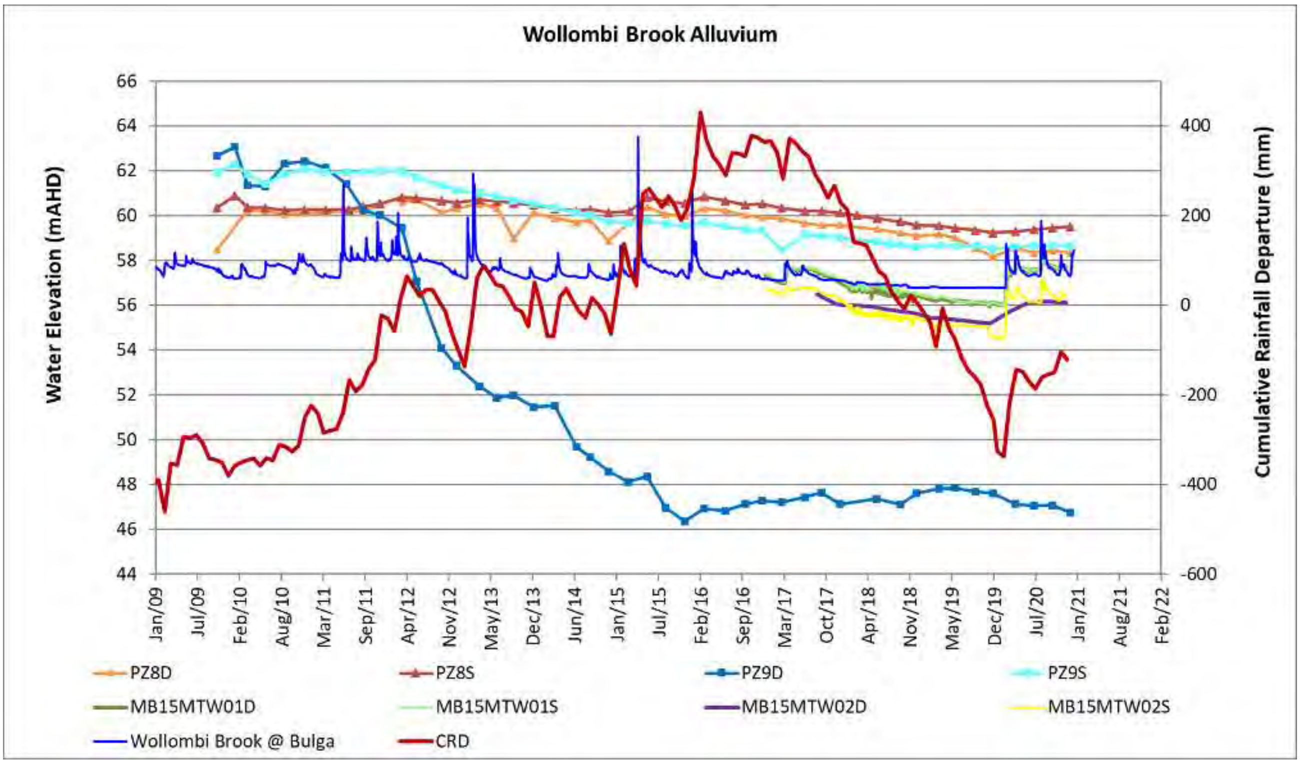

Figure 6-5 Groundwater Levels – Wollombi Brook Alluvium Bores PZ8, PZ9, MB15MTW01 and MB15MTW02

Groundwater elevations trends for bores over 600 m from Wollombi Brook, at the south-western end of site (PZ8 and PZ9), are presented in **Figure 6-5**Error! Reference source not found.. Trends for the MB15MTW alluvial bores are also included for comparison. The graph also includes rainfall trends (CRD) and stream elevations for Wollombi Brook as recorded at Bulga. As with the bores adjacent to Wollombi Brook, Error! Reference source not found. shows a general decline in groundwater levels within the alluvium during the three-year drought period, with most bores responding to the February and March 2020 above average rainfall with groundwater elevations recovering.

It is also noted that groundwater levels within shallow overburden bore PZ9D declined from commencement of monitoring in 2009 to 2016. Between 2016 and 2017 groundwater levels gradually rose before becoming more stable over 2019. Bore PZ9D is positioned closest to the active operations at Loders Pit. The decline in groundwater levels within the shallow overburden material (e.g. at PZ9D from 2010 to 2015) likely reflects depressurisation from mining, as predicted as part of the mine approvals (AGE, 2014b). Both PZ9S and PZ9D are shallow, with total bore depths of 7 m and 24 m, respectively. The difference in groundwater trends in these bores highlights the limited vertical hydraulic connection between the Permian coal measures and surficial sediments at this location.

6.3.3 Permian Coal Measures

Groundwater level trends for the Permian coal measures are discussed in stratigraphic order in **Section 6.3.3.1** to **Section 6.3.3.9** below. This includes further discussion on the shallow overburden, shallow coal seams (Whybrow, Redbank Creek and Wambo seams), Blakefield Seam, Bowfield Seam, Warkworth Seam, Vaux Seam and Bayswater Seam.

6.3.3.1 Shallow Overburden

Ten monitoring bores intersect the shallow overburden material, including PZ7D, PZ8D, PZ9D, MTD605P, MTD614P, MTD616P, MBW02, MB15MTW01D, MB15MTW02D, and MB15MTW03. Groundwater level trends for bores nested with alluvial bores (PZ7D, PZ8D, PZ9D, MB15MTW01D, and MB15MTW02D) are discussed in **Section 0** with single bore MB15MTW03 is also shown in **Figure 6-4** for comparison. The general decline in groundwater elevations previously observed in MB15MTW03 during 2019 have begun trending upwards since 2020 (**Figure 6-4**).

Groundwater elevation trends for bores MTD605P, MTD614P, MTD616P, and MBW02 are presented in **Figure 6-6**. **Figure 6-6** shows stable to slightly declining groundwater levels within the shallow overburden material. The exception to this is bore MTD616P in which slightly increasing groundwater levels were recorded between January 2018 and May 2020. Subsequent groundwater elevations have declined and stabilised at approximately 71.4 mAHD. Given the CRD generally declined from 2017 to 2019, it would not be expected that groundwater elevations would rise. As reported in the previous annual review, no land use changes, or activities are known to have occurred near the bore that may have caused this rising trend. Further investigation into site conditions around MTD616P should be undertaken to confirm this.

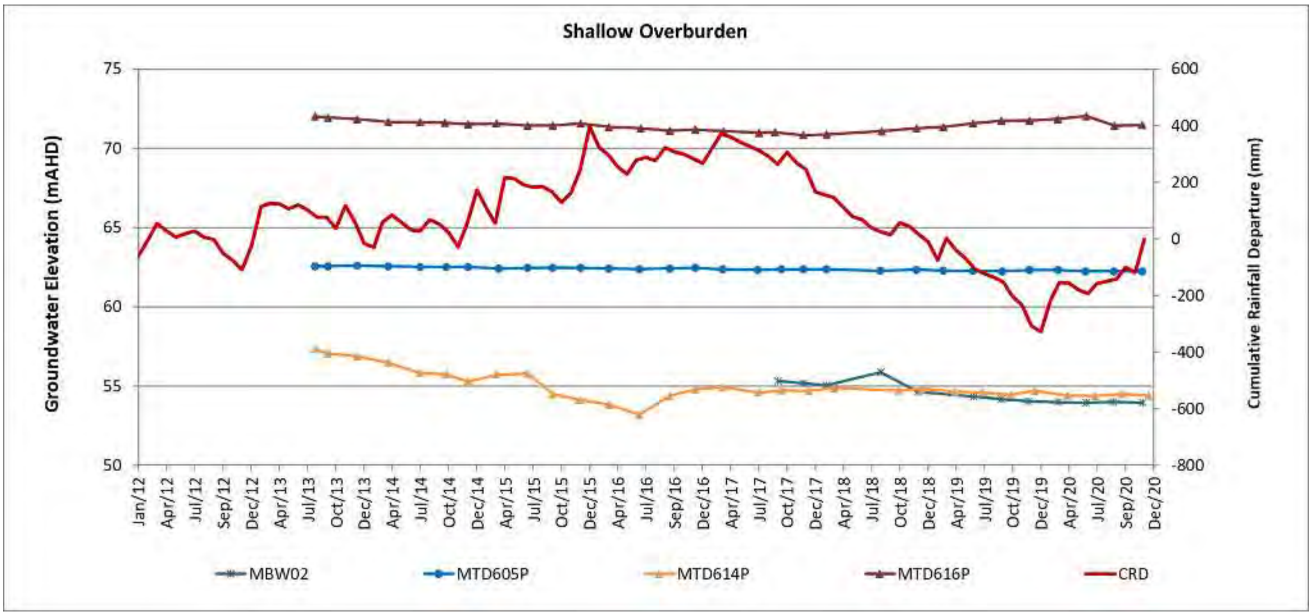

Figure 6-6 Hydrograph of Shallow Permian Coal Measures

6.3.3.2 Whybrow, Redbank Creek and Wambo Seams

Historical groundwater elevation trends for bores intersecting the shallow coal seams (Whybrow, Redbank Creek and Wambo seams) are presented in **Figure 6-7**. The graph shows that although larger seasonal fluctuations occurred in some bores during 2020 compared to the previous year, generally long term trends have remained similar to the previous year.

Groundwater elevations at WD625P (Whybrow ~1.4 km from pit), WOH2153B (Wambo ~2.1 km from pit) and WOH2154B (Wambo ~2.3 km from pit) remained relatively similar throughout 2019 and 2020. This is likely due to the distance that these bores are from the pit.

Groundwater elevations in the following bores increased significantly with above average rainfall and continued declining subsequently – likely exhibiting responses to depressurisation of the coal seams as a result of mining operations:

- WOH2154A (Redbank)
- WOH2155A (Redbank)
- WD622P (Wambo)
- WOH2156A (Redbank)

The following bores follow relatively different trends compared to other bores discussed above:

- WOH2156B (Wambo) – had been stable during 2019 but groundwater level decline began in 2020 and continued with at an increased rate towards the end of 2020
- WOH2155B (Wambo) – gradual decline had been ongoing since 2017, with rate of decline increasing in mid-2020 and stabilising towards the end of 2020

WOH2156B and WOH2155B are similarly distanced from pit disturbance and are in the same seam. WOH2156B has a much higher groundwater elevation at ~68 mAHD compared to ~58 mAHD at WOH2155B, ~55 mAHD at WOH2154B and ~45 mAHD at WD622P. Groundwater elevation in these bores suggest that the general flow direction is from west towards the river; however, with depressurisation of aquifers, there is also local flow towards the pit disturbance.

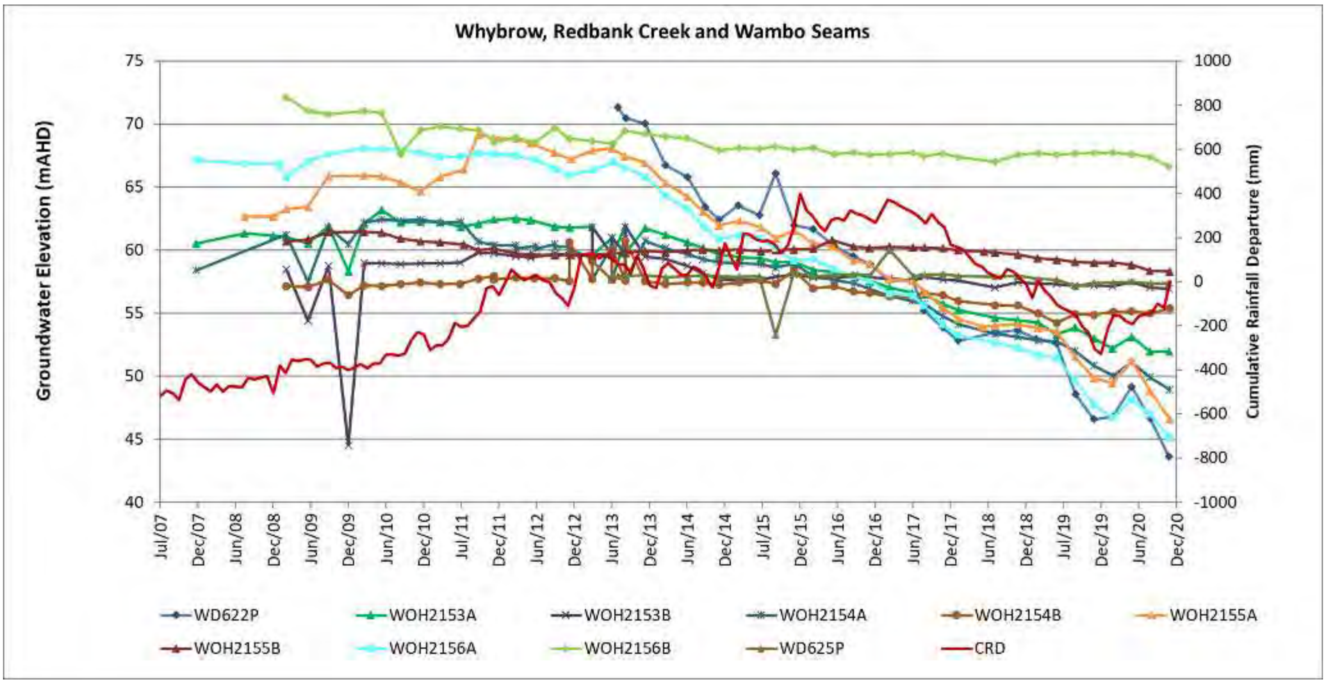

Figure 6-7 Hydrograph of Whybrow, Wambo and Redbank Creek Seams

Groundwater elevation trends for VWP sensors installed within the Whybrow and Wambo seams are presented in **Figure 6-8** and **Figure 6-9,** respectively. The Whybrow Seam hydrograph shows that groundwater elevations have remained relatively stable throughout 2020, with the exception of a minor decline in MTD614 S1 of ~1 m. These trends are similar to those observed in the Whybrow Seam standpipe monitoring bores mentioned above. Groundwater elevations in the Wambo Seam recovered temporarily following above average rainfall in February and March 2020. Despite this temporary relief, the declining trends continued over the rest of the year as a result of coal seam depressurisation. It should be noted that 'noise' (short-term fluctuations of up to 2 m) observed in water level data from MTD605 Sensor 2 since mid-2018 and MTD616 P1 over the entire dataset may indicate faulty VWP sensors. This is especially likely since MTD614 Sensor 1 located approximately 800 m to the east of MTD605 does not exhibit the same fluctuations, and such frequent fluctuations would not be related to rainfall or stream water level fluctuations. Further investigation into the condition of MTD616 P1 and MTD605 S2 sensors should be undertaken before the sensor should be replaced.

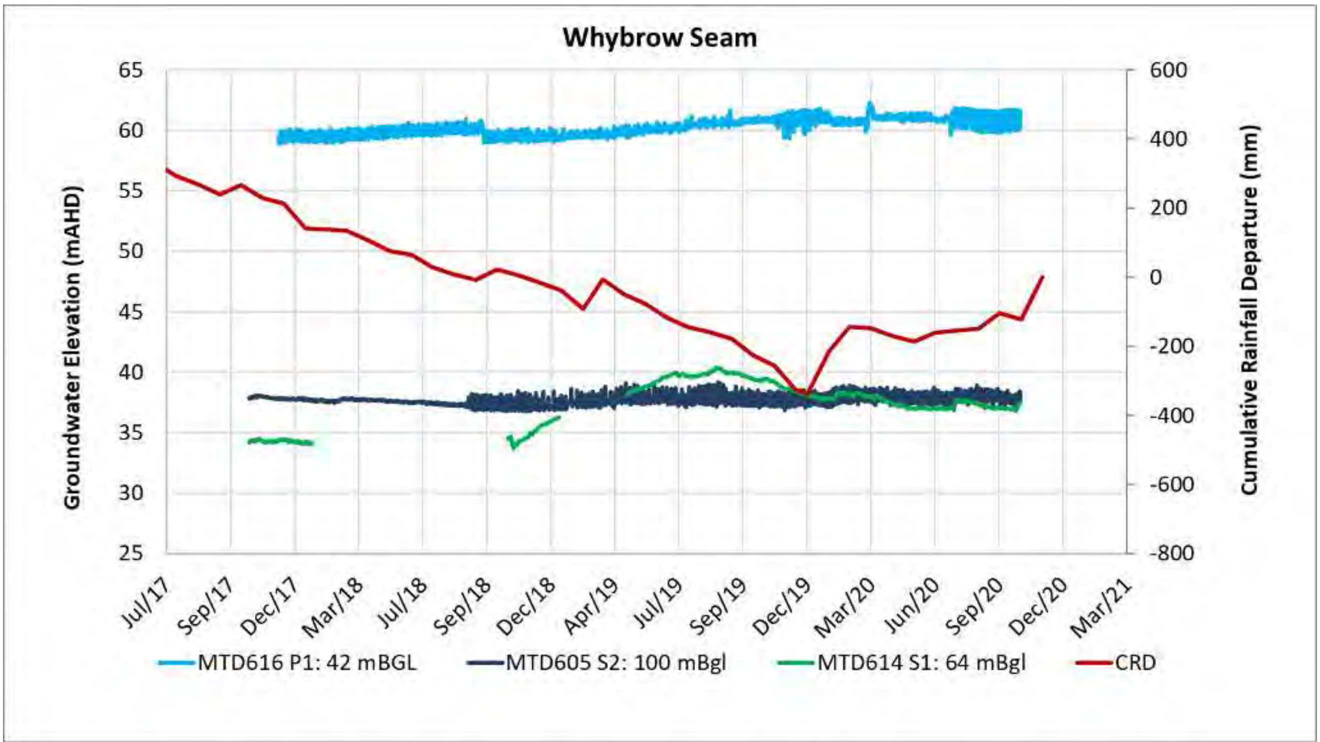

Figure 6-8 VWP Hydrograph of Whybrow Seam

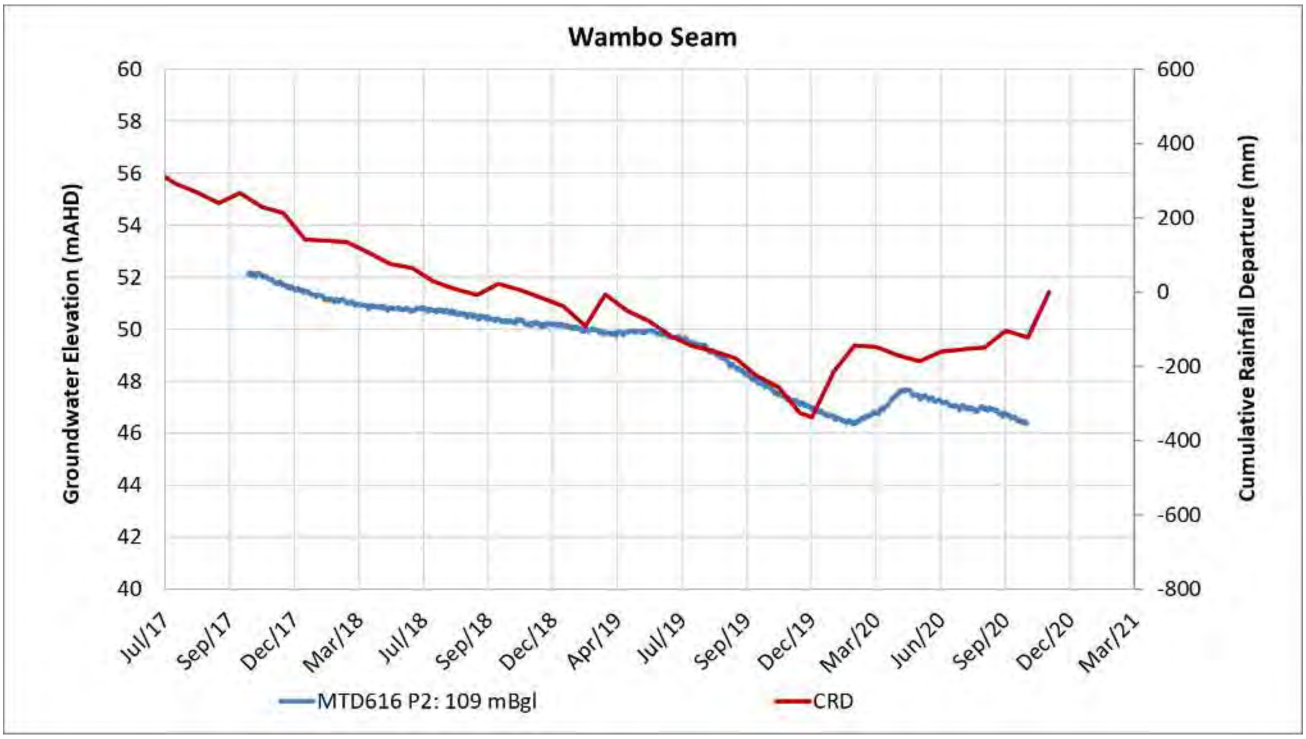

Figure 6-9 VWP Hydrograph of Wambo Seam

6.3.3.3 Blakefield Seam

Historical groundwater elevation trends for bores intersecting the Blakefield Seam are presented in **Figure 6-10**. The graph shows that during 2020 groundwater elevations ranged between 32.85 mAHD and 51.76 mAHD.

Contrary to the previous year's trends, groundwater elevations at OH1125(1) temporarily increased following above average rainfall in February and March 2020. Levels subsequently declined gradually back to a similar elevation to pre-increase levels. Rainfall had very minimal impact on groundwater elevations in OH1222(1) in early 2020. Groundwater levels in this bore continuously declined in 2020. Groundwater elevations in WOH2139A was relatively stable during the first half of 2020, until an approximately 2 m decline occurred in August; however, in November 2020 groundwater elevations returned to similar levels to those observed in the first half of 2020. This could be attributed to the above average rainfall event that was received in December 2020.

Groundwater elevation trends for VWP sensors installed within the Blakefield Seam are presented in **Figure 6-11**. The graph shows that during 2020 groundwater elevations within the seam slightly declined at MTD605 (corresponding to likely depressurisation of coal seams) but remained relatively stable at MTD614 S2 (possibly due to some recharge from rainfall infiltration and cross-aquifer interaction).

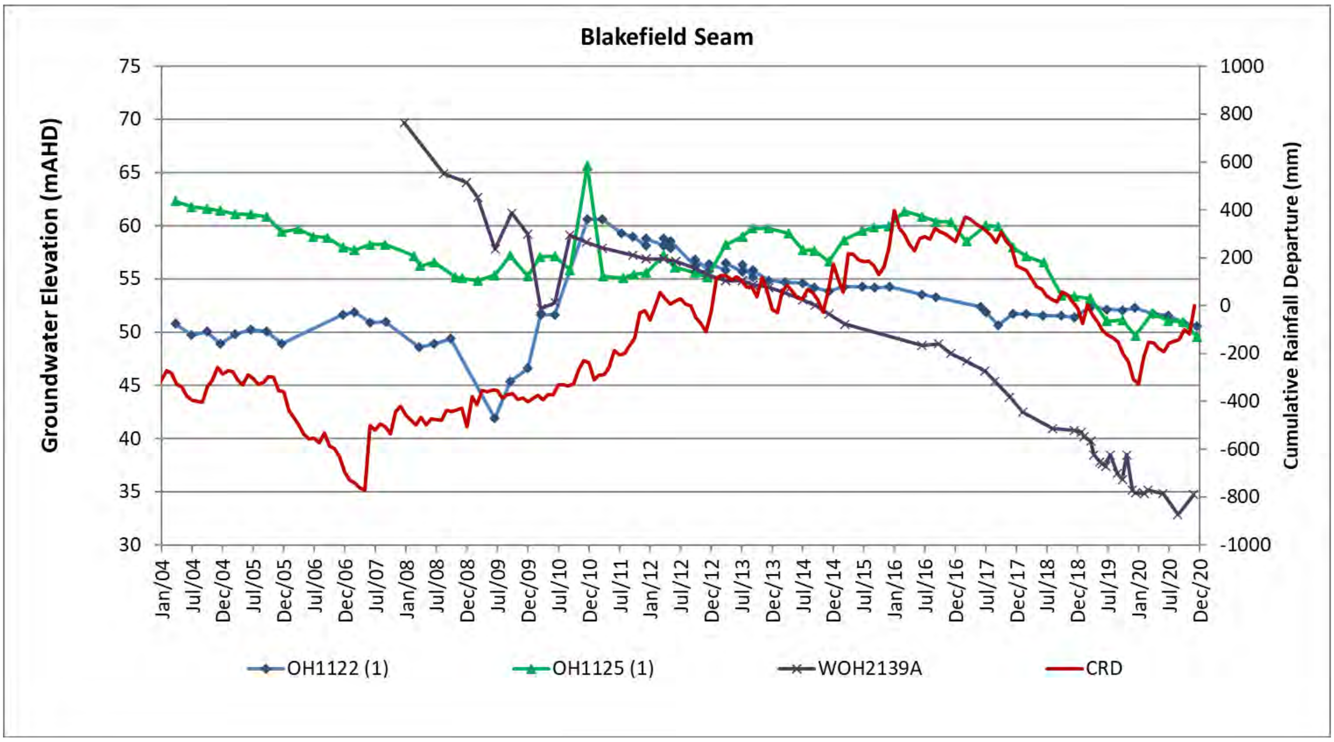

Figure 6-10 Hydrograph of Blakefield Seam

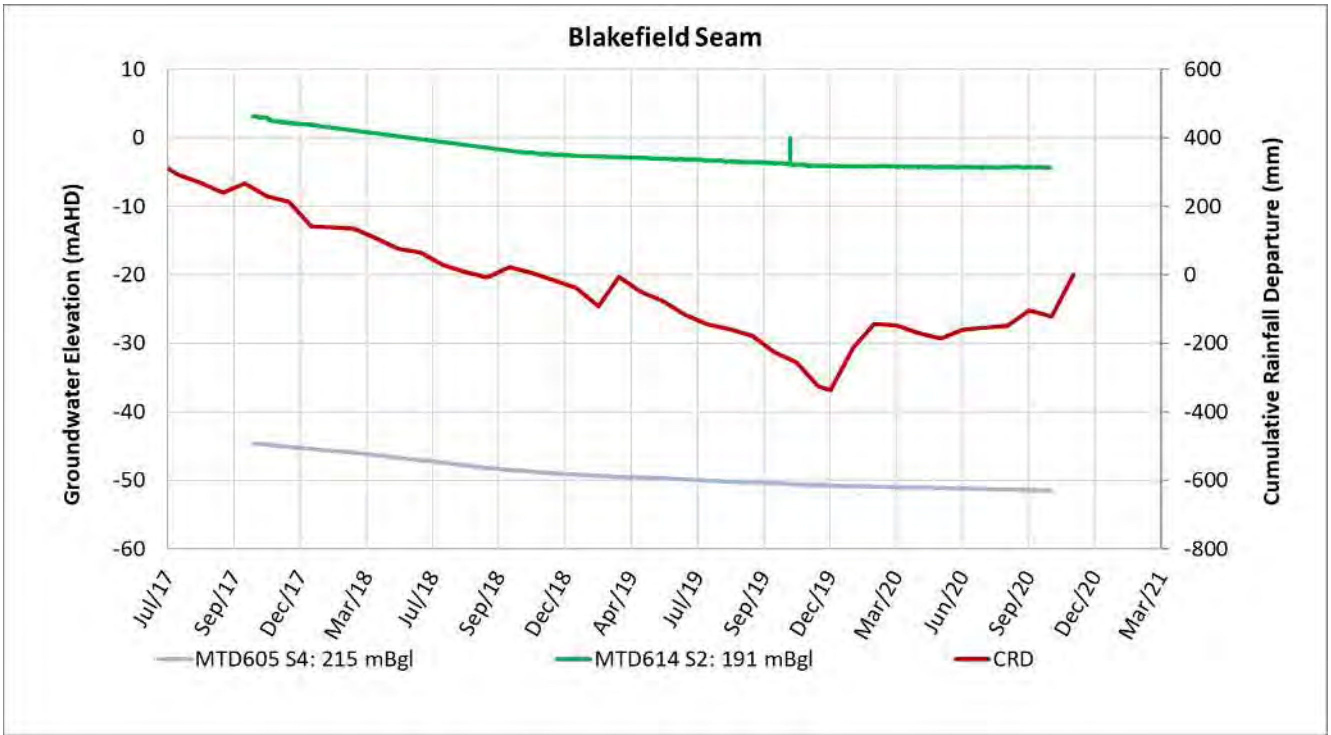

Figure 6-11 VWP Hydrograph of Blakefield Seam

6.3.3.4 Woodlands Hill Seam

Groundwater elevation trends for VWP sensors installed within the Woodlands Hill Seam are presented in **Figure 6-12**. The graph shows that in 2020 groundwater elevations within the seam at VWP WD625 were variable – possibly due to factors such as water storage activities and underground mining activities at Wambo, whereas at VWP MTD616 P3 groundwater elevations continued to decline for the first half of the year in 2020, but stabilised at ~17.3 mAHD during the latter half of 2020. MTD616 is located to the north west of Loders Pit and west of West Pit. The decreasing groundwater elevations are likely due to dewatering of the coal seam from mining of these pits. Stabilisation of groundwater elevations could indicate cessation of depressurisation of the Woodlands Hill Seam and/or increase in recharge from rehabilitated pits that had intercepted this coal seam.

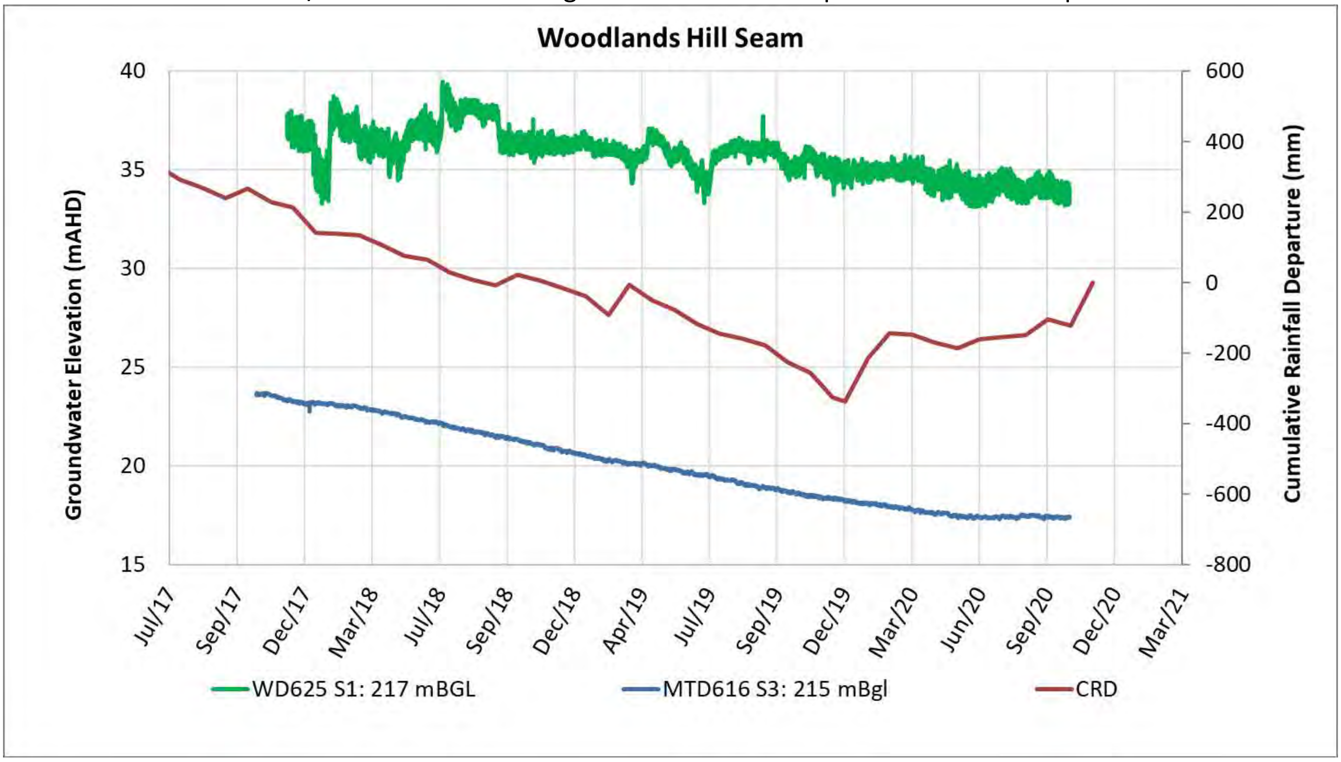

Figure 6-12 VWP Hydrograph of Woodlands Hill Seam

6.3.3.5 Bowfield Seam

Historical groundwater elevation trends for bores intersecting the Bowfield Seam are presented in **Figure 6-13**. The graph shows that during 2020 groundwater elevations in Bore OH1125(3) initially increased from 28.98 mAHD in January 2020 to 39.11 mAHD in May 2020. Further fluctuations occurred over the course of the year until the bore resumed a declining trend towards the end of the year at a rate ranging from -1.6 to -2.5 m/month. Bore OH1125(3) is located directly to the north of North Pit and the decline may relate to drawdown towards active mining within the pit to the south. As mentioned in the previous annual review, the trend may also be influenced by abstraction from LUG Bore located approximately 1.25 km to the north west. The LUG bore intersects the historical Lemington Underground workings, which mined through the deeper Mt Arthur Seam. The groundwater level drawdown observed in the latter part of 2020 may be a combination of the effects of mining of the North Pit and licenced abstraction from the LUG bore.

The targeted formation of bore OH1125(2) (shown also in **Figure 6-13**) is not currently known. This bore has been recorded as dry since 2012. No data was available for this reporting period but it is assumed that this bore is still dry.

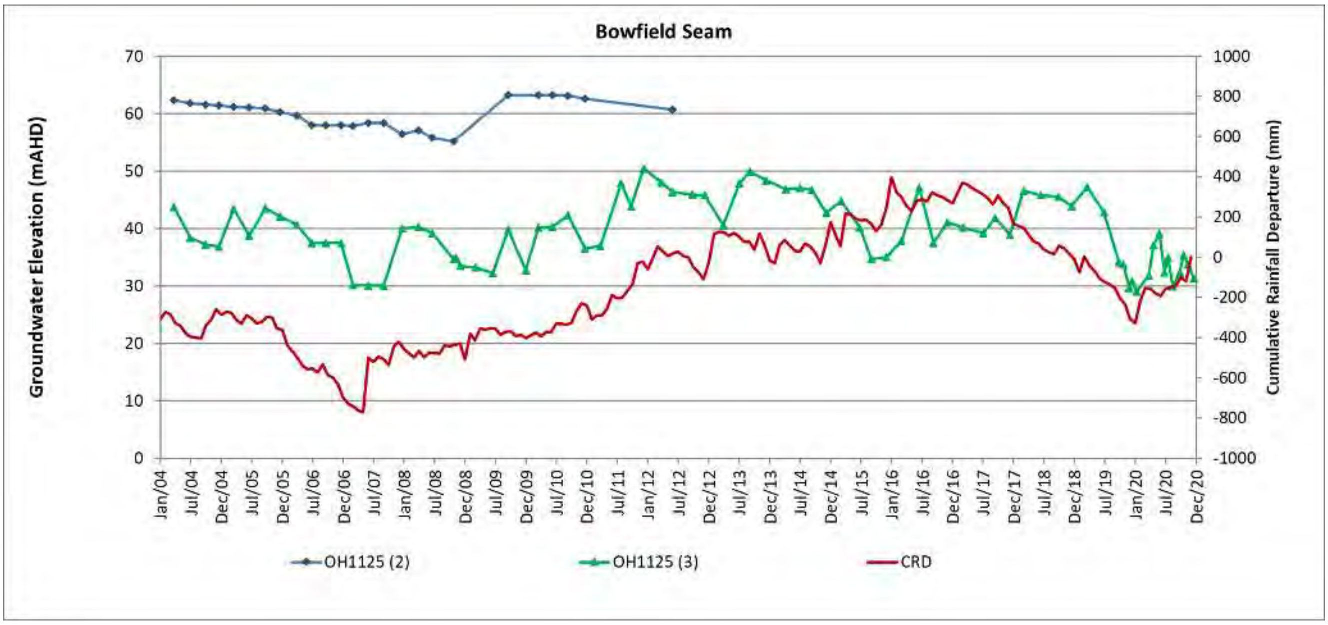

Figure 6-13 Hydrograph of Bowfield Seam

6.3.3.6 Warkworth Seam

Historical groundwater level trends for nested bores at OH1338 (1 and 2) intersecting the Warkworth Seam at bore OH1138 at two different depths (24.8 m and 42.8 m, respectively) are presented in **Figure 6-14**. The graph shows that during 2020 groundwater elevations ranged between 55.33 mAHD and 60.03 mAHD and levels declined by up to 0.36 m in the shallower bore and up to 0.79 m in the deeper bore. The bore is located north of North Pit and the decline may relate to drawdown towards active mining within the pit to the south-west. The trend may also be influenced by abstraction from LUG Bore approximately 1.25 km to the north-west (as similarly could be the case for OH1125(3)).

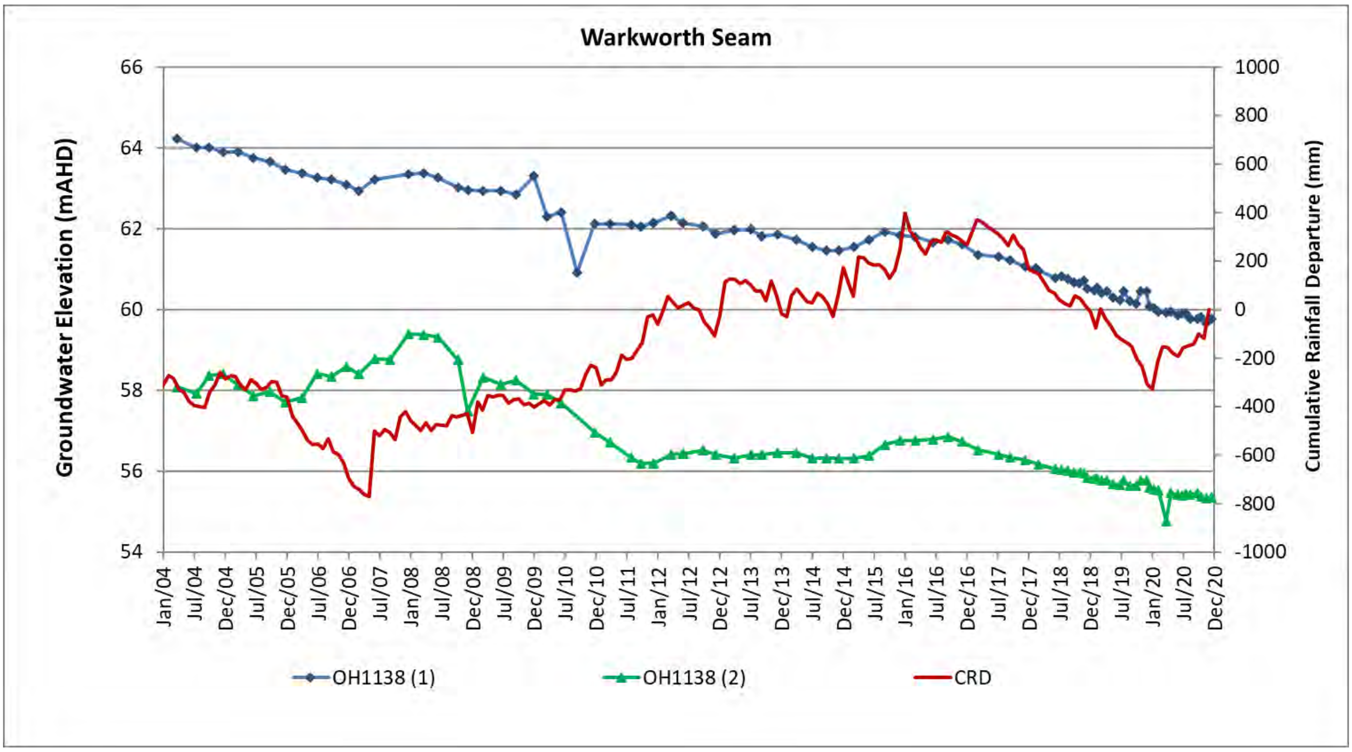

Figure 6-14 Hydrograph of Warkworth Seam

6.3.3.7 Mt Arthur and Piercefield Seams

Historical groundwater elevation trends for VWP sensors intersecting the Mt Arthur and Piercefield coal seams are presented in **Figure 6-15** and **Figure 6-16** respectively. At MTD605 water level data was erroneous from November 2019 to January 2020. After this period, data has been available, showing a continuous decline in groundwater elevation towards 0 mAHD during October 2020.

Figure 6-15 shows that during 2020, the decline in groundwater elevation for MTD616 P4 stabilised temporarily at approximately 11.5 mAHD, as did WD625 S2 at approximately 34.1 mAHD. The long-term stable elevations observed in WD625 suggest that depressurisation of the coal seams associated with North Pit are not influencing groundwater levels within the Mt Arthur seam at this location.

Figure 6-16 shows that following gradual groundwater level recovery within the Piercefield Seam during 2019, groundwater elevation in WD615 S1 has stabilised at a level of approximately 25.6 mAHD during 2020. VWP WD615 is located along the southern boundary of North Pit, within a rehabilitated area of the pit. The VWP sensor WD625 S2 is located in the seam underlying the mined coal seam at this location. The increase in groundwater elevation within the Piercefield Seam is potentially an indication of recharge from the overlying spoil as groundwater recovery takes place in the rehabilitated areas.

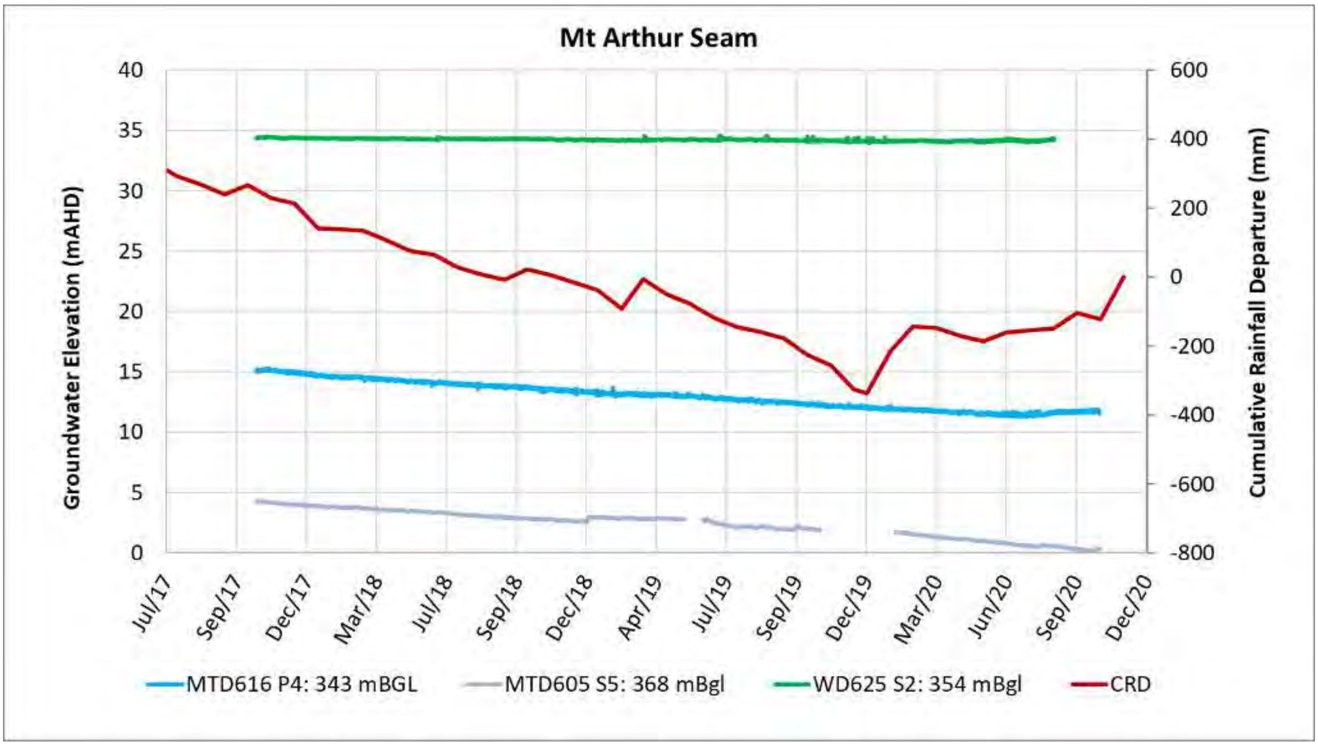

Figure 6-15 VWP hydrograph of Mt Arthur Seam

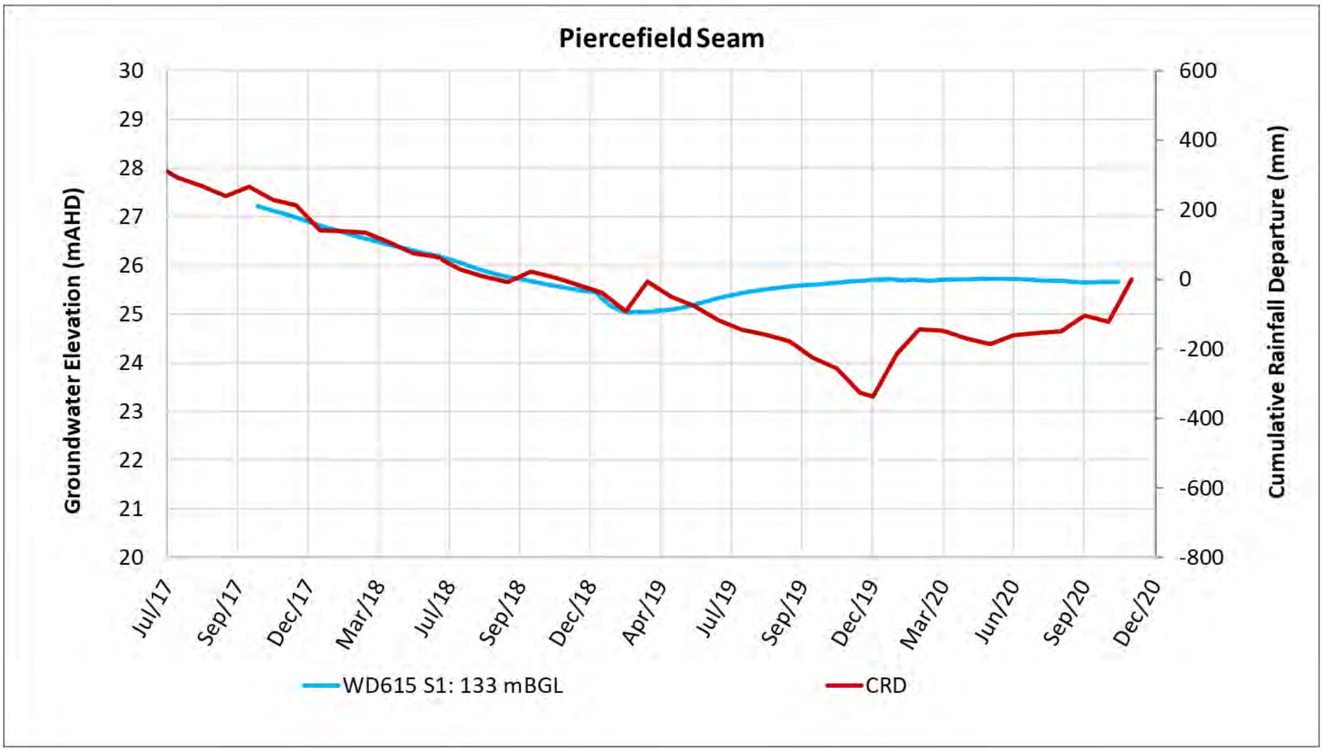

Figure 6-16 VWP hydrograph of Piercefield Seam

6.3.3.8 Vaux Seam

Historical groundwater elevation trends for bores intersecting the Vaux Seam around MTW are presented in **Figure 6-17**. The graph shows that during 2020 groundwater elevations within the Vaux Seam, north of North Pit, (OH1126) ranged between 45.71 mAHD and 46.01 mAHD. OH1137 has remained dry from September 2019 onwards. These trends are similar to trends observed within the Warkworth Seam, which may relate to depressurisation of the coal seams below the actively mined seams at MTW, or due to surrounding mine operations that target the Vaux Seam.

Groundwater elevations within bore OH1121 remained stable over 2020. This bore is located upgradient (east) of MTW and is reported in the WMP to intersect the shallow Vaux Seam (20 m depth). However, as noted in the previous annual review, upon review of the geology map (**Figure 3-4**) the Jerry's Plains Subgroup that the Vaux Seam is within is not present at this location. Therefore, the condition and construction details of the bore should be further reviewed.

Groundwater level trends for VWP sensors installed within the Vaux Seam are presented in **Figure 6-18** and **Figure 6-19**. WD625 is located to the west of North Pit, MTD605 is located to the west of Loders Pit and MTD616 is located to the south west of West Pit.

The sensor for MTD605 (S6) appears to have failed in June 2016 and the logger stopped in June 2019 according to the summary notes provided to SLR. It is recommended that this sensor is replaced. MTD616 P5 has declined approximately 4 m between 2017 and 2020 (**Figure 6-18**). The overall rate of decline appears to be at a steady rate; however, water levels exhibit sinusoidal fluctuations that are likely related to pumping and recovery of water levels in the Vaux Seam. The water level in MTD605 S6 was also following a declining trend, but not dropping at the same rate (approximately 1.6 m between 2017 and 2019). The overall trends observed at these two VWPs are similar to those seen in OH1126 and OH1137 (mentioned above). Therefore, it is also likely that these bores are influenced by surrounding mine operations that target the Vaux Seam. The VWP data from WD625 S3 indicates that only 12 cm of decline has been recorded in the Vaux Seam over the three years of monitoring at this location (**Figure 6-19**).

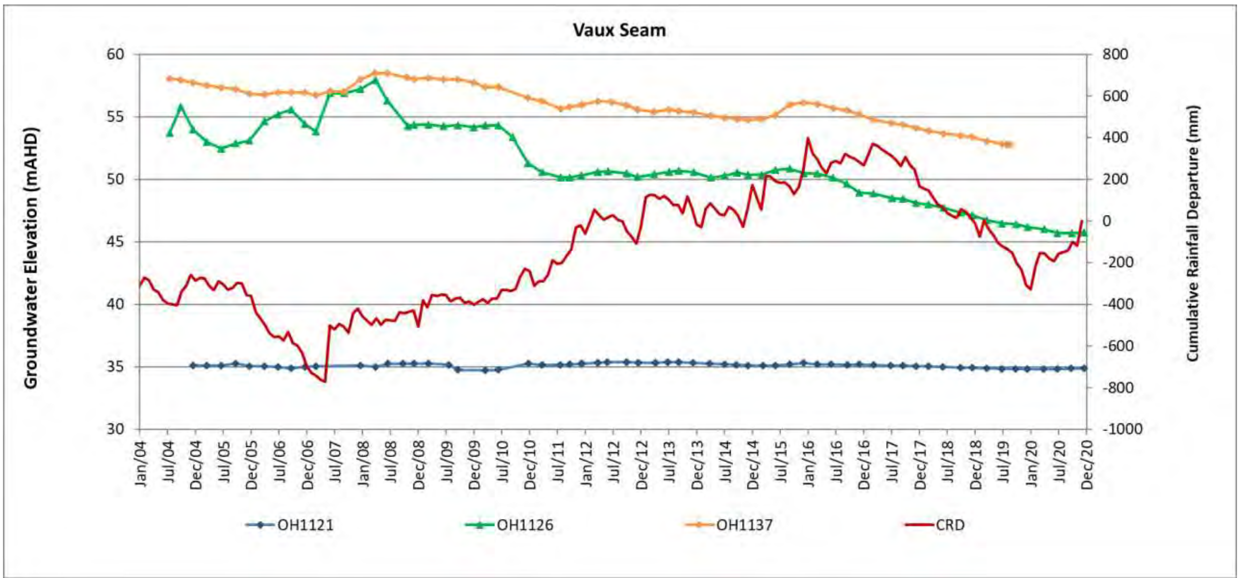

Figure 6-17 Hydrograph of Vaux Seam

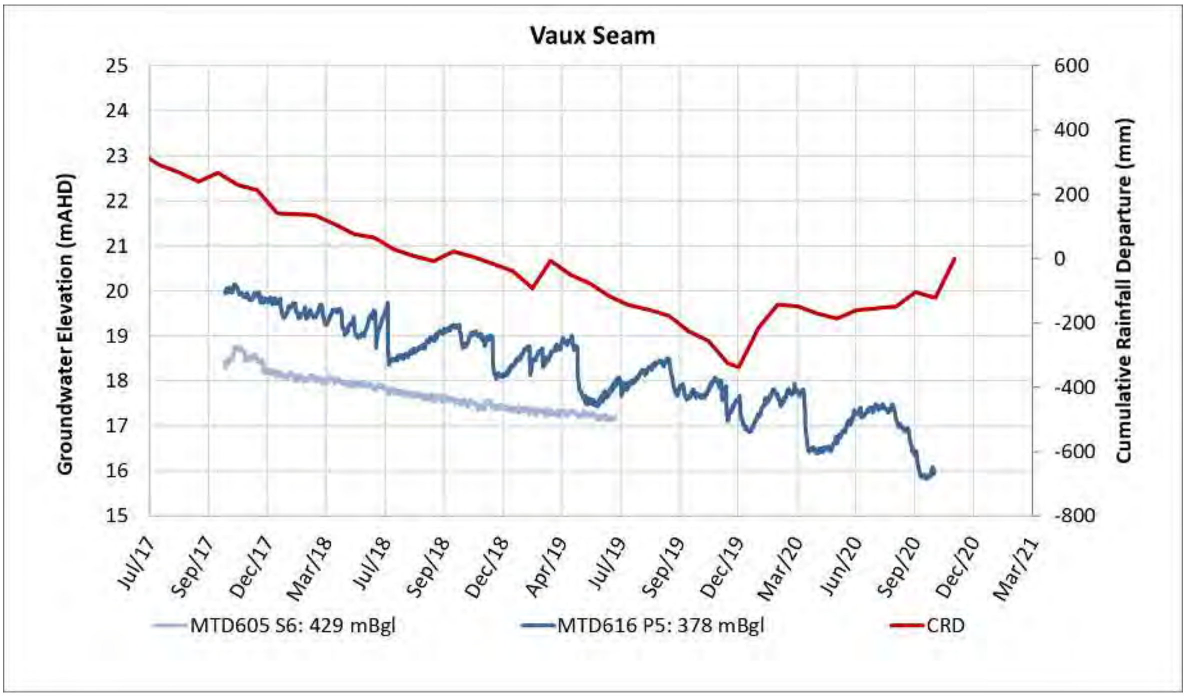

Figure 6-18 VWP hydrograph of MTD616 P5 and MTD605 S6 (Vaux Seam)

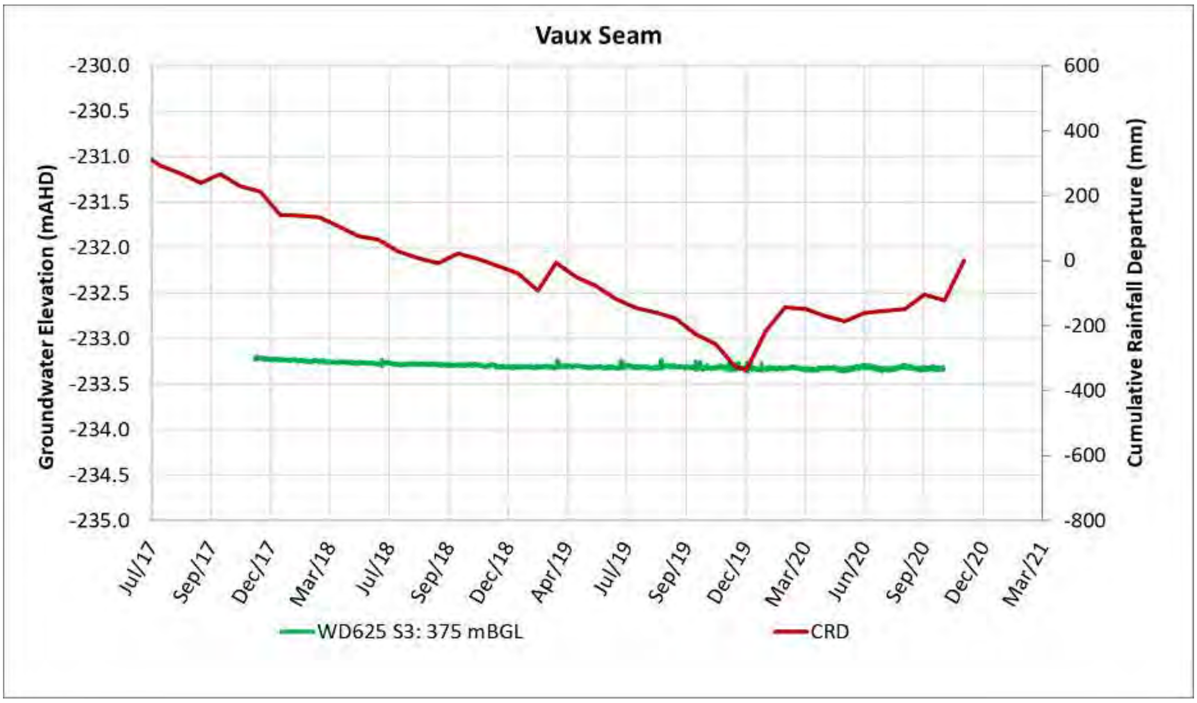

Figure 6-19 VWP hydrograph of WD625 S3 (Vaux Seam)

6.3.3.9 Bayswater Seam

Historical groundwater elevations trends for bores intersecting the Bayswater Seam that are south east of South Pit at MTW are presented in **Figure 6-20**. The graph shows that groundwater elevations at bores including GW98 MTCL 2, GW98 MTCL 1, GW 9706, GW 9708, GW 9707, GW 9709 and OH1127, remained either relatively stable or have increased during 2020. Groundwater elevations ranged between 35.24 mAHD and 68.54 mAHD. All bores presented in **Figure 6-20** are located to the south east of South Pit. Past trends in these bores have been a very gradual long-term decline, even throughout a seven-year period of above average annual rainfall (seen as a positive trend in the CRD). This could potentially be related to depressurisation of the Bayswater Seam by surrounding mining operations that target this seam.

Groundwater elevation trends for VWP sensors installed around the site at MTW within the Bayswater Seam are presented in **Figure 6-21**, **Figure 6-22**, and **Figure 6-23**. During 2020 the following observations were noted with regard to groundwater elevations:

- Decline of 1 m during 2020 in MTD605 S7.
- Decline of 0.5 m during 2020 in MTD616 P6.
- Upwards trend in WD615 S2, with ~5 m of increase when excluding the frequent sinusoidal fluctuations over the 2020 monitoring period (Note: range of groundwater elevations in 2020 was ~12.5 m).
- Gradual decline in WD625 S4 of less than 0.1 m during 2020.

With the exception of WD615 all VWP locations are situated to the west of the main mine pits (North Pit, West Pit and Loders Pit). WD615 is located within the eastern portion of the North Pit. The increase in groundwater elevations observed in WD615 corresponds with the increasing elevations observed within the Piercefield Seam at the same location. The increase may be an indication of recovering groundwater levels within rehabilitated areas of the North Pit resulting in recharge to the underlying coal seams. This is supported by the sinusoidal fluctuations mentioned above for WD615 S2, which appears to be related to a delayed response to rainfall and lack of rainfall (see the CRD in **Figure 6-22**). The declining water levels in MTD605 S7 and MTD616 P6 over the reporting period could potentially be attributed to depressurisation of the Bayswater Seam by surrounding mining operations that target this seam.

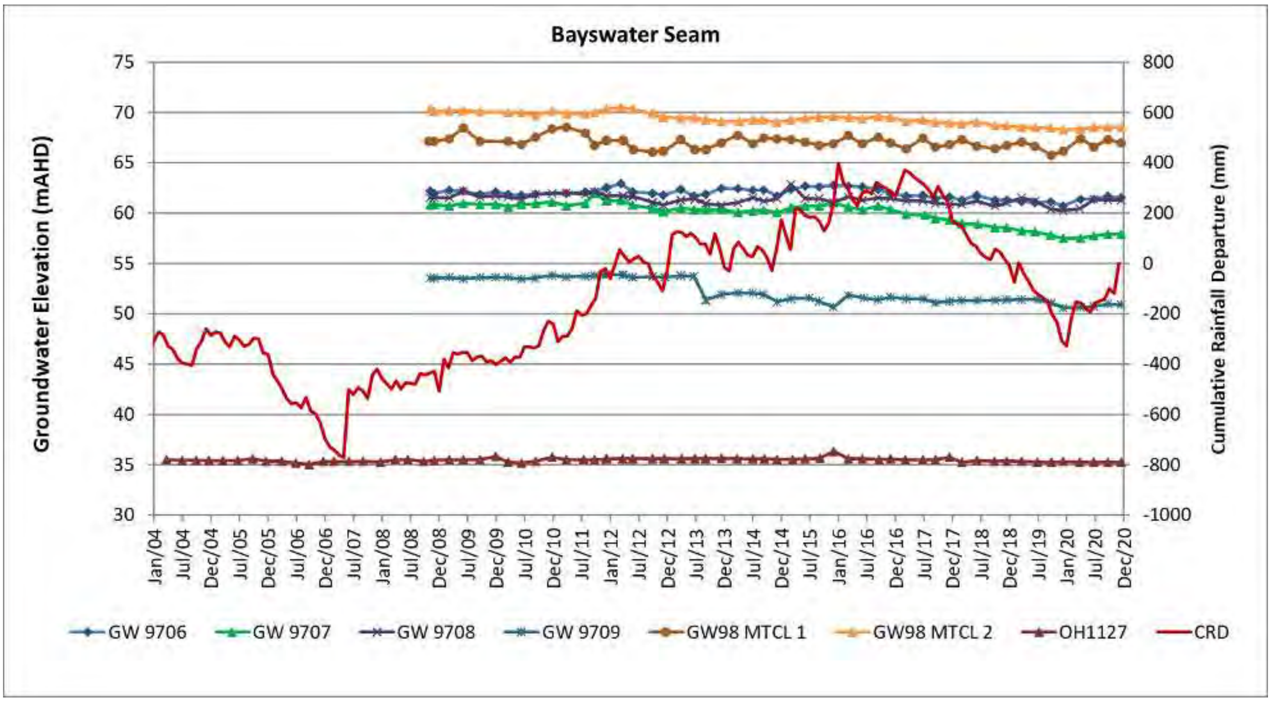

Figure 6-20 Hydrograph of Bayswater Seam

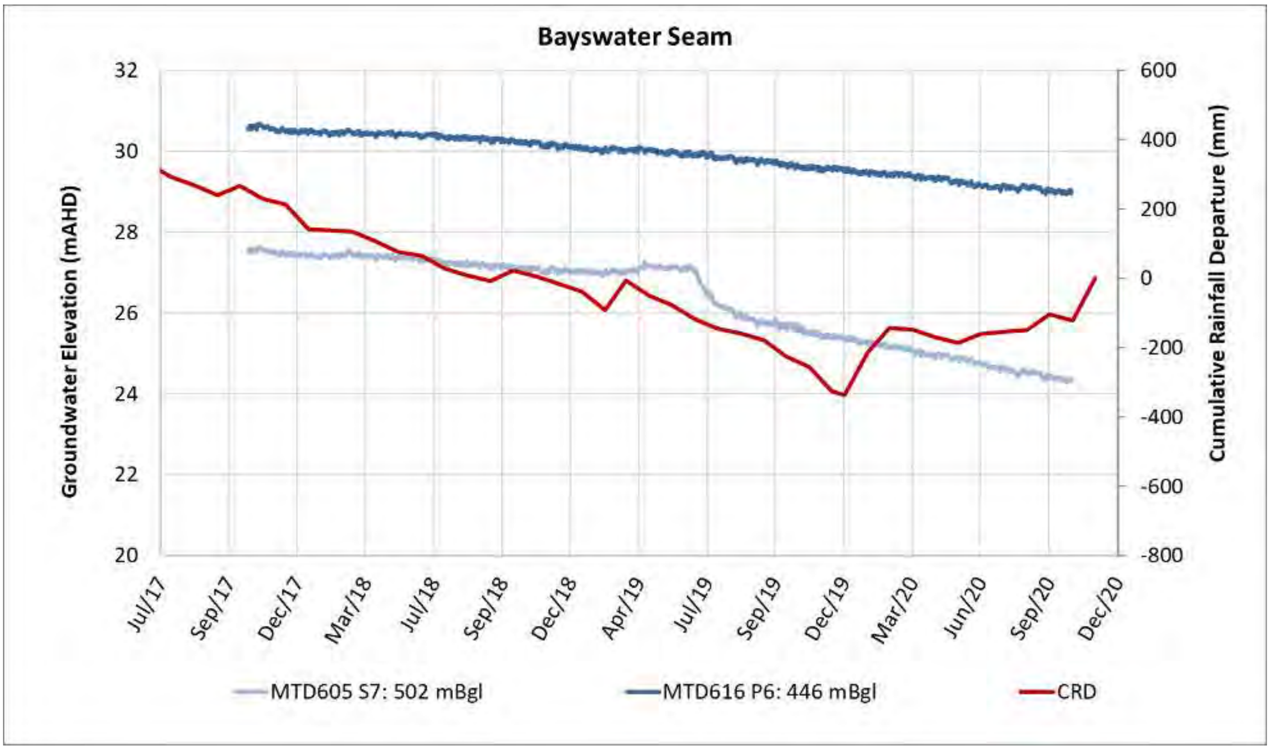

Figure 6-21 VWP hydrograph of Bayswater Seam

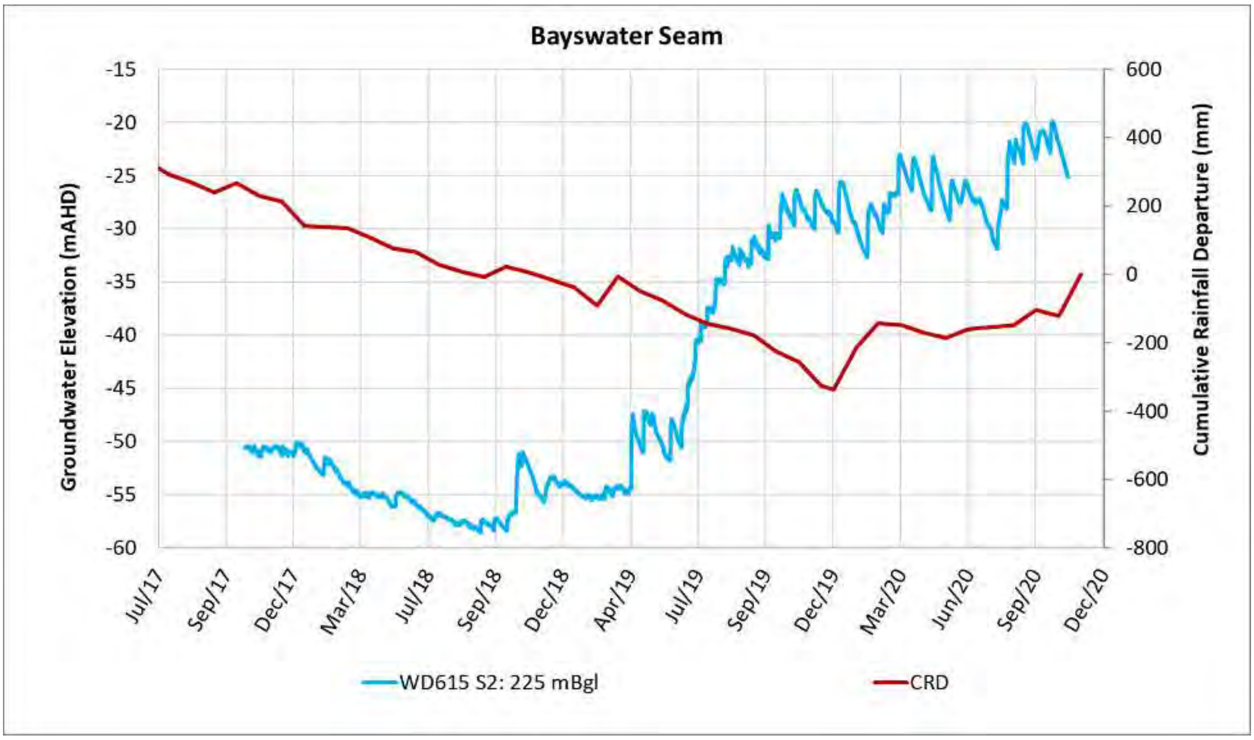

Figure 6-22 VWP Hydrograph for WD615 S2 (Bayswater Seam)

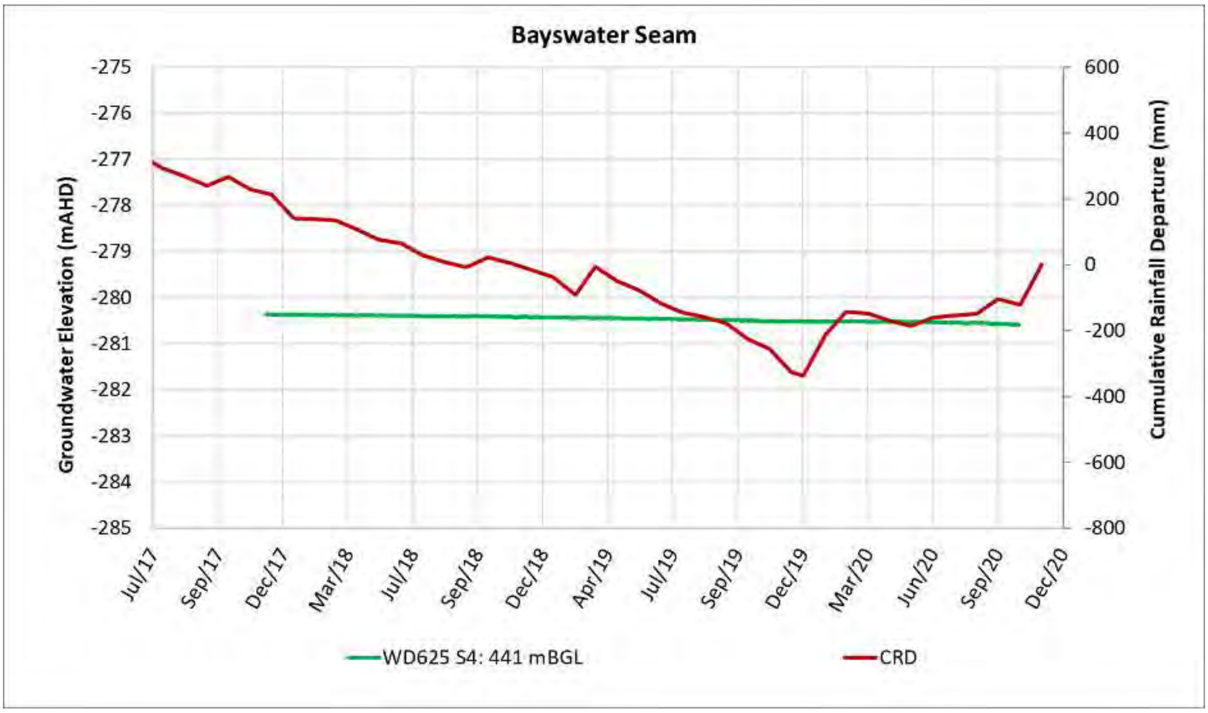

Figure 6-23 VWP Hydrograph for WD625 S4 (Bayswater Seam)

6.4 Water Quality

A summary of the water quality results are provided for each of the main water-bearing units (regolith, alluvium and Permian coal measures) below. Routine EC and pH readings and historical trends are presented in **Appendix B** and **Appendix C**, respectively.

6.4.1 Regolith

Over the 2020 monitoring period, triggers were exceeded for the following bores within the regolith:

- Bore OH786: Groundwater samples collected exceeded the upper pH trigger level of 7.7 in Q2; and
- Bore OH787: Groundwater samples collected exceeded the EC trigger level of 18,467 µS/cm in Q1, Q2, Q3 and Q4.

The exceedance observed in the sample collected from bore OH786 occurred in June 2020 with a pH value of 8.0. Historical pH values observed in OH786 prior to the exceedance have ranged from 6.7 to 7.9; therefore, this exceedance was slightly above historical records. Previous exceedances of EC at this bore attributed elevated EC to below average rainfall conditions and potentially suspended solids in the sample due to sediment accumulation at the bottom of the bore. It is unlikely that this pH exceedance was also related to suspended sediments as the data suggests that there is no correlation between higher pH values and high EC. The higher pH in Q2 may potentially be attributed to the equipment (i.e. slightly out of calibration at the time of sampling); the sampling methodology or simply due to natural variation. Given that the subsequent Q3 and Q4 pH values were below the upper trigger limit, the Q2 exceedance is believed to be an anomaly and is not indicative of a long term change to groundwater quality at this bore.

The exceedances observed in samples collected from bore OH787 occurred during every quarter of 2020. Historical EC readings indicate a gradual increasing trend from 2016 onwards, while at the same time exhibiting seasonal fluctuations likely related to rainfall. The highest EC concentration was measured in September 2020 at 19,610 µS/cm and is slightly above historical levels. This trend may relate to the area having received below average rainfall from 2017 to 2019, resulting in almost drying out of the bore and associated nearby regolith. As mentioned in the previous annual review, groundwater levels were recorded at OH787 between 13.90 m and 14.03 m depth, which are above the reported base of the bore (15.05 m depth). Available construction details indicate the screen extends to 12.1 m. This difference in reported bore depths may suggest that a sump exists, potentially influencing results. As per the previous year’s recommendation, a review of the bore condition and construction is required to verify the bore depth.

6.4.2 Alluvium

During 2020, routine monitoring of EC and pH were conducted for most alluvial monitoring bores on a quarterly basis. Exceptions to this were:

- OH944: The bore was recorded as dry throughout 2020;
- OH943 and PZ9S: The bores were recorded as having insufficient water for sampling throughout 2020; and

Bores targeting the Warkworth Sands MB15MTW04 to MB15MTW11 were recorded as dry throughout 2020. Alluvial groundwater quality in 2020 varies between the different units, as discussed below:

- Warkworth Sands: EC of the groundwater samples collected ranges between 1,441 µS/cm and 1,599 µS/cm and pH ranges between 6.7 and 6.9 for bore PZ7S.

- Hunter River: EC of the groundwater samples collected ranges between 12,080 µS/cm and 13,760 µS/cm and pH was consistently at 7.0 throughout the year (OH788 only);
- Regolith: EC of the groundwater samples collected ranges between 560 µS/cm and 25,100 µS/cm and pH ranges between 6.6 and 8.0; and
- Wollombi Brook: EC of the groundwater samples collected ranges between 14,520 µS/cm and 15,220 µS/cm and pH ranges between 6.6 and 6.7

Discussion of water quality trends and triggers are included for each alluvial unit from **Section 6.4.2.1** to **Section 6.4.2.3**.

Full water quality analysis was conducted for the site alluvial bores in accordance with the WMP. Exceptions to this include:

- Bores MB15MTW04 to MB15MTW11 and OH944 were dry throughout 2020;
- OH944 was dry; and
- OH943 and PZ9S had insufficient water available for sampling.

Full water quality data from groundwater collected from site alluvial bores is presented in **Appendix D** and summarised below:

- Total aluminium: values ranged from below the limit of reporting 0.06 mg/L to 18.9 mg/L (PZ7S);
- Total arsenic: values ranged from below the LOR of 0.001 mg/L to 0.008 mg/L (PZ7S);
- Total cadmium: all values were recorded as below the LOR of 0.0001 mg/L except PZ7S (0.0002 mg/L);
- Total copper: values ranged from below the LOR of 0.001 mg/L to 0.069 mg/L (PZ7S);
- Total lead: concentrations were below the limit of reporting of less than 0.001 mg/L, except for PZ7S with a total lead concentration of 0.039 mg/L;
- Total nickel: values ranged from 0.001 mg/L to 0.054 mg/L (PZ7S);
- Total selenium: all concentrations were below the LOR of 0.01 mg/L;
- Total zinc: all concentrations below the limit of reporting or less than 0.01 mg/L, except for bore PZ7S that recorded a total selenium concentration of 0.167 mg/L;
- Total boron: concentrations were generally below the LOR of 0.05, except for bores MB01 and OH788 (0.08 mg/L and 0.09 mg/L, respectively); and
- Total mercury: all concentrations were reported below the LOR of 0.0001 mg/L.

6.4.2.1 Warkworth Sands

Over the 2020 monitoring period, no groundwater samples collected from bores within the Warkworth Sands Alluvium exceeded any trigger levels.

6.4.2.2 Hunter River Alluvium

Over the 2020 monitoring period, in groundwater samples collected the following triggers were exceeded for the bores within the Hunter River alluvium:

- Bore OH788 exceeded the EC trigger level of 12,234 µS/cm in Q1, Q3 and Q4.

Over 2020 SWL in bore OH788 was relatively stable ranging between 10.01 m and 10.06 m bgl. The depth of bore OH788 is reported as 22.1 m with the screen depth reported as 21.6 m. Following recommendations made in the 2018 AEMR, the sampling methodology for the quarterly monitoring changed from a grab sample to low flow. The increase in EC concentrations observed over 2019 may be as a result of this change. Lower than average rainfall over 2019 may also contribute to an increase in EC concentrations within the Hunter River Alluvium. This may have resulted in reduced recharge and therefore less fresh water entering the system. In 2020, during which above average rainfall was recorded, a reduction in EC along with slightly lower pH values has occurred which is acceptable (as rainfall is fresh and generally has a pH of on average ~5.6).

6.4.2.3 Wollombi Brook Alluvium

Over the 2020 monitoring period, the following triggers were exceeded in groundwater samples collected from bores within the Woollombi Brook alluvium:

- Bore PZ8S recorded EC above the trigger limit of 15,086 µS/cm Q3.

The exceedance of the EC trigger at PZ8S was marginal, with a measured EC value of 15,220 µS/cm which is 134 µS/cm higher than the trigger. As observed over the previous monitoring period, groundwater elevations in PZ8S had been continuously declining, until recharge occurred in March 2020. This recharge event resulted in a continuous water level increase at PZ8S during 2020. Rather than seeing a freshening effect on groundwater, EC increased instead. Increased EC is unlikely to be the result of upwards movement of groundwater from underlying shallow overburden as the vertical gradient is downwards at PZ8. Furthermore, the lateral groundwater flow direction is towards the open cut mine, so a likely source of higher EC water could be from the west of PZ8S, e.g. Wollombi Brook. This could very likely be from evapo-concentration of Wollombi Brook water which gets flushed through the alluvium towards PZ8S with the onset of rainfall and stream flow. Nonetheless, in Q4 EC declined, supporting the initial flush of slightly more saline water through the alluvial system.

6.4.3 Permian Coal Measures

Routine monitoring of EC and pH in groundwater samples collected was conducted for all monitoring bores intersecting the Permian coal measures and overburden material on a quarterly basis over 2020. Exceptions to this include:

- OH1125(2) which could not be sampled as the bore was dry over 2020;
- OH1137 which was dry over 2020; and
- WOH2156B which had insufficient water for sampling in Q1, Q2, and Q4.

Groundwater quality for the Permian Coal Measures in 2020 varied between the different units, as discussed below.

- In 2020, in groundwater samples collected from within the shallow overburden material of the Permian coal measures recorded EC that ranged between 1,610 µS/cm and 17,910 µS/cm and pH ranges between 5.8 and 7.7.
- During 2020, in groundwater samples collected from within the Permian coal measures recorded EC that ranged between 1,530 µS/cm and 23,100 µS/cm and pH ranges between 5.9 and 8.0.

In accordance with the WMP full water quality analysis was conducted for the bores targeting the Permian coal measures. The exceptions are outlined above. Full water quality data is presented in **Appendix D** and summarised below:

Full water quality data from groundwater collected from bores within the shallow overburden:

- Total aluminium: concentrations ranged from below the LOR of 0.01 mg/L to 1.69 mg/L (PZ9D);
- Total arsenic: concentrations ranged from below the LOR of 0.001 mg/L to 0.024 mg/L (PZ9D);
- Total cadmium: all bores reported concentrations which were below the LOR of 0.0001 mg/L;
- Total copper concentrations ranged from below the LOR of 0.001 mg/L to 0.191 mg/L (PZ9D);
- Total lead concentrations ranged from below the LOR of 0.001 mg/L to 0.022 mg/L (PZ9D);
- Total nickel concentrations ranged from below the LOR of 0.001 mg/L to 0.152 mg/L (PZ8D);
- Total selenium: concentrations were below the LOR of 0.01 mg/L for all bores;
- Total zinc: concentrations ranged from below the LOR of 0.005 mg/L to 0.347 mg/L (PZ9D);
- Total boron: concentrations ranged from 0.08 mg/L to 0.3 mg/L (MTD605P); and
- Total mercury: concentrations were below the LOR of 0.0001 mg/L for all bores.

Full water quality data from groundwater collected from bores within the Permian Coal Measures:

- Total aluminium: concentrations ranged from below the LOR of 0.01 mg/L to 24 mg/L (WOH2153B);
- Total arsenic: concentrations ranged from below the LOR of 0.001 mg/L to 0.009 mg/L (OH1126);
- Total cadmium: concentrations ranged from below the LOR of 0.0001 mg/L to 0.0009 mg/L (OH1138(1));
- Total copper concentrations ranged from below the LOR of 0.001 mg/L to 0.041 mg/L (OH1127);
- Total lead concentrations ranged from below the LOR of 0.001 mg/L to 0.052 mg/L (OH1126);
- Total nickel concentrations ranged from below the LOR of 0.001 mg/L to 0.026 mg/L (OH1126);
- Total selenium: concentrations were below the LOR of 0.01 mg/L for all bores except GW98 MTCL 1 which recorded a concentration of 0.02 mg/L;
- Total zinc: concentrations ranged from below the LOR of 0.005 mg/L to 1.2 mg/L (OH1126);
- Total boron: concentrations ranged from below the LOR of 0.05 mg/L to 0.42 mg/L (GW9707); and
- Total mercury: concentrations were below the LOR of 0.0001 mg/L for all bores with the exception of (OH1138(1)) which recorded a concentration of 0.0018 mg/L.

6.4.3.1 Shallow Overburden Trigger Exceedances

Over the 2020 monitoring period, the following triggers were exceeded in groundwater samples collected from bores within the shallow overburden.

- Bore MTD605P recorded an EC above the trigger level of 17,488 µS/cm throughout 2020;
- Bore MTD616P below the lower pH trigger level of 6.8 throughout 2020.
- Bore MB15MTW01D recorded a pH below the lower trigger level of 6.8 throughout 2020.

6.4.3.2 Permian Coal Measures Trigger Exceedances

Over the 2020 monitoring period, the following triggers were exceeded in groundwater samples collected from bores within the Permian coal measures:

- Bore WD625P exceeded the EC trigger level of 12,086 µS/cm in Q1 and Q4.
- Bore GW9709 recorded EC marginally above the trigger level of 23,000 µS/cm in Q3.
- Bore WOH2141A exceeded the EC trigger level of 10,527 µS/cm in Q1, Q2 and Q4.
- Bore WOH2153A recorded pH values above the upper trigger level of 7.9 in Q1, Q2 and Q3.
- Bore WOH2139A recorded pH values above the upper trigger level of 7.9 in Q3.
- Bore OH1138 (1) recorded pH values below the lower trigger value of 6 in Q1 and Q3.
- Bore GW98MTCL2 below the lower pH trigger level of 6.6 in Q2 and Q4.

Further discussion on EC and pH trends for bores WOH2139A and OH1138(1) is included below.

Bore WOH2139A is located directly west of North Pit and intersects the Blakefield Seam with a total bore depth of 98 m. All pH results including quarterly and additional monthly monitoring results were above the upper trigger limit throughout 2020 and have been since August 2017. EC concentrations for bore WOH2139A were below the trigger throughout 2020; however, a significant increase in EC of 6,350 µS/cm was also observed between March and October 2017. Comparison of the data shows that changes in pH and EC are generally inversely proportional to variation in groundwater level, i.e. increasing as water levels decrease and vice versa. The trends for pH and EC in comparison to the SWL in the bore are presented in **Figure 6-24** and **Figure 6-25**. Given the proximity of WOH2139A to North Pit, the changes in water quality in relation to changes in water levels is expected.

The EC and pH values for bore WOH2139A are slightly different to those recorded in the other monitoring bores intersecting the Blakefield Seam (OH1122 (1) and OH1125 (1)). Within the monitoring network bore OH1125 (1) is located directly to the north of the North Pit, with bore OH1122 (1) located directly to the south of the West Pit. Review of historical and 2020 water quality data shows that pH and EC within the Blakefield Seam are variable at different locations within the unit, e.g. EC ~14,000 µS/cm at OH1125(1) and ~12,000 µS/cm at OH1122(1). It is possible for post-2017 water in WOH2139A to appear more similar to the other Blakefield Seam bores. There is potential for movement of groundwater and mixing of different water qualities given the larger hydraulic gradients in the aquifer caused by depressurisation and the groundwater system move towards a new equilibrium (physically and chemically). As recommended in the previous annual review, a review of the construction details and lithological logs for each bore should be undertaken to confirm that each bore is targeting the Blakefield Seam. A review of sampling techniques should be undertaken as it was previously identified that grab samples were taken at WOH2139A, whereas bore OH1122 (1) has been sampled using full purge techniques. The difference in techniques may therefore result in the variability in quality observed between the bores.

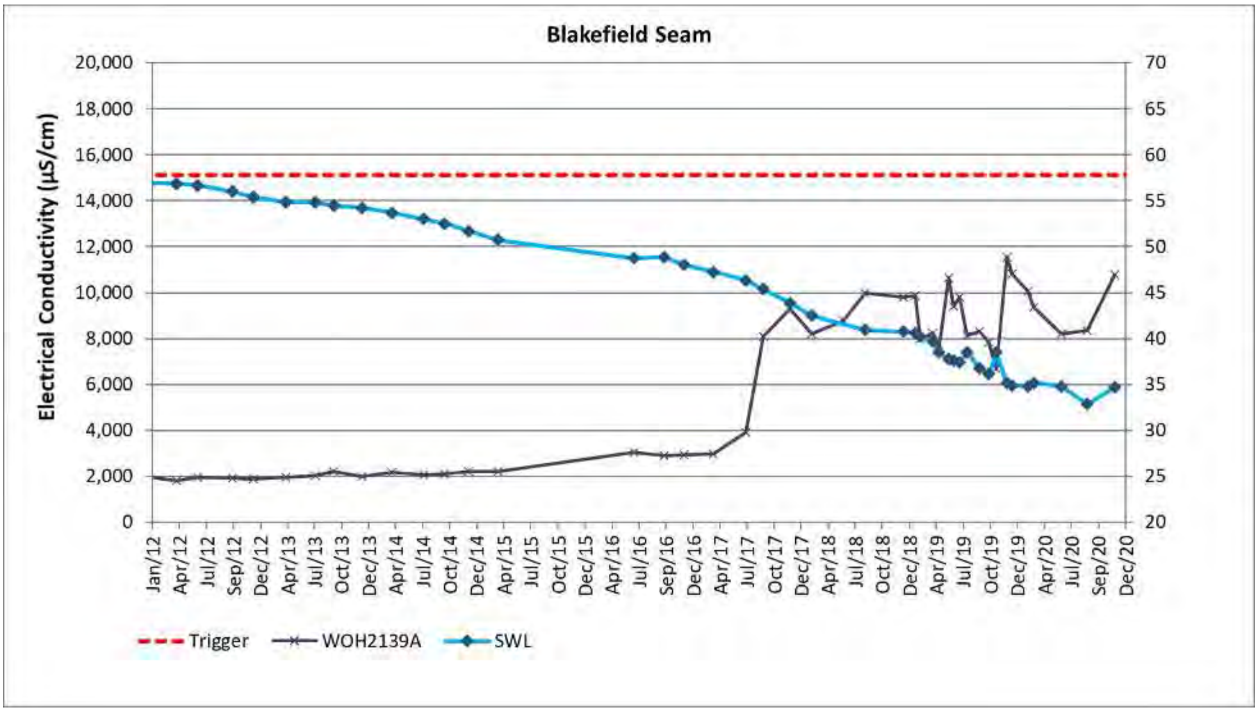

Figure 6-24 Electrical Conductivity and SWL Trends at WOH2139A

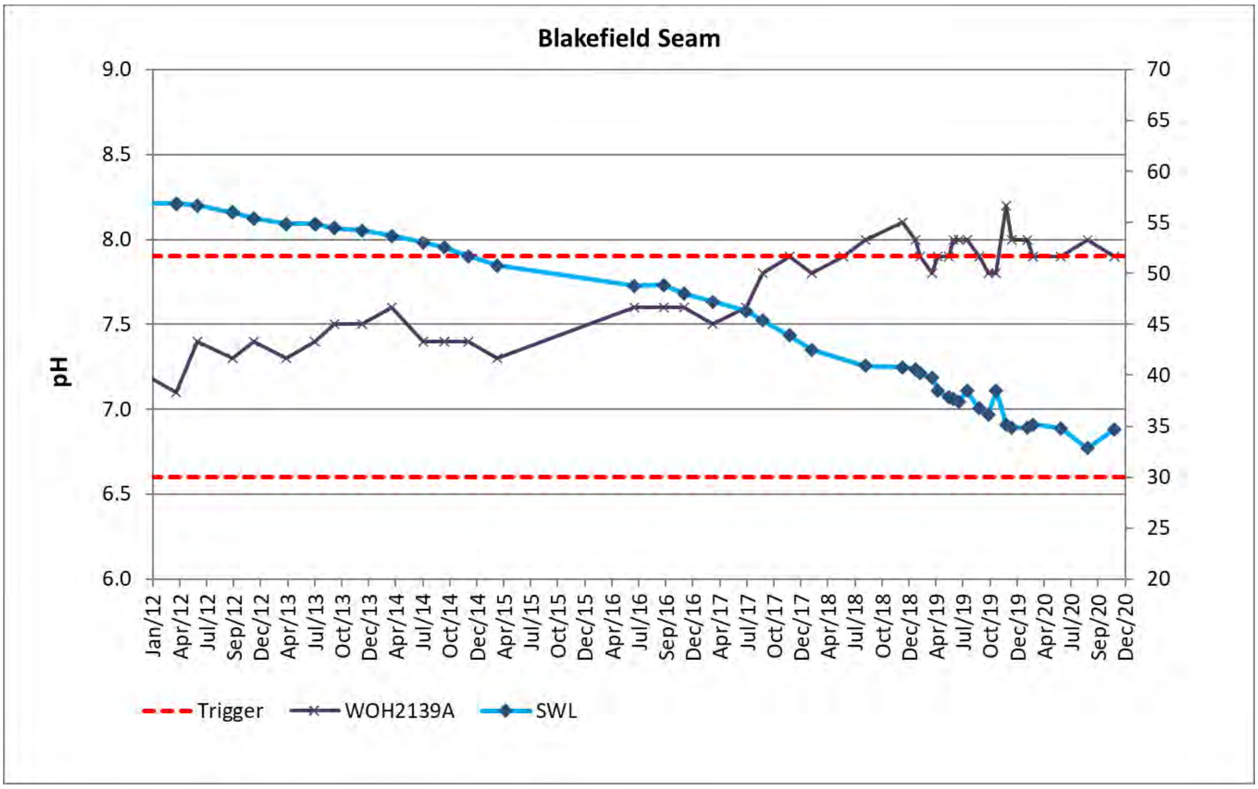

Figure 6-25 pH and SWL Trends at WOH2139A

Bore OH1138 is constructed as a nested bore with two discrete 32 mm PVC standpipes within the one borehole, both of which target the shallow Warkworth Seam. OH1138(1) is apparently screened from 20.8 m to 24.8 m depth and OH1138(2) is apparently screened from 38.8 m to 42.8 m depth. The bores are located on the north side of North Pit. Trends in water quality for the two bores are presented in **Figure 6-26.**

Exceedances of the lower trigger level for pH (6.3) has been ongoing since September 2017. Measured pH values during 2020 have remained relatively stable, although slightly lower than those recorded in 2019. Apart from the historical shift in pH values below the lower trigger level, there are no discernible ongoing trends. A comparison of groundwater elevations in OH1138(1) and OH1138 (2) indicate a potential downwards flow gradient at this location. This means there is potential for flow between the two depths within the Warkworth Seam; however, it does not indicate potential for impact to occur from a source at the ground surface. As discussed previously in the annual review for 2019, assessment of water quality data from the adjacent surface water dam 27N resulted in no clear correlation to trends in OH1138. Further assessment of groundwater flow directions and a detailed assessment of pH measurements in other monitoring bores in the network and within the Warkworth Seam could help in better understanding the changes that have occurred to the water quality in this bore. Additionally, the triggers for OH1138(1) should be revised to allow for detection of new trends and potential impact.

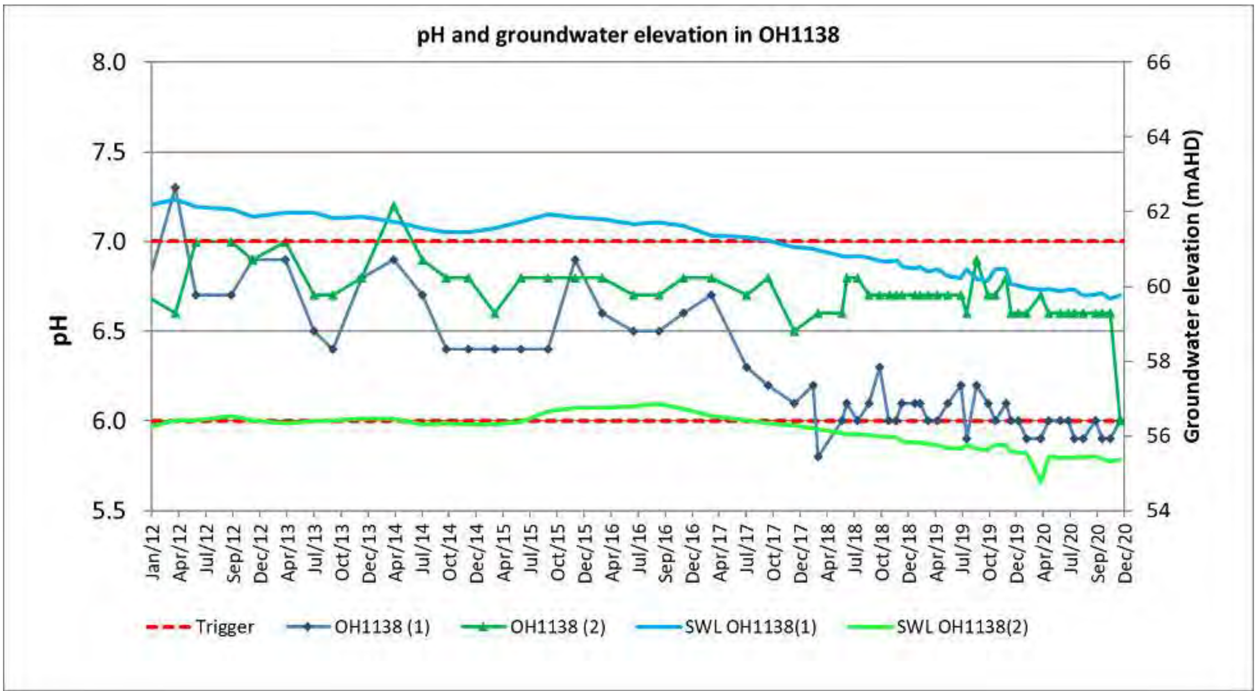

Figure 6-26 Water Quality Trends at OH1138(1) and OH1138(2)

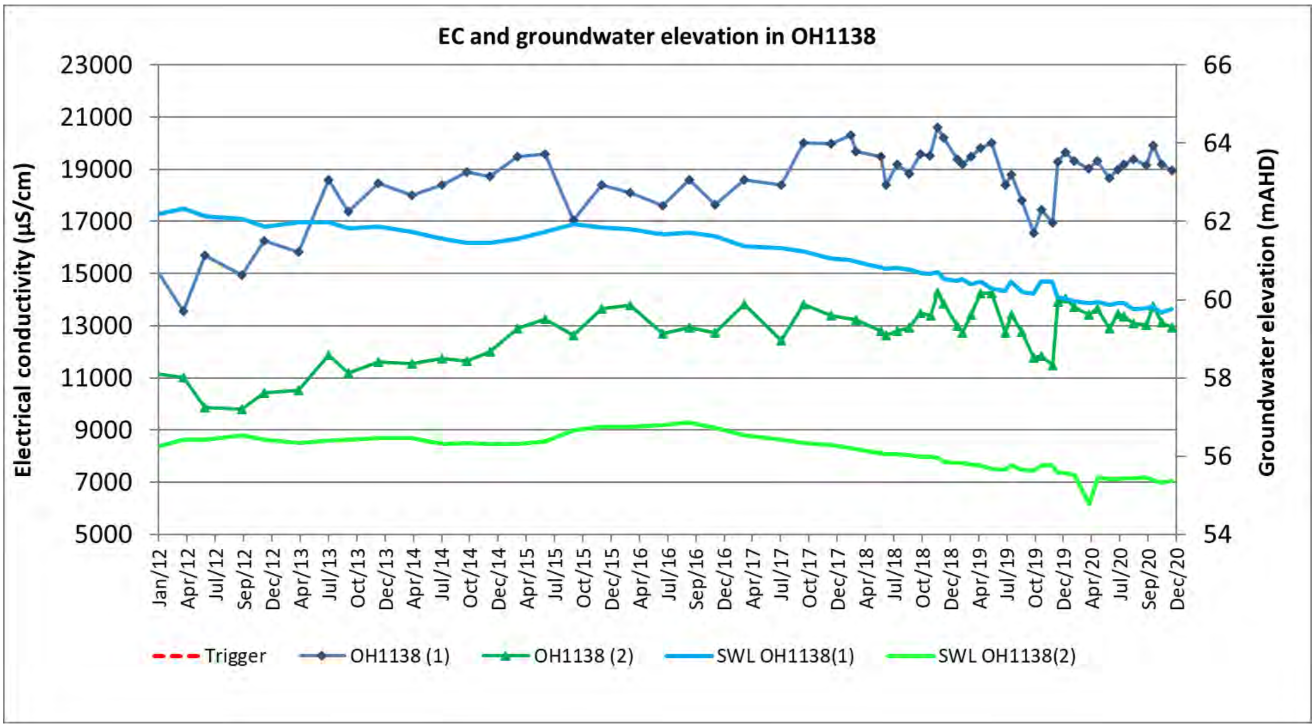

Figure 6-27 Electrical Conductivity and SWL Trends at OH1138(1) and OH1138(2)

6.5 Groundwater Take

Interception of groundwater occurs at site due to a range of activities, including direct interception of groundwater with mining activities, and indirect interception via induced inter-formation flows due to depressurisation of the Permian coal measures. Each activity and the estimated groundwater take for the various water sources is discussed below. Note, the information presented does not capture the full mine water balance but only a summary of available information provided to SLR.

6.5.1 Groundwater Inflows to Mine Operations

A numerical groundwater model was developed for MTW and updated by AGE (2015). The model was calibrated up to 2014 conditions and replicates mine progression to year 2035. As discussed in **Section 2.2**, AGE (2015) present predicted groundwater take (direct and indirect) from the various groundwater sources. AGE (2015) report that MTW operations were predicted to intercept up to approximately 500 ML of water from the North Coast Fractured and Porous Rock water source. AGE (2015) report that the predicted indirect interception of water, via inter-formational flows due to depressurisation of the Permian coal measures, for 2020 was approximately:

- 3.5 ML from the Hunter River Regulated Water Source;
- 11.5 ML from the Hunter Unregulated and Alluvial Water Sources; and
- 210 ML from the North Coast Fractured and Porous Rock water source.

6.5.2 Surface Water Abstraction

Over 2020, surface water was abstracted from the Hunter River in accordance with licence conditions. Metered volumes recorded by Yancoal show 1,455.2 ML of water was pumped from the Hunter River over the 2020 calendar year.

6.5.3 Groundwater Abstraction

Lemington Underground (LUG) bore is an abstraction bore at the Hunter Valley Operations. The bore is constructed into the abandoned LUG mine void underlying HVO and is licensed to take up to 1,800 ML of water from the North Coast Fractured and Porous Rock aquifer (WAL 39798) per water year (July to June). The licenses are held by HVO but utilised by MTW as part of a water sharing agreement.

The bore is equipped with a flow meter, with total monthly abstraction documented. Based on the flow volumes recorded from July 2019 to June 2020 a total of 1,475.2 ML of water was abstracted from the LUG bore, which is within the licensed allocation of 1,800 ML/year.

6.5.4 Summary of Water Take For 2020

Water take from the various groundwater and surface water sources associated with MTW are presented in **Table 6-4** for the 2020 calendar year. Abstraction volumes from the LUG bore are not presented within **Table 6-4** as they are reported through HVO's licencing and reporting processes.

Table 6-4 Predicted Groundwater Take (ML) for 2020

	Hunter Regulated	Hunter Unregulated	North Coast Fractured and Porous Rock
Mt Thorley Pit Excavation	~0.5	~5.5	~80
Warkworth Pit Excavation	~3.0	~6.0	~130
Surface Water Abstraction	1,455.2	0	-
Total	**1,458.7**	**11.5**	**210**

As shown in **Table 6-4**, over the 2020 reporting year the total take under the Hunter River Regulated water source was estimated at 1,458.7 ML, total take from Hunter Unregulated water source was estimated at 11.5 ML and 210 ML from the North Coast Fractured and Porous Rock water source. These volumes are within the licensed volumes (see **Section 2.3**) for each water source.

6.6 Verification Model Predictions

In accordance with Schedule 3 Condition 26(b) (Mount Thorley SSD 6465) and Condition 27 (b) (Warkworth SSD 6464), the WMP includes requirements to review the numerical groundwater model every 3 years, comparing monitoring results with modelled predictions. The original numerical groundwater model for MTW was developed in 2014 as part of the Continuation Project (AGE, 2014a and AGE, 2014b). The model was developed using MODFLOW-SURFACT code to simulate groundwater response to mining over time. The model comprises 16 layers with 98,644 cells (76,089 active) per model layer. The numerical groundwater model was updated in 2015 by AGE (2015), with changes made to the model design (i.e. mine progress, extent of alluvium, flood levee and final void) and the hydraulic parameters recalibrated.

SLR were provided with the AGE (2015) numerical groundwater model predictions, which have been graphed against observed groundwater levels at the site in **Appendix E**. Review of the trends has identified that the predicted groundwater level trends generally correspond to trends within observed data. However, at a few of the bores and VWP sensors the model predicted less drawdown than observed, as discussed below:

- GW9707, GW9708, and GW9709 – groundwater observations recorded a decline from 2017 and through 2020 in the range of 1 m and 2.5 m compared to stable levels within the model. The model replicated the bores as being within layer 16 (basement) but construction details indicate the bores are within the shallow (<30 m deep) weathered Bayswater Seam.
- OH1123 – groundwater observations indicate a rapid decline in groundwater levels from 2014, while the model predicted a more gradual decline in groundwater levels. The difference appears to relate to actual mine progression, model cell discretisation and influence from abstraction from LUG Bore not captured in the model.
- OH1126, OH1137, and OH1138_2 – the bores intersect shallow (13 m to 53 m depth) Permian coal measures (Warkworth Seam and Vaux Seam) to the north of North Pit. The bores record a general decline in groundwater levels since 2008, while the model predicted a rise in groundwater levels. This difference may relate to how the model replicates recovery within the rehabilitated spoil at North Pit. The difference may also relate to influence of licenced groundwater abstraction from the Lemington Underground Bore that is not replicated within the model.

- WD462_P1 – is a VWP sensor that targets the Vaux Seam to the west of North Pit, which is mined down to the shallow Mt Arthur Seam. The VWP recorded a decline about 6 m in groundwater levels since July 2015, while the model predicted about 1 m decline in groundwater levels. As outlined within the AGE (2014a) groundwater assessment report, this likely relates to depressurisation of the seams below the base of the pit as well as cumulative impacts from surrounding operations.
- WOH2153A, WOH2154A, WOH2155A, and WOH2156A – all four bores are reported to intersect the Redbank Creek Seam at depths of between 30 m and 70 m. This seam is not present within the numerical groundwater model; therefore, the bores are represented in the model as intersecting the lower permeability interburden material in Layer 4.
- Recent trends in observed data vary from modelled at VWPs WD625_P3, WD615_P2, MTD605_P2, MTD605_P3, MTD605_P6, MTD605_P7, MTD613, MTD518, and WD609. The observed data appears inconsistent with historical trends and may reflect errors in data conversion.
- In contrast bore PZ9D was predicted to have higher drawdown than observed. The cause for discrepancy may relate to changes in mine scheduling and how pre-stripping and backfilling was captured within the model.

Overall, the numerical model appears to adequately replicate observed changes in groundwater levels for 2020 at most bores. However, work should be conducted to further refine the model predictions, as follows:

- Better match between actual mine progression and predicted mine progression (including spoil emplacement) for operations at MTW and surrounding mine operations;
- Include the licenced groundwater abstraction from LUG bore within the model;
- Include current climate and streamflow trends, as well as incorporate data from the installed bores (i.e. MB15MTW bores);
- Review calibrated parameters for spoil and vertical hydraulic conductivity within the Permian coal measures;
- Review monitoring bore construction details and confirm water bearing zones being monitored;
- Review the model structure and compare to the site geological model and available drill data; and
- Review data collected from VWPs including construction details and calibration certificates.

7 Conclusions and Recommendations

7.1 Conclusions

This annual groundwater review covers data collected over 2020 and was completed in compliance with:

- Warkworth Mine in accordance with Schedule 3 Condition 27 of the Warkworth Consent (SSD 6464); and
- Mt Thorley Mine in accordance with Schedule 3 Condition 25 of Development Consent (SSD 6465)

During 2020, operations across MTW included active mining at North Pit, Loders Pit and West Pit. Tailings Dam 1 has been rehabilitated, and Tailings Dam 2 is undergoing rehabilitation.

Review of climate data indicates that the region has experienced significant above average rainfall in February to March 2020 and in December 2020. Stream levels fluctuated throughout the year in Wollombi Brook in response to rainfall and surface water flows.

The groundwater bore network at MTW has been installed progressively over the life of the operations and acquired through land purchase. In accordance with the WMP 60 open standpipe bores require routine SWL and quality monitoring. The WMP also requires routine SWL monitoring of 10 VWPs, however based on discussion with site personnel and review of the data it is understood some of the VWP sensors may not be fully operational due to a range of factors (i.e. batteries, pressurisation of sensors above their working limit). To ensure that water level data continues to be collected across all aquifer units a review of all bores and VWPs in which logger / sensor failures have been reported should be undertaken. The review should include an assessment into whether the faulty logger / sensor can be repaired or whether replacement / rectification works are required.

Available VWP and monitoring bore logger data was reviewed to assess trends in groundwater levels over 2020. The data indicates that where saturated, groundwater elevations within the alluvium have started trending upwards in line with climate and stream flow trends. Groundwater within the Permian coal measures were mostly declining after exhibiting temporary head increases following above average rainfall events. Where observed, the decreasing elevations are believed to be attributed to depressurisation of the coal seams in relation to mining activities. The groundwater drawdown appears in line with the predicted drawdown with the coal measures around active mine areas.

As per the WMP, pH and EC concentrations are monitored on a quarterly basis at nominated bores, with a larger suite of analytes reviewed annually. Review of water quality results and comparison to trigger levels for EC and pH identified several trigger exceedances over 2020. It was identified that groundwater samples collected from several bores exceeded triggers for EC and pH; however, 2020 readings were in line with historical trends for these bores. It is also noted that MTW's sampling methodology for 2020 has remained the same as 2019 following changes made in response to annual review recommendations in 2018. It is recommended that a review of the triggers be undertaken in light of the revised sampling methodology. Groundwater quality trends outside of historical trends were observed for bore OH1138 and WOH2139A, which likely relate to potential movement of groundwater and mixing of different water qualities given the larger hydraulic gradients in the aquifer caused by depressurisation and the groundwater system moving towards a new equilibrium (physically and chemically).

In 2020, monitoring of the groundwater bore network was generally conducted in accordance with the GMP outlined within the WMP. Following recommendations made in the 2018 Annual Review, quarterly sampling methodologies were changed in 2019 and continued to be implemented in 2020, to be in general accordance with relevant standards. Annual water quality samples were also collected in general accordance with relevant standards. The exception to this was generally for cases where the condition of the bores (i.e. 32 mm casing) inhibited the ability to collect representative samples. Grab samples have been taken for monitoring bores WOH1239A, WOH2141A, WOH2153A, WOH1254A, WOH2155A, WOH2156A, WD622P, MBW02 and MBW03 within the network. This approach is not in line with industry standards and may not provide a representative water quality sample. The justification for this methodology should be reviewed to determine if more suitable methods (i.e. full purge or low flow) can be applied. A review into the requirement of these bores for the collection of water quality data for the WMP should be undertaken. If it is found that the continued collection of water quality data is required from a bore and suitable sampling methods cannot be adopted, then bore rectification works should be considered.

During 2020 water level and water quality readings were not taken at 14 bore locations due to a range of factors, such as dry or blocked bore conditions, insufficient water available due to purging methodology and access restrictions.

Quantification of groundwater take was undertaken based on reported volumes estimated for approved operations by AGE (2015) and metered abstraction volumes from bores and surface water pumps. Based on this, over the 2020 reporting year the total take under the Hunter Regulated water source was estimated at 1,458.7 ML. Total take from Hunter Unregulated water source was estimated at 11.5 ML and 210 ML from the North Coast Fractured and Porous Rock water source.

Comparison of observed groundwater levels against predicted levels generated from the numerical groundwater model were made. Overall, the numerical model was found to have adequately replicated observed changes in groundwater levels for 2020. Where modelled and observed values were significantly different, it was largely found that the difference in values could be attributed to differences in actual and predicted site conditions (i.e. climatic conditions, changes to mine progression / activities etc). A number of recommendations are therefore related to updating the model including a review of VWP data and construction, better matching of actual mine progression, inclusion of the LUG bore abstraction and the inclusion of current climate and streamflow trends.

Overall, the current monitoring network and program is generally adequate for satisfying current monitoring requirements of the WMP. There is good spatial of coverage of monitoring locations across the site, with multiple bores and VWP sensors installed into each relevant aquifer unit. To ensure this is maintained a network review should be undertaken with the purpose of identifying existing monitoring infrastructure that may need rectification or replacement due to potential impacts from current and future mining.

7.2 Recommendations

Based on review of the available data for 2020, the following recommendations have been made:

- Review the groundwater monitoring network and program to more clearly identify the purpose of each bore based on its location and construction, and align the compliance conditions to this purpose. Including inclusion of newly installed monitoring points and removal or replacement of bores/sensors from the program that have been identified as destroyed/erroneous.
- Check surveyed ground and casing elevations for bores including MBW6A and OH1125 (2).
- Check standpipe stickup measurements for MTD605P, MTD614P and MTD616P.

- Check VWPs and monitoring bore loggers are working correctly (i.e. check/replace batteries and logger depths) and adjust the site barometric logger to log on the hour (i.e. 9 am, 10 am, 11 am etc.).
- Recommended VWP sensor investigations and replacements/ removal include:
  - WD645 S1 (replace/ remove) and S5 (investigate first);
  - WD646R S2 (replace/ remove) and S5 (investigate first);
  - MTD605 S2 (investigate first) and S6 (replace/ remove); and
  - MTD616 P1 (investigate first – particularly noting the correct naming convention and sensor depth as there have been a range of names for this array of VWPs relating to different depths, e.g. P1, sensor 1, S1, VW1 etc.).
- Investigate ground conditions, bore construction and logger data for nested bore PZ7S and PZ7D.
- Installation of data logger within bore OH786 and replacement of logger for PZ7S.
- Review of logger installation depths for MB15MTW02S as the currently verified depth is not providing accurate water levels compared to manual dipped measurements. The standpipe stickup should also be checked for MB15MTW02S.
- Investigate the condition of the logger in MB15MTW03 and replace logger if it is found to be faulty.
- The monitoring methodology and bore logs should be assessed to devise a suitable method for attaining water quality samples. This is important as the last full water quality suite analysis undertaken for OH786 was in June 2016.
- Review the bore condition and construction records to verify the total bore depth for OH787.
- Review the bore logs for MB15MTW01S and MB15MTW02S to determine whether target geology is alluvium or weathered Permian coal measures.
- Review bore logs for OH1121 to determine if the bore has been installed in the Vaux Seam which according to geology map should not be present at this location.
- Further investigation into site conditions around MTD616P should be undertaken to confirm that no land use changes or activities have caused rising groundwater level trends in this bore.
- Review of groundwater quality triggers to ensure they are reasonable and adequately capture historical trends for bores and account for changing climate conditions.
- Continue to update the numerical groundwater model to account for climate trends and actual mine progression activities that have evolved since the initial model development.

8 References

ANZECC & ARMCANZ 2000, Australian and New Zealand guidelines for fresh and marine water quality. *Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand*, Canberra, 1-103.

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APPENDIX A

Groundwater Monitoring Program

ID	Easting	Northing	Top of Casing Elevation (mAHD)	Bore Depth (m bTOC)	Geology	Groundwater Monitoring Program			
						Water Level	EC	pH	Full WQ
OH786a	320542	6392674	55.7	7.1	Regolith	Q	Q	Q	A
OH787	320982	6391921	50.0	12.1	Regolith	Q	Q	Q	A*
OH788	321482	6390967	45.4	22.1	Hunter River Alluvium	Q	Q	Q	A
OH942	320536	6392622	55.8	13.2	Regolith	Q	Q	Q	A*
OH943	321476	6390963	45.0	9.9	Hunter River Alluvium	Q	Q	Q	A
OH944	321113	6391035	47.9	8.2	Hunter River Alluvium	Q	Q	Q	A
G3(2)	317787	6385253	73.0	4.1	Wollombi Brook Alluvium				
PZ8S	317002	6385411	65.8		Wollombi Brook Alluvium	Q	Q	Q	A
PZ9S	317542	6385642	65.4	6.9	Wollombi Brook Alluvium	Q	Q	Q	A
MB15MTW01S	315909	6385605			Wollombi Brook Alluvium	Q	Q	Q	A
MB15MTW02S	313823	6387224			Wollombi Brook Alluvium	Q	Q	Q	A
MBW01	314379	6386796	62.4	11.0	Alluvium	Q	Q	Q	A
PZ7S	314055	6392671	58.4	11.1	Aeolian Warkworth Sands	Q	Q	Q	A
MB15MTW04	314993	6392645		6.5	Warkworth Sands	Q	Q	Q	A
MB15MTW05	314645	6392758		6.9	Warkworth Sands	Q	Q	Q	A
MB15MTW06	314438	6392801		6.9	Warkworth Sands	Q	Q	Q	A
MB15MTW07	314965	6392085		6.8	Warkworth Sands	Q	Q	Q	A
MB15MTW08	314296	6392182		6.8	Warkworth Sands	Q	Q	Q	A
MB15MTW09	313995	6392219		3.1	Warkworth Sands	Q	Q	Q	A
MB15MTW10	314667	6392134		3.7	Warkworth Sands	Q	Q	Q	A
MB15MTW11	314352	6392417		6.9	Warkworth Sands	Q	Q	Q	A
PZ7D	314057	6392684	58.4	30.5	Shallow Overburden	Q	Q	Q	A
PZ8D	317001	6385418	65.8	37.0	Shallow Overburden	Q	Q	Q	A
PZ9D	317541	6385652	65.5	24.0	Shallow Overburden	Q	Q	Q	A
MTD616P	316269	6387618	77.8	29.0	Shallow Overburden	Q	Q	Q	A
MTD614P	317259	6386175	72.6	30.0	Shallow Overburden - Conglomerate	Q	Q	Q	A
MBW02	314373	6386798	62.6	60.4	Shallow Overburden	Q	Q	Q	A
MB15MTW01D	315910	6385604			Shallow Overburden? Alluvium?	Q	Q	Q	A
MTD605P	316279	6386156	77.4	42.0	Shallow Overburden - sandstone	Q	Q	Q	A
MB15MTW02D	313823	6387219			Shallow Overburden? Alluvium?	Q	Q	Q	A
MB15MTW03	313722	6388917		22.7	Shallow Overburden - Wollombi alluvium?	Q	Q	Q	A
WD625P	314669	6390487	76.4	31.0	Whybrow Seam	Q	Q	Q	A
WOH2153A	313881	6391429	68.3	42.6	Redbank Crk Seam	Q	Q	Q	A
WOH2154A	313976	6389990	68.9	69.4	Redbank Crk Seam	Q	Q	Q	A
WOH2155A	315278	6390138	74.6	46.0	Redbank Crk Seam	Q	Q	Q	A
WOH2156A	315874	6388866	80.4	31.5	Redbank Crk Seam	Q	Q	Q	A
WOH2153B	313881	6391429	68.3	62.4	Wambo Seam	Q	Q	Q	A
WOH2154B	313976	6389990	68.9	98.0	Wambo Seam	Q	Q	Q	A
WOH2155B	315278	6390138	74.6	73.1	Wambo Seam	Q	Q	Q	A
WOH2156B	315874	6388866	80.4	80.1	Wambo Seam	Q	Q	Q	A
WD622P	316229	6389585	84.5	55.0	Wambo Seam	Q	Q	Q	A
MBW04	314368	6386800	62.4	162.0	Wambo	Q	Q	Q	A
WOH2139A	315249	6391511	91.7	96.0	Blakefield	Q	Q	Q	A*
OH1122 (1)	318545	6387886	100.6	49.6	Blakefield Seam	Q	Q	Q	A*
OH1122 (2)	318545	6387886	100.6	112.6	Woodlands Hill Seam				
OH1122 (3)	318545	6387886	100.6	152.6	Bowfield Seam				
OH1125 (1)	316511	6392875	86.2	40.0	Blakefield	Q	Q	Q	A*

ID	Easting	Northing	Top of Casing Elevation (mAHD)	Bore Depth (m bTOC)	Geology	Groundwater Monitoring Program			
						Water Level	EC	pH	Full WQ
OH1125 (2)	316511	6392875	86.2	25.3	Unknown - Blakefield?	Q	Q	Q	A*
OH1125 (3)	316511	6392875	86.2	62.7	Bowfield Seam	Q	Q	Q	A*
OH1138 (1)	317835	6393346	70.7	24.8	Warkworth Seam	Q	Q	Q	A
OH1138 (2)	317835	6393346	70.7	42.8	Warkworth Seam	Q	Q	Q	A
OH1121	321902	6391030	45.6	20.3	Vane Subgroup	Q	Q	Q	A
OH1126	318586	6393387	64.5	52.5	Vaux	Q	Q	Q	A
OH1137	318266	6393377	67.9	17.8	Vaux	Q	Q	Q	A
OH1127	321444	6392097	51.2	29.0	Vane Subgroup	Q	Q	Q	A
GW 9706	322404	6387589	64.2	21.2	Bayswater	Q	Q	Q	A
GW 9707	322319	6387569	63.9	21.0	Bayswater	Q	Q	Q	A
GW 9708	322158	6387209	73.1	29.6	Bayswater	Q	Q	Q	A
GW 9709	322251	6388026	60.3	21.0	Bayswater	Q	Q	Q	A
GW98MTCL1	322188	6387032	77.8	19.7	Bayswater	Q	Q	Q	A
GW98MTCL2	322669	6387462	79.5	27.6	Bayswater	Q	Q	Q	A
WOH2141A	314989	6392647	91.6	45.6	Whynot Seam	Q	Q	Q	A
PZ1_VW1	321350	6387310	72.1	41.0	Mt Arthur Seam (Shallow)	Q			
PZ1_VW2	321350	6387310	72.1	42.0	Mt Arthur Seam (Deep)	Q			
PZ2_VW1	321445	6387218	68.1	48.6	Mt Arthur Seam (Shallow)	Q			
PZ2_VW2	321445	6387218	68.1	49.6	Mt Arthur Seam (Deep)	Q			
WD609A	318803	63922	129.9	110.0	Spoil	Q			
WD615_P1	319281	6391347	160.0	133.0	Piercefield Seam	Q			
WD615_P2	319281	6391347	160.0	225.0	Bayswater Seam	Q			
WD625_P1	314663	6390483	76.4	217.0	Woodlands Hill	Q			
WD625_P2	314663	6390483	76.4	354.0	Mt Arthur Seam	Q			
WD625_P3	314663	6390483	76.4	375.0	Vaux Seam	Q			
WD625_P4	314663	6390483	76.4	441.0	Bayswater Seam	Q			
WD622_P1	316236	6389588	84.5	54.0	Wambo Seam	Q			
WD622_P2	316236	6389588	84.5	165.0	Woodlands Hill Seam	Q			
WD622_P3	316236	6389588	84.5	314.0	Mt Arthur Seam	Q			
WD622_P4	316236	6389588	84.5	334.0	Vaux Seam	Q			
WD622_P5	316236	6389588	84.5	408.0	Bayswater Seam	Q			
MTD616_P1	316274	6387621	77.7	42.0	Whybrow Seam	Q			
MTD616_P2	316274	6387621	77.7	109.0	Wambo Seam	Q			
MTD616_P3	316274	6387621	77.7	215.0	Woodlands Hill Seam	Q			
MTD616_P4	316274	6387621	77.7	343.0	Mt Arthur Seam	Q			
MTD616_P5	316274	6387621	77.7	378.0	Vaux Seam	Q			
MTD616_P6	316274	6387621	77.7	446.0	Bayswater Seam	Q			
MTD613 (VWP)	320778	6387025	150.5	384.0	Broonie/Bayswater Seam?	Q			
MTD605_P1	316512	6386159	77.1	58.0	Weathered OB over Whybrow	Q			
MTD605_P2	316512	6386159	77.1	100.0	Whybrow Seam	Q			
MTD605_P3	316512	6386159	77.1	149.0	IB btw Wambo and Whynot	Q			
MTD605_P4	316512	6386159	77.1	215.0	Blakefield Seam	Q			
MTD605_P5	316512	6386159	77.1	368.0	Mt Arthur Seam	Q			
MTD605_P6	316512	6386159	77.1	429.0	Vaux Seam	Q			
MTD605_P7	316512	6386159	77.1	502.0	Bayswater Seam	Q			
MTD614_P1	317265	6386174	72.4	64.0	Whybrow Seam	Q			
MTD614_P2	317265	6386174	72.4	191.0	Glen Munro Seam	Q			
MTD614_P3	317265	6386174	72.4	342.0	Mt Arthur Seam	Q			
MTD614_P4	317265	6386174	72.4	383.0	Vaux Seam	Q			

ID	Easting	Northing	Top of Casing Elevation (mAHD)	Bore Depth (m bTOC)	Geology	Groundwater Monitoring Program			
						Water Level	EC	pH	Full WQ
MTD614_P5	317265	6386174	72.4	453.0	Bowfield Seam	Q			
WD456 (VWP)			100.6		Bayswater Seam	Q			
WD462_P1	315529	6391358	101.7	354.6	Vaux Seam	Q			
WD462_P2	315529	6391358	101.7	354.6	Bowfield Seam	Q			
WD462_P3	315529	6391358	101.7	354.6	Woodlands Hill Seam	Q			
MTD517_P1	317521	6386147	77.3		Mt Arthur Seam	Q			
MTD517_P2	317521	6386147	77.3		Woodlands Hill Seam	Q			
MTD517_P3	317521	6386147	77.3		Wambo Seam	Q			
MTD518_P1	316512	6386156	80.0		Mt Arthur Seam	Q			
MTD518_P2	316512	6386156	80.0		Blakefield/Woodlands Hill Seam	Q			
MTD518_P3	316512	6386156	80.0		Wambo Seam	Q			
MBW03	314387	6386794	62.4	84.2	Whybrow Seam	Q	Q	Q	A
MBW6A						Q	Q	Q	A

Notes:

TOC – top of casing
Q – Quarterly
A – Annual
 # Comprehensive analysis includes metals Mo, V and Cr

APPENDIX B

Groundwater Level and Quality Readings 2020

Bore ID	Target Geology	EC Trigger 95th	pH Trigger 5th –95th		Q1				Q2				Q3				Q4			
					SWL mbTOC	SWL mAHD	pH	EC	SWL mbTOC	SWL mAHD	pH	EC	SWL mbTOC	SWL mAHD	pH	EC	SWL mbTOC	SWL mAHD	pH	EC
OH786	Regolith	1311	6.7	7.7	1.8	53.85	7.2	872	2.15	53.5	**8**	892	1.07	54.58	7.2	**560**	0.84	54.81	7.3	748
OH787	Regolith	18467	7.2	7.7	13.98	35.98	7.5	**19450**	14	35.96	7.6	**18830**	14.01	35.95	7.3	**19610**	14.03	35.93	7.4	**19370**
OH788	Hunter River Alluvium	12234	7	7.9	10.05	35.33	7	**13760**	10.06	35.32	**7**	12080	10.04	35.34	**7**	**12270**	10.01	35.37	**7**	**12340**
OH942	Regolith	25435	6.5	6.9	9.58	46.17	6.6	25100	9.56	46.19	6.6	23900	9.6	46.15	6.6	24700	9.65	46.1	6.6	24800
OH943	Hunter River Alluvium	8395	7.1	7.6	9.66	35.38	-	-	9.69	35.35	-	-	9.7	35.34	-	-	9.65	35.39	-	-
OH944	Hunter River Alluvium																			
G3(2)	Wollombi Brook Alluvium																			
PZ8S	Wollombi Brook Alluvium	15086	6.5	7	6.46	59.29	6.7	14520	6.38	59.37	6.6	14940	6.3	59.45	6.7	**15220**	6.24	59.51	6.6	14690
PZ9S	Wollombi Brook Alluvium	16197	6.8	7	6.82	58.61	-	-	6.78	58.65	-	-	6.77	58.66	-	-	6.78	58.65	-	-
MB15MTW01S	Wollombi Brook Alluvium				5.82	57.508	6.7	1395	5.69	57.638	6.5	1467	5.38	57.948	6.5	1892	5.46	57.868	6.5	2110
MB15MTW02S	Wollombi Brook Alluvium				5.34	56.78	6.7	2610	5.56	56.56	6.9	2200	5.06	57.06	6.8	2190	5.44	56.68	6.9	1942
PZ7S	Aeolian Warkworth Sands	1749	6.7	7.5	8.06	50.38	6.7	1599	8.09	50.35	6.7	1491	8.18	50.26	6.9	1570	7.99	50.45	6.8	1441
MBW01	Alluvium				6.17	56.22	7.3	17480	6.2	56.19	7.3	17380	6.17	56.22	7.3	17750	6.15	56.24	7.3	18160
MB15MTW04	Warkworth Sands																			
MB15MTW05	Warkworth Sands																			
MB15MTW06	Warkworth Sands																			
MB15MTW07	Warkworth Sands																			
MB15MTW08	Warkworth Sands																			
MB15MTW09	Warkworth Sands																			
MB15MTW10	Warkworth Sands																			
MB15MTW11	Warkworth Sands																			

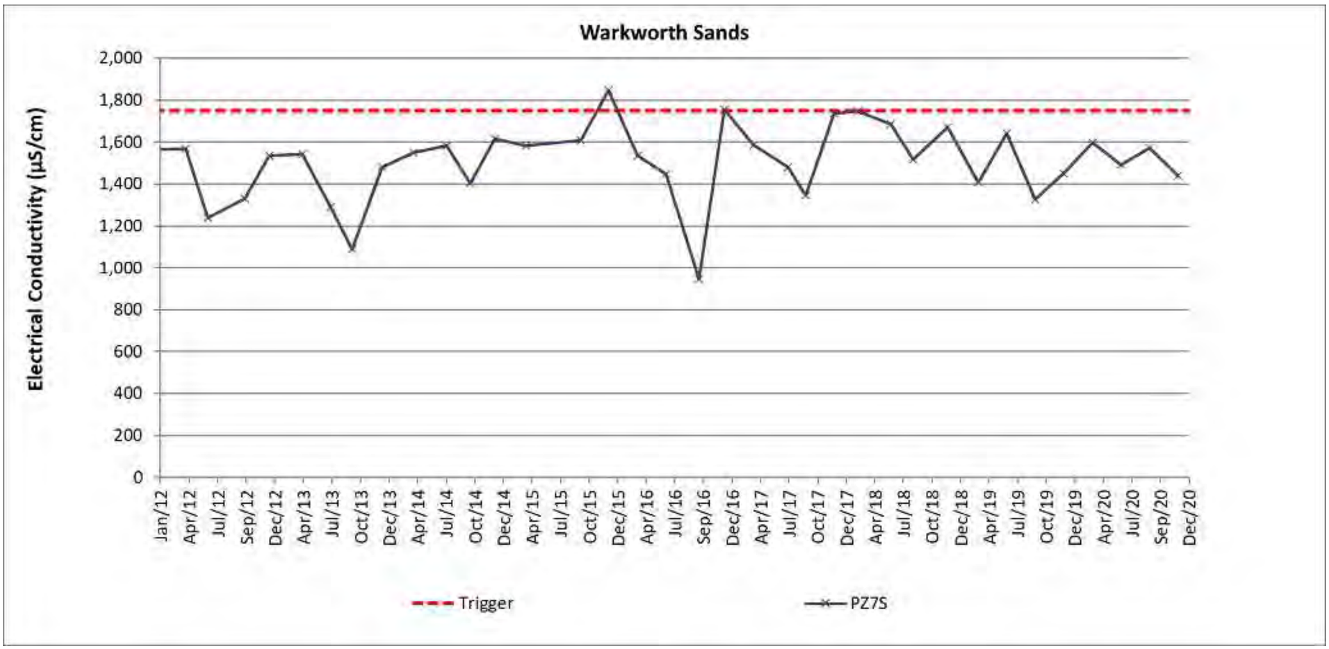
Bore ID	Target Geology	EC Trigger 95th	pH Trigger 5th –95th		Q1				Q2				Q3				Q4			
					SWL mbTOC	SWL mAHD	pH	EC	SWL mbTOC	SWL mAHD	pH	EC	SWL mbTOC	SWL mAHD	pH	EC	SWL mbTOC	SWL mAHD	pH	EC
PZ7D	Shallow Overburden	17488	6.8	8	7.84	50.58	7.4	1727	7.75	50.67	7.6	1752	7.73	50.69	7.6	1749	7.69	50.73	7.6	1741
PZ8D	Shallow Overburden	17488	6.8	8	7.22	58.55	7.4	8880	7.44	58.33	7.2	8550	7.33	58.44	7.5	8980	7.44	58.33	7.4	8690
PZ9D	Shallow Overburden	17488	6.8	8	18.4	47.12	7.1	15100	18.47	47.05	7	10190	18.44	47.08	7	10540	18.78	46.74	7	10490
MTD616P	Shallow Overburden	17488	6.8	8	5.96	71.86	**6.7**	15200	5.77	72.05	6.8	14920	6.38	71.44	6.8	14340	6.35	71.47	**6.7**	14330
MTD614P	Shallow Overburden - Conglomerate	17488	6.8	8	18.19	54.4	7.4	6500	18.2	54.39	7.2	6400	18.09	54.5	7.5	6670	18.19	54.4	7.2	6780
MBW02	Shallow Overburden	17488	6.8	8	8.63	53.98	7.2	11900	8.65	53.96	7.2	12370	8.61	54	7.2	10950	8.65	53.96	7.1	11330
MB15MTW01D	Shallow Overburden?	17488	6.8	8	6	57.333	**5.4**	976	5.79	57.543	**5.9**	2470	5.49	57.843	**5.8**	1610	5.69	57.643	**5.9**	1675
MTD605P	Shallow Overburden - sandstone	17488	6.8	8	15.04	62.32	7.2	**17910**	15.1	62.26	7.1	**17510**	15.11	62.25	7.3	**17780**	15.1	62.26	7.2	**17830**
MB15MTW02D	Shallow Overburden?	17488	6.8	8	6.31	55.701	7.6	10210	5.89	56.121	7.6	9910	5.85	56.161	7.6	9560	5.89	56.121	7.7	9970
MB15MTW03	Shallow Overburden?	17488	6.8	8	6.65	54.267	6.9	13150	6.58	54.337	6.9	12740	6.43	54.487	6.9	12520	6.39	54.527	6.8	12810
WD625P	Whybrow Seam	12086	7.1	7.3	18.98	57.42	7.2	**12230**	18.93	57.47	7.2	12020	19.05	57.35	7.1	11950	19.03	57.37	7.2	**12470**
MBW03	Whybrow Seam				8.32	54.05	7.2	9940	8.24	54.13	7.2	10550	8.15	54.22	7.2	10350	8.22	54.15	7.2	10390
WOH2153A	Redbank Crk Seam	15948	7	7.9	16.07	52.19	**8**	2650	15.13	53.13	**8**	2610	16.32	51.94	**8**	2570	16.3	51.96	7.9	2740
WOH2154A	Redbank Crk Seam	15948	7	7.9	18.87	50.02	7.6	4860	17.8	51.09	7.6	4800	19	49.89	7.6	4660	19.95	48.94	7.5	4960
WOH2155A	Redbank Crk Seam	15948	7	7.9	25.1	49.45	7.3	8890	23.36	51.19	7.3	8910	25.73	48.82	7.2	8730	27.94	46.61	7.2	9170
WOH2156A	Redbank Crk Seam	15948	7	7.9	33.69	46.69	7	15120	32.26	48.12	7.1	14800	33.41	46.97	7	14580	35.24	45.14	7	15050
WOH2153B	Wambo Seam	14080	7	7.8	11.13	57.13	7.3	1673	10.8	57.46	7.3	1629	11.24	57.02	7.1	1530	11.33	56.93	7	1576
WOH2154B	Wambo Seam	14080	7	7.8	13.79	55.1	7.4	8770	13.75	55.14	7.4	8690	13.92	54.97	7.4	8660	13.53	55.36	7.2	9150
WOH2155B	Wambo Seam	14080	7	7.8	15.55	59	7.6	5680	15.71	58.84	7.6	5500	16.19	58.36	7.6	5490	16.24	58.31	7.4	7190

Bore ID	Target Geology	EC Trigger 95th	pH Trigger 5^{th} – 95^{th}		Q1				Q2				Q3				Q4			
					SWL mbTOC	SWL mAHD	pH	EC	SWL mbTOC	SWL mAHD	pH	EC	SWL mbTOC	SWL mAHD	pH	EC	SWL mbTOC	SWL mAHD	pH	EC
WOH2156B	Wambo Seam	14080	7	7.8	12.67	67.71	-	-	12.76	67.62	-	-	12.98	67.4	7.4	13770	13.76	66.62	-	-
WD622P	Wambo Seam	14080	7	7.8	37.7	46.76	7.4	8970	35.31	49.15	7.4	8500	37.84	46.62	7.3	8450	40.85	43.61	7.3	8560
MBW04	Wambo	14080	7	7.8	12.91	49.52	7.5	13060	13.15	49.28	7.6	12920	13.16	49.27	7.5	12820	13.35	49.08	7.3	13320
WOH2139A	Blakefield	15106	6.6	7.9	56.55	35.16	7.9	9350	56.89	34.82	7.9	8210	58.86	32.85	**8**	8350	57	34.71	7.9	10800
OH1122 (1)	Blakefield Seam	15106	6.6	7.9	48.8	51.75	7.1	12230	48.99	51.56	7.1	12420	49.66	50.89	7.1	12530	49.96	50.59	7	12200
OH1125 (1)	Blakefield	15106	6.6	7.9	34.44	51.76	6.7	13720	35.11	51.09	6.7	14590	35.26	50.94	6.7	13970	36.64	49.56	6.7	14020
OH1125 (2)	Unknown																			
OH1125 (3)	Bowfield Seam	14656	6.6	6.9	54.31	31.89	6.8	13730	53.79	32.41	6.7	14100	53.9	32.3	6.7	14230	54.93	31.27	6.8	13850
OH1138 (1)	Warkworth	19995	6	7	10.8	59.92	**5.9**	19020	10.81	59.91	6	18990	10.81	59.91	**5.9**	19180	10.95	59.77	6	18960
OH1138 (2)	Warkworth	19995	6	7	15.95	54.77	6.7	13420	15.31	55.41	6.6	13460	15.28	55.44	6.6	13360	15.36	55.36	6	12930
OH1121	Vane Subgroup	17765	6.7	7.1	10.82	34.82	7	8900	10.82	34.82	7	8300	10.78	34.86	6.9	8950	10.78	34.86	6.9	10000
OH1126	Vaux	17765	6.7	7.1	18.51	46.01	6.8	14790	18.81	45.71	6.8	15100	18.81	45.71	6.7	13640	18.79	45.73	6.7	14290
OH1137	Vaux	17765	6.7	7.1																
OH1127	Vane Subgroup	23000	6.6	7.5	15.95	35.27	6.9	11950	15.96	35.26	6.9	11750	15.95	35.27	6.8	12350	15.98	35.24	6.9	12040
GW 9706	Bayswater	23000	6.6	7.5	2.84	61.4	6.8	4340	2.85	61.39	6.9	4510	2.56	61.68	7	4710	2.73	61.51	6.9	4750
GW 9707	Bayswater	23000	6.6	7.5	6.39	57.54	6.7	20100	6.2	57.73	6.9	19600	5.98	57.95	6.9	21200	6.03	57.9	7	20700
GW 9708	Bayswater	23000	6.6	7.5	12.71	60.43	6.7	13890	11.79	61.35	6.7	12410	11.84	61.3	6.7	13060	11.82	61.32	6.7	12880
GW 9709	Bayswater	23000	6.6	7.5	9.69	50.64	6.7	21500	9.58	50.75	6.8	21100	9.37	50.96	7	**23100**	9.45	50.88	**6.8**	**22700**
GW98MTCL1	Bayswater	23000	6.6	7.5	10.33	67.42	7.1	6500	11.15	66.6	7.1	6120	10.42	67.33	7.2	6160	10.8	66.95	7.2	5970
GW98MTCL2	Bayswater	23000	6.6	7.5	11.1	68.37	6.6	16380	10.96	68.51	**6.5**	16370	10.93	68.54	6.6	16620	10.94	68.53	**6.5**	16450
WOH2141A	Whynot Seam	10527	7.5	7.8	44.58	47.01	7.8	**10940**	44.71	46.88	7.8	**10580**	44.75	46.84	7.7	9980	44.48	47.11	7.7	**10650**
MBW6A					7.4		6.3	780	7.07		6.5	684	6.7		6.6	492	6.92		6.5	512

***Note**:* *SWL – standing water level*
mbTOC – meters below top of casing
NS – Casing elevation not surveyed
"-" – insufficient water

APPENDIX C

Groundwater Quality Graphs


Warkworth Sands
Electrical Conductivity (µS/cm)
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
Jan/12
Apr/12
Jul/12
Sep/12
Dec/12
Apr/13
Jul/13
Oct/13
Dec/13
Apr/14
Jul/14
Oct/14
Dec/14
Apr/15
Jul/15
Oct/15
Dec/15
Apr/16
Jul/16
Sep/16
Dec/16
Apr/17
Jul/17
Oct/17
Dec/17
Apr/18
Jul/18
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Jul/19
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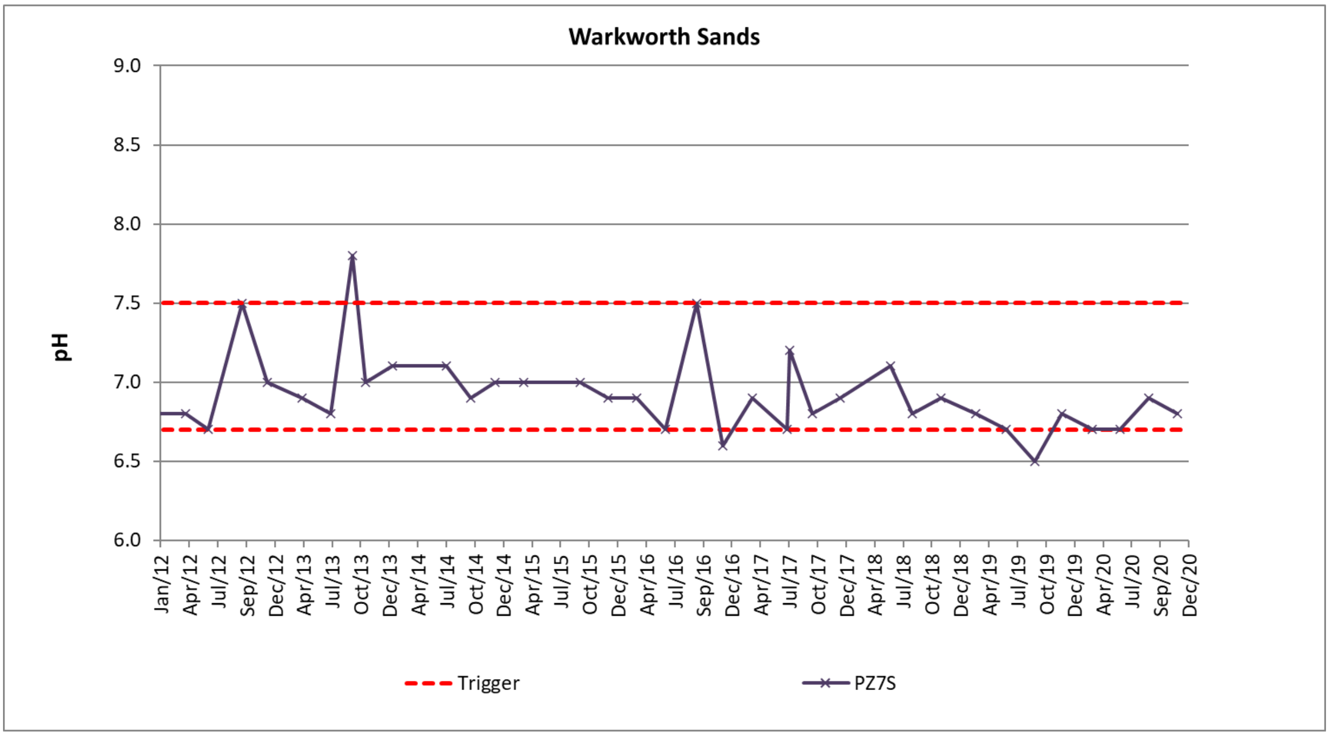
Dec/19
Apr/20
Jul/20
Sep/20
Dec/20
Trigger
PZ7S


Warkworth Sands
pH
9.0
8.5
8.0
7.5
7.0
6.5
6.0
Jan/12
Apr/12
Jul/12
Sep/12
Dec/12
Apr/13
Jul/13
Oct/13
Dec/13
Apr/14
Jul/14
Oct/14
Dec/14
Apr/15
Jul/15
Oct/15
Dec/15
Apr/16
Jul/16
Sep/16
Dec/16
Apr/17
Jul/17
Oct/17
Dec/17
Apr/18
Jul/18
Oct/18
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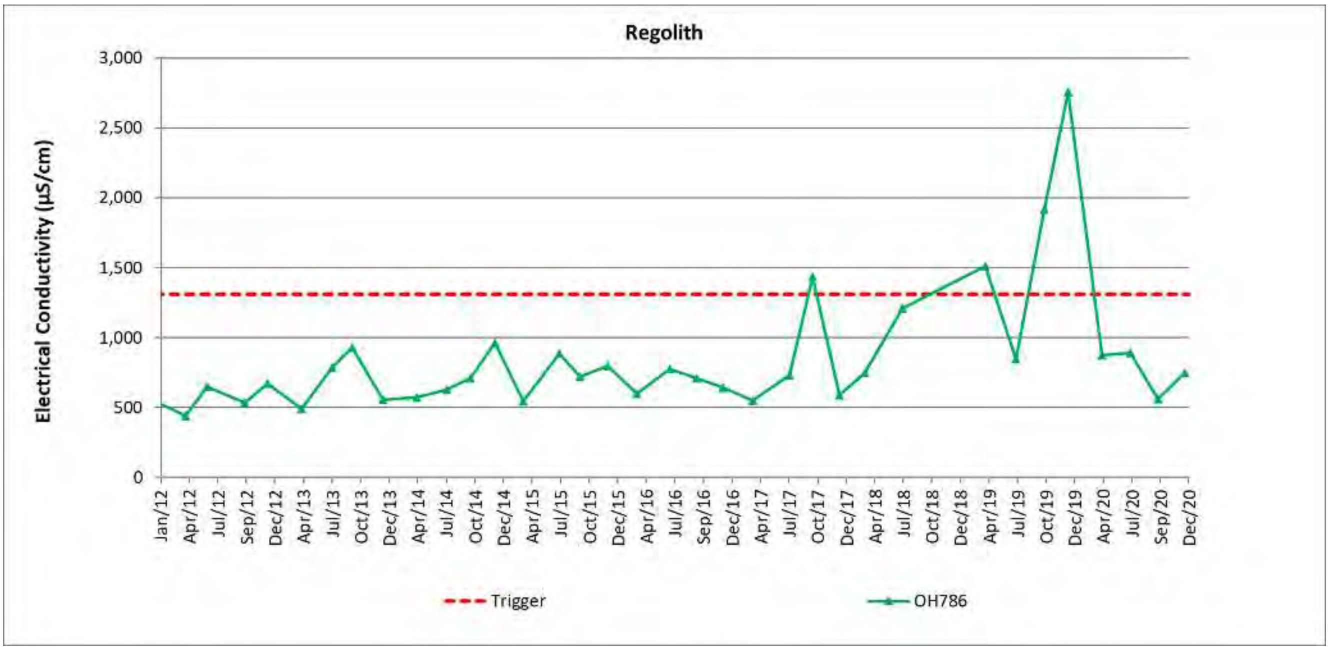
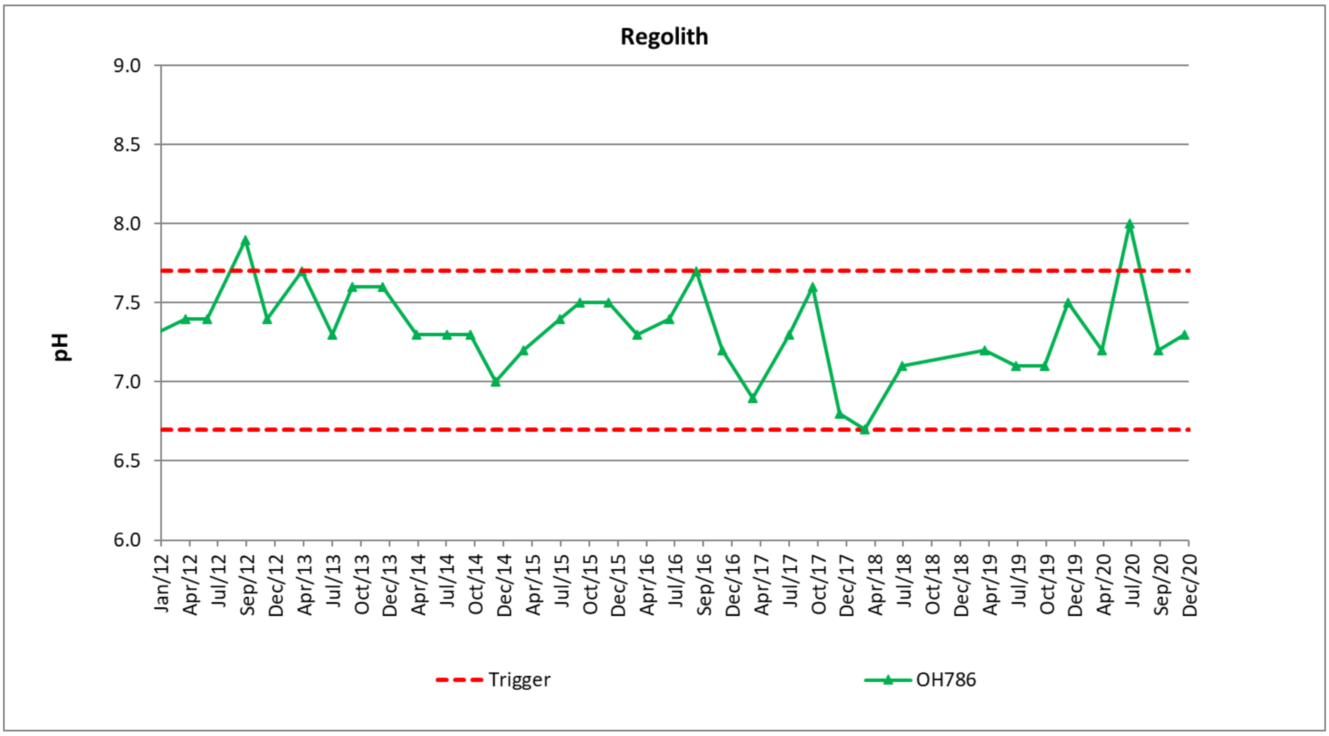
Apr/19
Jul/19
Oct/19
Dec/19
Apr/20
Jul/20
Sep/20
Dec/20
Trigger
PZ7S


Regolith
Electrical Conductivity (µS/cm)
3,000
2,500
2,000
1,500
1,000
500
0
Jan/12
Apr/12
Jul/12
Sep/12
Dec/12
Apr/13
Jul/13
Oct/13
Dec/13
Apr/14
Jul/14
Oct/14
Dec/14
Apr/15
Jul/15
Oct/15
Dec/15
Apr/16
Jul/16
Sep/16
Dec/16
Apr/17
Jul/17
Oct/17
Dec/17
Apr/18
Jul/18
Oct/18
Dec/18
Apr/19
Jul/19
Oct/19
Dec/19
Apr/20
Jul/20
Sep/20
Dec/20
Trigger
OH786


Regolith
pH
9.0
8.5
8.0
7.5
7.0
6.5
6.0
Jan/12
Apr/12
Jul/12
Sep/12
Dec/12
Apr/13
Jul/13
Oct/13
Dec/13
Apr/14
Jul/14
Oct/14
Dec/14
Apr/15
Jul/15
Oct/15
Dec/15
Apr/16
Jul/16
Sep/16
Dec/16
Apr/17
Jul/17
Oct/17
Dec/17
Apr/18
Jul/18
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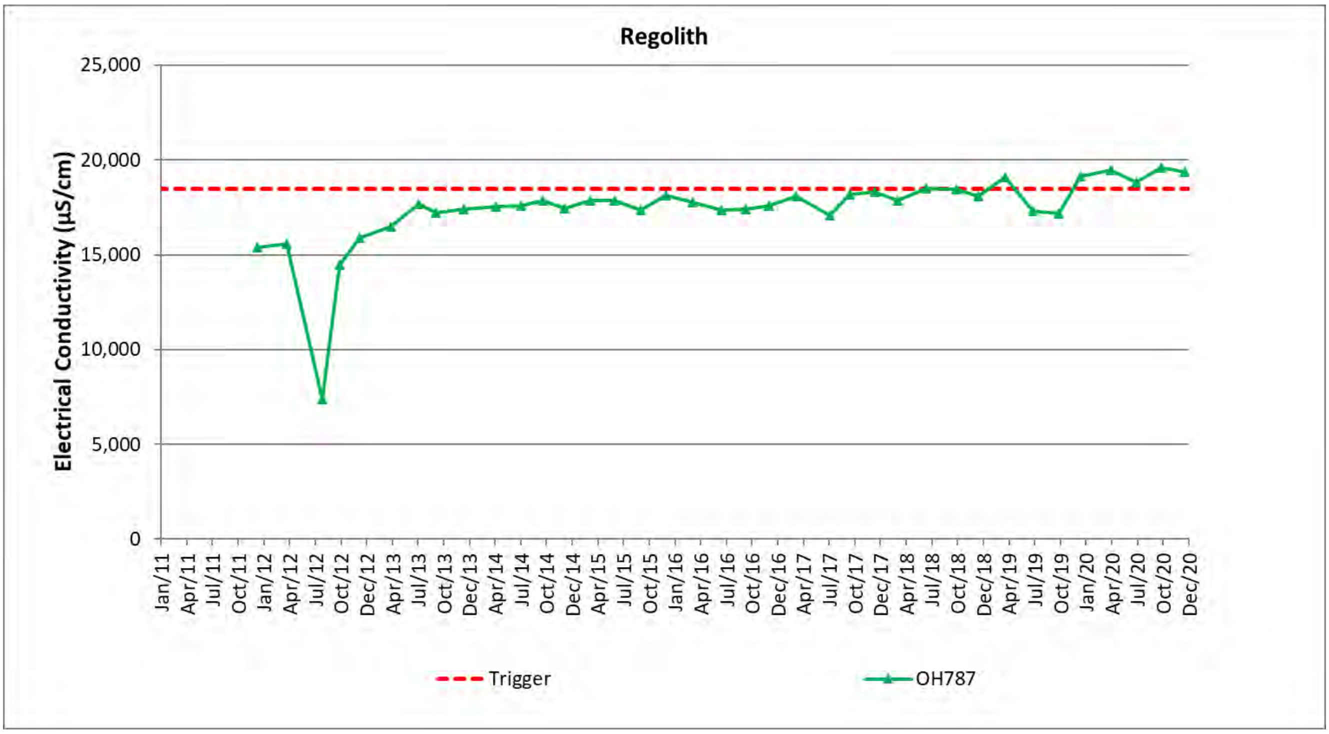
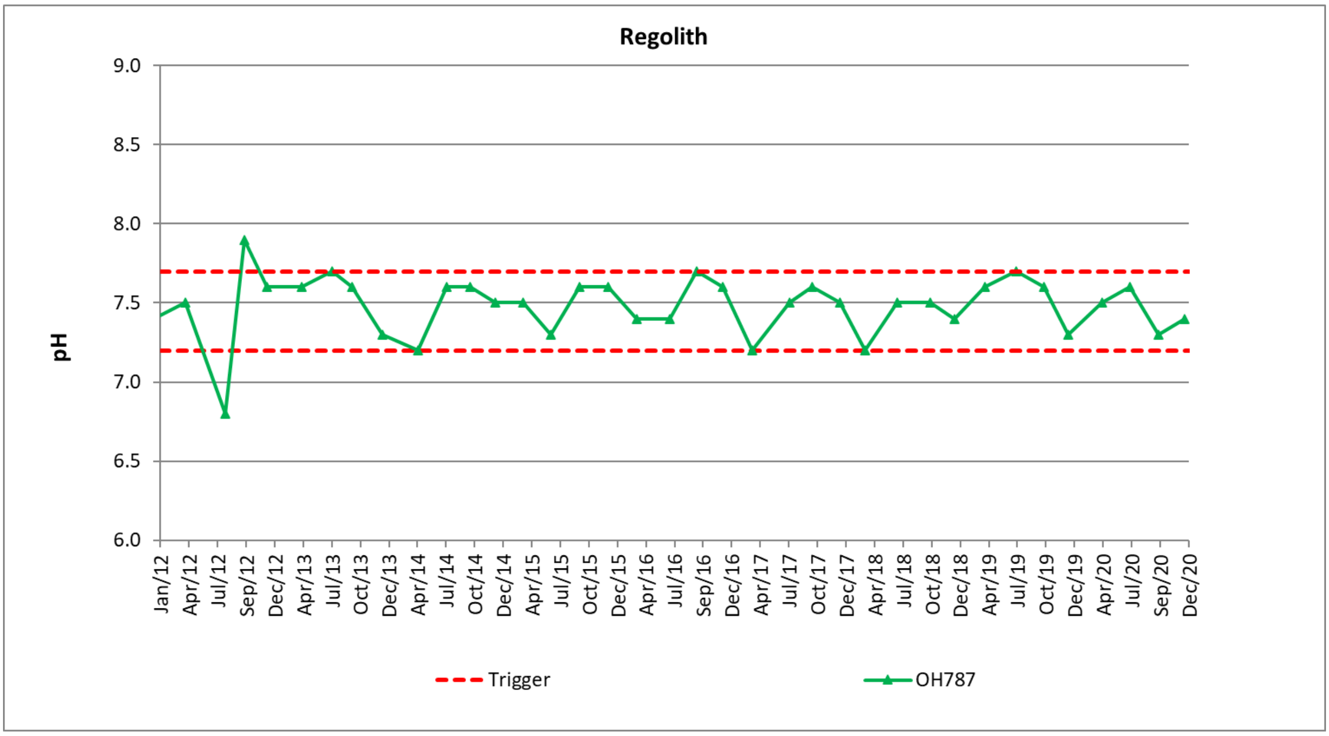
Jul/19
Oct/19
Dec/19
Apr/20
Jul/20
Sep/20
Dec/20
Trigger
OH786



Regolith
Electrical Conductivity (µS/cm)
25,000
20,000
15,000
10,000
5,000
0
Jan/11
Apr/11
Jul/11
Oct/11
Jan/12
Apr/12
Jul/12
Oct/12
Dec/12
Apr/13
Jul/13
Oct/13
Dec/13
Apr/14
Jul/14
Oct/14
Dec/14
Apr/15
Jul/15
Oct/15
Jan/16
Apr/16
Jul/16
Oct/16
Dec/16
Apr/17
Jul/17
Oct/17
Dec/17
Apr/18
Jul/18
Oct/18
Dec/18
Apr/19
Jul/19
Oct/19
Jan/20
Apr/20
Jul/20
Oct/20
Dec/20
Trigger
OH787



Regolith
pH
9.0
8.5
8.0
7.5
7.0
6.5
6.0
Jan/12
Apr/12
Jul/12
Sep/12
Dec/12
Apr/13
Jul/13
Oct/13
Dec/13
Apr/14
Jul/14
Oct/14
Dec/14
Apr/15
Jul/15
Oct/15
Dec/15
Apr/16
Jul/16
Sep/16
Dec/16
Apr/17
Jul/17
Oct/17
Dec/17
Apr/18
Jul/18
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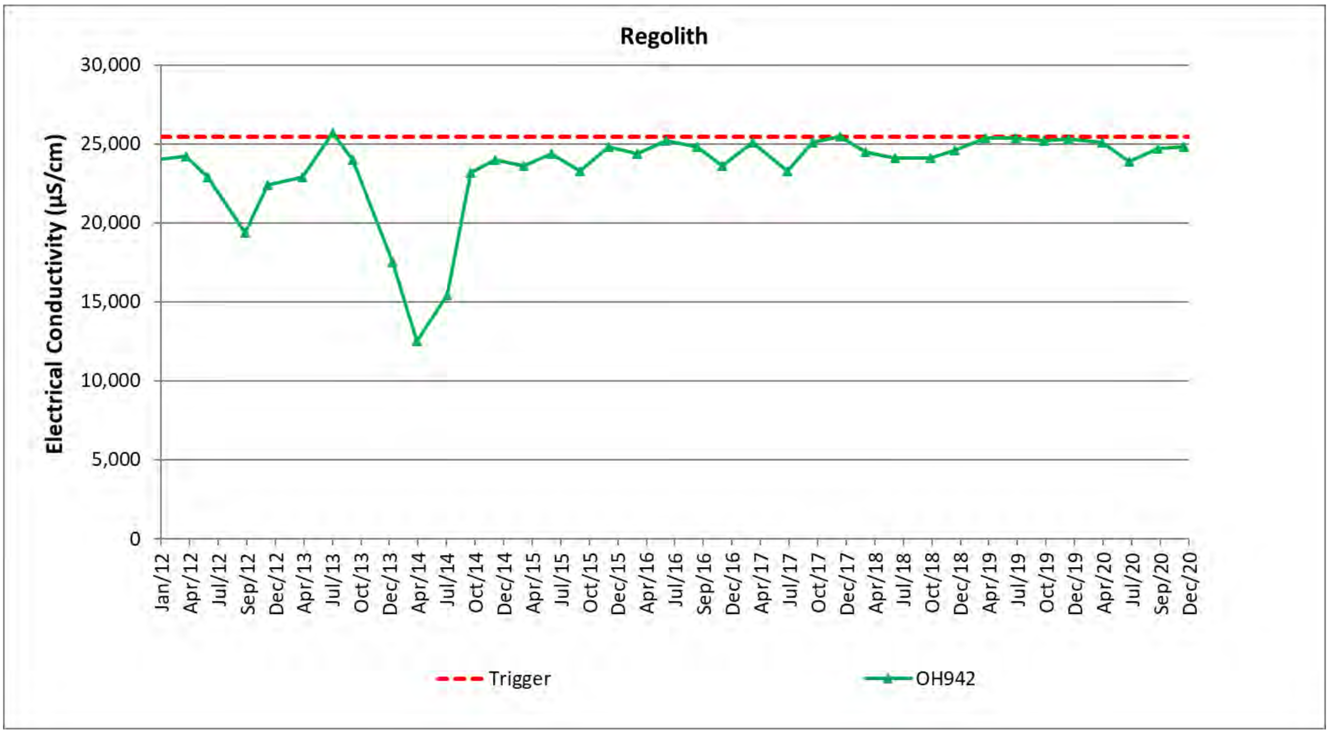
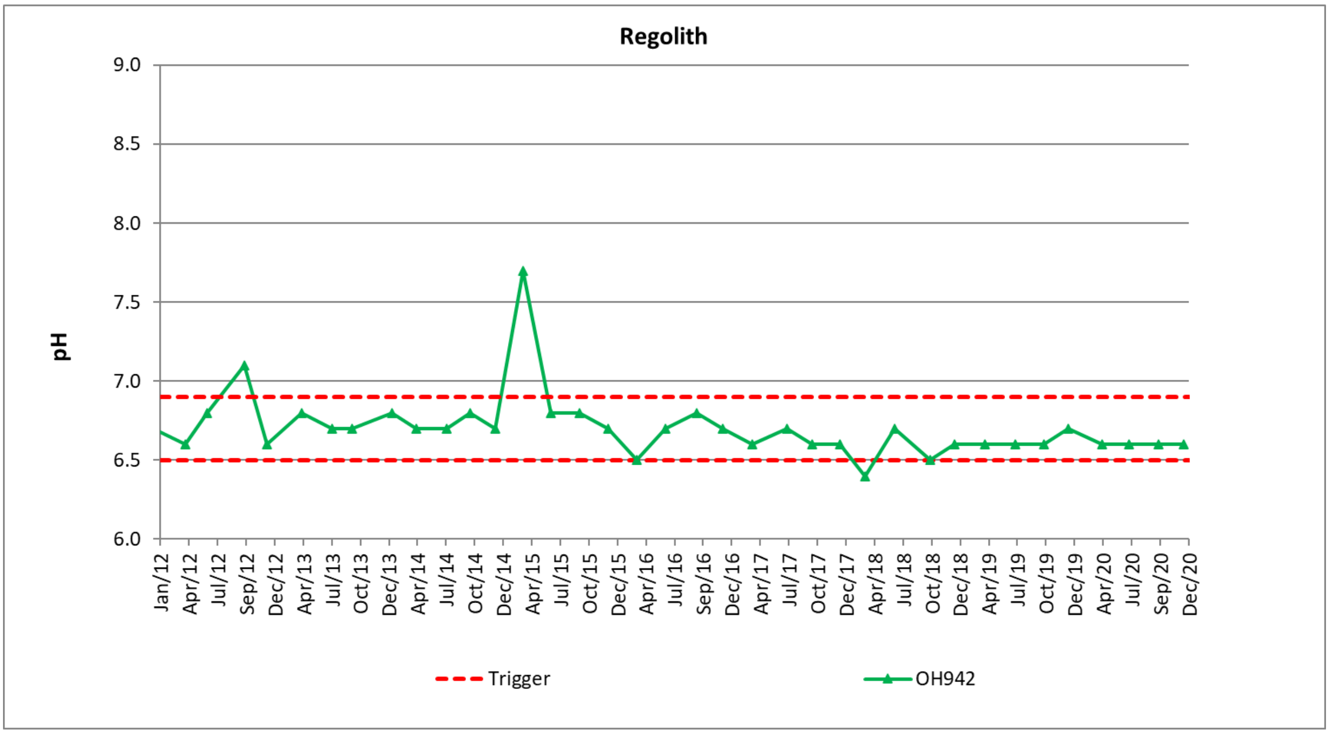
Jul/20
Sep/20
Dec/20
Trigger
OH787



Regolith
Electrical Conductivity (µS/cm)
30,000
25,000
20,000
15,000
10,000
5,000
0
Jan/12
Apr/12
Jul/12
Sep/12
Dec/12
Apr/13
Jul/13
Oct/13
Dec/13
Apr/14
Jul/14
Oct/14
Dec/14
Apr/15
Jul/15
Oct/15
Dec/15
Apr/16
Jul/16
Sep/16
Dec/16
Apr/17
Jul/17
Oct/17
Dec/17
Apr/18
Jul/18
Oct/18
Dec/18
Apr/19
Jul/19
Oct/19
Dec/19
Apr/20
Jul/20
Sep/20
Dec/20
Trigger
OH942



Regolith
pH
9.0
8.5
8.0
7.5
7.0
6.5
6.0
Jan/12
Apr/12
Jul/12
Sep/12
Dec/12
Apr/13
Jul/13
Oct/13
Dec/13
Apr/14
Jul/14
Oct/14
Dec/14
Apr/15
Jul/15
Oct/15
Dec/15
Apr/16
Jul/16
Sep/16
Dec/16
Apr/17
Jul/17
Oct/17
Dec/17
Apr/18
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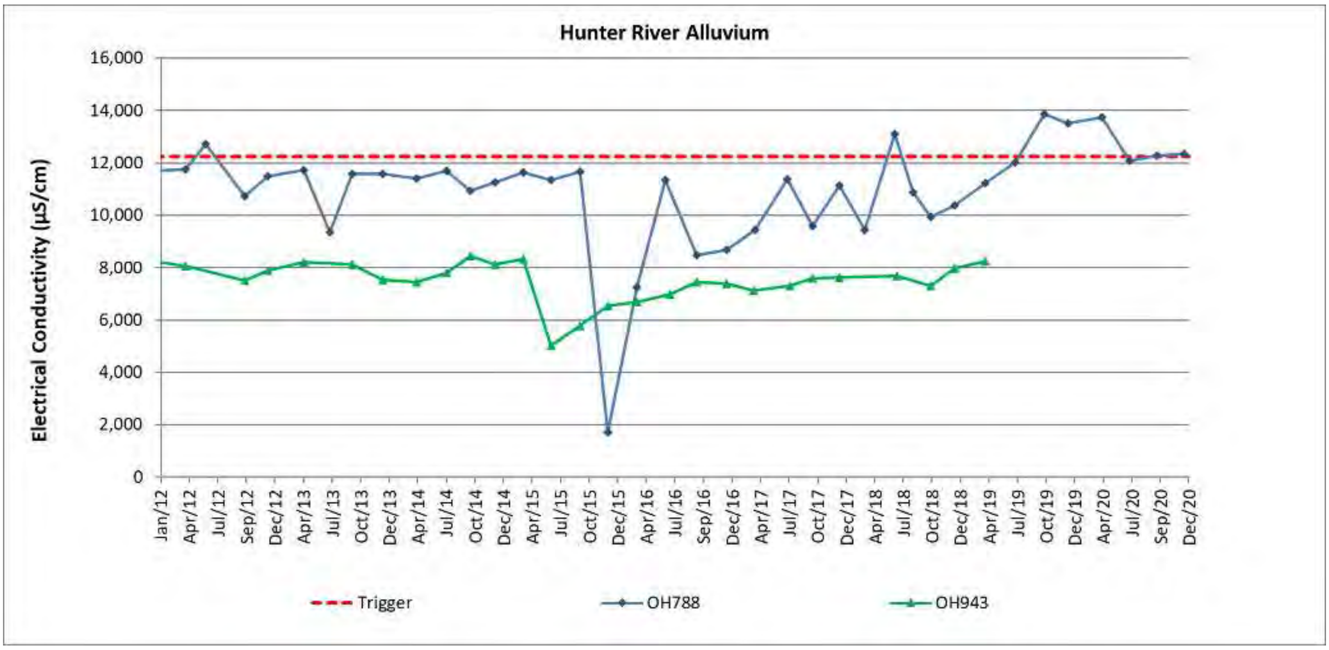
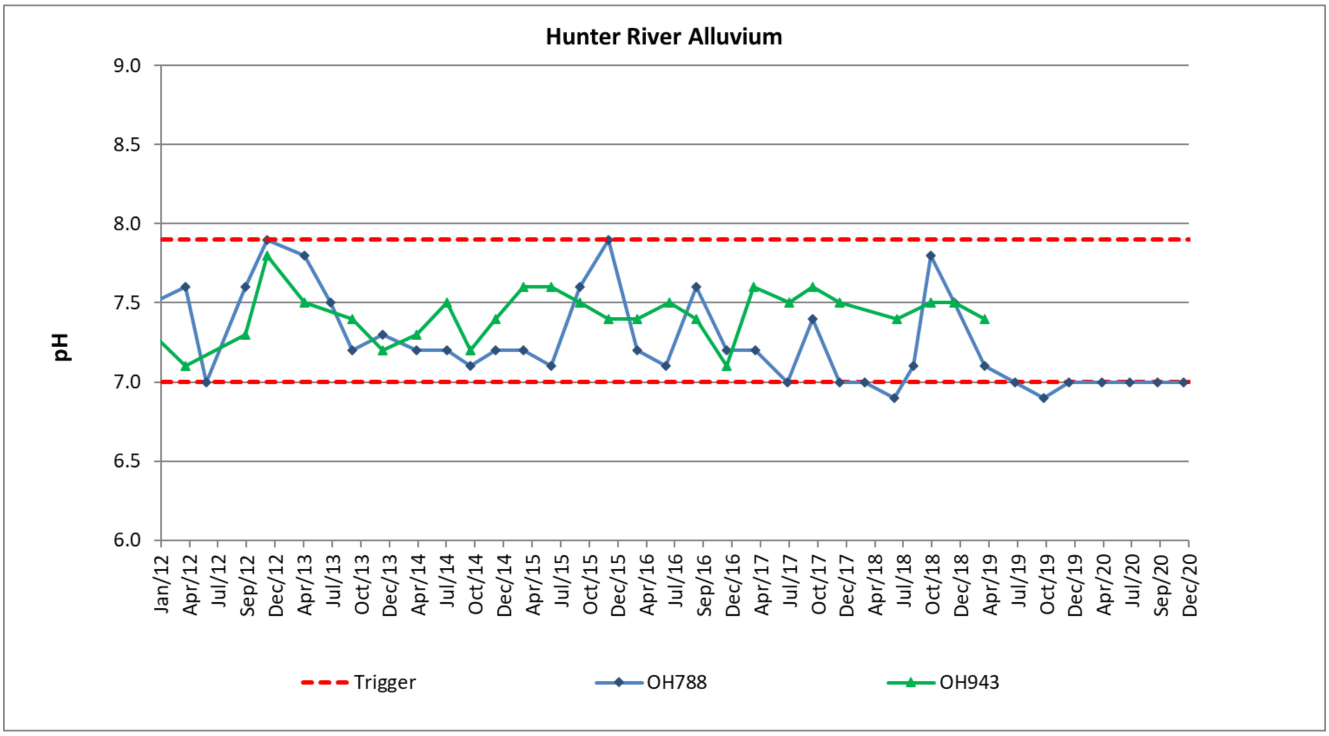
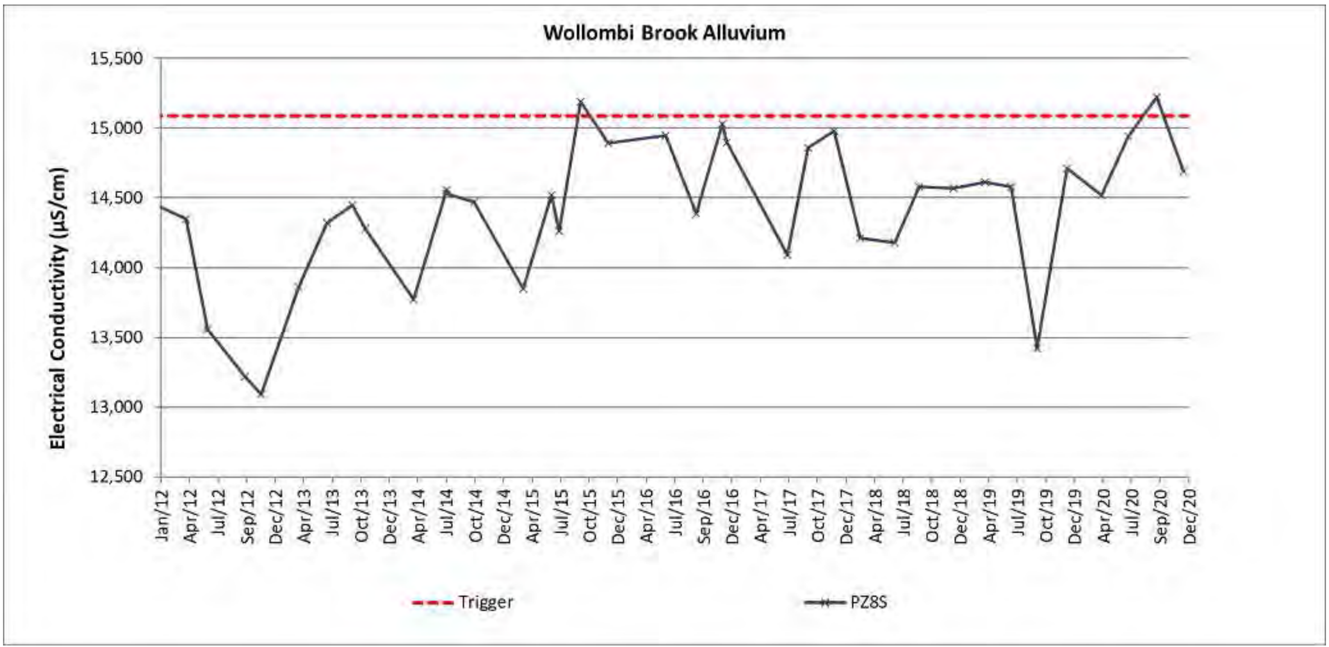
Jul/20
Sep/20
Dec/20
Trigger
OH942


Hunter River Alluvium
Electrical Conductivity (µS/cm)
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Jan/12
Apr/12
Jul/12
Sep/12
Dec/12
Apr/13
Jul/13
Oct/13
Dec/13
Apr/14
Jul/14
Oct/14
Dec/14
Apr/15
Jul/15
Oct/15
Dec/15
Apr/16
Jul/16
Sep/16
Dec/16
Apr/17
Jul/17
Oct/17
Dec/17
Apr/18
Jul/18
Oct/18
Dec/18
Apr/19
Jul/19
Oct/19
Dec/19
Apr/20
Jul/20
Sep/20
Dec/20
Trigger
OH788
OH943


Hunter River Alluvium
pH
9.0
8.5
8.0
7.5
7.0
6.5
6.0
Jan/12
Apr/12
Jul/12
Sep/12
Dec/12
Apr/13
Jul/13
Oct/13
Dec/13
Apr/14
Jul/14
Oct/14
Dec/14
Apr/15
Jul/15
Oct/15
Dec/15
Apr/16
Jul/16
Sep/16
Dec/16
Apr/17
Jul/17
Oct/17
Dec/17
Apr/18
Jul/18
Oct/18
Dec/18
Apr/19
Jul/19
Oct/19
Dec/19
Apr/20
Jul/20
Sep/20
Dec/20
Trigger
OH788
OH943


Wollombi Brook Alluvium
Electrical Conductivity (µS/cm)
15,500
15,000
14,500
14,000
13,500
13,000
12,500
Jan/12
Apr/12
Jul/12
Sep/12
Dec/12
Apr/13
Jul/13
Oct/13
Dec/13
Apr/14
Jul/14
Oct/14
Dec/14
Apr/15
Jul/15
Oct/15
Dec/15
Apr/16
Jul/16
Sep/16
Dec/16
Apr/17
Jul/17
Oct/17
Dec/17
Apr/18
Jul/18
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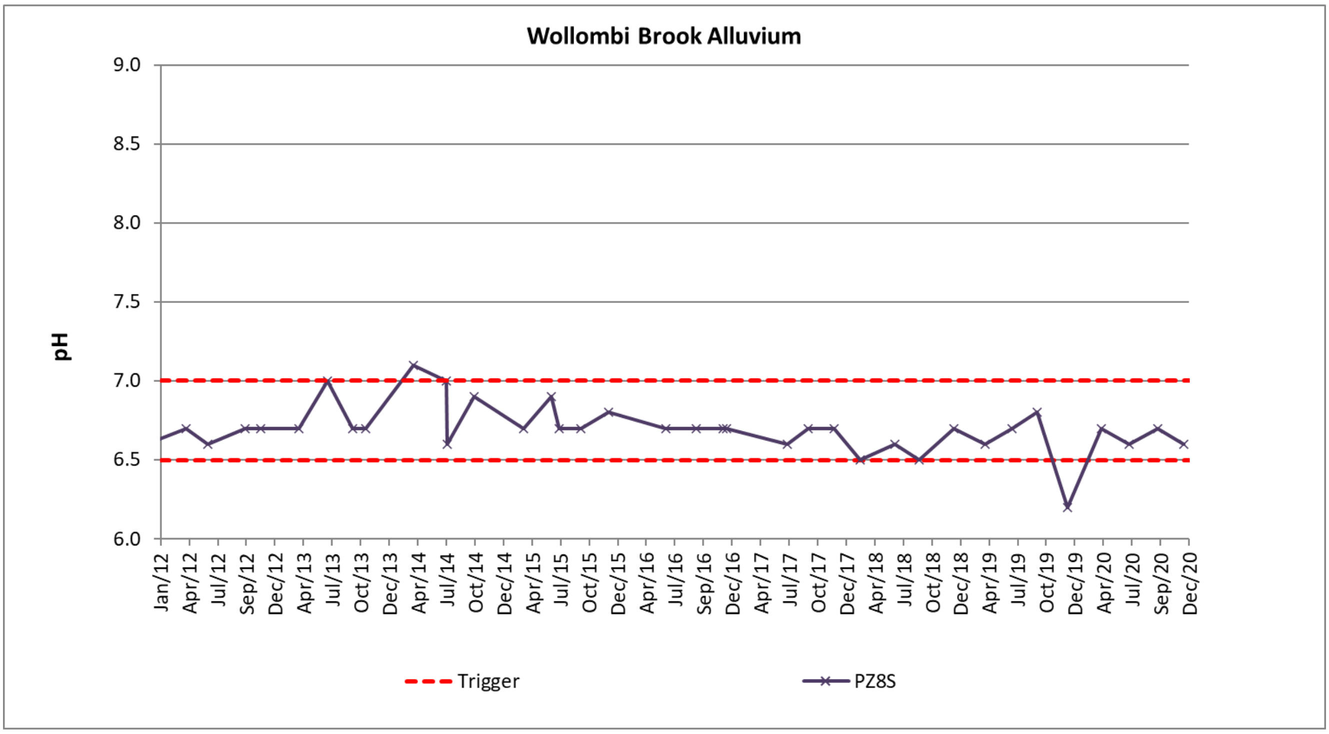
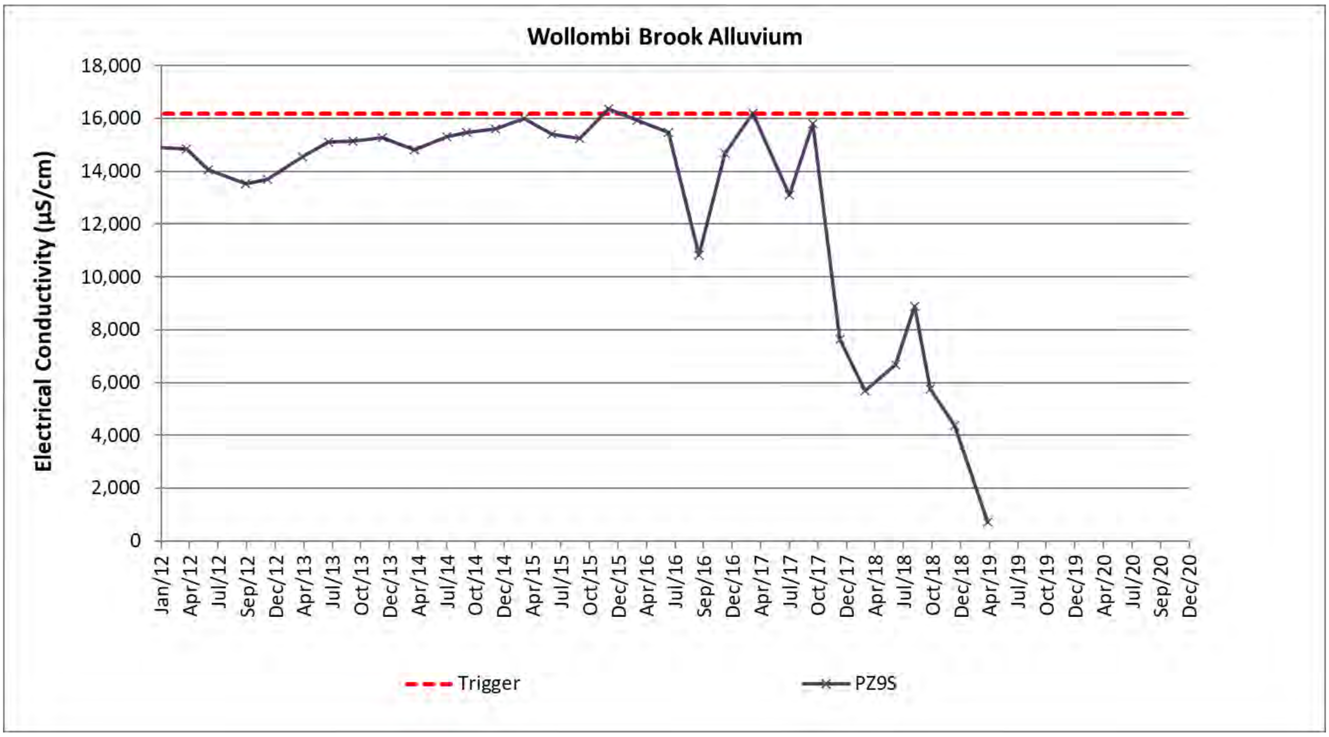
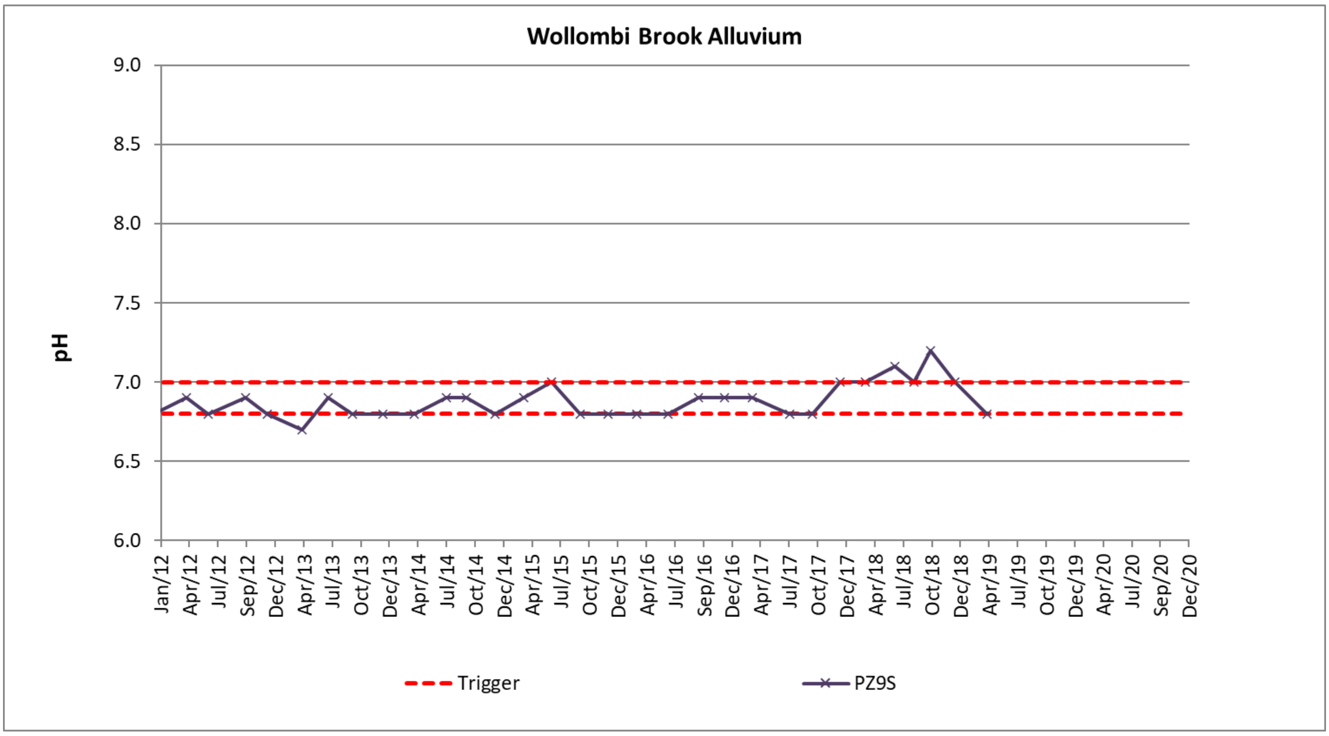
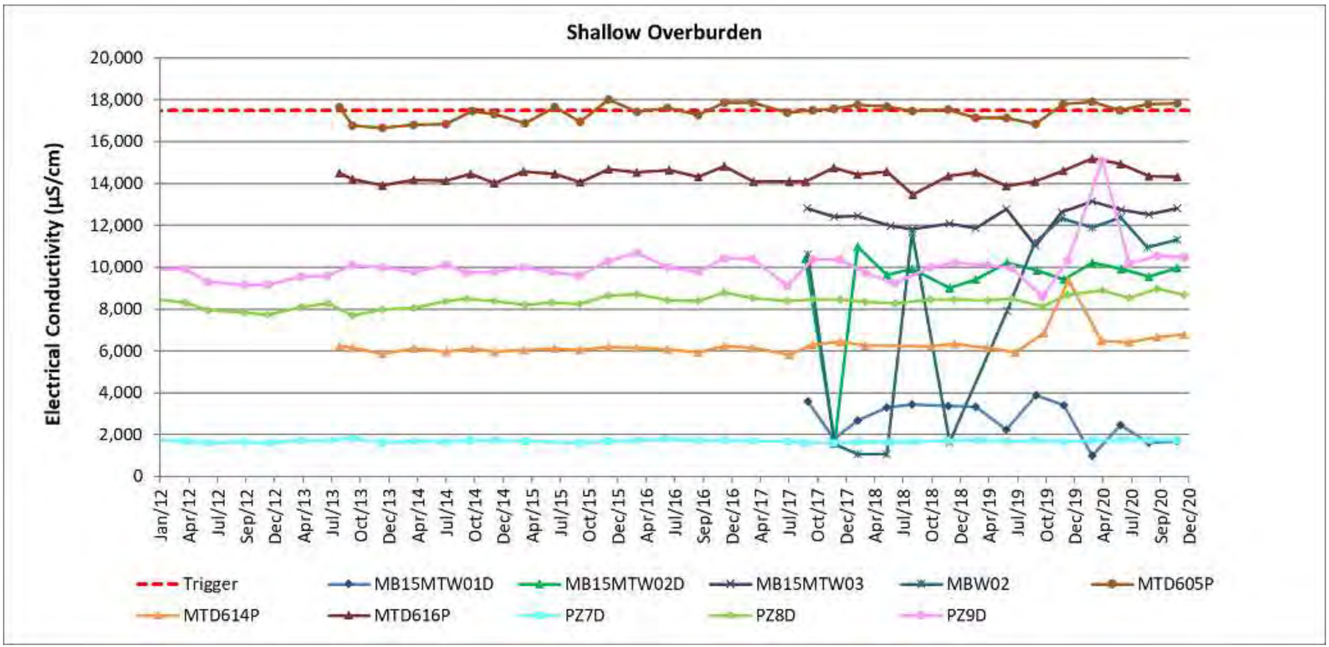
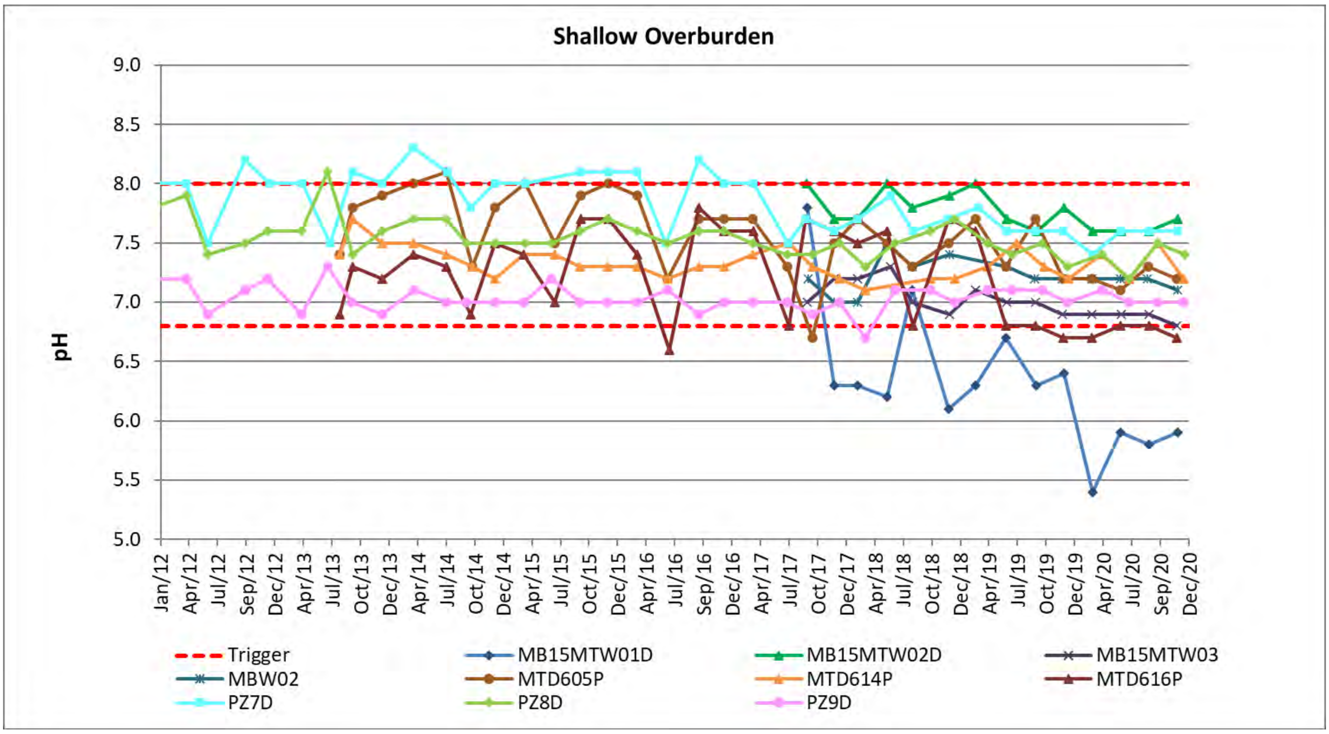
Jul/20
Sep/20
Dec/20
Trigger
PZ8S

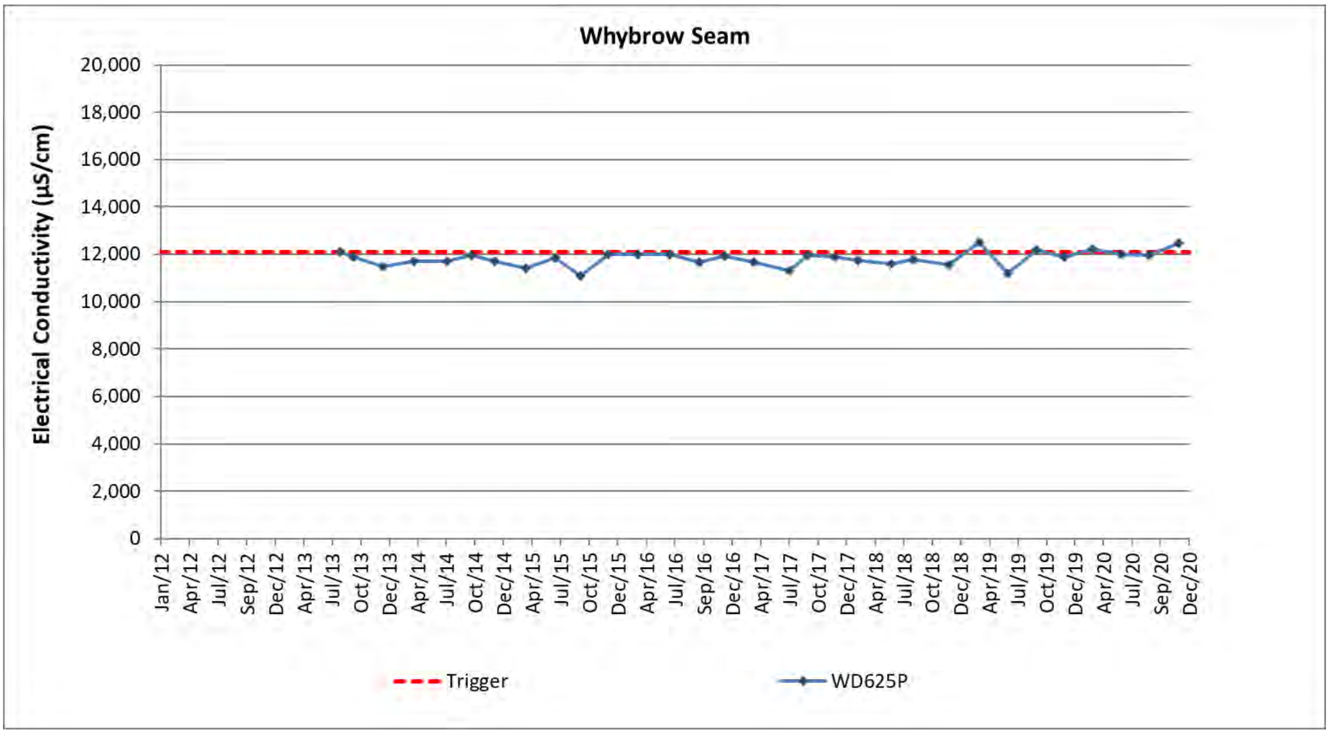

Wollombi Brook Alluvium
pH
9.0
8.5
8.0
7.5
7.0
6.5
6.0
Jan/12
Apr/12
Jul/12
Sep/12
Dec/12
Apr/13
Jul/13
Oct/13
Dec/13
Apr/14
Jul/14
Oct/14
Dec/14
Apr/15
Jul/15
Oct/15
Dec/15
Apr/16
Jul/16
Sep/16
Dec/16
Apr/17
Jul/17
Oct/17
Dec/17
Apr/18
Jul/18
Oct/18
Dec/18
Apr/19
Jul/19
Oct/19
Dec/19
Apr/20
Jul/20
Sep/20
Dec/20
Trigger
PZ8S


Wollombi Brook Alluvium
Electrical Conductivity (µS/cm)
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Jan/12 Apr/12 Jul/12 Sep/12 Dec/12 Apr/13 Jul/13 Oct/13 Dec/13 Apr/14 Jul/14 Oct/14 Dec/14 Apr/15 Jul/15 Oct/15 Dec/15 Apr/16 Jul/16 Sep/16 Dec/16 Apr/17 Jul/17 Oct/17 Dec/17 Apr/18 Jul/18 Oct/18 Dec/18 Apr/19 Jul/19 Oct/19 Dec/19 Apr/20 Jul/20 Sep/20 Dec/20
Trigger
PZ9S

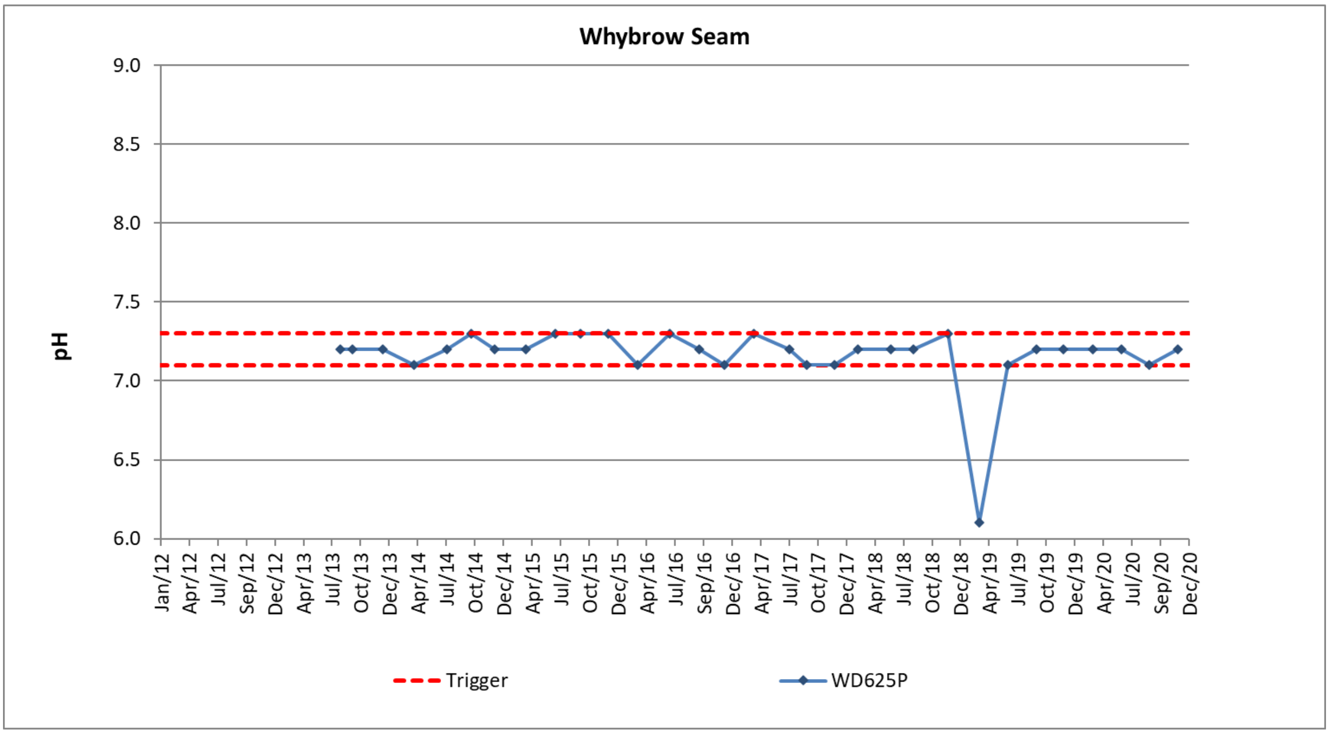

Wollombi Brook Alluvium
pH
9.0
8.5
8.0
7.5
7.0
6.5
6.0
Jan/12 Apr/12 Jul/12 Sep/12 Dec/12 Apr/13 Jul/13 Oct/13 Dec/13 Apr/14 Jul/14 Oct/14 Dec/14 Apr/15 Jul/15 Oct/15 Dec/15 Apr/16 Jul/16 Sep/16 Dec/16 Apr/17 Jul/17 Oct/17 Dec/17 Apr/18 Jul/18 Oct/18 Dec/18 Apr/19 Jul/19 Oct/19 Dec/19 Apr/20 Jul/20 Sep/20 Dec/20
Trigger
PZ9S


Shallow Overburden
Electrical Conductivity (µS/cm)
Trigger
MB15MTW01D
MB15MTW02D
MB15MTW03
MBW02
MTD605P
MTD614P
MTD616P
PZ7D
PZ8D
PZ9D

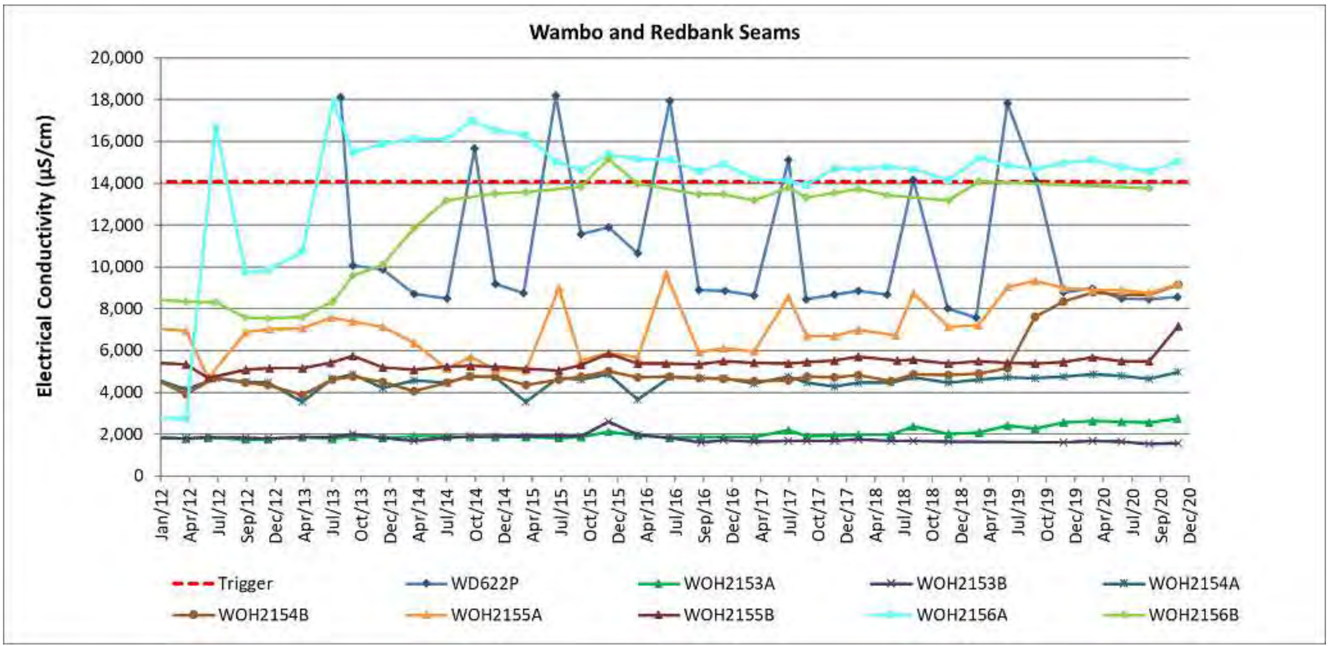

Shallow Overburden
pH
Trigger
MB15MTW01D
MB15MTW02D
MB15MTW03
MBW02
MTD605P
MTD614P
MTD616P
PZ7D
PZ8D
PZ9D

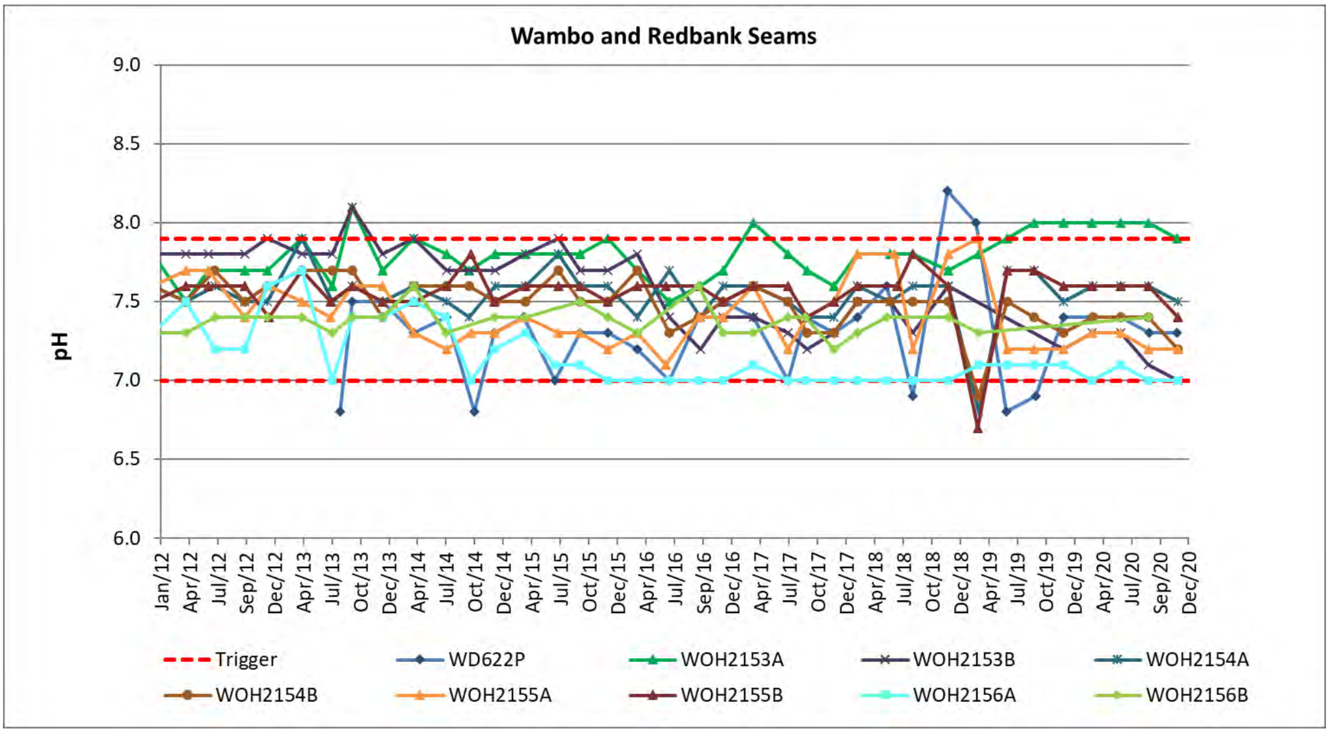


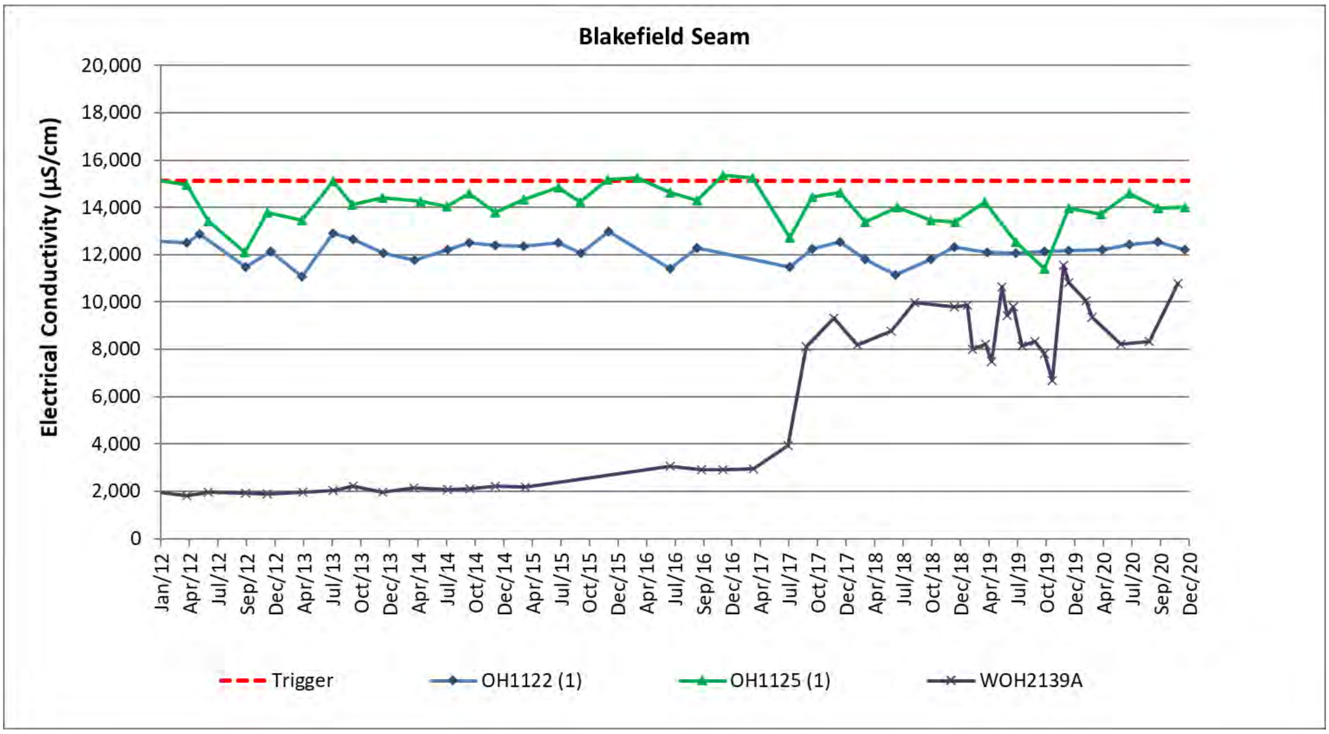
Whybrow Seam
Electrical Conductivity (µS/cm)
20,000
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Jan/12
Apr/12
Jul/12
Sep/12
Dec/12
Apr/13
Jul/13
Oct/13
Dec/13
Apr/14
Jul/14
Oct/14
Dec/14
Apr/15
Jul/15
Oct/15
Dec/15
Apr/16
Jul/16
Sep/16
Dec/16
Apr/17
Jul/17
Oct/17
Dec/17
Apr/18
Jul/18
Oct/18
Dec/18
Apr/19
Jul/19
Oct/19
Dec/19
Apr/20
Jul/20
Sep/20
Dec/20
Trigger
WD625P

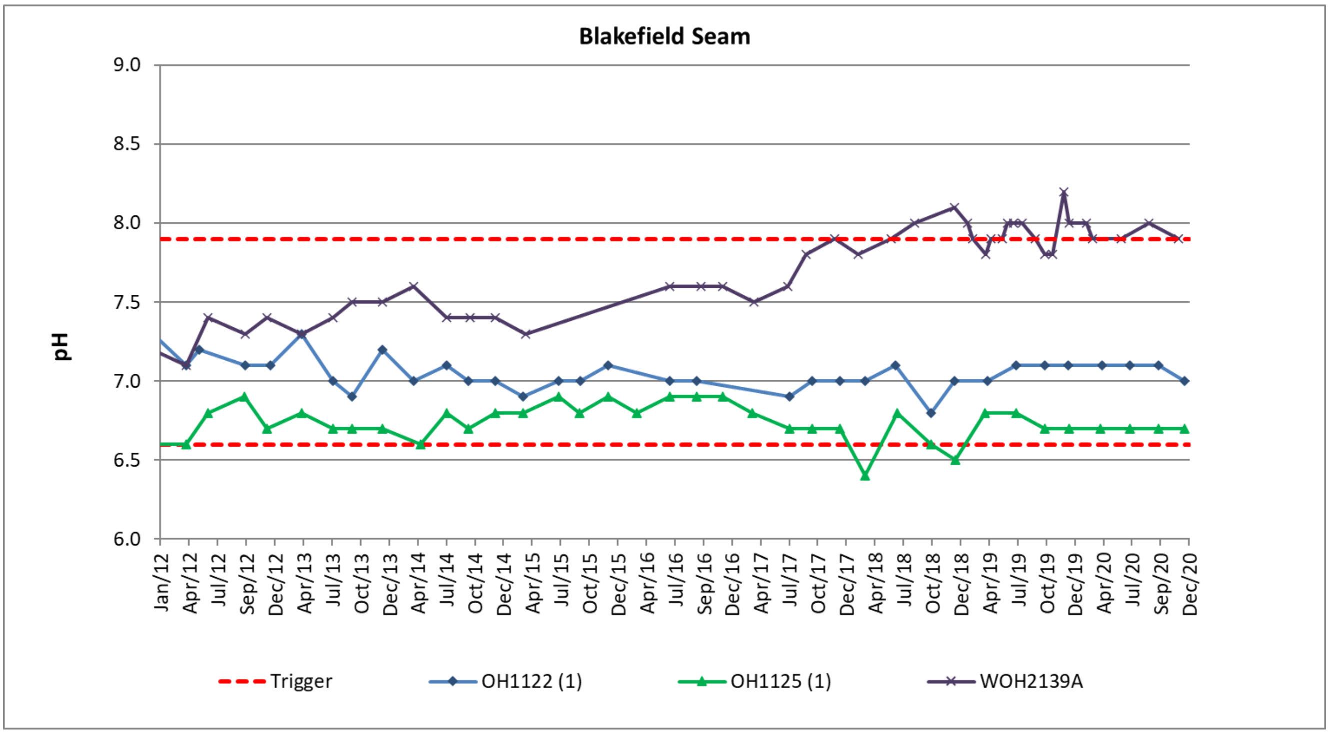


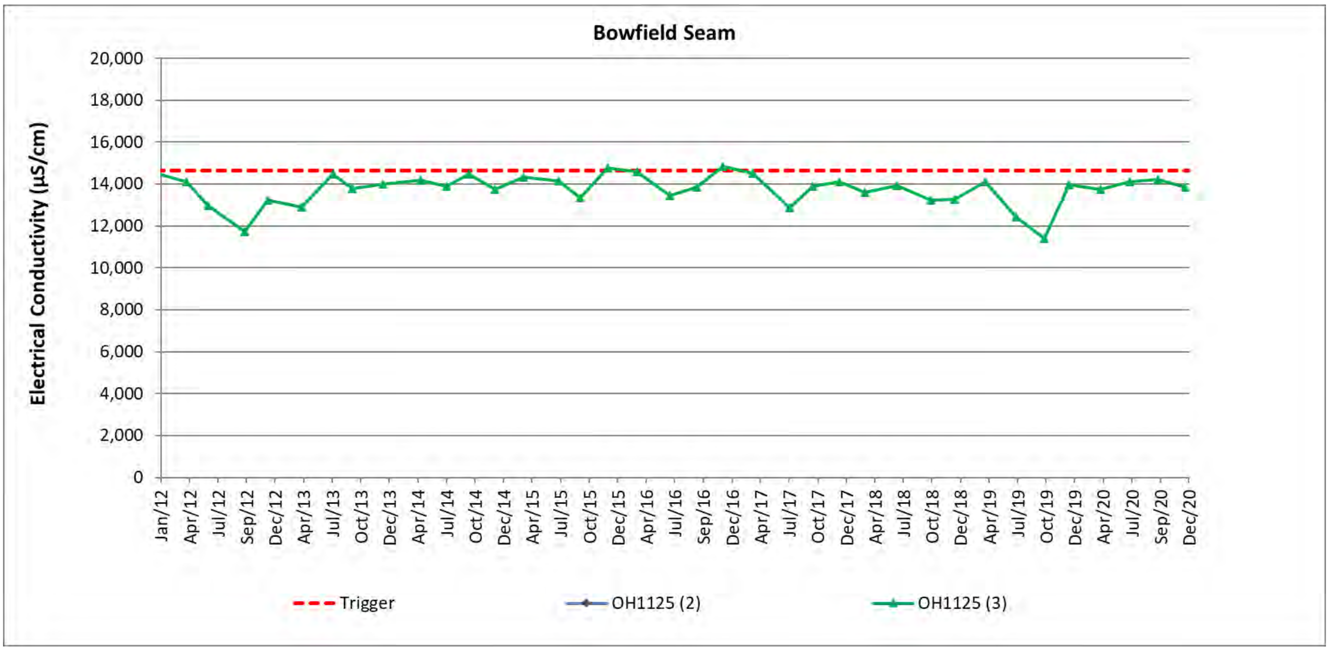
Whybrow Seam
pH
9.0
8.5
8.0
7.5
7.0
6.5
6.0
Jan/12
Apr/12
Jul/12
Sep/12
Dec/12
Apr/13
Jul/13
Oct/13
Dec/13
Apr/14
Jul/14
Oct/14
Dec/14
Apr/15
Jul/15
Oct/15
Dec/15
Apr/16
Jul/16
Sep/16
Dec/16
Apr/17
Jul/17
Oct/17
Dec/17
Apr/18
Jul/18
Oct/18
Dec/18
Apr/19
Jul/19
Oct/19
Dec/19
Apr/20
Jul/20
Sep/20
Dec/20
Trigger
WD625P

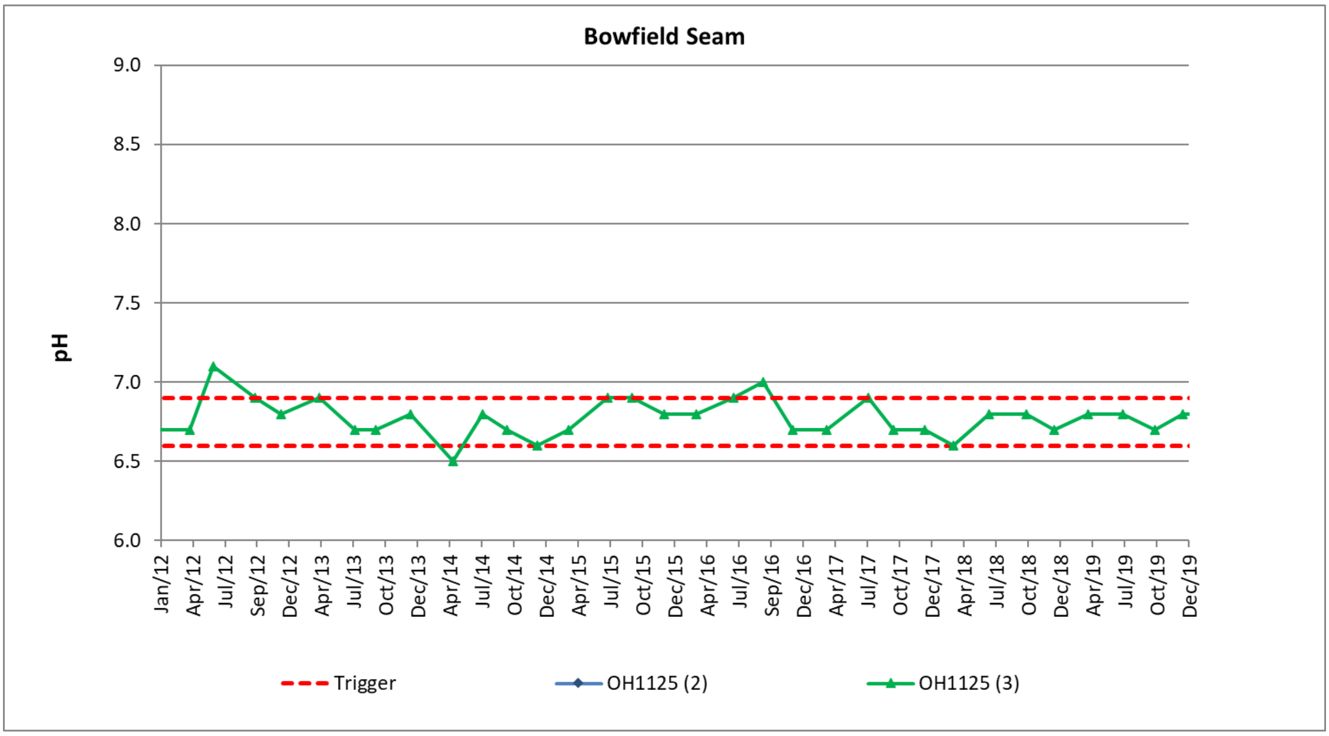

Wambo and Redbank Seams
Electrical Conductivity (µS/cm)
20,000
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Jan/12
Apr/12
Jul/12
Sep/12
Dec/12
Apr/13
Jul/13
Oct/13
Dec/13
Apr/14
Jul/14
Oct/14
Dec/14
Apr/15
Jul/15
Oct/15
Dec/15
Apr/16
Jul/16
Sep/16
Dec/16
Apr/17
Jul/17
Oct/17
Dec/17
Apr/18
Jul/18
Oct/18
Dec/18
Apr/19
Jul/19
Oct/19
Dec/19
Apr/20
Jul/20
Sep/20
Dec/20
Trigger
WD622P
WOH2153A
WOH2153B
WOH2154A
WOH2154B
WOH2155A
WOH2155B
WOH2156A
WOH2156B

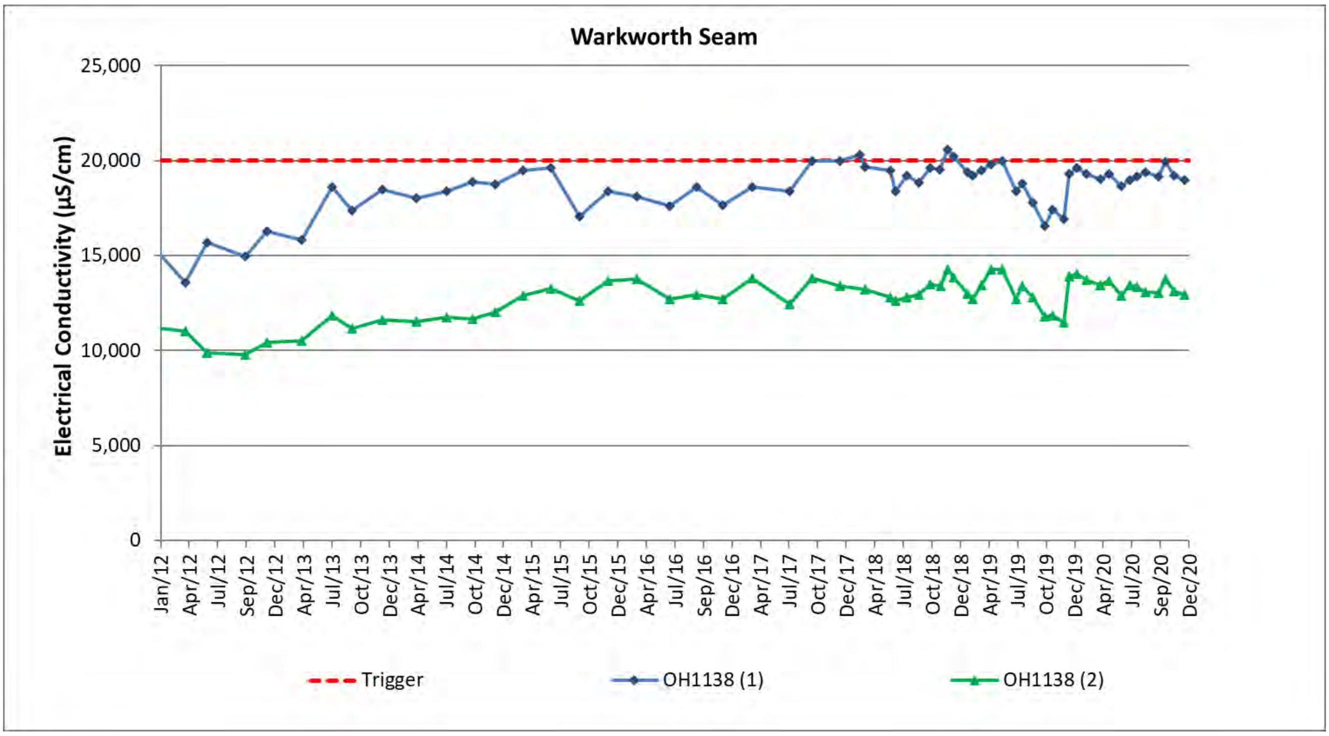

Wambo and Redbank Seams
pH
9.0
8.5
8.0
7.5
7.0
6.5
6.0
Jan/12
Apr/12
Jul/12
Sep/12
Dec/12
Apr/13
Jul/13
Oct/13
Dec/13
Apr/14
Jul/14
Oct/14
Dec/14
Apr/15
Jul/15
Oct/15
Dec/15
Apr/16
Jul/16
Sep/16
Dec/16
Apr/17
Jul/17
Oct/17
Dec/17
Apr/18
Jul/18
Oct/18
Dec/18
Apr/19
Jul/19
Oct/19
Dec/19
Apr/20
Jul/20
Sep/20
Dec/20
Trigger
WD622P
WOH2153A
WOH2153B
WOH2154A
WOH2154B
WOH2155A
WOH2155B
WOH2156A
WOH2156B

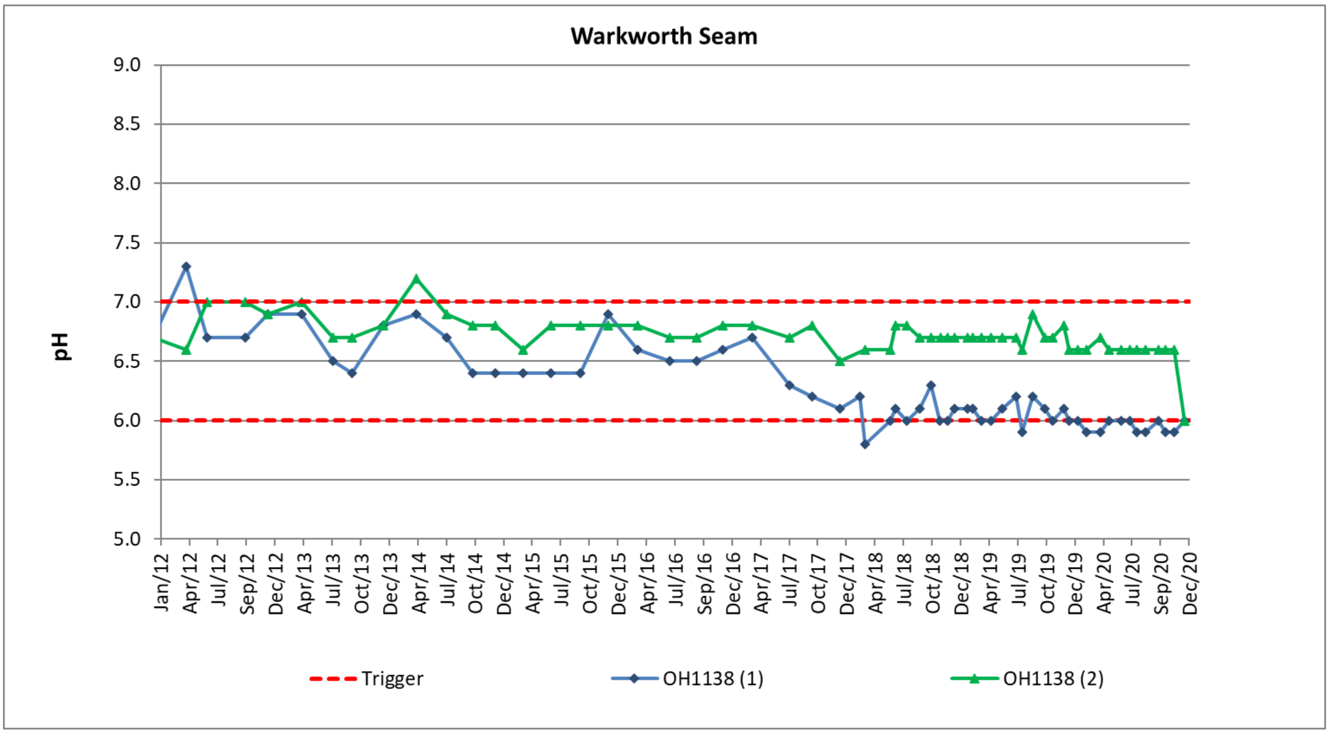

Blakefield Seam
Electrical Conductivity (µS/cm)
20,000
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Jan/12 Apr/12 Jul/12 Sep/12 Dec/12 Apr/13 Jul/13 Oct/13 Dec/13 Apr/14 Jul/14 Oct/14 Dec/14 Apr/15 Jul/15 Oct/15 Dec/15 Apr/16 Jul/16 Sep/16 Dec/16 Apr/17 Jul/17 Oct/17 Dec/17 Apr/18 Jul/18 Oct/18 Dec/18 Apr/19 Jul/19 Oct/19 Dec/19 Apr/20 Jul/20 Sep/20 Dec/20
Trigger
OH1122 (1)
OH1125 (1)
WOH2139A

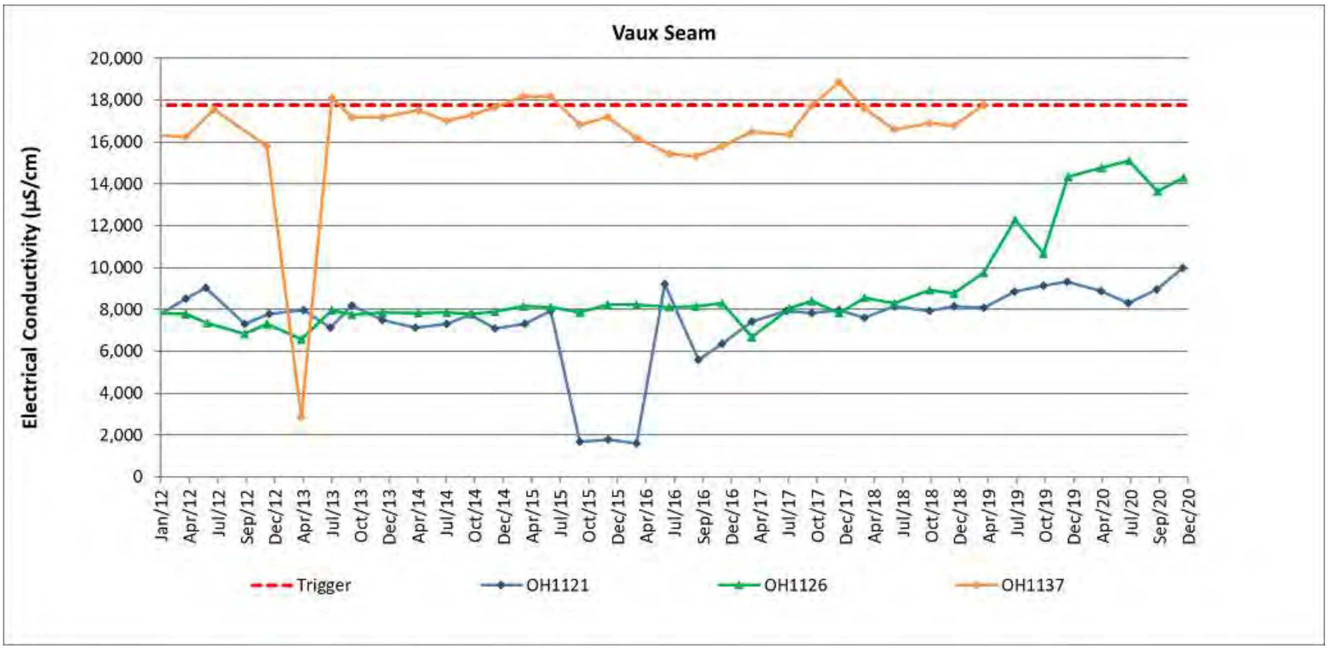

Blakefield Seam
pH
9.0
8.5
8.0
7.5
7.0
6.5
6.0
Jan/12 Apr/12 Jul/12 Sep/12 Dec/12 Apr/13 Jul/13 Oct/13 Dec/13 Apr/14 Jul/14 Oct/14 Dec/14 Apr/15 Jul/15 Oct/15 Dec/15 Apr/16 Jul/16 Sep/16 Dec/16 Apr/17 Jul/17 Oct/17 Dec/17 Apr/18 Jul/18 Oct/18 Dec/18 Apr/19 Jul/19 Oct/19 Dec/19 Apr/20 Jul/20 Sep/20 Dec/20
Trigger
OH1122 (1)
OH1125 (1)
WOH2139A

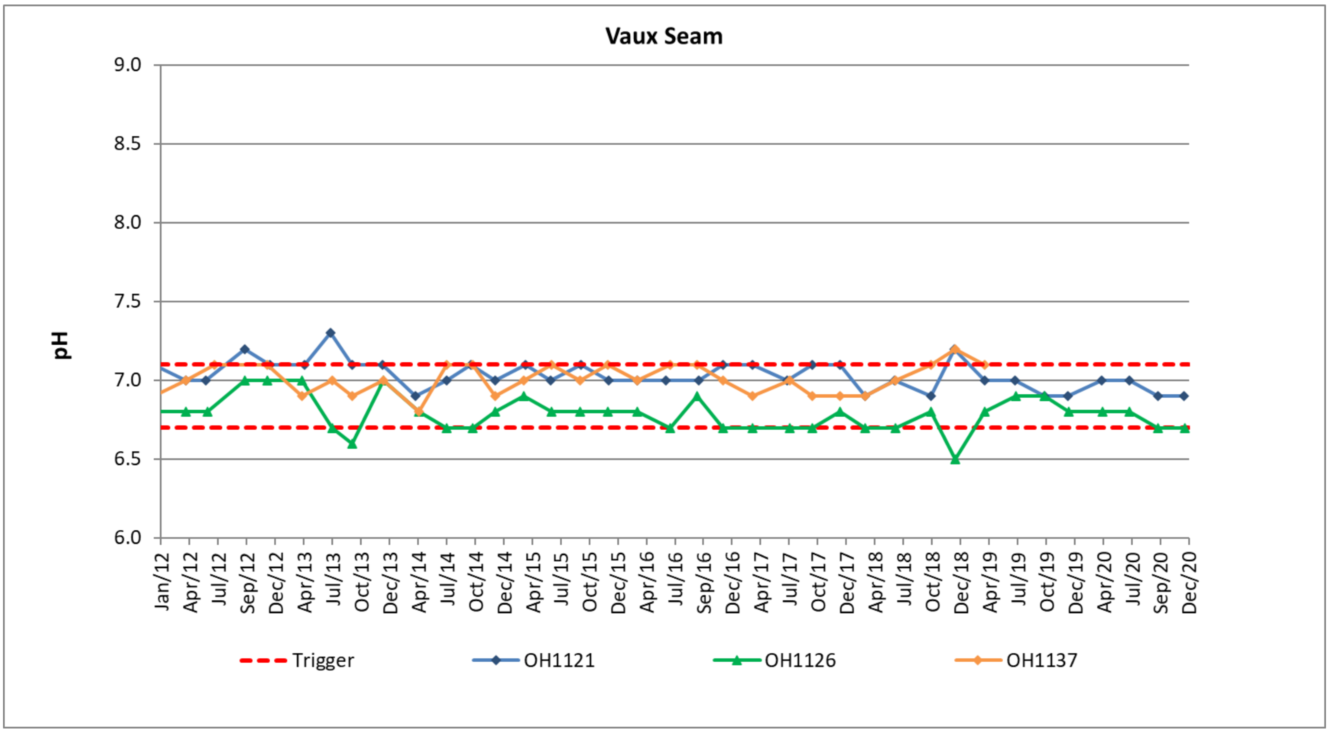

Bowfield Seam
Electrical Conductivity (µS/cm)
20,000
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Jan/12
Apr/12
Jul/12
Sep/12
Dec/12
Apr/13
Jul/13
Oct/13
Dec/13
Apr/14
Jul/14
Oct/14
Dec/14
Apr/15
Jul/15
Oct/15
Dec/15
Apr/16
Jul/16
Sep/16
Dec/16
Apr/17
Jul/17
Oct/17
Dec/17
Apr/18
Jul/18
Oct/18
Dec/18
Apr/19
Jul/19
Oct/19
Dec/19
Apr/20
Jul/20
Sep/20
Dec/20
Trigger
OH1125 (2)
OH1125 (3)

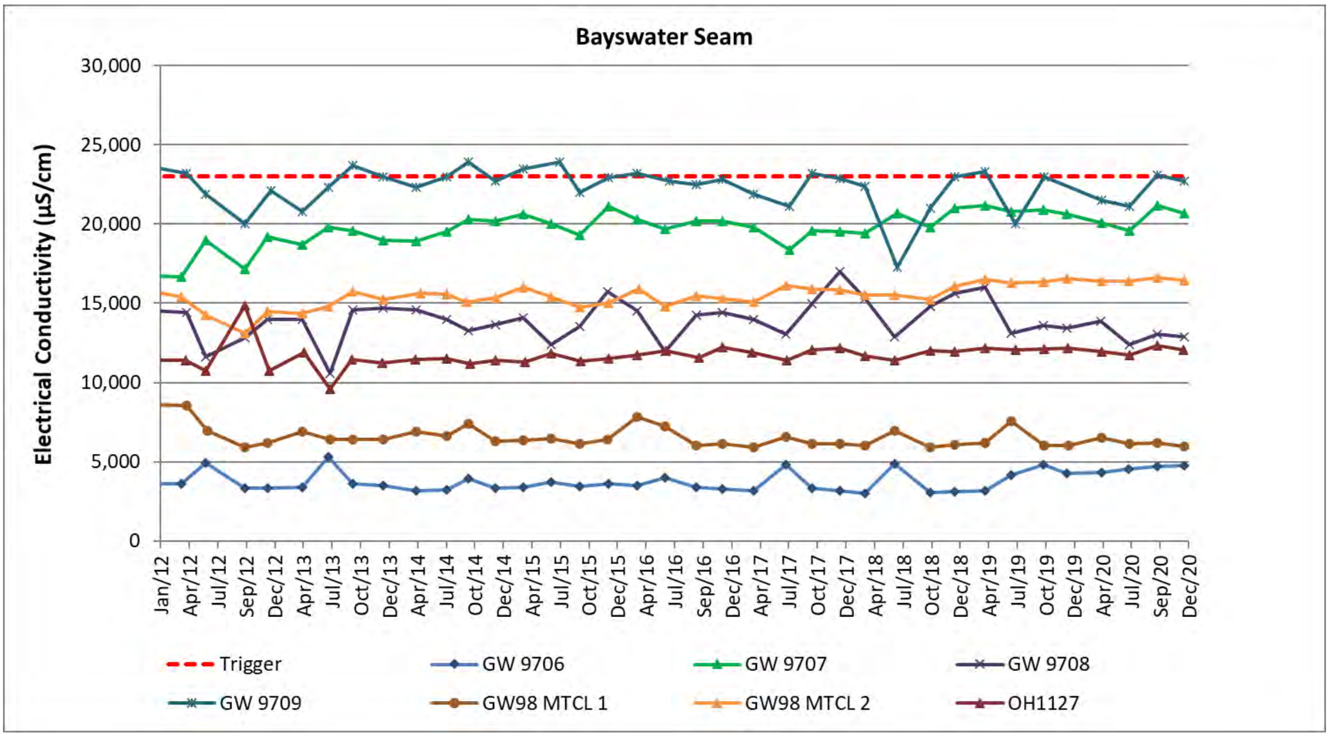

Bowfield Seam
pH
9.0
8.5
8.0
7.5
7.0
6.5
6.0
Jan/12
Apr/12
Jul/12
Sep/12
Dec/12
Apr/13
Jul/13
Oct/13
Dec/13
Apr/14
Jul/14
Oct/14
Dec/14
Apr/15
Jul/15
Oct/15
Dec/15
Apr/16
Jul/16
Sep/16
Dec/16
Apr/17
Jul/17
Oct/17
Dec/17
Apr/18
Jul/18
Oct/18
Dec/18
Apr/19
Jul/19
Oct/19
Dec/19
Trigger
OH1125 (2)
OH1125 (3)

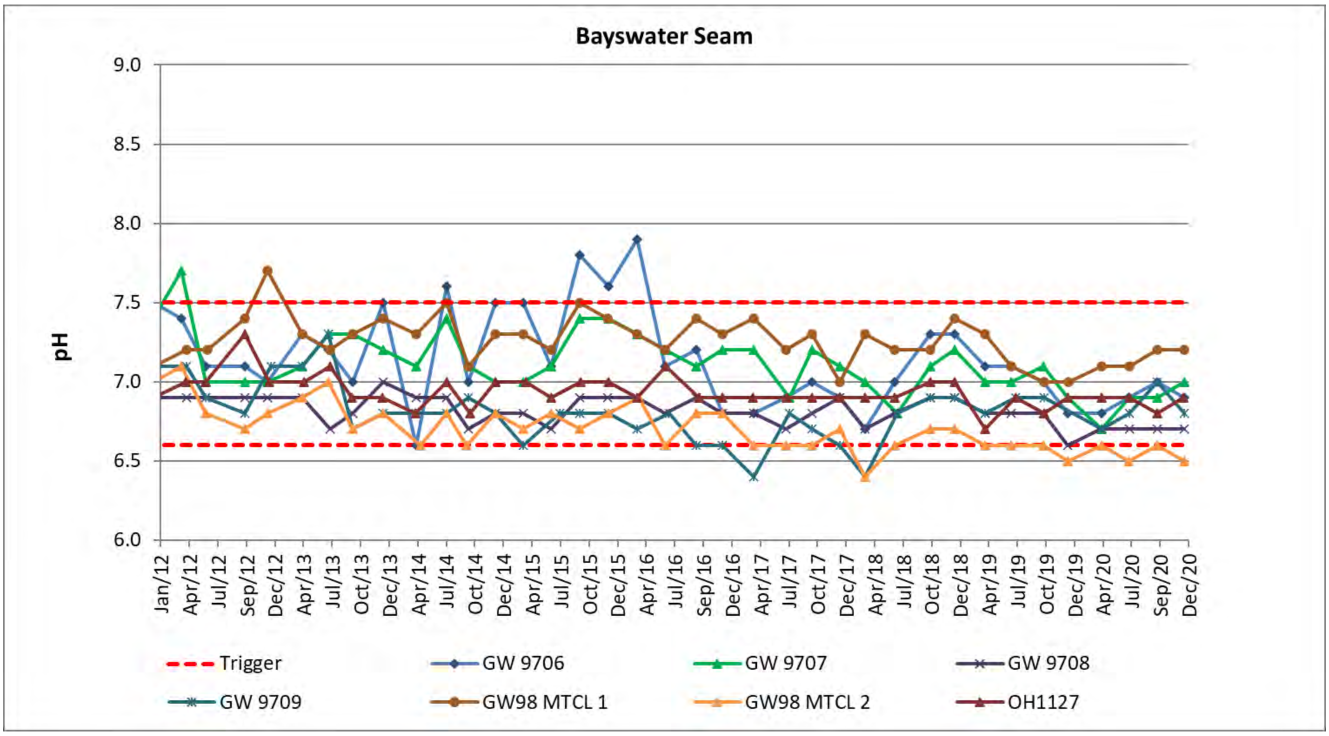

Warkworth Seam
Electrical Conductivity (µS/cm)
25,000
20,000
15,000
10,000
5,000
0
Jan/12
Apr/12
Jul/12
Sep/12
Dec/12
Apr/13
Jul/13
Oct/13
Dec/13
Apr/14
Jul/14
Oct/14
Dec/14
Apr/15
Jul/15
Oct/15
Dec/15
Apr/16
Jul/16
Sep/16
Dec/16
Apr/17
Jul/17
Oct/17
Dec/17
Apr/18
Jul/18
Oct/18
Dec/18
Apr/19
Jul/19
Oct/19
Dec/19
Apr/20
Jul/20
Sep/20
Dec/20
Trigger
OH1138 (1)
OH1138 (2)


Warkworth Seam
pH
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
Jan/12
Apr/12
Jul/12
Sep/12
Dec/12
Apr/13
Jul/13
Oct/13
Dec/13
Apr/14
Jul/14
Oct/14
Dec/14
Apr/15
Jul/15
Oct/15
Dec/15
Apr/16
Jul/16
Sep/16
Dec/16
Apr/17
Jul/17
Oct/17
Dec/17
Apr/18
Jul/18
Oct/18
Dec/18
Apr/19
Jul/19
Oct/19
Dec/19
Apr/20
Jul/20
Sep/20
Dec/20
Trigger
OH1138 (1)
OH1138 (2)


Vaux Seam
Electrical Conductivity (µS/cm)
20,000
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Jan/12
Apr/12
Jul/12
Sep/12
Dec/12
Apr/13
Jul/13
Oct/13
Dec/13
Apr/14
Jul/14
Oct/14
Dec/14
Apr/15
Jul/15
Oct/15
Dec/15
Apr/16
Jul/16
Sep/16
Dec/16
Apr/17
Jul/17
Oct/17
Dec/17
Apr/18
Jul/18
Oct/18
Dec/18
Apr/19
Jul/19
Oct/19
Dec/19
Apr/20
Jul/20
Sep/20
Dec/20
Trigger
OH1121
OH1126
OH1137


Vaux Seam
pH
9.0
8.5
8.0
7.5
7.0
6.5
6.0
Jan/12
Apr/12
Jul/12
Sep/12
Dec/12
Apr/13
Jul/13
Oct/13
Dec/13
Apr/14
Jul/14
Oct/14
Dec/14
Apr/15
Jul/15
Oct/15
Dec/15
Apr/16
Jul/16
Sep/16
Dec/16
Apr/17
Jul/17
Oct/17
Dec/17
Apr/18
Jul/18
Oct/18
Dec/18
Apr/19
Jul/19
Oct/19
Dec/19
Apr/20
Jul/20
Sep/20
Dec/20
Trigger
OH1121
OH1126
OH1137


Bayswater Seam
Electrical Conductivity (µS/cm)
30,000
25,000
20,000
15,000
10,000
5,000
0
Jan/12 Apr/12 Jul/12 Sep/12 Dec/12 Apr/13 Jul/13 Oct/13 Dec/13 Apr/14 Jul/14 Oct/14 Dec/14 Apr/15 Jul/15 Oct/15 Dec/15 Apr/16 Jul/16 Sep/16 Dec/16 Apr/17 Jul/17 Oct/17 Dec/17 Apr/18 Jul/18 Oct/18 Dec/18 Apr/19 Jul/19 Oct/19 Dec/19 Apr/20 Jul/20 Sep/20 Dec/20
Trigger
GW 9706
GW 9707
GW 9708
GW 9709
GW98 MTCL 1
GW98 MTCL 2
OH1127


Bayswater Seam
pH
9.0
8.5
8.0
7.5
7.0
6.5
6.0
Jan/12 Apr/12 Jul/12 Sep/12 Dec/12 Apr/13 Jul/13 Oct/13 Dec/13 Apr/14 Jul/14 Oct/14 Dec/14 Apr/15 Jul/15 Oct/15 Dec/15 Apr/16 Jul/16 Sep/16 Dec/16 Apr/17 Jul/17 Oct/17 Dec/17 Apr/18 Jul/18 Oct/18 Dec/18 Apr/19 Jul/19 Oct/19 Dec/19 Apr/20 Jul/20 Sep/20 Dec/20
Trigger
GW 9706
GW 9707
GW 9708
GW 9709
GW98 MTCL 1
GW98 MTCL 2
OH1127

APPENDIX D

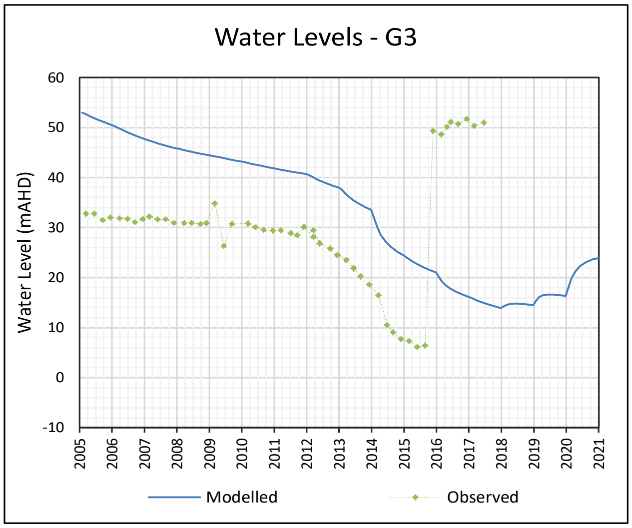
Full Water Quality Data 2020

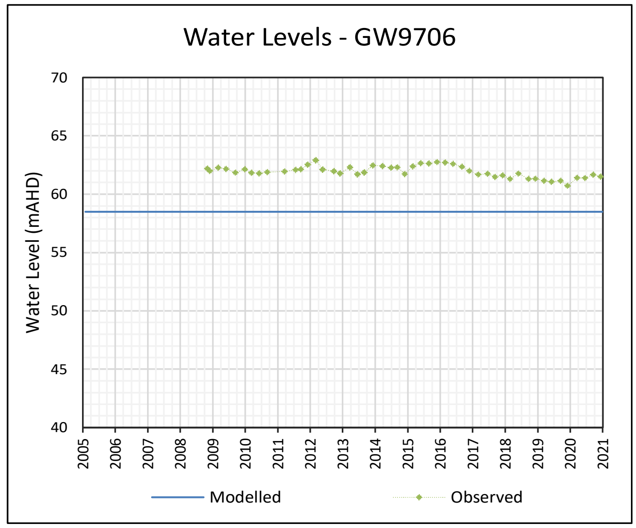
Station	Geology	Time	Date	SWL RL Calc	pH Field	EC Field (uS/cm (25TRef))	Water Temp (Deg C)	Comment	TDS - Total (mg/l)	Hydroxide Alkalinity as CaCO3	Carbonate Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO3	Total Alkalinity as CaCO3	Acidity as CaCO3	SO4 - Total (mg/l)	Cl- (mg/l)	Ca - Total (mg/l)
PZ7S	Aeolian Warkworth Sands	8:45	27-05-2020	50.35	6.7	1,491	20.8										
MB15MTW04	Warkworth Sands	12:15	29-05-2020	#N/A				Dry									
MB15MTW05	Warkworth Sands	12:00	29-05-2020	#N/A				Dry									
MB15MTW06	Warkworth Sands	11:45	29-05-2020	#N/A				Dry									
MB15MTW07	Warkworth Sands	13:00	29-05-2020	#N/A				Dry									
MB15MTW08	Warkworth Sands	13:40	29-05-2020	#N/A				Dry									
MB15MTW09	Warkworth Sands	0.58	43980.0	#N/A				Dry									
MB15MTW09	Warkworth Sands	0.52	44070.0	#N/A				Dry									
MB15MTW09	Warkworth Sands	0.55	44161.0	#N/A				Dry									
MB15MTW10	Warkworth Sands		43888.0	#N/A				No access - waiting on gate construction									
MB15MTW10	Warkworth Sands	0.55	43980.0	#N/A				Dry									
MB15MTW10	Warkworth Sands	0.51	44070.0	#N/A				Dry									
MB15MTW10	Warkworth Sands	0.53	44161.0	#N/A				Dry									
MB15MTW11	Warkworth Sands	0.37	43888.0	#N/A				Dry									
MB15MTW11	Warkworth Sands	0.52	43980.0	#N/A				Dry									
MB15MTW11	Warkworth Sands	0.49	44070.0	#N/A				Dry									
MB15MTW11	Warkworth Sands	0.55	44159.0	#N/A				Dry									
OH786	Regolith	9:25	26-05-2020	55.01													
OH786	Regolith	8:50	26-06-2020	53.50	8.0	892	19.1	g water level after high rainfall in Feb 20. Insufficent sample for lab analysis									
OH787	Regolith	8:40	26-06-2020	35.96	7.6	18,830	18.1		11600	<1	<1	1550	1550	34	356	6460	69
OH788	Hunter River Alluvium	13:25	24-06-2020	35.32	7.0	12,080	19.9	Suspended solids	7180	<1	<1	1480	1480		375	3980	99
OH943	Hunter River Alluvium	8:30	26-06-2020	35.35				Purged 27/03/2020. Insufficient water for sampling									
OH944	Hunter River Alluvium	13:30	22-06-2020	#N/A				Dry									
MB15MTW01S	Wollombi Brook Alluvium	12:05	25-05-2020	57.64	6.5	1,467	19.6										
MB15MTW02S	Wollombi Brook Alluvium	12:05	26-05-2020	56.56	6.9	2,200	20.7										
PZ8S	Wollombi Brook Alluvium	8:20	23-06-2020	59.37	6.6	14,940	19.7		8790	<1	<1	677	677		566	4920	126
PZ9S	Wollombi Brook Alluvium	10:45	23-06-2020	58.65				Insufficient Water									
MBW01	Alluvium	0.37	43887.0	56	7.3	17480	22.1										
MBW01	Alluvium	0.48	43978.0	56	7.3	17380	21.6										
MBW01	Alluvium	0.51	44064.0	56	7.3	17750	19.1		10700	<1	<1	1540	1540		472	5320	36
MB15MTW01D	Shallow Overburden? Alluvium?	13:45	27-05-2020	57.54	5.9	2,470	19.8	Purged 25/05/2020									
MB15MTW02D	Shallow Overburden? Alluvium?	14:25	29-05-2020	56.12	7.6	9,910	20.2	Purged 26/05/20									
MB15MTW03	Shallow Overburden - Wollombi alluvium?	9:15	28-05-2020	54.34	6.9	12,740	19.3										
MBW02	Shallow Overburden	12:45	27-05-2020	53.96	7.2	12,370	20.4										
MTD605P	Shallow Overburden - sandstone	13:10	25-05-2020	62.26	7.1	17,510	19.1										
MTD614P	Shallow Overburden - Conglomerate	11:10	23-06-2020	54.39	7.2	6,400	19.8		3800	<1	<1	1820	1820		113	1220	39
MTD616P	Shallow Overburden	9:40	26-05-2020	72.05	6.8	14,920	20.6										
PZ7D	Shallow Overburden	9:45	27-05-2020	50.67	7.6	1,752	21										
PZ8D	Shallow Overburden	8:50	23-06-2020	58.33	7.2	8,550	22.6		5000	<1	<1	1590	1590		<1	1710	32
PZ9D	Shallow Overburden	10:35	23-06-2020	47.05	7.0	10,190	18.5	Purged 22/06/2020	8010	<1	<1	1120	1120		442	3130	182
GW 9706	Bayswater	13:30	23-06-2020	61.39	6.9	4,510	19.0		2880	<1	<1	511	511		879	719	111
GW 9707	Bayswater	9:10	26-06-2020	57.73	6.9	19,600	18.9	Purged 22/06/2020	16200	<1	<1	887	887		5120	4940	461
GW 9708	Bayswater	8:15	24-06-2020	61.35	6.7	12,410	18.6	DTW Checked and EC checked	10600	<1	<1	738	738		5310	1620	537
GW 9709	Bayswater	9:40	26-06-2020	50.75	6.8	21,100	18.2	Purged 22/06/2020	17900	<1	<1	884	884		5680	5660	530
GW98 MTCL 1	Bayswater	0.388888889	26-06-2020	66.6	7.1	6120	18.3	Purged 22/06/2020	3940	<1	<1	936	936		832	1040	49
GW98 MTCL 2	Bayswater	11:55	23-06-2020	68.51	6.5	16,370	20.3		12400	<1	<1	654	654		4610	4090	637
OH1127	Vane Subgroup	10:10	24-06-2020	35.26	6.9	11,750	19.7		6710	<1	<1	2000	2000		<1	3550	151
OH1122 (1)	Blakefield Seam	8:40	25-06-2020	51.56	7.1	12,420	19.3		7340	<1	<1	1560	1560		547	3530	86
OH1125 (1)	Blakefield	10:10	25-06-2020	51.09	6.7	14,590	17.9		9280	<1	<1	978	978	90	694	4510	252
OH1125 (3)	Bowfield Seam	9:05	26-05-2020	39.11													
OH1125 (3)	Bowfield Seam	10:15	25-06-2020	32.41	6.7	14,100	17.7		9410	<1	<1	958	958	87	692	4480	260
WOH2139A	Blakefield	0.541666667	28-05-2020	34.82	7.9	8,210	22.1										
WOH2154A	Redbank Crk Seam	0.486111111	28-05-2020	51.09	7.6	4,800	20.6										
WOH2155A	Redbank Crk Seam	0.447916667	28-05-2020	51.19	7.3	8,910	20.2										
WOH2156A	Redbank Crk Seam	0.420138889	28-05-2020	48.12	7.1	14,800	22.1										
OH942	Regolith	11:50	24-06-2020	46.19	6.6	23,900	21		16200	<1	<1	728	728		1030	8350	176
OH1121	Vane Subgroup	10:50	24-06-2020	34.82	7.0	8,300	18.8		4860	<1	<1	694	694		227	2640	157
OH1126	Vaux	13:05	25-06-2020	45.71	6.6	15,100	20.2		9510	<1	<1	1110	1110	93	801	4690	154
OH1137	Vaux?	13:30	25-06-2020	#N/A				Dry									
MBW04	Wambo Seam	13:00	27-05-2020	49.28	7.6	12,920	23.3										
WD622P	Wambo Seam	0.5625	28-05-2020	49.15	7.4	8,500	21.2	Suspended solids									
WOH2154B	Wambo Seam	0.489583333	28-05-2020	55.14	7.4	8,690	19.3										
WOH2155B	Wambo Seam	0.659722222	28-05-2020	58.84	7.6	5,500	18.8										
WOH2156B	Wambo Seam	0.423611111	28-05-2020	67.62				Insufficient water									
OH1138 (1)	Warkworth Seam	9:50	29-05-2020	59.87	6.0	18,670	19.6										
OH1138 (1)	Warkworth Seam	12:05	25-06-2020	59.91	6.0	18,990	16.8		12700	<1	<1	238	238		425	7070	162
OH1138 (2)	Warkworth Seam	10:40	29-05-2020	55.42	6.6	12,910	19.1										
OH1138 (2)	Warkworth Seam	12:35	25-06-2020	55.41	6.6	13,460	18.2		9170	<1	<1	772	772		608	4490	517
MBW03	Whybrow Seam	12:35	27-05-2020	54.13	7.2	10,550	21.3	Gas Bubbles									
WD625P	Whybrow Seam	0.475694444	28-05-2020	57.47	7.2	12,020	19.3	Purged 26/05/2020									
WOH2141A	Whynot Seam	0.517361111	29-05-2020	46.88	7.8	10,580	22	Suspended solids									
MBW6A	0	13:10	26-05-2020	#N/A	6.5	684	21.2										

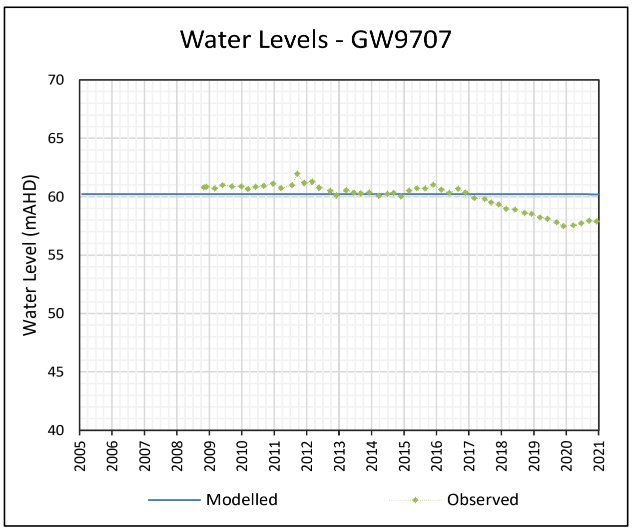
Station	Geology	Time	Date	Mg - Total (mg/l)	Na - Total (mg/l)	K - Total (mg/l)	Al - Total (mg/l)	As - Total (mg/l)	Cd - Total (mg/l)	Cu - Total (mg/l)	Pb - Total (mg/l)	Ni - Total (mg/l)	Se (mg/l)	Zn - Total (mg/l)	B (mg/l)	Hg - Total (mg/l)	Mo (mg/l)	V (mg/l)	Cr (mg/l)	F (mg/l)	Nitrogen Ammonia (mg/l)	Nitrite (mg/l)
PZ7S	Redbank Crk Seam	8:45	27-05-2020																			
MB15MTW04	Warkworth Seam	12:15	29-05-2020																			
MB15MTW05	Whynot Seam	12:00	29-05-2020																			
MB15MTW06	Hunter River Alluvium	11:45	29-05-2020																			
MB15MTW07	Bayswater	13:00	29-05-2020																			
MB15MTW08	Bayswater	13:40	29-05-2020																			
MB15MTW09	Shallow Overburden - Conglomerate	0.58	43980.0																			
MB15MTW09	Shallow Overburden - Conglomerate	0.52	44070.0																			
MB15MTW09	Redbank Crk Seam	0.55	44161.0																			
MB15MTW10	Bowfield Seam		43888.0																			
MB15MTW10	Shallow Overburden	0.55	43980.0																			
MB15MTW10	Vane Subgroup	0.51	44070.0																			
MB15MTW10	Regolith	0.53	44161.0																			
MB15MTW11	Warkworth Seam	0.37	43888.0																			
MB15MTW11	Wollombi Brook Alluvium	0.52	43980.0																			
MB15MTW11	Vane Subgroup	0.49	44070.0																			
MB15MTW11	00-01-1900	0.55	44159.0																			
OH786	Wambo Seam	9:25	26-05-2020																			
OH786	Warkworth Seam	8:50	26-06-2020																			
OH787	Regolith	8:40	26-06-2020	271	3890	53	0.44	0.002	<0.0001	0.004	0.002	0.006	<0.01	0.044	0.11	<0.0001	<0.001	0.01				
OH788	Bayswater	13:25	24-06-2020	280	2700	45	0.06	0.002	<0.0001	<0.001	<0.001	0.001	<0.01	<0.005	0.09	<0.0001						
OH943	Alluvium	8:30	26-06-2020																			
OH944	Vane Subgroup	13:30	22-06-2020																			
MB15MTW01S	Shallow Overburden	12:05	25-05-2020																			
MB15MTW02S	Wambo Seam	12:05	26-05-2020																			
PZ8S	Blakefield	8:20	23-06-2020	320	2930	12	0.1	0.001	<0.0001	0.01	<0.001	0.004	<0.01	<0.005	<0.05	<0.0001						
PZ9S	Vaux	10:45	23-06-2020																			
MBW01	Warkworth Sands	0.37	43887.0																			
MBW01	Blakefield	0.48	43978.0																			
MBW01	Wambo Seam	0.51	44064.0	196	3830	42	1.32	<0.001	<0.0001	<0.001	<0.001	0.011	<0.01	<0.005	0.08	<0.0001						
MB15MTW01D	Whybrow Seam	13:45	27-05-2020																			
MB15MTW02D	Warkworth Seam	14:25	29-05-2020																			
MB15MTW03	Wambo Seam	9:15	28-05-2020																			
MBW02	Redbank Crk Seam	12:45	27-05-2020																			
MTD605P	Whybrow Seam	13:10	25-05-2020																			
MTD614P	Regolith	11:10	23-06-2020	134	1320	19	0.77	0.005	<0.0001	0.027	0.006	0.007	<0.01	0.085	0.14	<0.0001						
MTD616P	Aeolian Warkworth Sands	9:40	26-05-2020																			
PZ7D	Wambo Seam	9:45	27-05-2020																			
PZ8D	Blakefield Seam	8:50	23-06-2020	42	2120	11	0.11	0.01	<0.0001	0.007	<0.001	0.152	<0.01	<0.005	0.24	<0.0001						
PZ9D	Bowfield Seam	10:35	23-06-2020	314	1830	27	1.69	0.024	<0.0001	0.191	0.022	0.044	<0.01	0.347	0.09	<0.0001						
GW 9706	Vane Subgroup	13:30	23-06-2020	98	880	12	<0.01	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.01	<0.005	0.14	<0.0001						
GW 9707	Regolith	9:10	26-06-2020	722	3740	37	0.2	0.001	0.0002	0.005	0.002	0.009	<0.01	0.051	0.42	<0.0001						
GW 9708	Vaux?	8:15	24-06-2020	501	2400	39	0.02	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.01	<0.005	0.27	<0.0001						
GW 9709	Bowfield Seam	9:40	26-06-2020	810	4150	40	1.26	0.002	<0.0001	0.004	0.004	0.012	<0.01	0.022	0.32	<0.0001						
GW98 MTCL 1	Warkworth Seam	0.388888889	26-06-2020	87	1220	25	0.23	<0.001	0.0002	0.003	0.001	0.002	0.02	0.031	0.16	<0.0001						
GW98 MTCL 2	Hunter River Alluvium	11:55	23-06-2020	588	2900	65	0.06	<0.001	<0.0001	<0.001	<0.001	0.002	<0.01	0.006	0.22	<0.0001						
OH1127	Warkworth Seam	10:10	24-06-2020	148	2630	18	0.02	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.01	<0.005	0.15	<0.0001						
OH1122 (1)	Bayswater	8:40	25-06-2020	349	2190	54	1.43	0.002	<0.0001	0.007	0.009	0.005	<0.01	0.171	0.14	<0.0001	<0.001	<0.01				
OH1125 (1)	Regolith	10:10	25-06-2020	556	1990	40	0.32	0.002	<0.0001	0.004	0.002	0.01	<0.01	0.041	0.08	<0.0001	<0.001	<0.01				
OH1125 (3)	Shallow Overburden - Wollombi alluvium?	9:05	26-05-2020																			
OH1125 (3)	Regolith	10:15	25-06-2020	560	1970	40	3.3	0.004	<0.0001	0.016	0.015	0.01	<0.01	0.291	0.08	<0.0001	<0.001	0.02				
WDH2139A	Warkworth Sands	0.541666667	28-05-2020																			
WDH2154A	Warkworth Sands	0.496111111	28-05-2020																			
WDH2155A	Warkworth Sands	0.447916667	28-05-2020																			
WDH2156A	Warkworth Sands	0.420138889	28-05-2020																			
OH942	Bayswater	11:50	24-06-2020	811	4890	42	5.1	0.001	<0.0001	0.004	0.001	0.007	<0.01	0.007	0.09	0.0005	<0.001	0.01				
OH1121	Warkworth Seam	10:50	24-06-2020	174	1580	13	0.02	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.01	<0.005	0.11	<0.0001						
OH1126	Hunter River Alluvium	13:05	25-06-2020	376	2680	61	11.1	0.009	0.0003	0.041	0.052	0.026	<0.01	1.2	0.09	<0.0001						
OH1137	Bowfield Seam	13:30	25-06-2020																			
MBW04	Redbank Crk Seam	13:00	27-05-2020																			
WD622P	Shallow Overburden? Alluvium?	0.5625	28-05-2020																			
WDH2154B	Warkworth Sands	0.489583333	28-05-2020																			
WDH2155B	Warkworth Sands	0.659722222	28-05-2020																			
WDH2156B	Warkworth Sands	0.423611111	28-05-2020																			
OH1138 (1)	Shallow Overburden	9:50	29-05-2020																			
OH1138 (1)	Warkworth Seam	12:05	25-06-2020	802	2780	115	4.19	0.004	0.0009	0.006	0.008	0.024	<0.01	0.04	<0.05	0.0011						
OH1138 (2)	Wollombi Brook Alluvium	10:40	29-05-2020																			
OH1138 (2)	Warkworth Seam	12:35	25-06-2020	461	1730	34	1.29	0.003	<0.0001	0.015	0.009	0.004	<0.01	0.011	<0.05	<0.0001						
MBW03	Wambo Seam	12:35	27-05-2020																			
WD625P	Warkworth Sands	0.475694444	28-05-2020																			
WDH2141A	Bayswater	0.517361111	29-05-2020																			
MBW6A	Shallow Overburden	13:10	26-05-2020																			

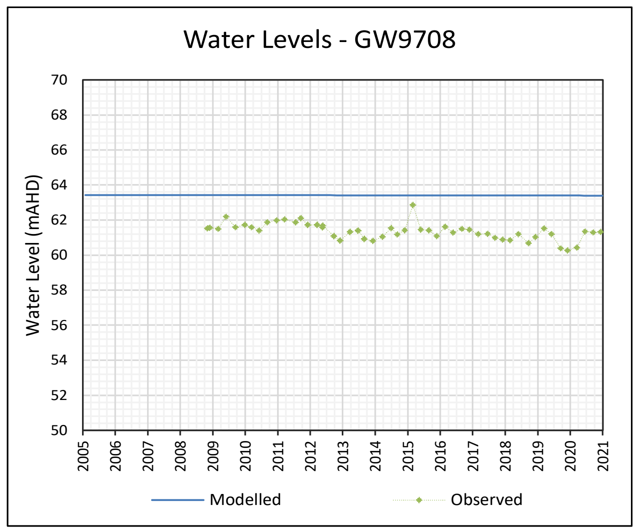
APPENDIX E

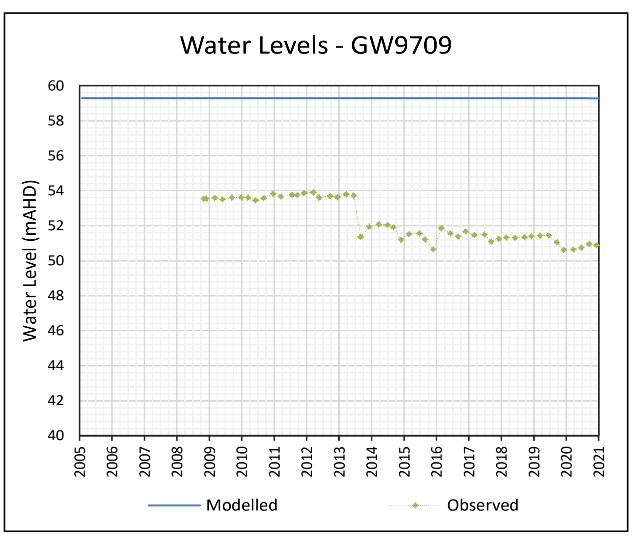
Model Verification Hydrographs

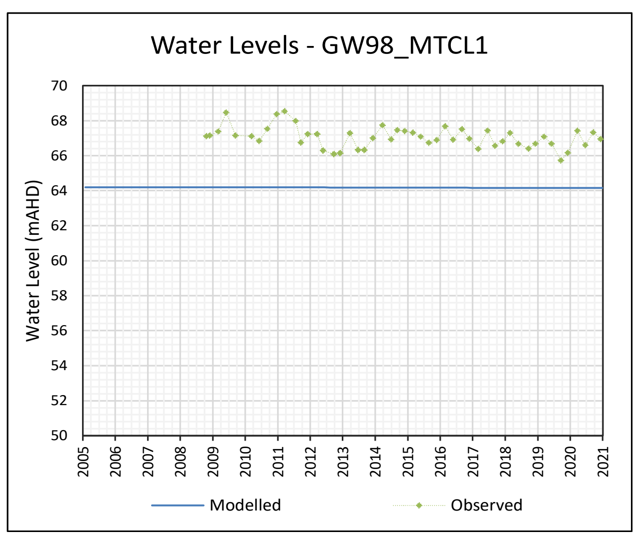

Water Levels - G3
60
50
40
30
20
10
0
-10
Water Level (mAHD)
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Modelled
Observed

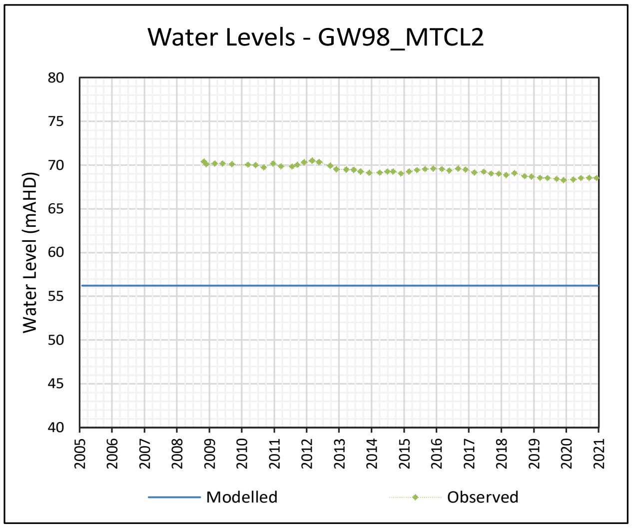

Water Levels - GW9706
70
65
60
55
50
45
40
Water Level (mAHD)
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Modelled
Observed

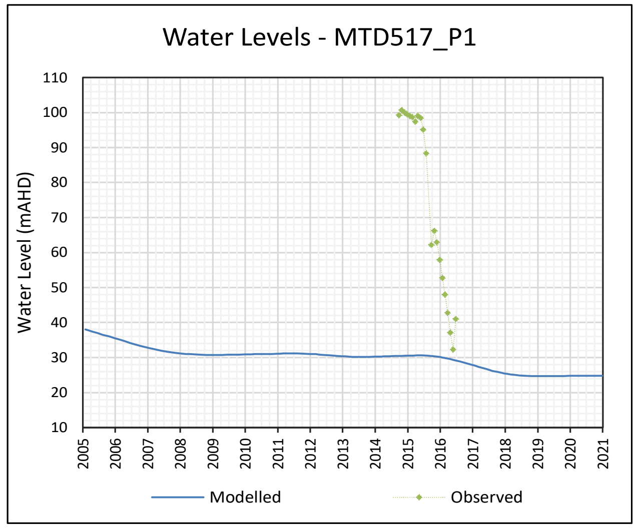

Water Levels - GW9707
70
65
60
55
50
45
40
Water Level (mAHD)
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Modelled
Observed

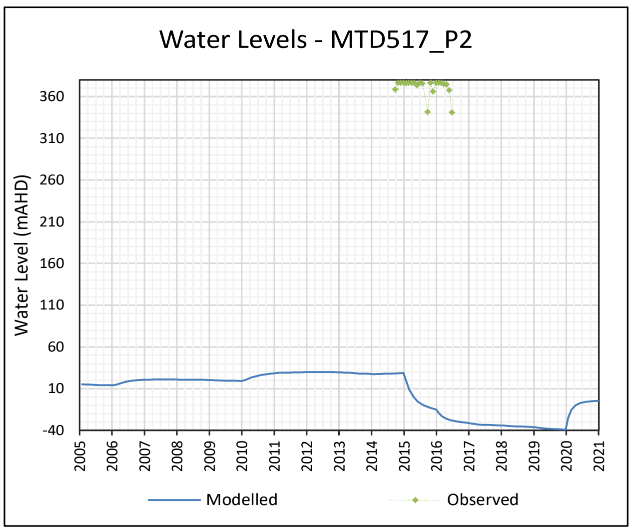

Water Levels - GW9708
70
68
66
64
62
60
58
56
54
52
50
Water Level (mAHD)
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Modelled
Observed

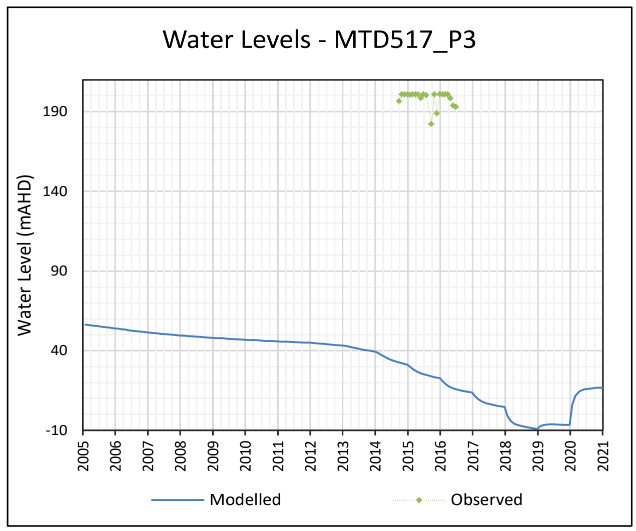

Water Levels - GW9709
60
58
56
54
52
50
48
46
44
42
40
Water Level (mAHD)
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Modelled
Observed

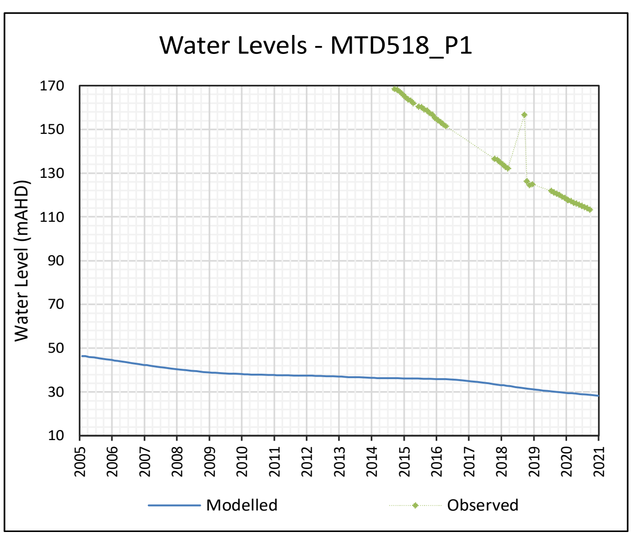

Water Levels - GW98_MTCL1
70
68
66
64
62
60
58
56
54
52
50
Water Level (mAHD)
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Modelled
Observed

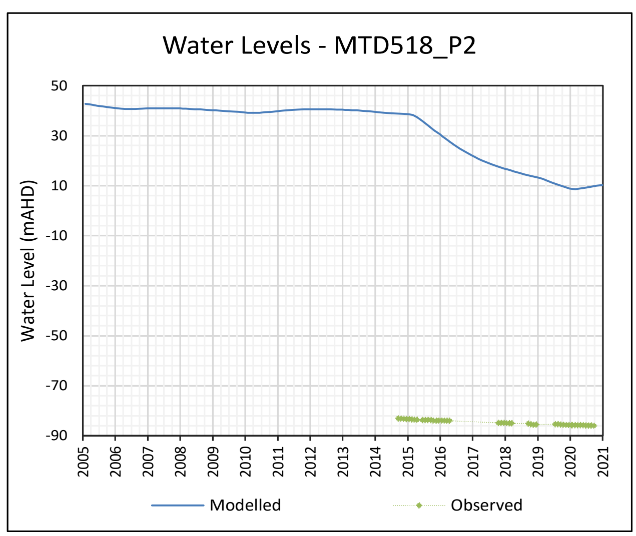

Water Levels - GW98_MTCL2
Water Level (mAHD)
80
75
70
65
60
55
50
45
40
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Modelled
Observed

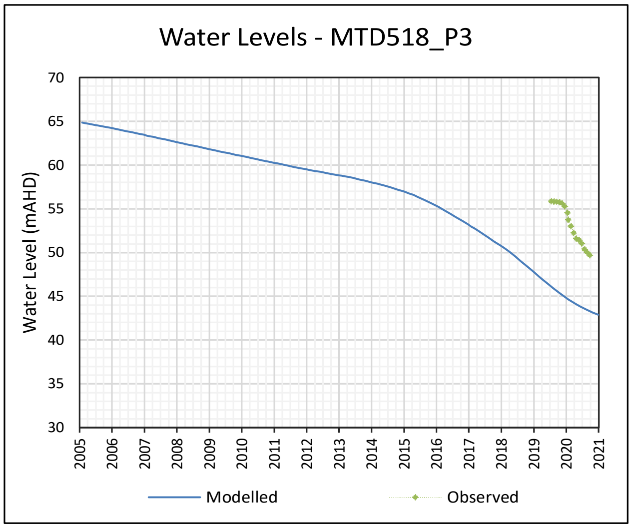

Water Levels - MTD517_P1
Water Level (mAHD)
110
100
90
80
70
60
50
40
30
20
10
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Modelled
Observed

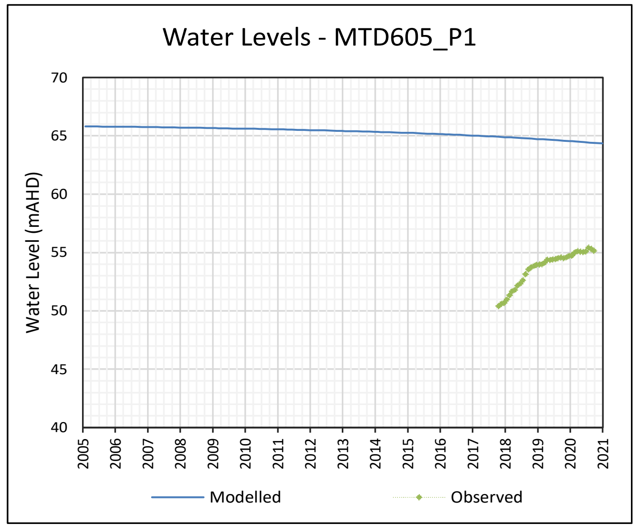

Water Levels - MTD517_P2
Water Level (mAHD)
360
310
260
210
160
110
60
10
-40
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Modelled
Observed

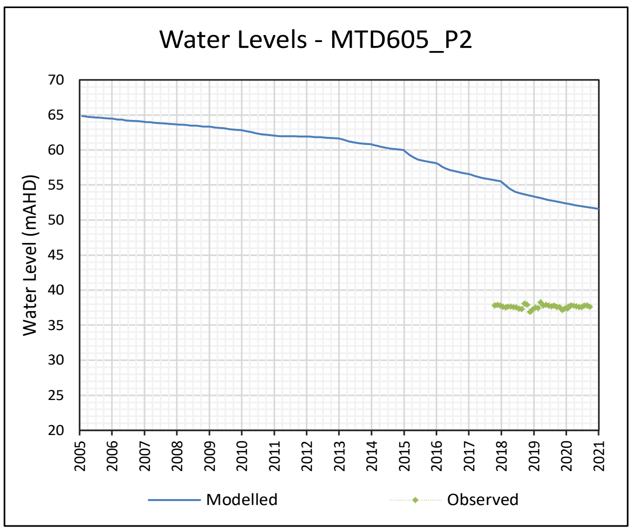

Water Levels - MTD517_P3
Water Level (mAHD)
190
140
90
40
-10
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Modelled
Observed

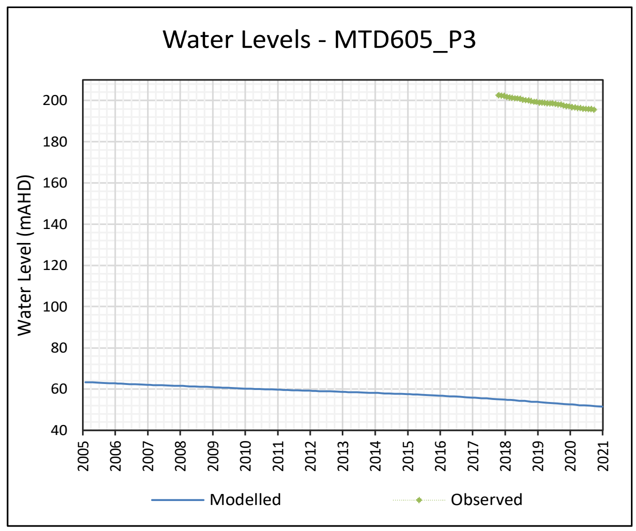

Water Levels - MTD518_P1
Water Level (mAHD)
170
150
130
110
90
70
50
30
10
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Modelled
Observed

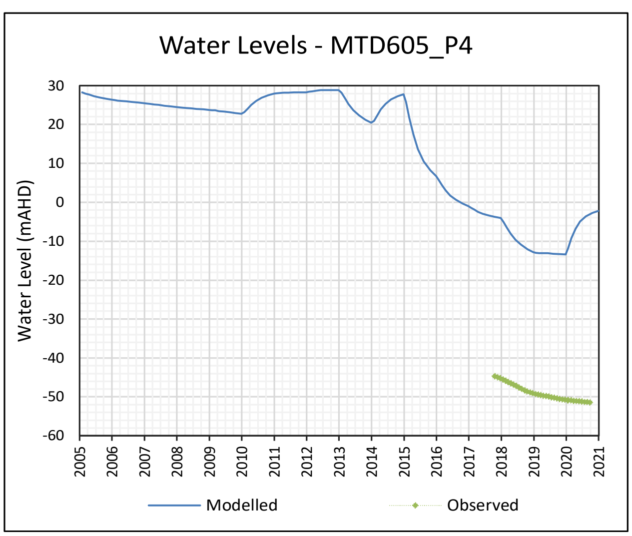

Water Levels - MTD518_P2
Water Level (mAHD)
50
30
10
-10
-30
-50
-70
-90
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Modelled
Observed

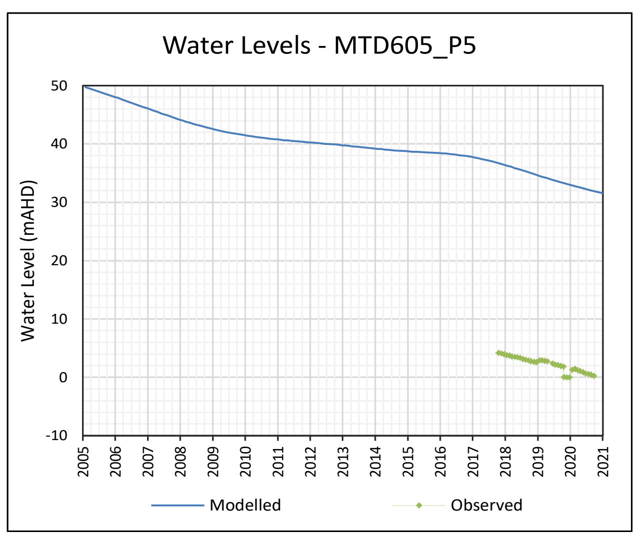

Water Levels - MTD518_P3
Water Level (mAHD)
Modelled
Observed

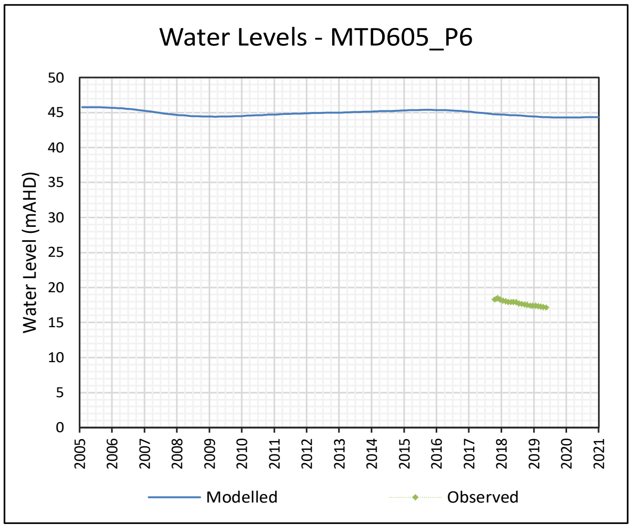

Water Levels - MTD605_P1
Water Level (mAHD)
Modelled
Observed

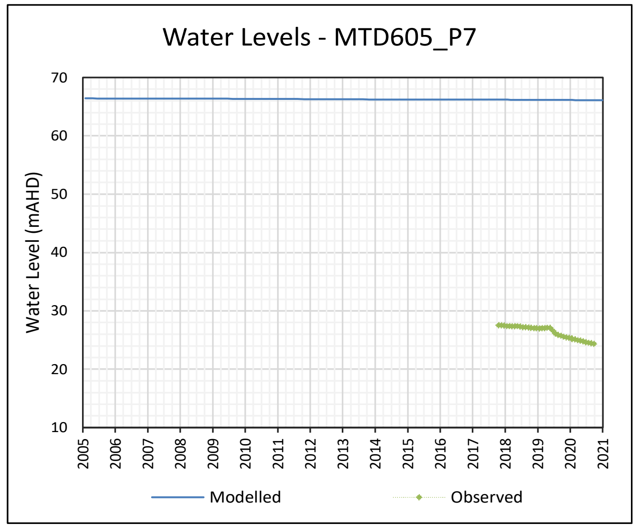

Water Levels - MTD605_P2
Water Level (mAHD)
Modelled
Observed

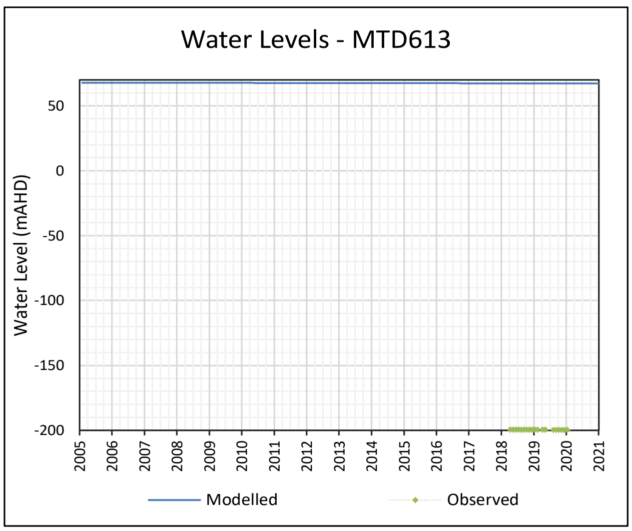

Water Levels - MTD605_P3
Water Level (mAHD)
Modelled
Observed

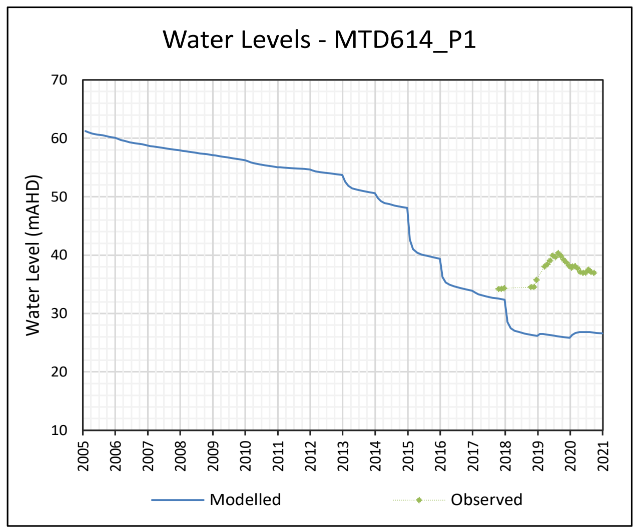

Water Levels - MTD605_P4
Water Level (mAHD)
Modelled
Observed

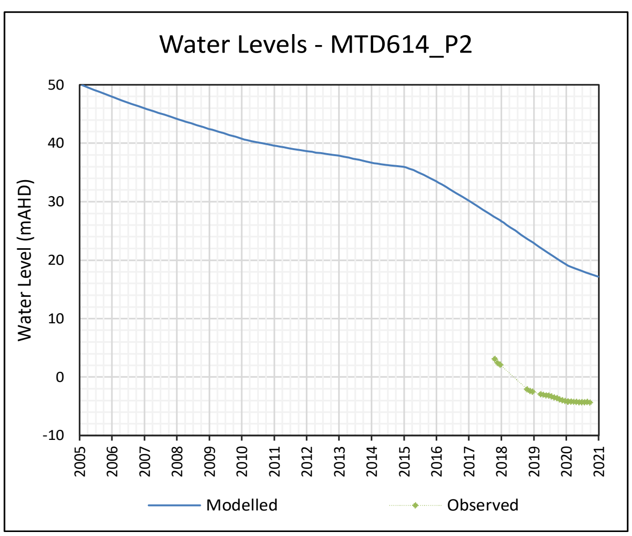

Water Levels - MTD605_P5
Water Level (mAHD)
Modelled
Observed

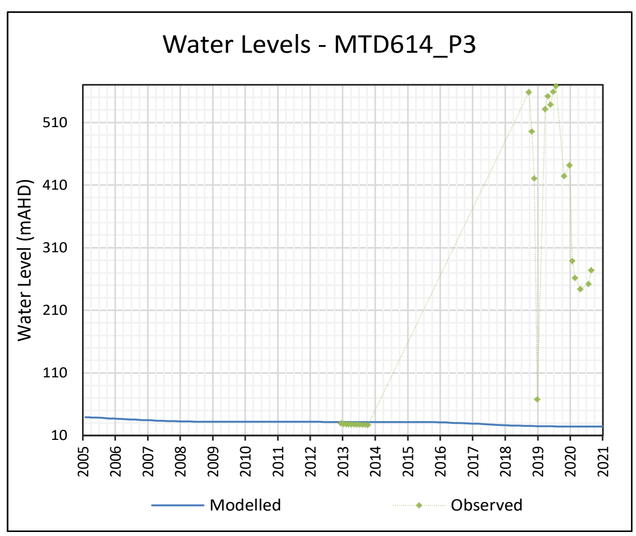

Water Levels - MTD605_P6
Water Level (mAHD)
Modelled
Observed

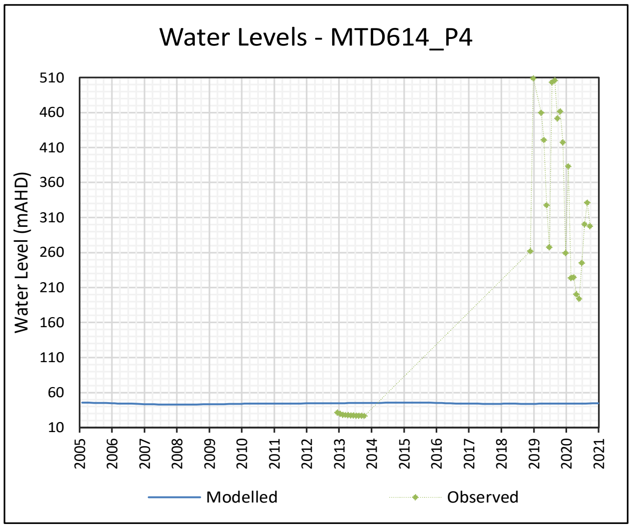

Water Levels - MTD605_P7
Water Level (mAHD)
Modelled
Observed

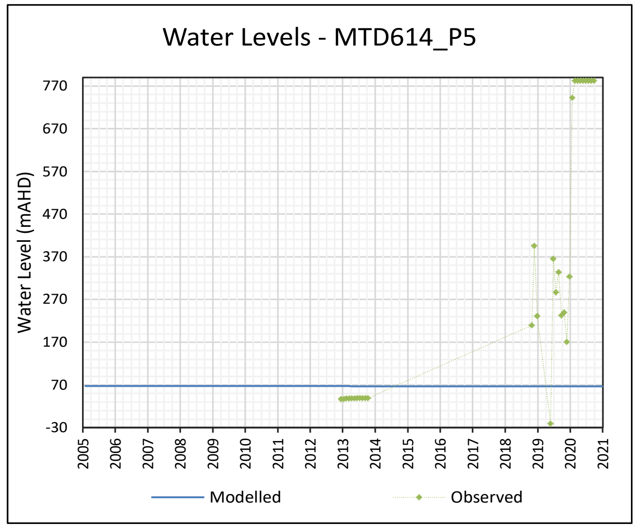

Water Levels - MTD613
Water Level (mAHD)
Modelled
Observed

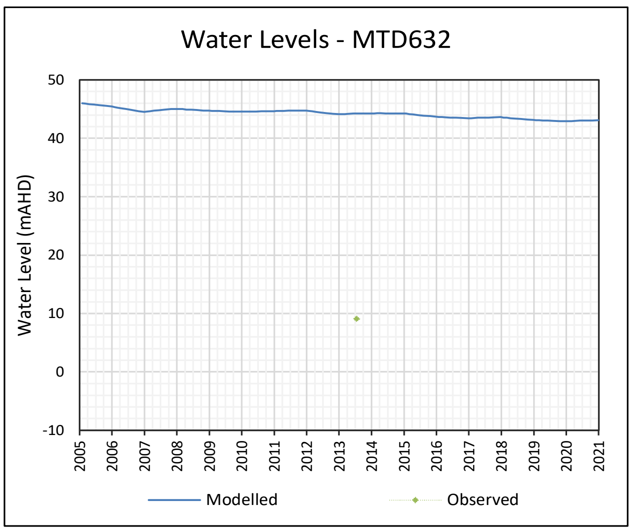

Water Levels - MTD614_P1
Water Level (mAHD)
Modelled
Observed

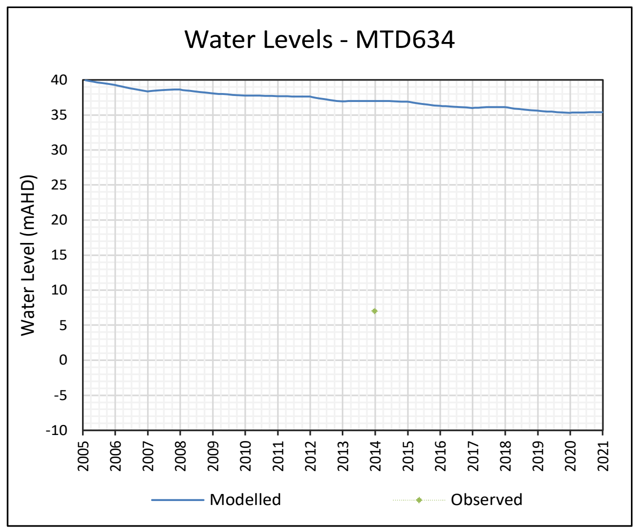

Water Levels - MTD614_P2
Water Level (mAHD)
Modelled
Observed

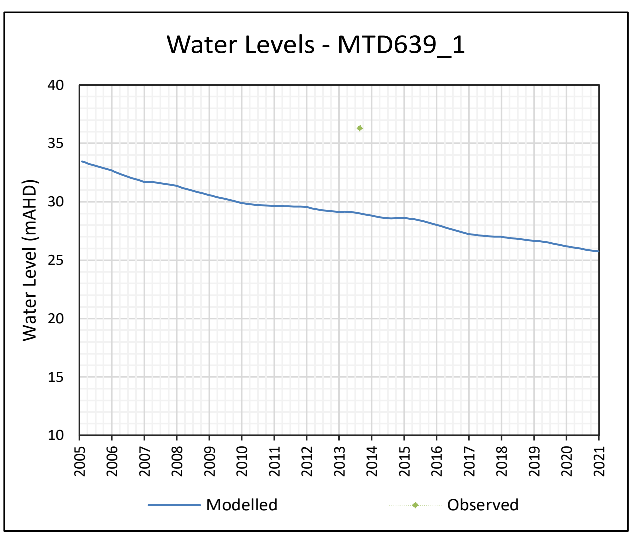

Water Levels - MTD614_P3
Water Level (mAHD)
Modelled
Observed

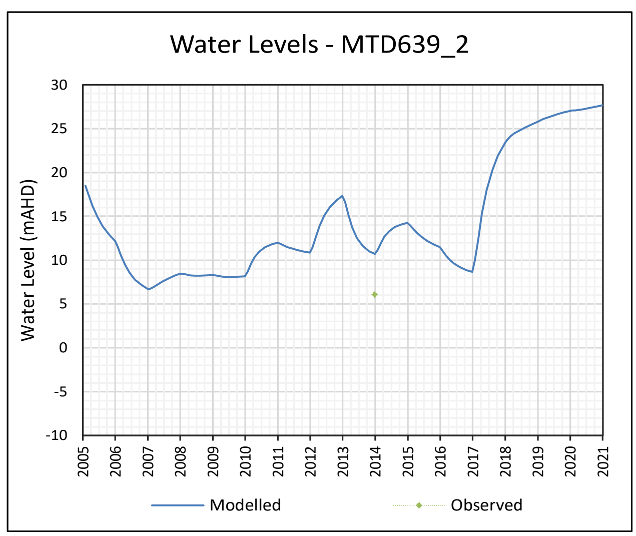

Water Levels - MTD614_P4
Water Level (mAHD)
510
460
410
360
310
260
210
160
110
60
10
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Modelled
Observed

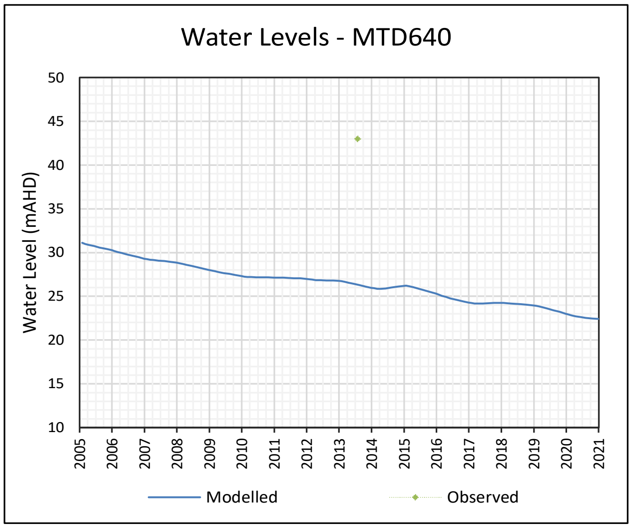

Water Levels - MTD614_P5
Water Level (mAHD)
770
670
570
470
370
270
170
70
-30
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Modelled
Observed

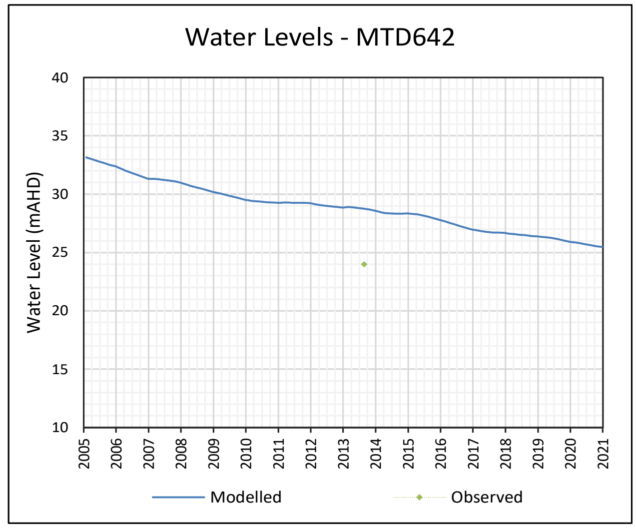

Water Levels - MTD632
Water Level (mAHD)
50
40
30
20
10
0
-10
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Modelled
Observed

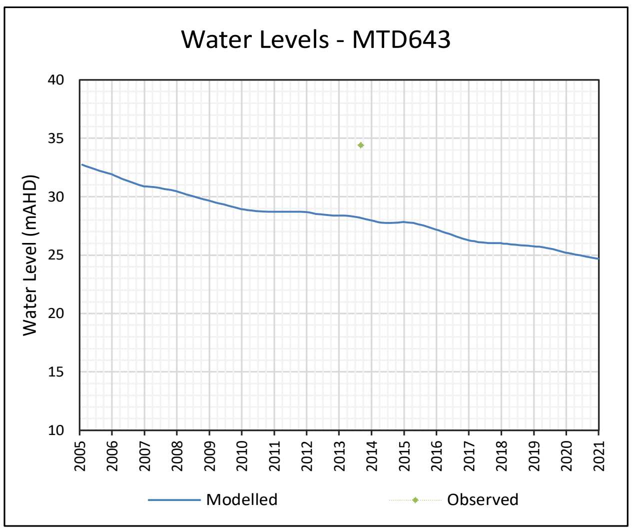

Water Levels - MTD634
Water Level (mAHD)
40
35
30
25
20
15
10
5
0
-5
-10
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Modelled
Observed

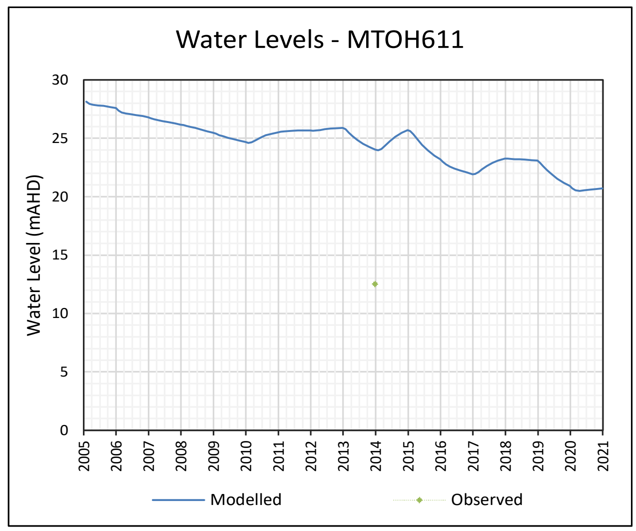

Water Levels - MTD639_1
Water Level (mAHD)
40
35
30
25
20
15
10
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Modelled
Observed

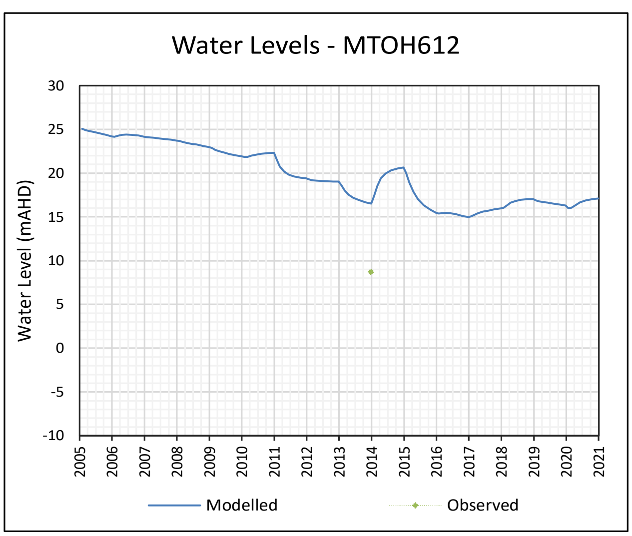

Water Levels - MTD639_2
Water Level (mAHD)
30
25
20
15
10
5
0
-5
-10
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Modelled
Observed

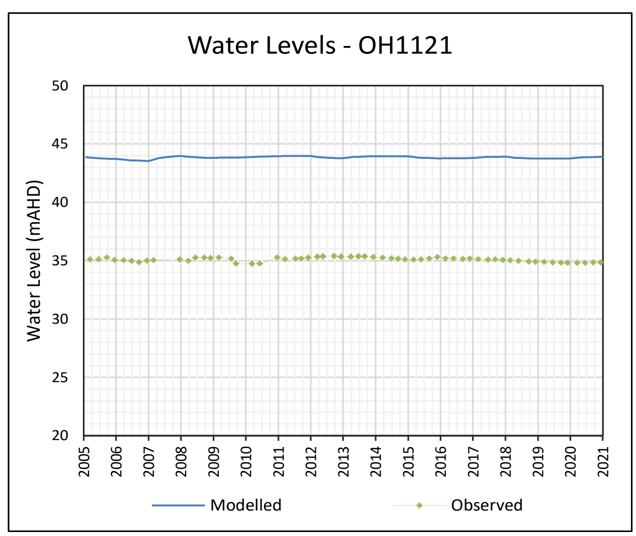

Water Levels - MTD640
Water Level (mAHD)
50
45
40
35
30
25
20
15
10
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Modelled
Observed

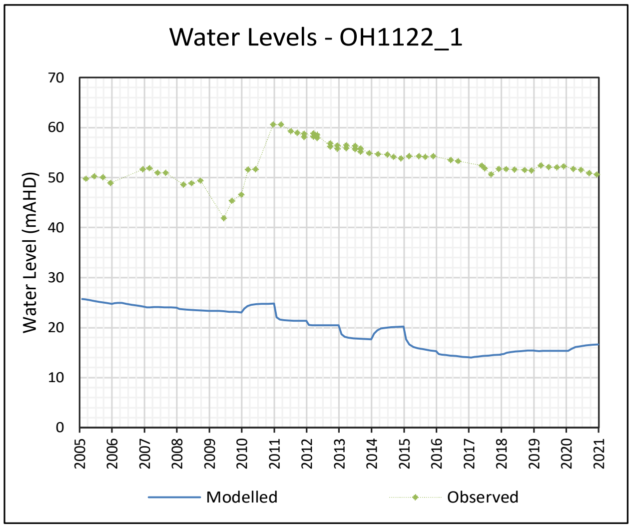

Water Levels - MTD642
Water Level (mAHD)
40
35
30
25
20
15
10
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Modelled
Observed

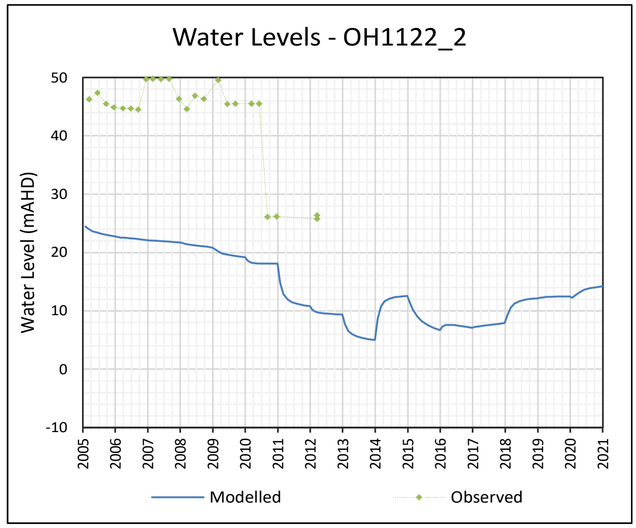

Water Levels - MTD643
Water Level (mAHD)
40
35
30
25
20
15
10
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Modelled
Observed

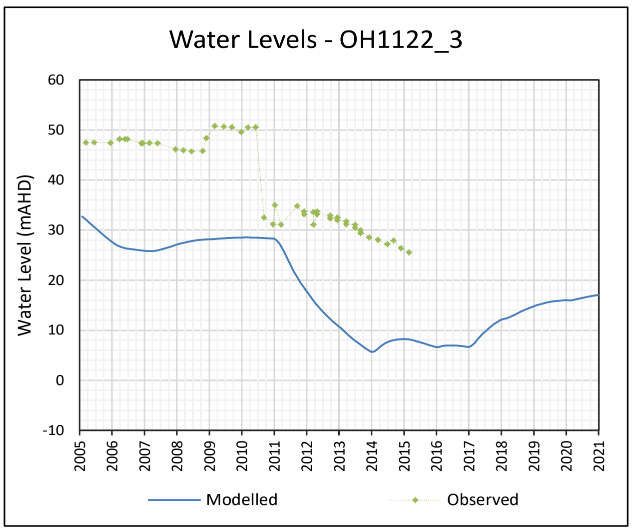

Water Levels - MTOH611
Water Level (mAHD)
30
25
20
15
10
5
0
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Modelled
Observed

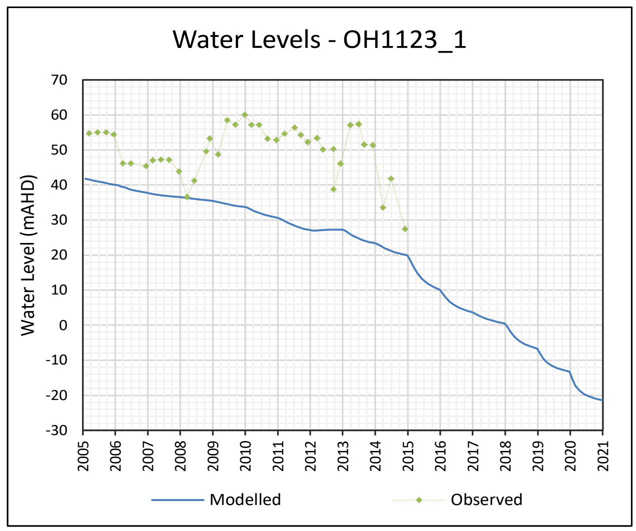

Water Levels - MTOH612
Water Level (mAHD)
30
25
20
15
10
5
0
-5
-10
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Modelled
Observed

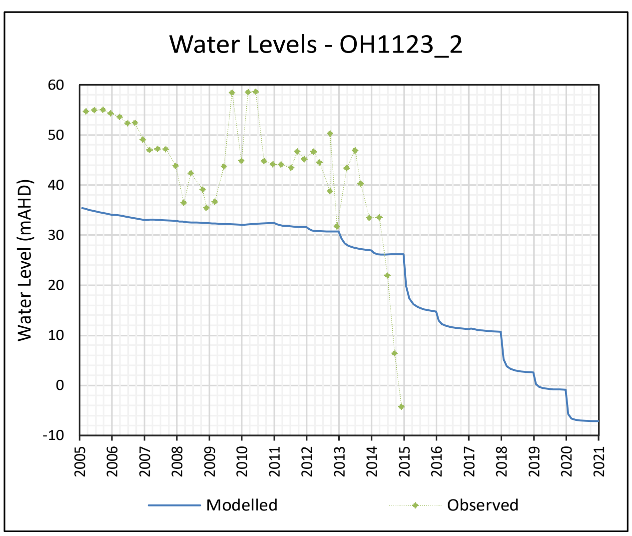

Water Levels - OH1121
Water Level (mAHD)
50
45
40
35
30
25
20
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Modelled
Observed

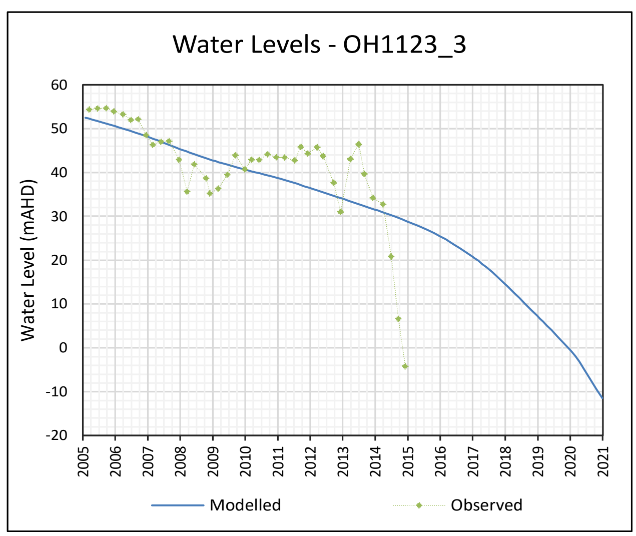

Water Levels - OH1122_1
Water Level (mAHD)
Modelled
Observed

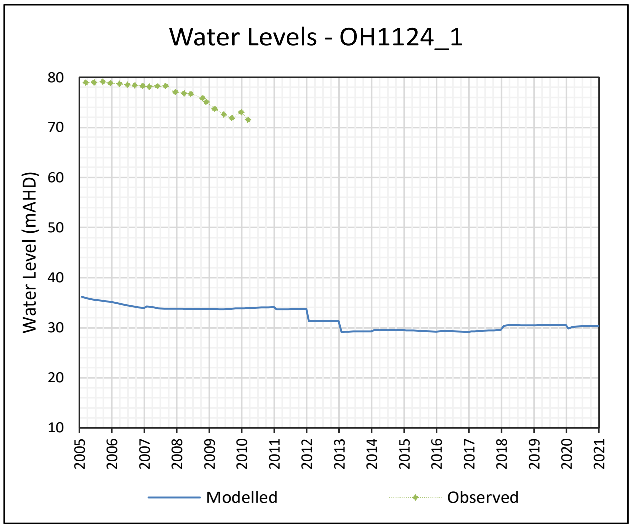

Water Levels - OH1122_2
Water Level (mAHD)
Modelled
Observed

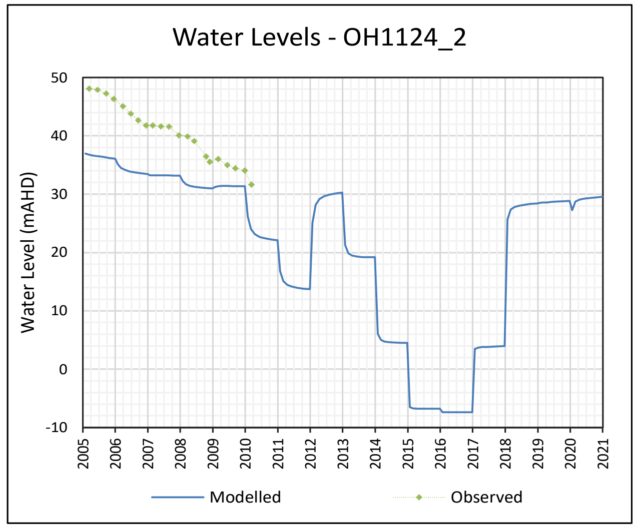

Water Levels - OH1122_3
Water Level (mAHD)
Modelled
Observed

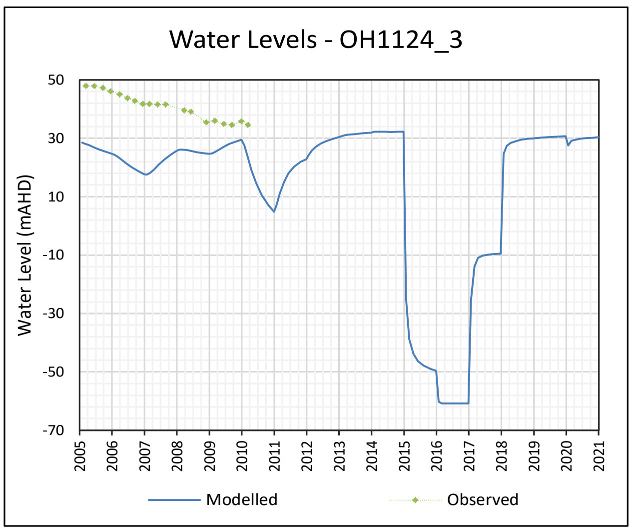

Water Levels - OH1123_1
Water Level (mAHD)
Modelled
Observed

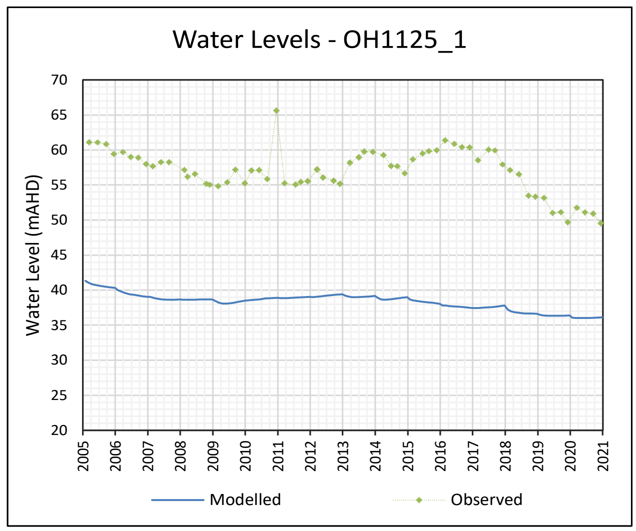

Water Levels - OH1123_2
Water Level (mAHD)
Modelled
Observed

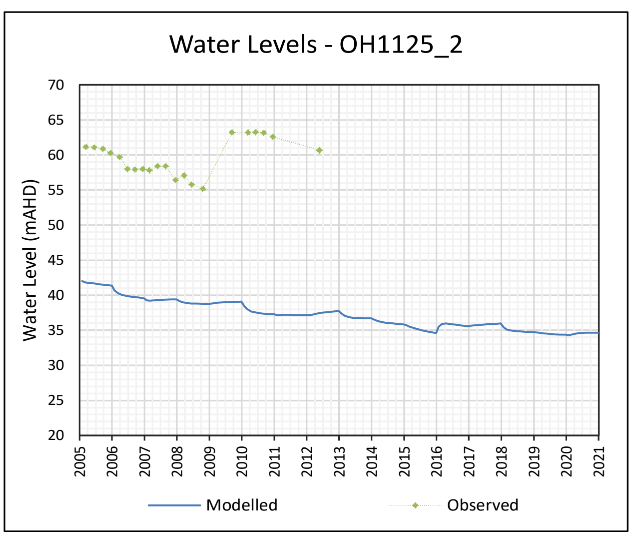

Water Levels - OH1123_3
Water Level (mAHD)
Modelled
Observed

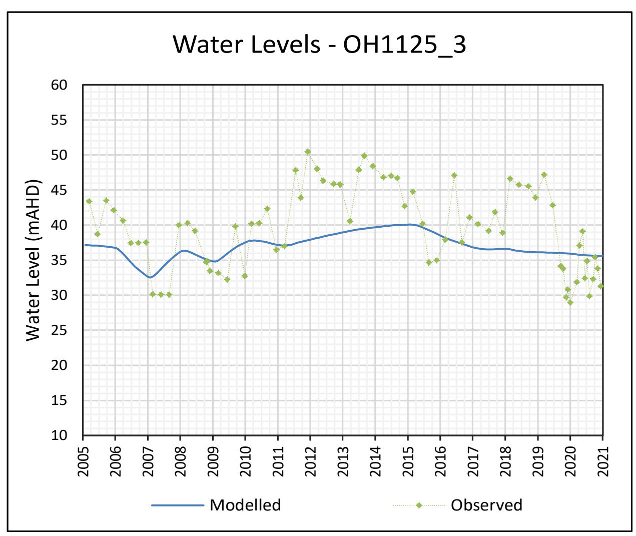

Water Levels - OH1124_1
Water Level (mAHD)
Modelled
Observed

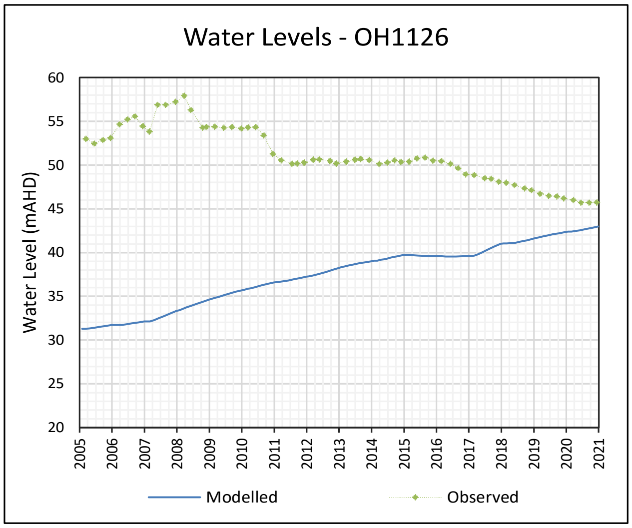

Water Levels - OH1124_2
Water Level (mAHD)
Modelled
Observed

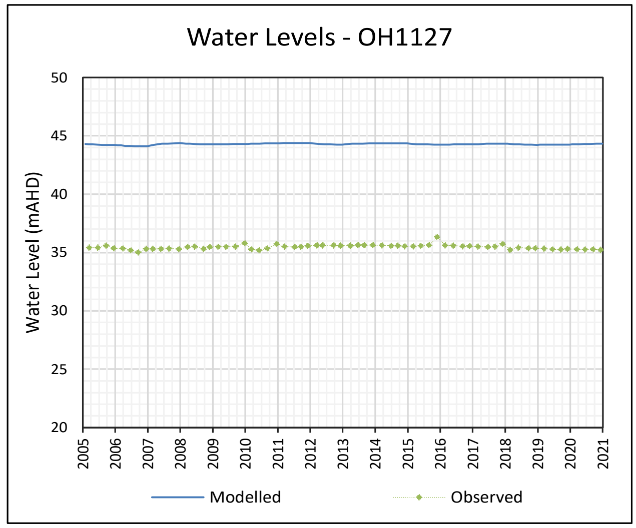

Water Levels - OH1124_3
Water Level (mAHD)
Modelled
Observed

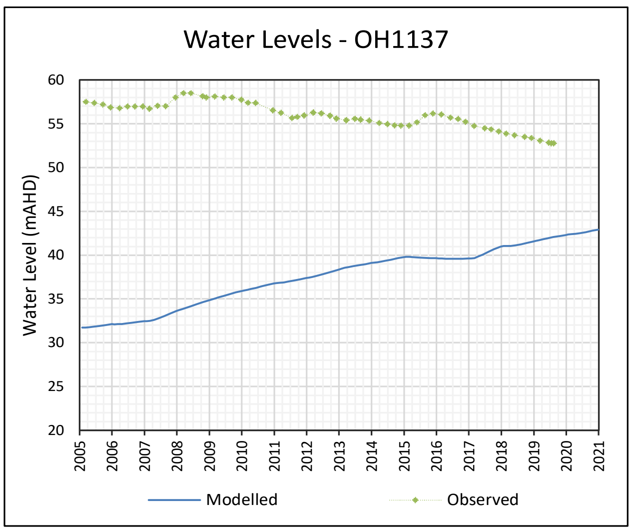

Water Levels - OH1125_1
Water Level (mAHD)
Modelled
Observed

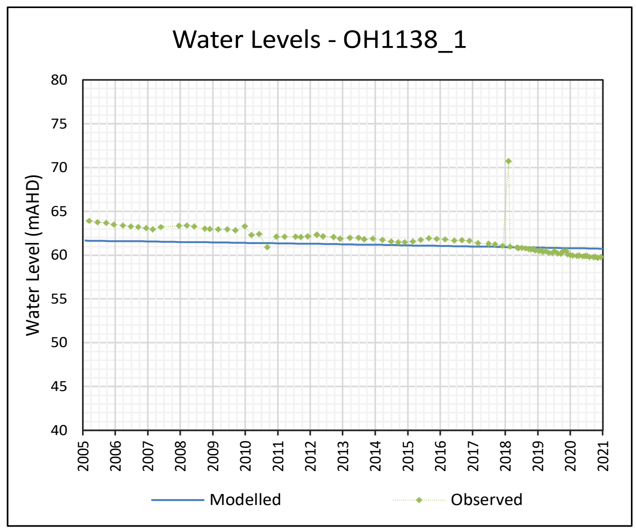

Water Levels - OH1125_2
Water Level (mAHD)
Modelled
Observed

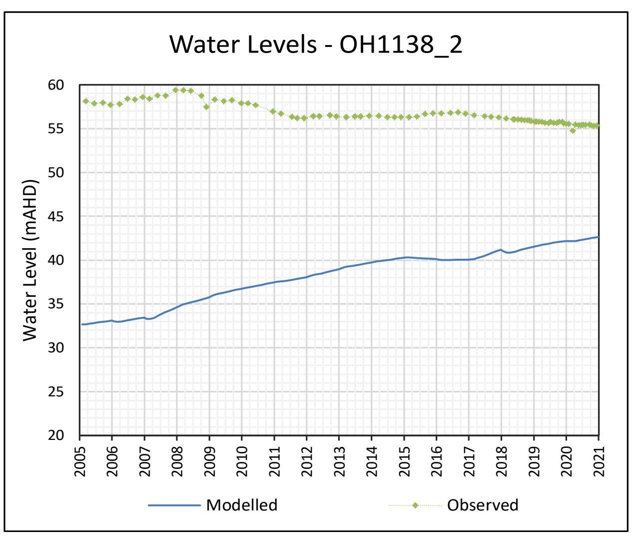

Water Levels - OH1125_3
Water Level (mAHD)
Modelled
Observed

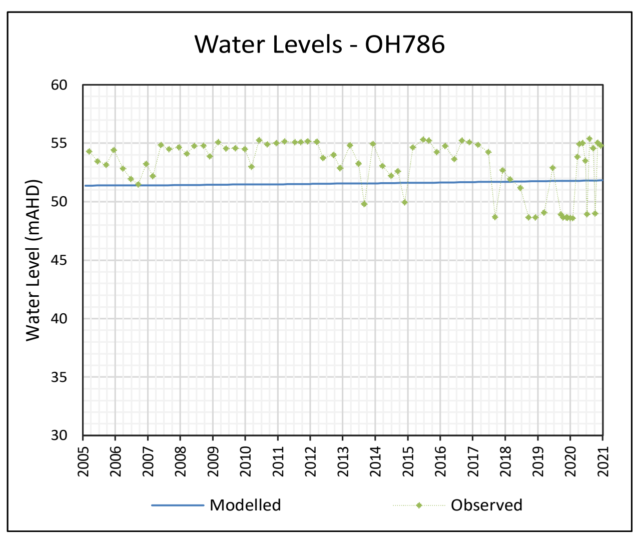

Water Levels - OH1126
Water Level (mAHD)
Modelled
Observed

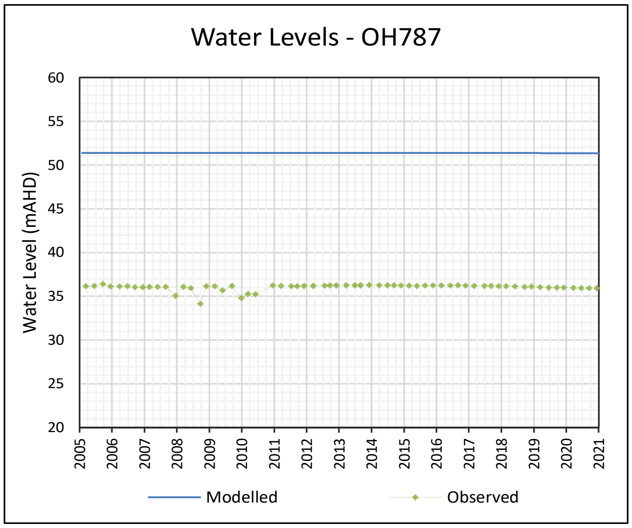

Water Levels - OH1127
Water Level (mAHD)
Modelled
Observed

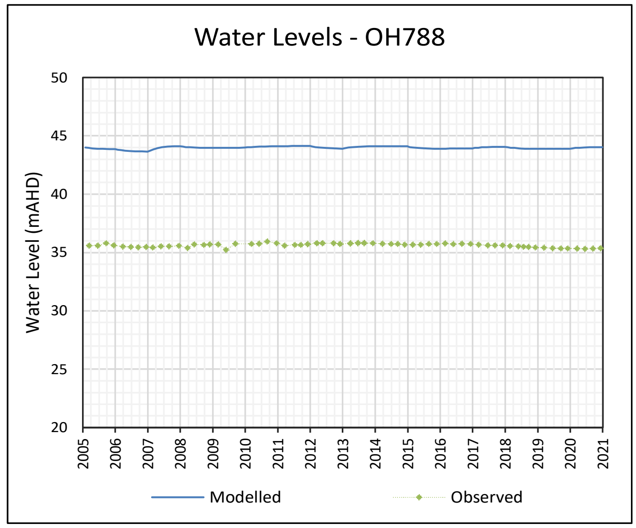

Water Levels - OH1137
Water Level (mAHD)
Modelled
Observed

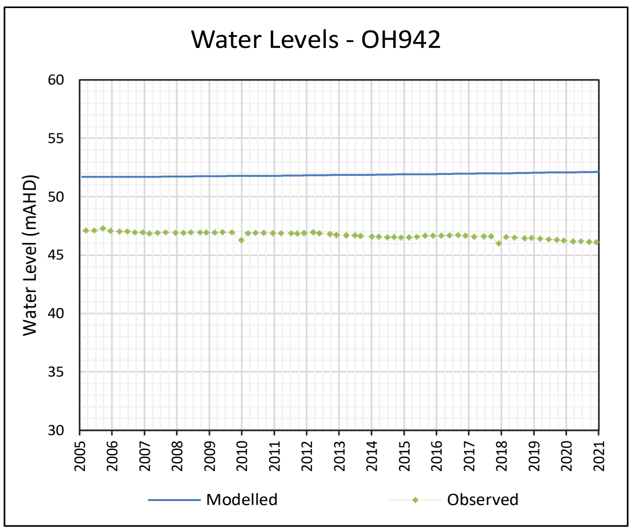

Water Levels - OH1138_1
Water Level (mAHD)
Modelled
Observed

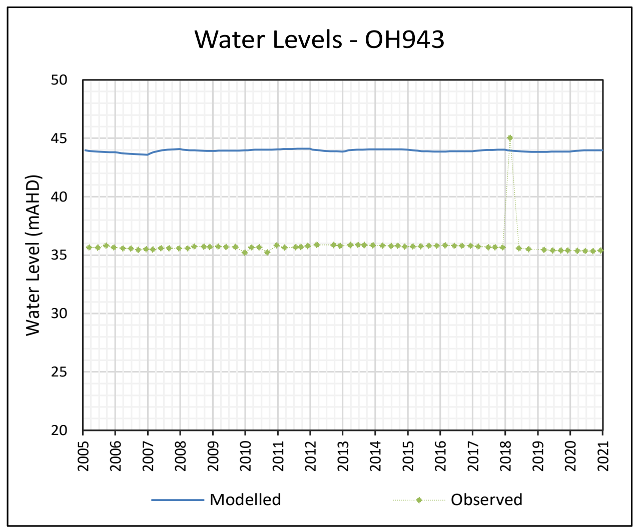

Water Levels - OH1138_2
Water Level (mAHD)
Modelled
Observed

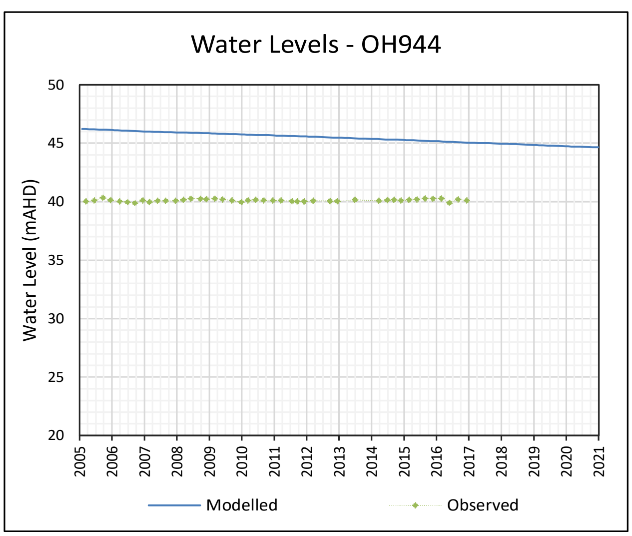

Water Levels - OH786
Water Level (mAHD)
Modelled
Observed

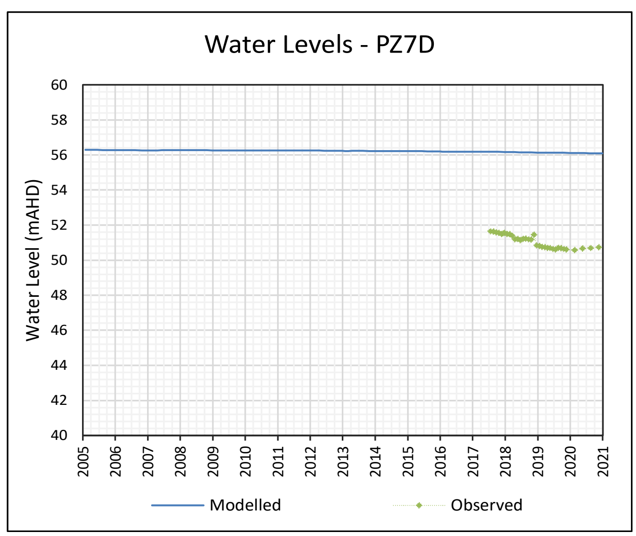

Water Levels - OH787
Water Level (mAHD)
Modelled
Observed

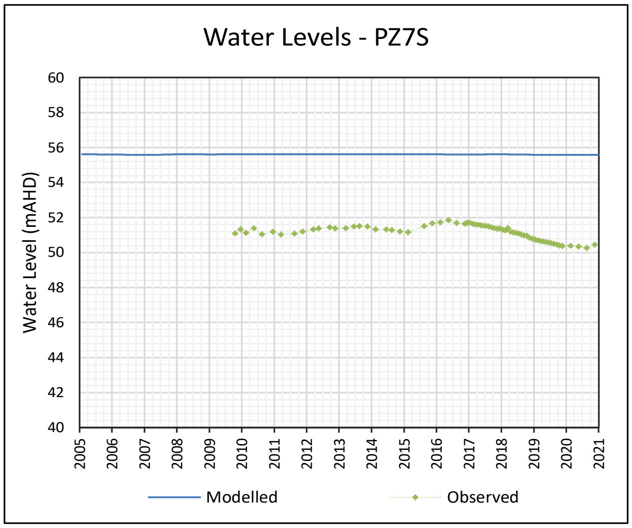

Water Levels - OH788
Water Level (mAHD)
Modelled
Observed

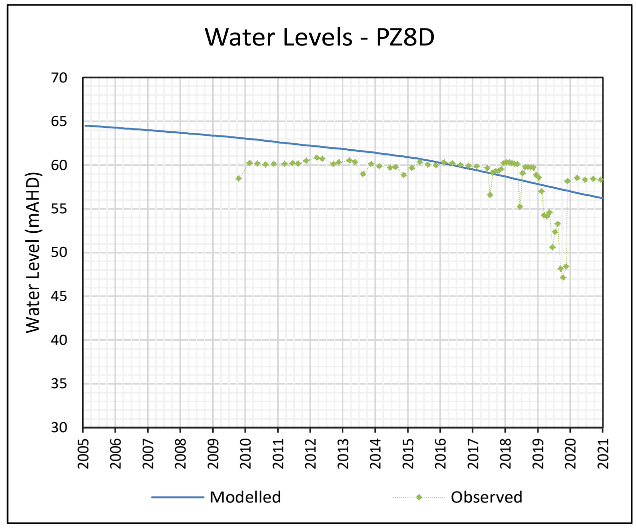

Water Levels - OH942
Water Level (mAHD)
Modelled
Observed

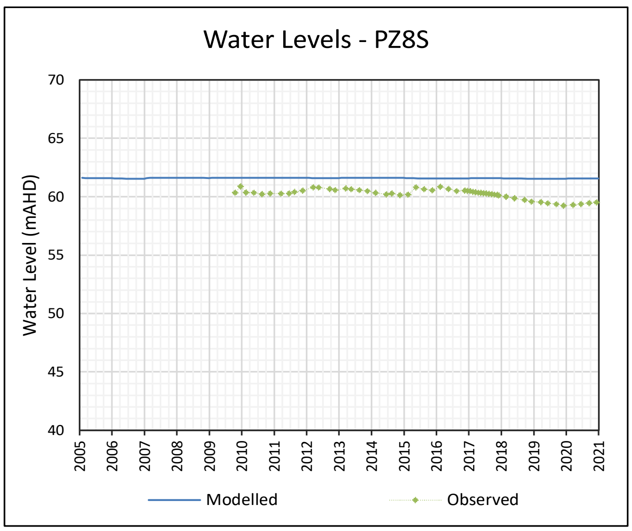

Water Levels - OH943
Water Level (mAHD)
Modelled
Observed

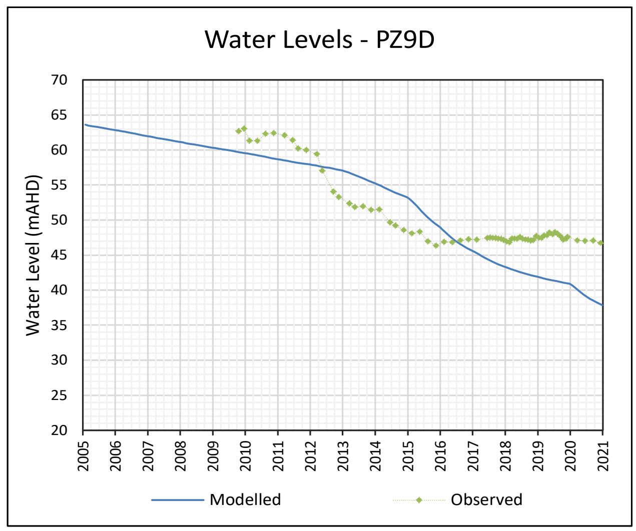

Water Levels - OH944
Water Level (mAHD)
Modelled
Observed

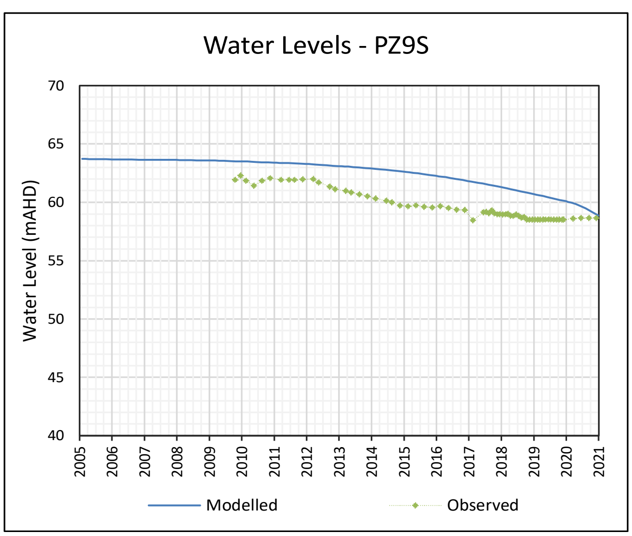

Water Levels - PZ7D
Water Level (mAHD)
Modelled
Observed

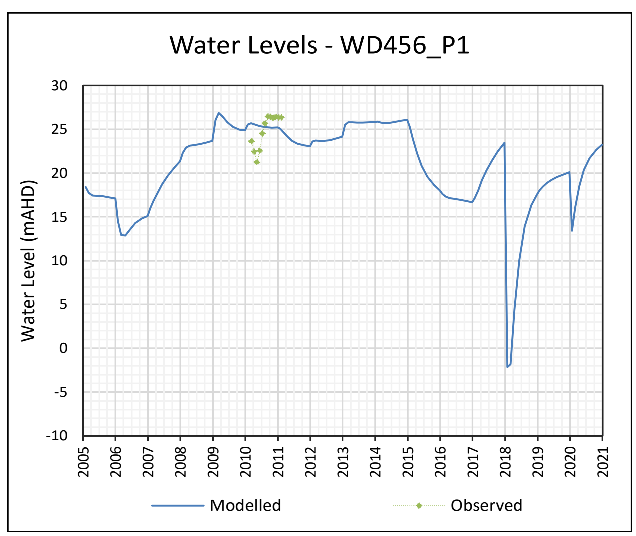

Water Levels - PZ7S
Water Level (mAHD)
60
58
56
54
52
50
48
46
44
42
40
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Modelled
Observed

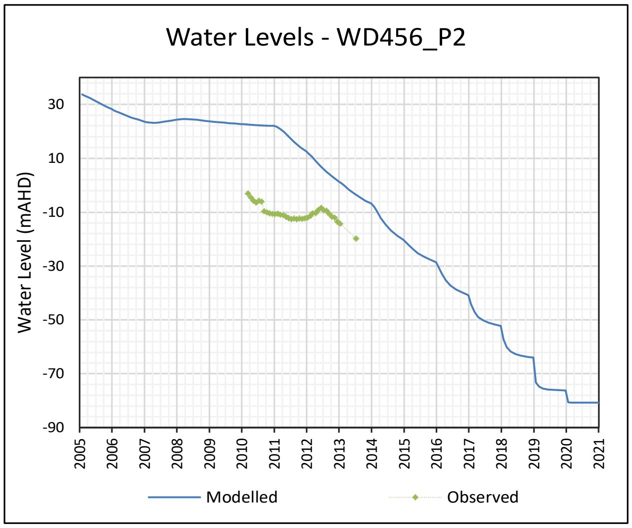

Water Levels - PZ8D
Water Level (mAHD)
70
65
60
55
50
45
40
35
30
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Modelled
Observed

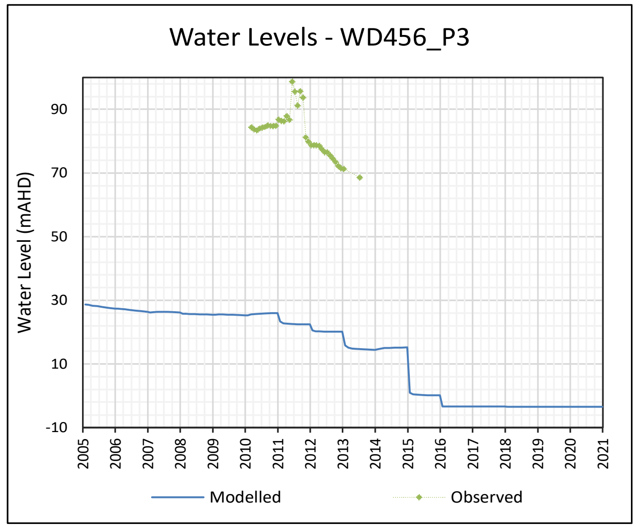

Water Levels - PZ8S
Water Level (mAHD)
70
65
60
55
50
45
40
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Modelled
Observed

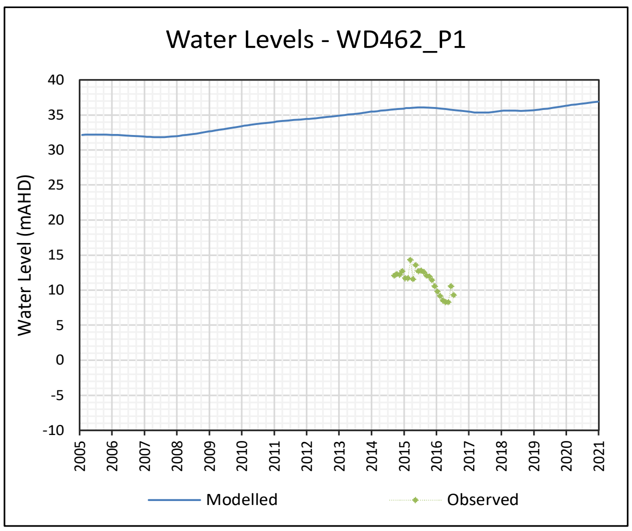

Water Levels - PZ9D
Water Level (mAHD)
70
65
60
55
50
45
40
35
30
25
20
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Modelled
Observed

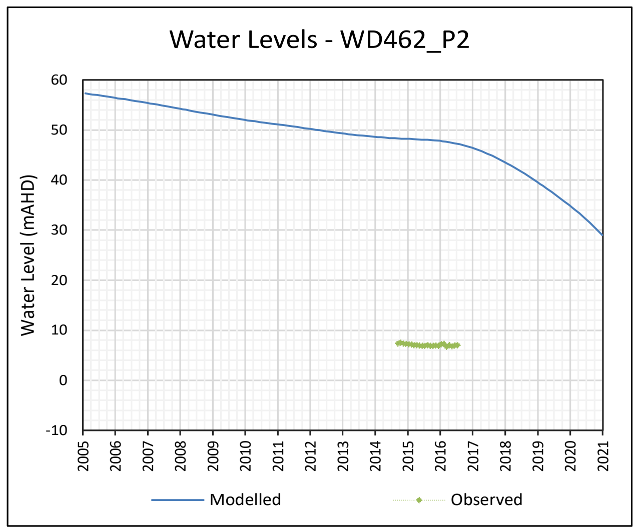

Water Levels - PZ9S
Water Level (mAHD)
70
65
60
55
50
45
40
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Modelled
Observed

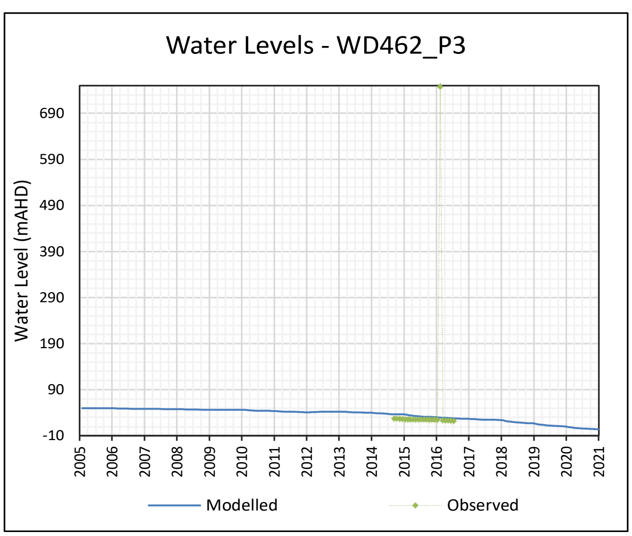

Water Levels - WD456_P1
Water Level (mAHD)
30
25
20
15
10
5
0
-5
-10
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Modelled
Observed

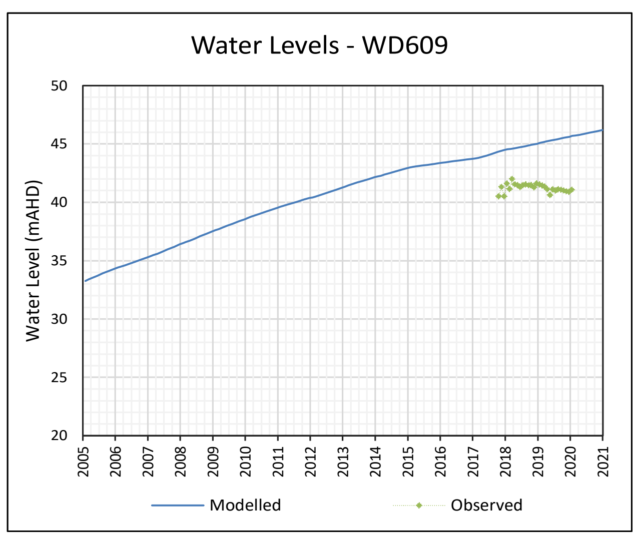

Water Levels - WD456_P2
Water Level (mAHD)
30
10
-10
-30
-50
-70
-90
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Modelled
Observed

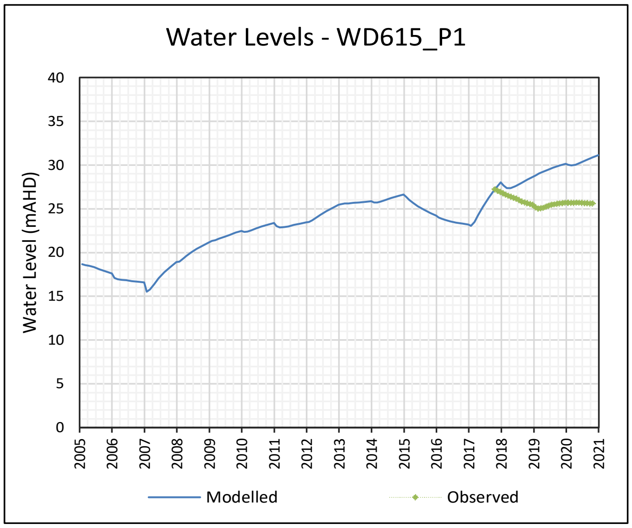

Water Levels - WD456_P3
Water Level (mAHD)
90
70
50
30
10
-10
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Modelled
Observed

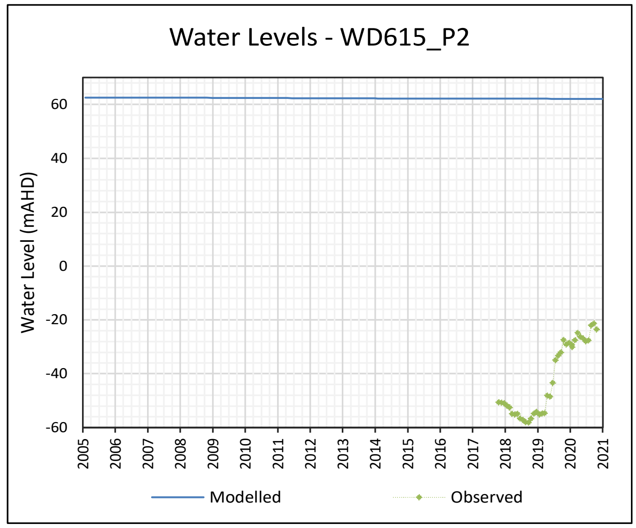

Water Levels - WD462_P1
Water Level (mAHD)
40
35
30
25
20
15
10
5
0
-5
-10
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Modelled
Observed

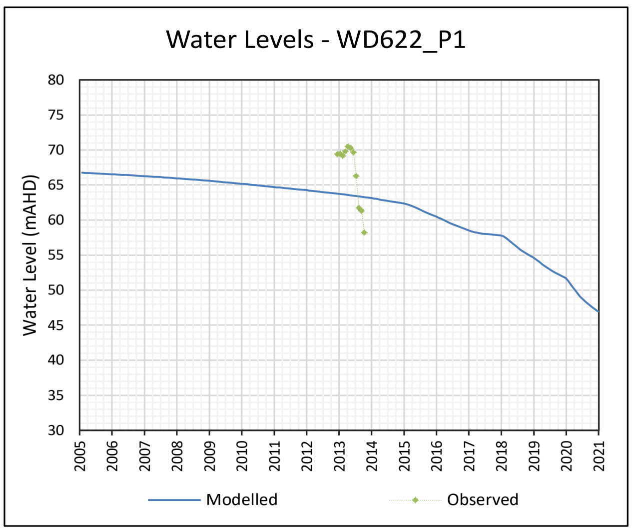

Water Levels - WD462_P2
Water Level (mAHD)
60
50
40
30
20
10
0
-10
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Modelled
Observed

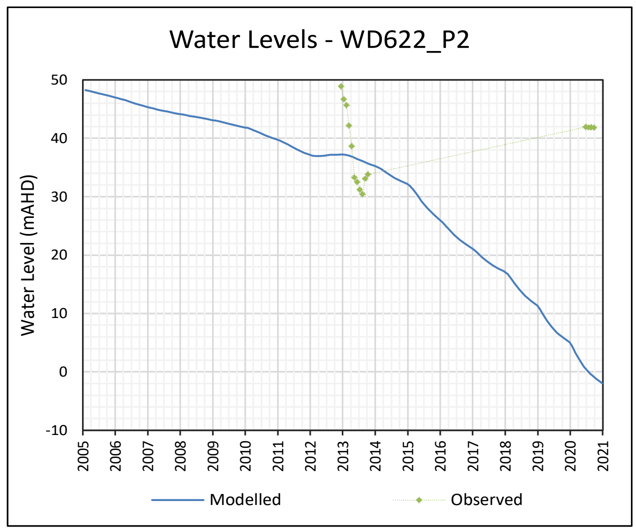

Water Levels - WD462_P3
Water Level (mAHD)
690
590
490
390
290
190
90
-10
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Modelled
Observed

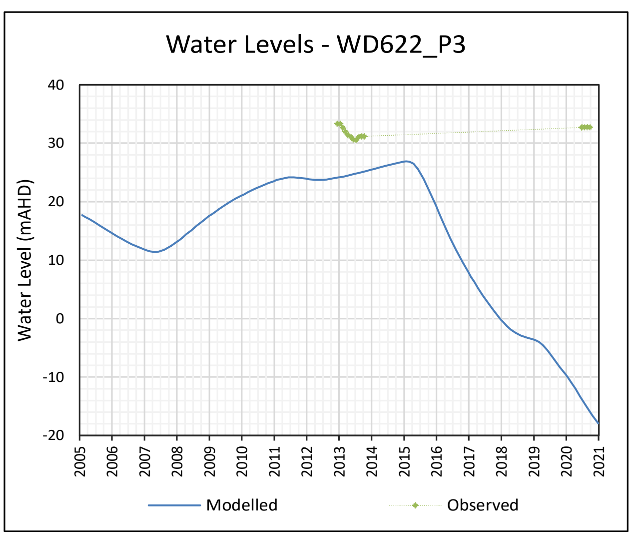

Water Levels - WD609
Water Level (mAHD)
50
45
40
35
30
25
20
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Modelled
Observed

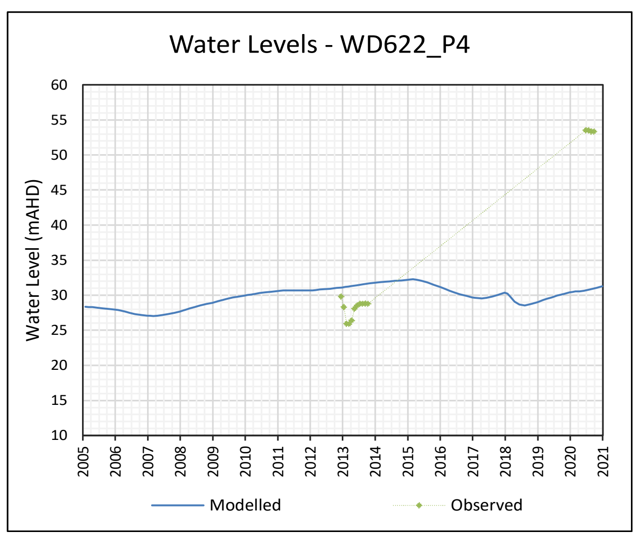

Water Levels - WD615_P1
Water Level (mAHD)
Modelled
Observed

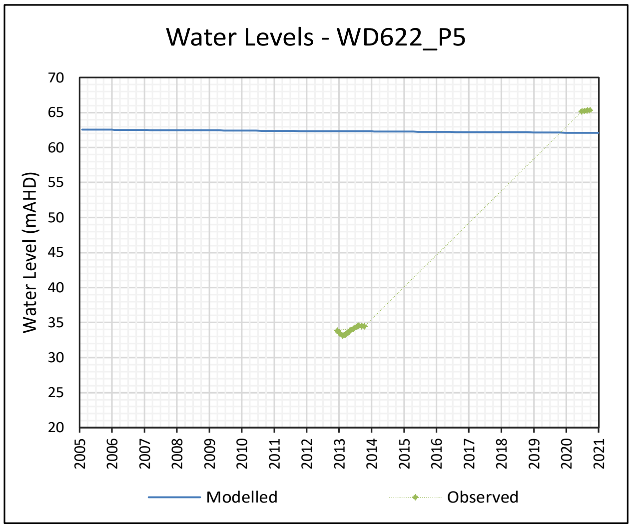

Water Levels - WD615_P2
Water Level (mAHD)
Modelled
Observed


Water Levels - WD622_P1
Water Level (mAHD)
Modelled
Observed


Water Levels - WD622_P2
Water Level (mAHD)
Modelled
Observed


Water Levels - WD622_P3
Water Level (mAHD)
Modelled
Observed


Water Levels - WD622_P4
Water Level (mAHD)
Modelled
Observed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Water Level (mAHD)
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65
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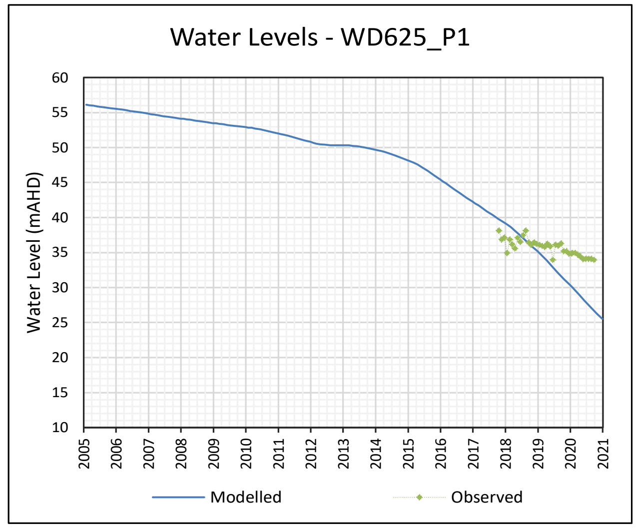
55
50
45
40
35
30
25
20
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Modelled
Observed


Water Levels - WD625_P1
Water Level (mAHD)
60
55
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30
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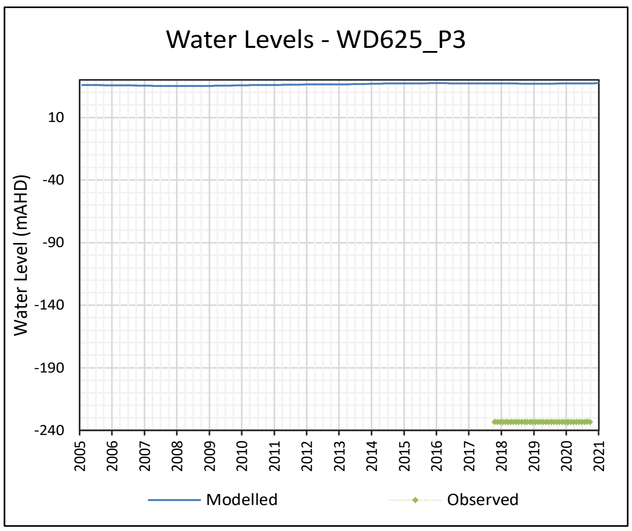
20
15
10
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Modelled
Observed


Water Levels - WD625_P3
Water Level (mAHD)
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-90
-140
-190
-240
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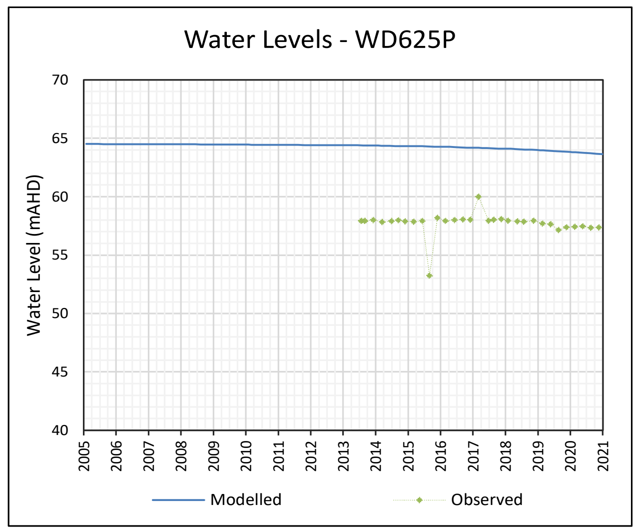
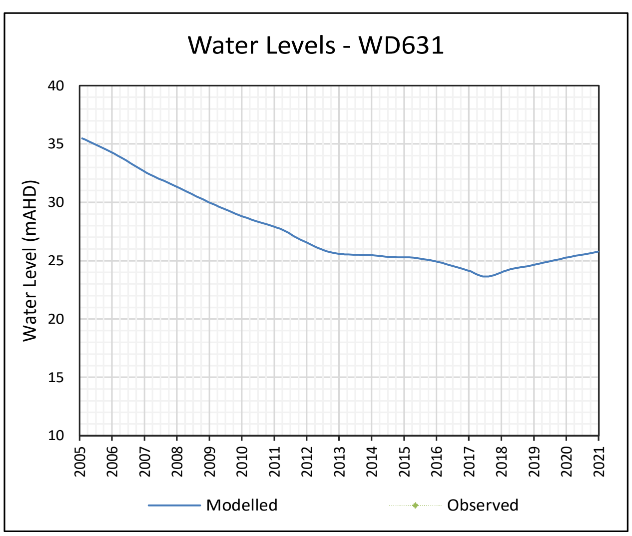
Modelled
Observed


Water Levels - WD625P
Water Level (mAHD)
70
65
60
55
50
45
40
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Modelled
Observed


Water Levels - WD631
Water Level (mAHD)
40
35
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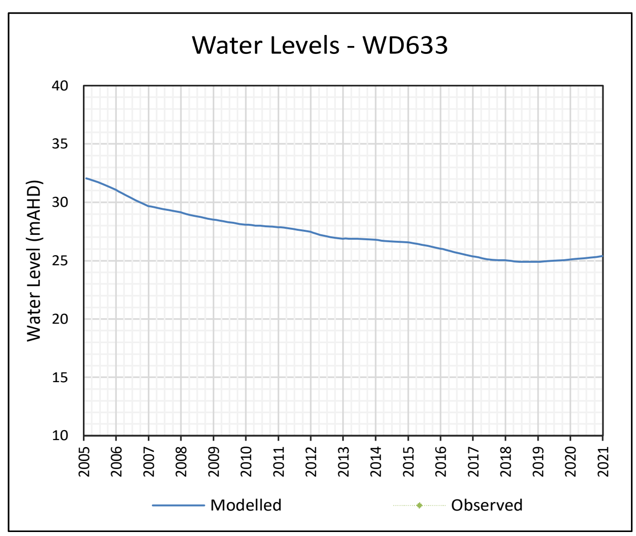
25
20
15
10
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Modelled
Observed


Water Levels - WD633
Water Level (mAHD)
40
35
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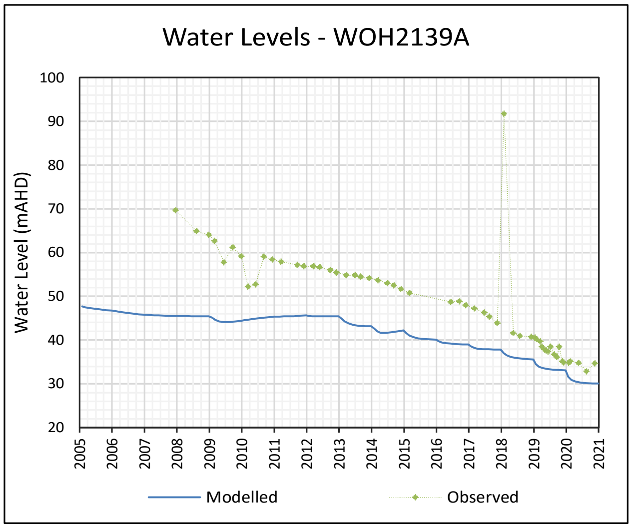
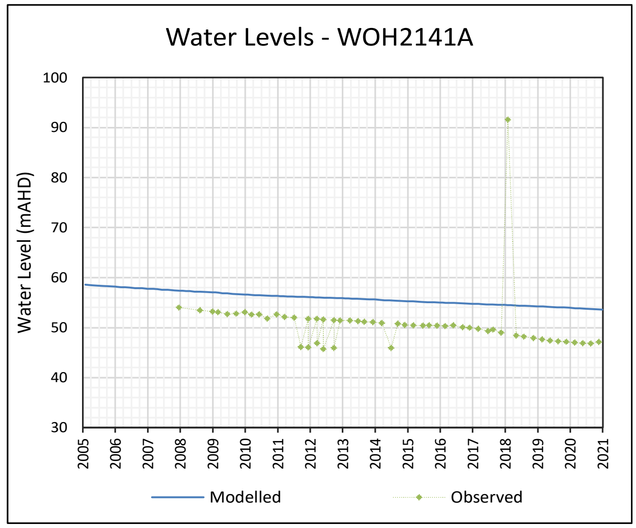
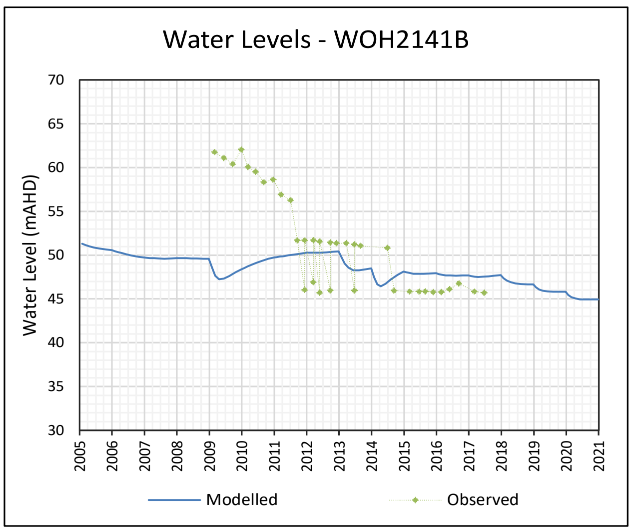
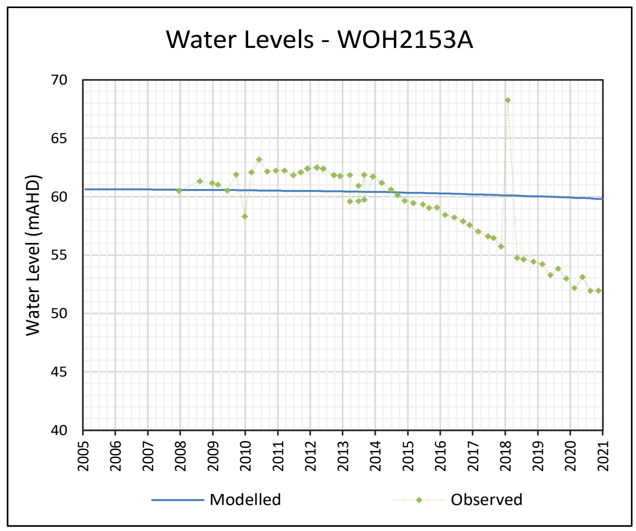
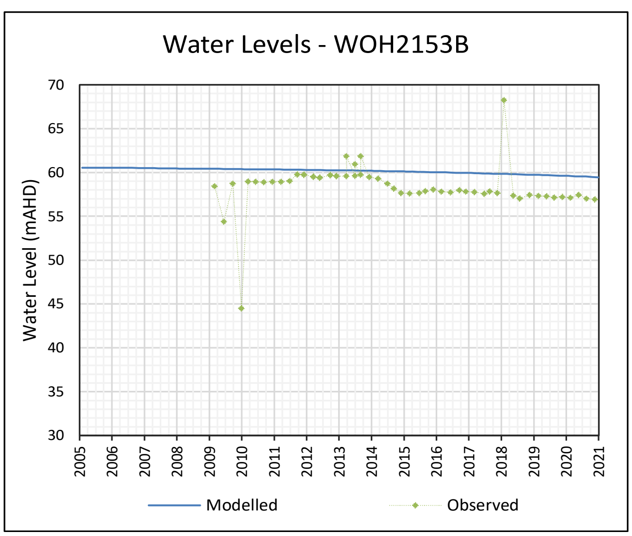
20
15
10
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Modelled
Observed

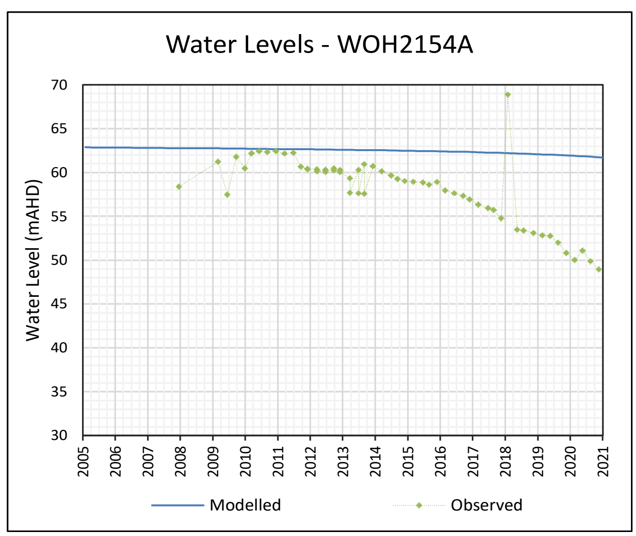

Water Levels - WOH2139A
Water Level (mAHD)
Modelled
Observed


Water Levels - WOH2141A
Water Level (mAHD)
Modelled
Observed


Water Levels - WOH2141B
Water Level (mAHD)
Modelled
Observed


Water Levels - WOH2153A
Water Level (mAHD)
Modelled
Observed


Water Levels - WOH2153B
Water Level (mAHD)
Modelled
Observed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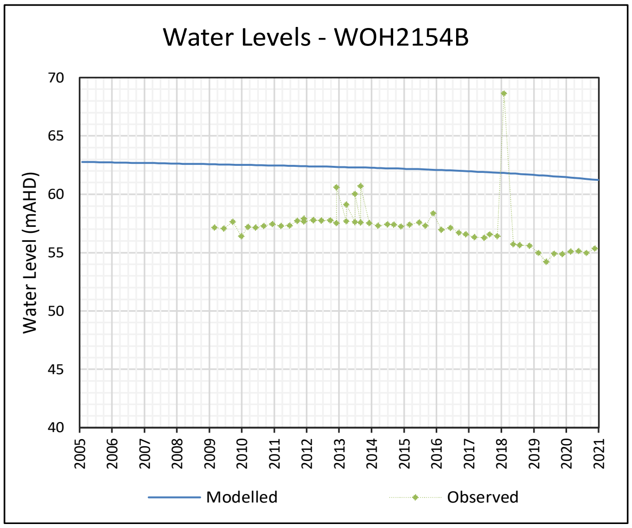
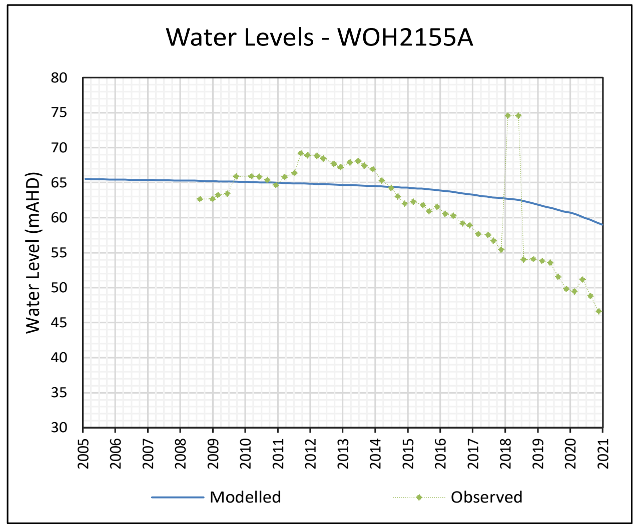
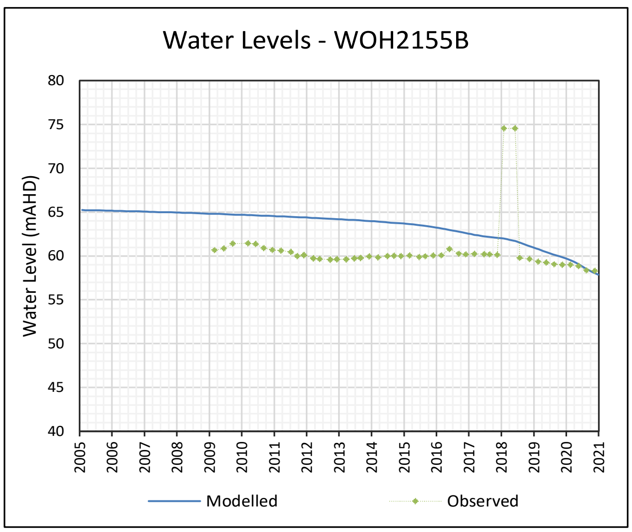
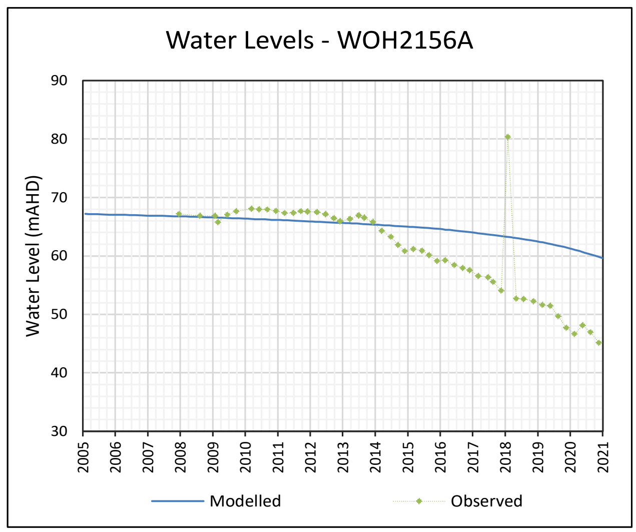
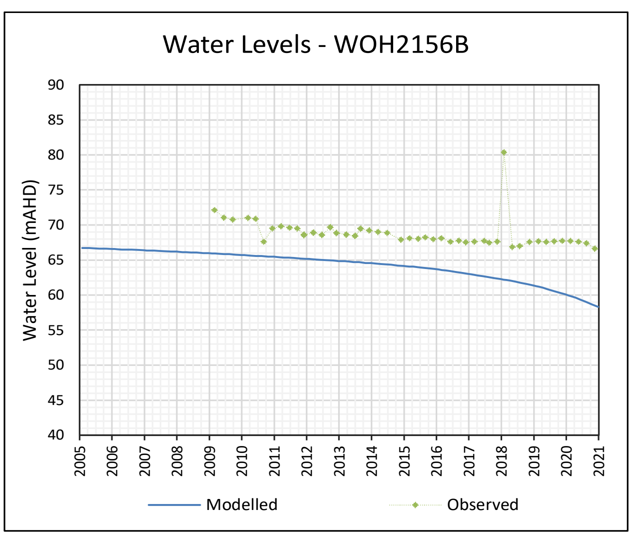
Water Level (mAHD)
Modelled
Observed


Water Levels - WOH2154B
Water Level (mAHD)
Modelled
Observed


Water Levels - WOH2155A
Water Level (mAHD)
Modelled
Observed


Water Levels - WOH2155B
Water Level (mAHD)
Modelled
Observed


Water Levels - WOH2156A
Water Level (mAHD)
Modelled
Observed


Water Levels - WOH2156B
Water Level (mAHD)
Modelled
Observed

ASIA PACIFIC OFFICES

BRISBANE
Level 2, 15 Astor Terrace
Spring Hill QLD 4000
Australia
T: +61 7 3858 4800
F: +61 7 3858 4801

CANBERRA
GPO 410
Canberra ACT 2600
Australia
T: +61 2 6287 0800
F: +61 2 9427 8200

DARWIN
Unit 5, 21 Parap Road
Parap NT 0820
Australia
T: +61 8 8998 0100
F: +61 8 9370 0101

GOLD COAST
Level 2, 194 Varsity Parade
Varsity Lakes QLD 4227
Australia
M: +61 438 763 516

MACKAY
21 River Street
Mackay QLD 4740
Australia
T: +61 7 3181 3300

MELBOURNE
Suite 2, 2 Domville Avenue
Hawthorn VIC 3122
Australia
T: +61 3 9249 9400
F: +61 3 9249 9499

NEWCASTLE
10 Kings Road
New Lambton NSW 2305
Australia
T: +61 2 4037 3200
F: +61 2 4037 3201

PERTH
Ground Floor, 503 Murray Street
Perth WA 6000
Australia
T: +61 8 9422 5900
F: +61 8 9422 5901

SYDNEY
2 Lincoln Street
Lane Cove NSW 2066
Australia
T: +61 2 9427 8100
F: +61 2 9427 8200

TOWNSVILLE
Level 1, 514 Sturt Street
Townsville QLD 4810
Australia
T: +61 7 4722 8000
F: +61 7 4722 8001

TOWNSVILLE SOUTH
12 Cannan Street
Townsville South QLD 4810
Australia
T: +61 7 4772 6500

WOLLONGONG
Level 1, The Central Building
UoW Innovation Campus
North Wollongong NSW 2500
Australia
T: +61 404 939 922

AUCKLAND
68 Beach Road
Auckland 1010
New Zealand
T: +64 27 441 7849

NELSON
6/A Cambridge Street
Richmond, Nelson 7020
New Zealand
T: +64 274 898 628

Appendix 5:
Annual Rehabilitation Report Summary Table

Annual Rehabilitation Report Form, Rehabilitation Maps and Rehabilitation Summary

Annual Rehabilitation Report Form – Mines
Year Ending: 2020
Mine: Mt Thorley Warkworth
Company: Yancoal Australia
Plans Attached:
Mt Thorley Warkworth – AER 2020
Approved Mining Operations Plan:
MTW MOP Amendment C (2015 – 2021) – Approval Date 24/11/2020
Total Area Covered by Mining Operations Plan:
MTW MOP – 6,185ha
Total Area Covered by Mining Lease for This Mine: 6,185ha

Table 1: Rehabilitation Progress 2020

Rehabilitation Activity Type	Domain Identifier	Primary Domain	Secondary Domain	Total Area Last Reported (ha)	Total Area to date (ha)
1.1 Active mining and infrastructure area, facilities, including roads and tracks	1A	Final Void	Final Void	373.0	397.4
	2C	Water Management Areas	Rehabilitation Area - Grassland	42.1	64.1
	2E	Water Management Areas	Rehabilitation Area - Woodland EEC	22.8	1.1
	3C	Infrastructure Area	Rehabilitation Area - Grassland	100.6	169.3
	3E	Infrastructure Area	Rehabilitation Area - Woodland EEC	68.5	0.1
	4C	Tailings Storage Facility	Rehabilitation Area - Grassland	76.4	37.1
	4D	Tailings Storage Facility	Rehabilitation Area - Woodland	11.7	75.5
	4E	Tailings Storage Facility	Rehabilitation Area - Woodland EEC	88.3	97.0
	5C	Overburden Emplacement Area	Rehabilitation Area - Grassland	363.2	184.9
	5D	Overburden Emplacement Area	Rehabilitation Area - Woodland	242.1	247.9

Rehabilitation Activity Type	Domain Identifier	Primary Domain	Secondary Domain	Total Area Last Reported (ha)	Total Area to date (ha)
	5E	Overburden Emplacement Area	Rehabilitation Area - Woodland EEC	1191.11	1326.9
	Total Active			2579.8	2601.3
1.2 Decommissioning	Total - Decommissioning			0.0	0.0
1.3 Landform Establishment	4C	Tailings Storage Facility	Rehabilitation Area - Grassland	0.1	0.0
	4E	Tailings Storage Facility	Rehabilitation Area - Woodland EEC	0.2	0.4
	5C	Overburden Emplacement Area	Rehabilitation Area - Grassland	3.2	1.4
	5D	Overburden Emplacement Area	Rehabilitation Area - Woodland	2.7	0.0
	5E	Overburden Emplacement Area	Rehabilitation Area - Woodland EEC	18.0	16.6
	Total - Landform Establishment			24.2	18.4
1.4 Growth Medium Development	2C	Water Management Areas	Rehabilitation Area - Grassland	1.2	4.0
	2E	Water Management Areas	Rehabilitation Area - Woodland EEC	2.9	0.0
	4E	Tailings Storage Facility	Rehabilitation Area - Woodland EEC	4.0	4.0
	5C	Overburden Emplacement Area	Rehabilitation Area - Grassland	18.9	16.1
	5D	Overburden Emplacement Area	Rehabilitation Area - Woodland	26.1	0.0
	5E	Overburden Emplacement Area	Rehabilitation Area - Woodland EEC	81.8	62.4
	Total - Growth Medium Development			134.9	86.5
1.5 Ecosystem and Land Use Establishment	1A	Final Void	Final Void	1.5	1.2
	2C	Water Management Areas	Rehabilitation Area - Grassland	1.6	4.9
	2E	Water Management Areas	Rehabilitation Area - Woodland EEC	3.3	0.0
	3C	Infrastructure Area	Rehabilitation Area - Grassland	5.4	5.5
	3D	Infrastructure Area	Rehabilitation Area - Woodland	0.0	0.3
	3E	Infrastructure Area	Rehabilitation Area - Woodland EEC	0.5	0.1
	4C	Tailings Storage Facility	Rehabilitation Area - Grassland	26.4	27.0
	4D	Tailings Storage Facility	Rehabilitation Area - Woodland	1.4	0.6
	4E	Tailings Storage Facility	Rehabilitation Area - Woodland EEC	35.2	35.4

Rehabilitation Activity Type	Domain Identifier	Primary Domain	Secondary Domain	Total Area Last Reported (ha)	Total Area to date (ha)
	5C	Overburden Emplacement Area	Rehabilitation Area - Grassland	567.5	418.3
	5D	Overburden Emplacement Area	Rehabilitation Area - Woodland	52.8	201.7
	5E	Overburden Emplacement Area	Rehabilitation Area - Woodland EEC	446.7	532.9
	Total - Ecosystem and Land Use Establishment			1142.3	1227.9
1.6 Ecosystem and Land Use Development	1A	Final Void	Final Void	0.0	0.0
	2C	Water Management Areas	Rehabilitation Area - Grassland	0.0	0.0
	2E	Water Management Areas	Rehabilitation Area - Woodland EEC	0.0	0.0
	3C	Infrastructure Area	Rehabilitation Area - Grassland	0.0	0.0
	3D	Infrastructure Area	Rehabilitation Area - Woodland	0.0	0.0
	3E	Infrastructure Area	Rehabilitation Area - Woodland EEC	0.0	0.0
	4C	Tailings Storage Facility	Rehabilitation Area - Grassland	0.0	0.0
	4D	Tailings Storage Facility	Rehabilitation Area - Woodland	0.0	0.0
	4E	Tailings Storage Facility	Rehabilitation Area - Woodland EEC	0.0	0.0
	5C	Overburden Emplacement Area	Rehabilitation Area - Grassland	0.0	0.0
	5D	Overburden Emplacement Area	Rehabilitation Area - Woodland	0.0	0.0
	5E	Overburden Emplacement Area	Rehabilitation Area - Woodland EEC	0.0	0.0
	Total - Ecosystem and Land Use Development			0.0	0.0
1.7 Rehabilitation Complete	Total - Rehabilitation Complete			0.0	0.0
1.8 Total Area Disturbed (items 1.1 to 1.7)	1A	Final Void	Final Void	374.5	398.6
	2C	Water Management Areas	Rehabilitation Area - Grassland	44.9	73.0
	2E	Water Management Areas	Rehabilitation Area - Woodland EEC	29.0	1.1
	3C	Infrastructure Area	Rehabilitation Area - Grassland	106.0	174.8
	3D	Infrastructure Area	Rehabilitation Area - Woodland	0.0	0.3
	3E	Infrastructure Area	Rehabilitation Area - Woodland EEC	69.0	0.2

Rehabilitation Activity Type	Domain Identifier	Primary Domain	Secondary Domain	Total Area Last Reported (ha)	Total Area to date (ha)
	4C	Tailings Storage Facility	Rehabilitation Area - Grassland	102.9	64.1
	4D	Tailings Storage Facility	Rehabilitation Area - Woodland	13.1	76.1
	4E	Tailings Storage Facility	Rehabilitation Area - Woodland EEC	127.7	136.8
	5C	Overburden Emplacement Area	Rehabilitation Area - Grassland	952.8	620.7
	5D	Overburden Emplacement Area	Rehabilitation Area - Woodland	323.7	449.6
	5E	Overburden Emplacement Area	Rehabilitation Area - Woodland EEC	1737.6	1938.8
	Total Footprint			3881.2	3934.1

Table 2: Soil Management and Erosion, 2020

Soil Stockpiling/ Use	Soil Used This Period (m3)	Soil Pre-stripped This Period (m3)	Stockpile Inventory to Date (m3)	Soil Stockpiled Last Report (m3)
	28,600	35,200	666,929	660,357
2.2 Erosion Treatment	**Total Area to Date (ha)**	**Total Area Last Report (ha)**	**Total Area This Report (ha)**	**Area Retreated This Period (ha)**
Approx. area of sheet or gully erosion requiring reshaping topdressing and/or resowing	Not Available	6.0	7.8	0.0

Table 3: Weed Control

	Area (ha)
3.1 Approx. area adversely affected by weeds as of the date of this report	Not Available
3.2 Area treated for weed control during the period covered by the report	281.6
3.3 Give summary of control strategies used and verification by approval agency(s)	
Species targeted in rehabilitation areas during 2020 included: *Galenia pubescens*, Rhodes grass, green panic, *Acacia saligna*, mustard weed (Brassica), farmers friend (*Bidens pilosa*) and paddys lucerne (*Sida rhombifolia*). 66.1ha treated for weed control using boom spray or wick wiper treatment; 215.5ha treated for weed control using Quikspray units, backpack sprays, cut and paint or manual removal.	

Table 4: Management of Rehabilitation Areas

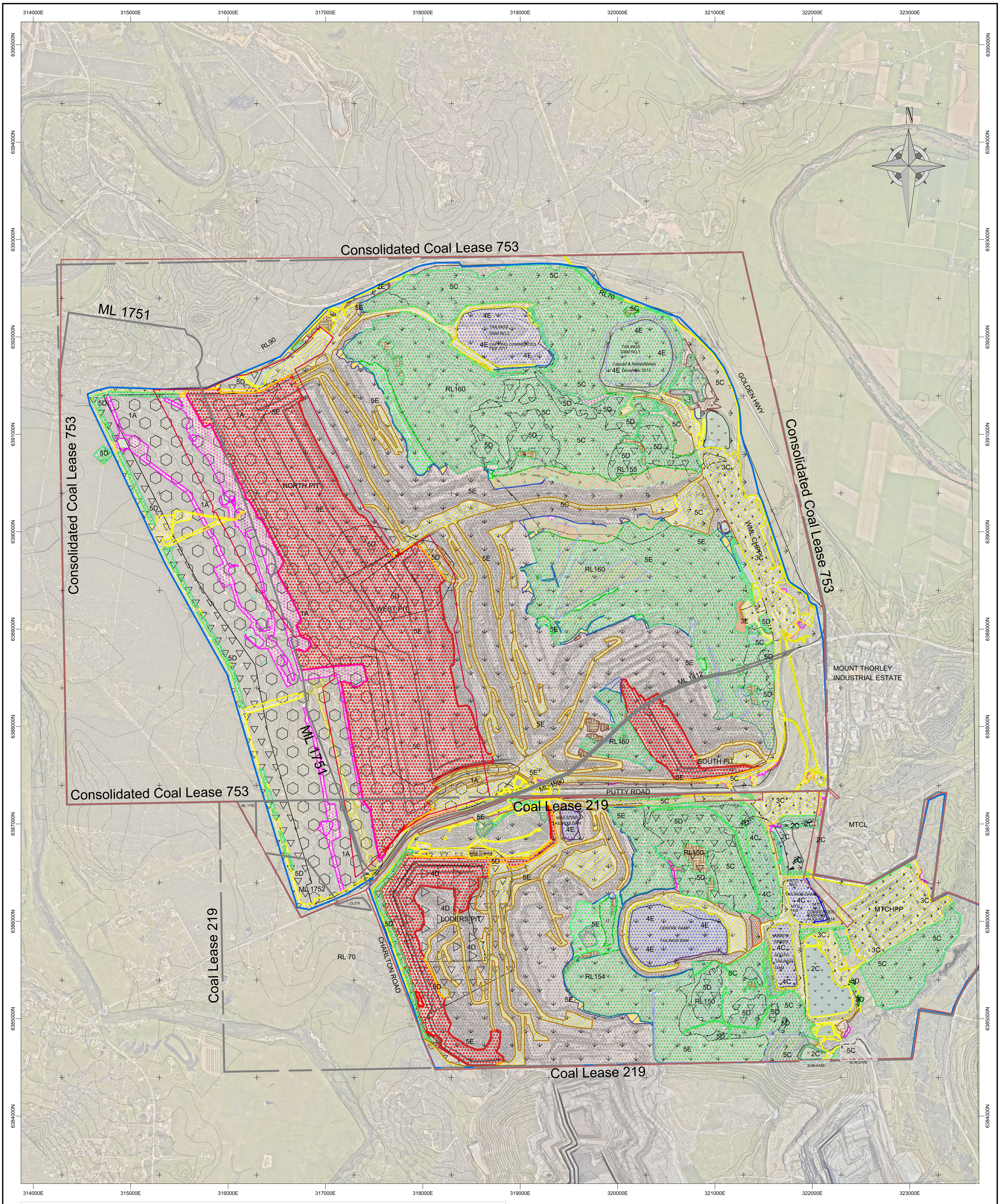
4.1 Area treated with maintenance fertiliser	0ha
4.2 Area treated by rotational grazing, cropping or slashing	0ha
Give Summary	

Table: 5 Variations to Rehabilitation Program

Has rehabilitation work proceeded generally in accordance with the conditions of an accepted Mining Operations Plan?	Yes
If not please cite any approval granted for variations, or briefly describe the seasonal conditions or other reasons for any changes and the nature of any changes which have been made.	NA

Table 6: Planned Operations During the Next Report Period

6.1 Area estimated to be disturbed	22ha
6.2 Area estimated to be rehabilitated	41ha of new rehabilitation; and 87ha of Stage 2 rehabilitation



Mining Tenement
- Project Approval Area
- Sublease Boundary
- Area of disturbance
- Expected mining area - 2020

Rehabilitation Phases
- Ecosystem and Land Use Establishment
- Growth of medium development
- Landform establishment
- Lease Boundary
- 2020- 5m Contours (AHD)

Primary Domains
- 1 - Final Void
- 2 - Water Management Area
- 3 - Infrastructure Area
- 4 - Tailings Storage Facility
- 5 - Overburden Emplacement

Secondary Domains
- A - Final Void
- B - Water Management Area
- C - Rehabilitation Area- Grassland
- D - Rehabilitation Area- Woodland Other
- E - Rehabilitation Area- Woodland EEC

Note: For plan clarity only, black polygons have been used for primary & secondary domains. Plan has been labeled with text.

Aerial photo date: 11th January 2021
Co-ordinate grid datum: MGA 2020 Zone 56
Height datum: Australian Height Datum (AHD71)

AEMR 2020 Areas
- Active Mining
- Shaped Spoils
- Shaped Spoils >10°
- Unshaped Spoils
- Topsoil Stripped
- Topsoil Spread > 18°
- Topsoil Spread
- New Rehabilitation
- New Temporary Rehabilitation
- Rehabilitation Existing
- Temporary Rehabilitation Existing
- Infrastructure
- Infrastructure Tailings
- Water Structures
- Topsoil Stockpile
- Compost Spread

SCHEDULE OF ENDORSEMENTS

REF	DATE	DESCRIPTION/REFERENCES	SIGNED
Full Plan	22-03-2021	Mine surveying content depicted on the plan is sourced from RT 769	J.SHERRITT
Full Plan	22-03-2021	Domain boundaries supplied by others.	J.SHERRITT
Full Plan	22-03-2021	Disturbance limits supplied by others.	J.SHERRITT
Full Plan	22-03-2021	Mining tenement & lease boundaries supplied by others.	J.SHERRITT
Full Plan	22-03-2021	Expected mining areas supplied by others.	J.SHERRITT
Full Plan	22-03-2021	Rehabilitation data & phases supplied by others.	J.SHERRITT

UNCONTROLLED IF PRINTED

YANCOAL
MT THORLEY WARKWORTH

0m 100m 250m 500m 1000m 1500m 2000m
SCALE 1:12500

I, James Sherritt, Registered Mining Surveyor, No. 8626, certify that to the best of my knowledge and belief the survey information on this plan conforms to the accuracy and standards required by the Department of Trade & Investment Resources & Energy, NSW.

Registered Mining Surveyor

22/03/2021
Date

MOUNT THORLEY OPERATIONS / WARKWORTH MINING Ltd.

Annual Environmental Review Plan 2020

REDUCTION RATIO: 1 : 12,500	A0
DRAWN BY: J. SHERRITT	DATE: 22/03/2021
APPROVED BY: B BAXTER	
PLAN No. MTW-1144	

Appendix 6:

Rehabilitation and Disturbance Summary

MTW Annual Review Appendix 6 – Rehabilitation Summary

Rehabilitation Site Name	Type	Coordinates (GDA2020)	Area (ha)	*Rehabilitation Summary*
CD RL180	Woodland	318,914.09 E 6,389,648.23 N	1.5	▪ The landform was constructed from a waste emplacement. ▪ The landform has been designed using a geomorphological landform approach based on alluvial analogues. Typical slope of the landform is 10 to 14 degrees with limited areas at 16 to 18 degrees. The slope has a primarily easterly aspect. ▪ Drainage is via rock-lined drainage lines, directing run-off to sediment control structures to the east. ▪ Landform surface preparation comprised bulk shaping, deep ripping, rock raking, and removal of oversize rock material. ▪ Clay loam/sandy clay loam topsoil from existing topsoil stockpiles was spread at a nominal thickness of 100mm. ▪ Soil ameliorants comprising recycled gypsum and Bettergrow Biomulch compost were applied at rates of 5t/ha and 50t/ha respectively. ▪ Growth medium preparation included ameliorant incorporation, rock windrowing, rock picking, and aerating as required ▪ Selective weed control of mainly Galenia pubescens was undertaken prior to sowing as weed and desirable native species had volunteered from the topsoil seed bank. ▪ The area was sown in September with Diverse Native Woodland at 15.7kg/ha. Non-flowable (grass) seed was spread onto the surface using a direct drill and then the flowable components of the seed mix were spread via an air-seeder mounted on the aerator implement. ▪ Selective weed control of mainly *Galenia pubescens* was undertaken after sowing when desirable native species and weed species had started to germinate.
CD RL185 Spoil/Compost	Woodland	319,915.41 E 6,389,705.84 N	0.5	▪ The landform was constructed from a waste emplacement. ▪ Typical slope of the landform is 10 degrees with a primarily southerly aspect. ▪ Drainage is via easterly draining contours reporting to an engineered rock-lined chute. ▪ Landform surface preparation comprised bulk shaping, deep ripping, rock raking, and removal of oversize rock material. ▪ No topsoil was added, spoil has been used as the growth medium.

Rehabilitation Site Name	Type	Coordinates (GDA2020)	Area (ha)	*Rehabilitation Summary*
				▪ Soil ameliorants comprising recycled gypsum and Bettergrow Biomulch compost were applied at rates of 5t/ha and 50t/ha respectively. ▪ Growth medium preparation included ameliorant incorporation, rock windrowing, rock picking, and aerating as required ▪ The area was sown in September with Diverse Native Woodland at 15.7kg/ha. Non-flowable (grass) seed was spread onto the surface using a direct drill and then the flowable components of the seed mix were spread via an air-seeder mounted on the aerator implement.
NPN RL185 Topsoil A	Woodland	317,595.39 E 6,391,651.07 N	5.5	▪ The landform was constructed from a waste emplacement. ▪ The landform has been designed using a geomorphological landform approach based on alluvial analogues. Typical slope of the landform is 14 degrees. The slope has a primarily easterly aspect. ▪ No water management structures were required on this slope due to short length of slope. ▪ Landform surface preparation comprised bulk shaping, deep ripping, rock raking, and removal of oversize rock material. ▪ Clay loam/sandy clay loam topsoil from existing topsoil stockpiles was spread at a nominal thickness of 100mm. ▪ Soil ameliorants comprising recycled gypsum and Bettergrow Biomulch compost were applied at rates of 5t/ha and 50t/ha respectively. ▪ Growth medium preparation included ameliorant incorporation, rock windrowing, rock picking, and aerating as required ▪ The area was sown in September with Diverse Native Woodland at 15.7kg/ha. Non-flowable (grass) seed was spread onto the surface using a direct drill and then the flowable components of the seed mix were spread via an air-seeder mounted on the aerator implement.
NPN RL185 Topsoil B	Woodland	317,309.02 E 6,392,099.08 N	1.1	▪ The landform was constructed from a waste emplacement. ▪ The landform has been designed using a geomorphological landform approach based on alluvial analogues. Typical slope of the landform is 10 to 14 degrees. The slope has a primarily westerly aspect. ▪ Drainage lines direct run-off to sediment control structures to the north. ▪ Landform surface preparation comprised bulk shaping, deep ripping, rock raking, and removal of oversize rock material.

Rehabilitation Site Name	Type	Coordinates (GDA2020)	Area (ha)	*Rehabilitation Summary*
				▪ Clay loam/sandy clay loam topsoil from existing topsoil stockpiles was spread at a nominal thickness of 100mm. ▪ Soil ameliorants comprising recycled gypsum and Bettergrow Biomulch compost were applied at rates of 5t/ha and 50t/ha respectively. ▪ Growth medium preparation included ameliorant incorporation, rock windrowing, rock picking, and aerating as required ▪ The area was sown in September with Diverse Native Woodland at 15.7kg/ha. Non-flowable (grass) seed was spread onto the surface using a direct drill and then the flowable components of the seed mix were spread via an air-seeder mounted on the aerator implement.
NPN RL185 Topsoil C	Woodland	317,294.44 E 6,392,202.45 N	1.0	▪ The landform was constructed from a waste emplacement. ▪ The landform has been designed using a geomorphological landform approach based on alluvial analogues. Typical slope of the landform is 10 to 14 degrees. The slope has a primarily westerly aspect. ▪ Drainage lines direct run-off to sediment control structures to the north. ▪ Landform surface preparation comprised bulk shaping, deep ripping, rock raking, and removal of oversize rock material. ▪ Clay loam/sandy clay loam topsoil from existing topsoil stockpiles was spread at a nominal thickness of 100mm. ▪ Soil ameliorants comprising recycled gypsum and Bettergrow Biomulch compost were applied at rates of 5t/ha and 50t/ha respectively. ▪ Growth medium preparation included ameliorant incorporation, rock windrowing, rock picking, and aerating as required ▪ The area was sown in September with Diverse Native Woodland at 15.7kg/ha. Non-flowable (grass) seed was spread onto the surface using a direct drill and then the flowable components of the seed mix were spread via an air-seeder mounted on the aerator implement.
NPN RL185 Topsoil D	Woodland	317,568.69 E 6,391,485.39 N	0.9	▪ The landform was constructed from a waste emplacement. ▪ The landform has been designed using a geomorphological landform approach based on alluvial analogues. Typical slope of the landform is less than 10 degrees. The slope has a primarily westerly aspect. ▪ No water management structures were required on this section of landform. ▪ Landform surface preparation comprised bulk shaping, deep ripping, rock raking, and removal of oversize rock material.

Rehabilitation Site Name	Type	Coordinates (GDA2020)	Area (ha)	*Rehabilitation Summary*
				▪ Clay loam/sandy clay loam topsoil from existing topsoil stockpiles was spread at a nominal thickness of 100mm. ▪ Soil ameliorants comprising recycled gypsum and Bettergrow Biomulch compost were applied at rates of 5t/ha and 50t/ha respectively. ▪ Growth medium preparation included ameliorant incorporation, rock windrowing, rock picking, and aerating as required ▪ The area was sown in September with Diverse Native Woodland at 15.7kg/ha. Non-flowable (grass) seed was spread onto the surface using a direct drill and then the flowable components of the seed mix were spread via an air-seeder mounted on the aerator implement.
CD Stockpile Base	Woodland	319,479.21 E 6,389,913.78 N	1.6	▪ The landform was constructed from a waste emplacement. ▪ The landform is flat in this area, no aspect. ▪ Area is flat and hence not requiring drainage controls. ▪ Landform surface preparation comprised minor shaping, deep ripping, rock raking, and removal of oversize rock material. ▪ Area was an old topsoil stockpile so there was remaining Clay loam/sandy clay loam topsoil from the floor of the stockpile at a nominal thickness of 100mm. ▪ Soil ameliorants comprising recycled gypsum and Bettergrow Biomulch compost were applied at rates of 5t/ha and 50t/ha respectively. ▪ Growth medium preparation included ameliorant incorporation and aerating as required ▪ The area was sown in October with Diverse Native Woodland at 15.7kg/ha. Non-flowable (grass) seed was spread onto the surface using a direct drill and then the flowable components of the seed mix were spread via an air-seeder mounted on the aerator implement.
MTO RL155	Woodland	319,497.01 E 6,386,545.70 N	9.5	▪ The landform was constructed from a waste emplacement. ▪ The landform has been designed using a geomorphological landform approach based on alluvial analogues. Typical slope of the landform is less than 10 degrees. The slope has a primarily westerly aspect. ▪ Drainage lines direct run-off to sediment control structures to the west. ▪ Landform surface preparation comprised bulk shaping, deep ripping, rock raking, and removal of oversize rock material.

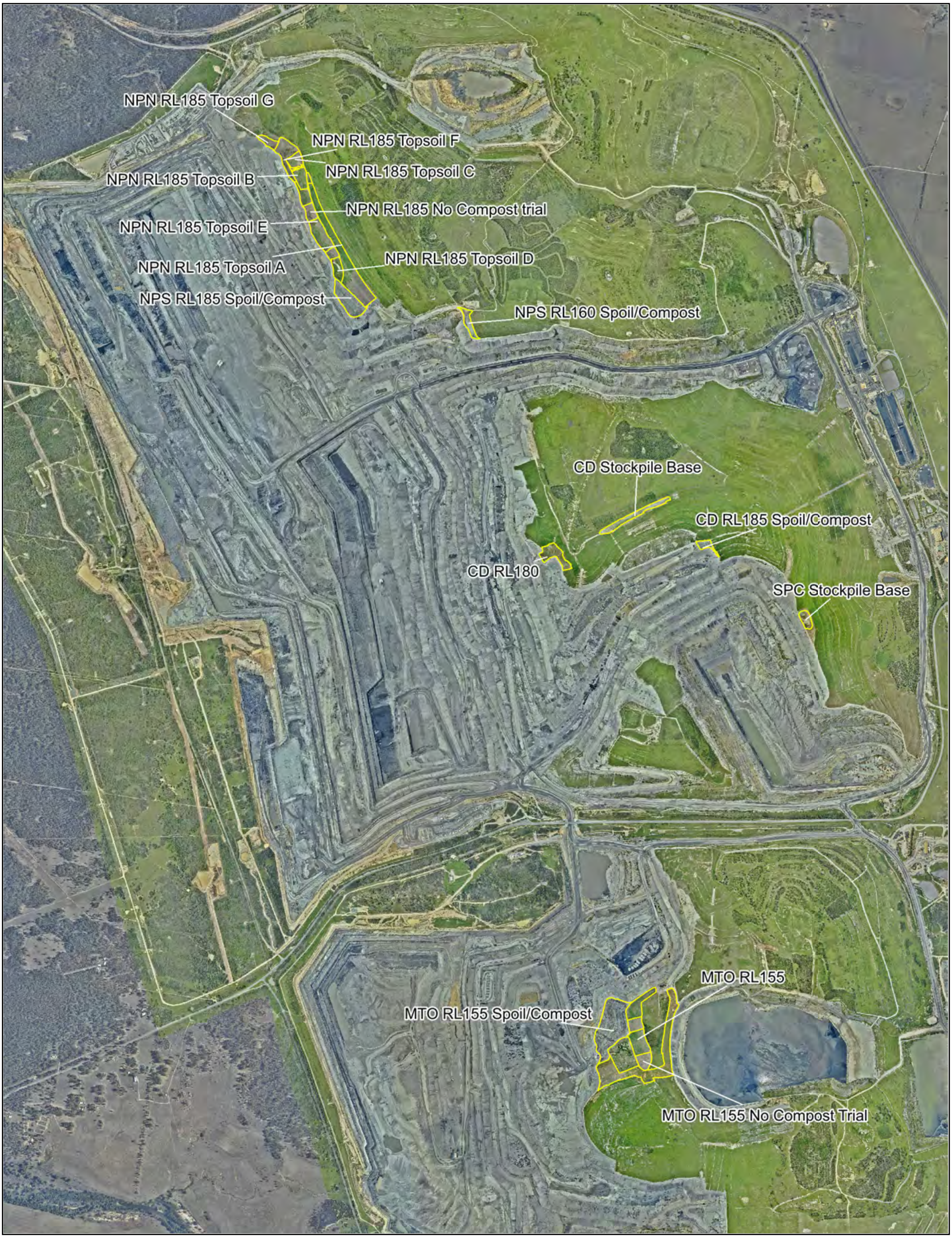
Rehabilitation Site Name	Type	Coordinates (GDA2020)	Area (ha)	*Rehabilitation Summary*
				▪ Clay loam/sandy clay loam topsoil from existing topsoil stockpiles was spread at a nominal thickness of 100mm. ▪ Soil ameliorants comprising recycled gypsum and Bettergrow Biomulch compost were applied at rates of 5t/ha and 50t/ha respectively. ▪ Growth medium preparation included ameliorant incorporation, rock windrowing, rock picking, and aerating as required ▪ The area was sown in October with Diverse Native Woodland at 15.7kg/ha. Non-flowable (grass) seed was spread onto the surface using a direct drill and then the flowable components of the seed mix were spread via an air-seeder mounted on the aerator implement.
MTO RL155 No Compost Trial	Woodland	319,533.04 E 6,386,404.50 N	1.6	▪ The landform was constructed from a waste emplacement. ▪ The landform has been designed using a geomorphological landform approach based on alluvial analogues. Typical slope of the landform is less than 10 degrees. The slope has a primarily westerly aspect. ▪ Drainage lines direct run-off to sediment control structures to the west. ▪ Landform surface preparation comprised bulk shaping, deep ripping, rock raking, and removal of oversize rock material. ▪ Clay loam/sandy clay loam topsoil from existing topsoil stockpiles was spread at a nominal thickness of 100mm. ▪ Recycled gypsum was applied at a rate of 5t/ha. No compost was applied to trial area. ▪ Growth medium preparation included ameliorant incorporation, rock windrowing, rock picking, and aerating as required ▪ The area was sown in October with Diverse Native Woodland at 15.7kg/ha. Non-flowable (grass) seed was spread onto the surface using a direct drill and then the flowable components of the seed mix were spread via an air-seeder mounted on the aerator implement.
NPN RL185 Topsoil E	Woodland	317,435.34 E 6,391,803.18 N	2.5	▪ The landform was constructed from a waste emplacement. ▪ The landform has been designed using a geomorphological landform approach based on alluvial analogues. Typical slope of the landform is less than 10 degrees. The slope has a primarily westerly aspect. ▪ No water management structures were required on this section of landform. ▪ Landform surface preparation comprised bulk shaping, deep ripping, rock raking, and removal of oversize rock material.

Rehabilitation Site Name	Type	Coordinates (GDA2020)	Area (ha)	*Rehabilitation Summary*
				▪ Sandy loam topsoil from stripping areas in North Pit South was spread directly at a nominal thickness of 100mm. ▪ Soil ameliorants comprising recycled gypsum and Bettergrow Biomulch compost were applied at rates of 5t/ha and 50t/ha respectively. ▪ Growth medium preparation included ameliorant incorporation, rock windrowing, rock picking, and aerating as required ▪ The area was sown in October with Diverse Native Woodland at 15.7kg/ha. Non-flowable (grass) seed was spread onto the surface using a direct drill and then the flowable components of the seed mix were spread via an air-seeder mounted on the aerator implement.
NPN RL185 No Compost trial	Woodland	317,394.34 E 6,391,864.08 N	1.2	▪ The landform was constructed from a waste emplacement. ▪ The landform has been designed using a geomorphological landform approach based on alluvial analogues. Typical slope of the landform is less than 10 degrees. The slope has a primarily westerly aspect. ▪ No water management structures were required on this section of landform. ▪ Landform surface preparation comprised bulk shaping, deep ripping, rock raking, and removal of oversize rock material. ▪ Sandy loam topsoil from stripping areas in North Pit South was spread directly at a nominal thickness of 100mm. ▪ Recycled gypsum was applied at a rate of 5t/ha. No compost was applied to trial area. ▪ Growth medium preparation included ameliorant incorporation, rock windrowing, rock picking, and aerating as required ▪ The area was sown in October with Diverse Native Woodland at 15.7kg/ha. Non-flowable (grass) seed was spread onto the surface using a direct drill and then the flowable components of the seed mix were spread via an air-seeder mounted on the aerator implement.
NPN RL185 Topsoil F	Woodland	317,223.21 E 6,392,199.62 N	1.7	▪ The landform was constructed from a waste emplacement. ▪ The landform has been designed using a geomorphological landform approach based on alluvial analogues. Typical slope of the landform is less than 10 degrees. The slope has a primarily westerly aspect. ▪ No water management structures were required on this section of landform. ▪ Landform surface preparation comprised bulk shaping, deep ripping, rock raking, and removal of oversize rock material.

Rehabilitation Site Name	Type	Coordinates (GDA2020)	Area (ha)	*Rehabilitation Summary*
				▪ Sandy loam topsoil from stripping areas in North Pit South was spread directly at a nominal thickness of 100mm. ▪ Soil ameliorants comprising recycled gypsum and Bettergrow Biomulch compost were applied at rates of 5t/ha and 50t/ha respectively. ▪ Growth medium preparation included ameliorant incorporation, rock windrowing, rock picking, and aerating as required ▪ The area was sown in November with Diverse Native Woodland at 15.7kg/ha. Non-flowable (grass) seed was spread onto the surface using a direct drill and then the flowable components of the seed mix were spread via an air-seeder mounted on the aerator implement.
NPN RL185 Topsoil G	Woodland	317,118.53 E 6,392,308.28 N	0.6	▪ The landform was constructed from a waste emplacement. ▪ The landform has been designed using a geomorphological landform approach based on alluvial analogues. Typical slope of the landform is 10 to 14 degrees. The slope has a primarily northerly aspect. ▪ Drainage lines direct water to rock lined drains to the north. ▪ Landform surface preparation comprised bulk shaping, deep ripping, rock raking, and removal of oversize rock material. ▪ Sandy loam topsoil from stripping areas in North Pit Northh was spread directly at a nominal thickness of 100mm. ▪ Soil ameliorants comprising recycled gypsum and Bettergrow Biomulch compost were applied at rates of 5t/ha and 50t/ha respectively. ▪ Growth medium preparation included ameliorant incorporation, rock windrowing, rock picking, and aerating as required ▪ The area was sown in November with Diverse Native Woodland at 15.7kg/ha. Non-flowable (grass) seed was spread onto the surface using a direct drill and then the flowable components of the seed mix were spread via an air-seeder mounted on the aerator implement.
NPS RL160 Spoil/Compost	Woodland	318,411.77 E 6,391,150.27 N	0.8	▪ The landform was constructed from a waste emplacement. ▪ The landform is flat in this area, no aspect. ▪ Area is flat and hence not requiring drainage controls. ▪ Landform surface preparation comprised bulk shaping, deep ripping, rock raking, and removal of oversize rock material. ▪ No topsoil was added, spoil has been used as the growth medium.

Rehabilitation Site Name	Type	Coordinates (GDA2020)	Area (ha)	*Rehabilitation Summary*
				▪ Soil ameliorants comprising recycled gypsum and Bettergrow Biomulch compost were applied at rates of 5t/ha and 50t/ha respectively. ▪ Growth medium preparation included ameliorant incorporation, rock windrowing, rock picking, and aerating as required ▪ The area was sown in November with Diverse Native Woodland at 15.7kg/ha. Non-flowable (grass) seed was spread onto the surface using a direct drill and then the flowable components of the seed mix were spread via an air-seeder mounted on the aerator implement.
NPS RL185 Spoil/Compost	Woodland	317,652.77 E 6,391,311.87 N	2.3	▪ The landform was constructed from a waste emplacement. ▪ The landform has been designed using a geomorphological landform approach based on alluvial analogues. Typical slope of the landform is less than 10 degrees. The slope has a primarily westerly aspect. ▪ Drainage lines direct water to the west. ▪ Landform surface preparation comprised bulk shaping, deep ripping, rock raking, and removal of oversize rock material. ▪ No topsoil was added, spoil has been used as the growth medium. ▪ Soil ameliorants comprising recycled gypsum and Bettergrow Biomulch compost were applied at rates of 5t/ha and 50t/ha respectively. ▪ Growth medium preparation included ameliorant incorporation, rock windrowing, rock picking, and aerating as required ▪ The area was sown in November with Diverse Native Woodland at 15.7kg/ha. Non-flowable (grass) seed was spread onto the surface using a direct drill and then the flowable components of the seed mix were spread via an air-seeder mounted on the aerator implement.
MTO RL155 Spoil/Compost	Woodland	319,338.95 E 6,386,598.29 N	5.7	▪ The landform was constructed from a waste emplacement. ▪ The landform has been designed using a geomorphological landform approach based on alluvial analogues. Typical slope of the landform is less than 10 degrees. The slope has a primarily westerly aspect. ▪ Drainage lines direct water to the west. ▪ Landform surface preparation comprised bulk shaping, deep ripping, rock raking, and removal of oversize rock material. ▪ No topsoil was added, spoil has been used as the growth medium. ▪ Soil ameliorants comprising recycled gypsum and Bettergrow Biomulch compost were applied at rates of 5t/ha and 50t/ha respectively.

Rehabilitation Site Name	Type	Coordinates (GDA2020)	Area (ha)	*Rehabilitation Summary*
				▪ Growth medium preparation included ameliorant incorporation, rock windrowing, rock picking, and aerating as required ▪ The area was sown in December with Diverse Native Woodland at 15.7kg/ha. Non-flowable (grass) seed was spread onto the surface using a direct drill and then the flowable components of the seed mix were spread via an air-seeder mounted on the aerator implement.
SPC Stockpile Base	Woodland		0.7	▪ The landform was constructed from a waste emplacement. ▪ The landform is flat in this area, no aspect. ▪ Area is flat and hence not requiring drainage controls. ▪ Landform surface preparation comprised minor shaping, deep ripping, rock raking, and removal of oversize rock material. ▪ Area was an old topsoil stockpile so there was remaining Clay loam/sandy clay loam topsoil from the floor of the stockpile at a nominal thickness of 100mm. ▪ Soil ameliorants comprising recycled gypsum and Bettergrow Biomulch compost were applied at rates of 5t/ha and 50t/ha respectively. ▪ Growth medium preparation included ameliorant incorporation and aerating as required ▪ The area was sown in December with Diverse Native Woodland at 15.7kg/ha. Non-flowable (grass) seed was spread onto the surface using a direct drill and then the flowable components of the seed mix were spread via an air-seeder mounted on the aerator implement.



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MTW
Rehabilitation Areas 2020

File: Rehab areas 2020.wor
Rehab Areas 2020.PDF
Aerial photo taken December 2020

Date:	25/03/2021
Produced By:	BB
Map Size:	A4 Portrait
Coordinate System:	MGA2020 Zone 56
Revision	01
Data Source	Various

Appendix 7:

IEA Action Status Table

Mount Thorley Warkworth Complex (SSD-6464 and SSD-6465) – Independent Environmental Audit 2020 – Progress with Audit Recommendations

NON-COMPLIANCE RECOMMENDATIONS AND RESPONSES			
Ref	**Non-Compliance**	**Hansen Bailey Recommendation**	**MTW Progress**
Previous IEA			
Table 6	Review process for documenting training records for training required by approvals. Implement process for documenting these training records as required.	No outstanding recommendations from previous IEA.	Review of process has been completed by MTW, and progress has been made but not finalised (e.g. Viewed BMP training procedures listing the role and purpose for Drill and Blast Engineer, Environment and Community Coordinator and Drill Coordinator). This will be completed during the 2021 Annual Review period.
SSD 6464			
Sch 2 Cond 9	The application to surrender DA-300-9-2002-i has not been approved by DPIE. Email from DPIE dated 3/3/20 states that DPIE does not have capacity to complete the surrender and will complete in "the near future".	Follow up with DPIE to seek surrender notice.	MTW followed up progress with DPIE during August 2020, and February 2021 and will follow up with DPIE to progress surrender of the relevant consent during the 2021 Annual Review period.
Sch 3 Cond 8	Three blast non-compliances during the IEA period. Two blasts exceeded the blast criteria of 120 dBA (28/12/18, 4/4/19). One blast was an administrative non-compliance for failure to capture the blast at the monitor (5/7/18). A penalty notice was issued from DPIE for the blast exceedance occurring on the 4/4/19.	Implement continuous improvement practices with the aim to avoid any blast exceedances.	MTW has already reacted with modification to blast practices in relation to each on the non-compliances noted, including engaging external investigations, modifications to blast permissions pages, and installing an additional weather station to assist review. As a further measure of continuous improvement, MTW are also working with stakeholders in the Hunter Valley to enable the implementation of a real time model, which will use real time meteorological data from weather stations throughout the Hunter Valley to better determine the effect of possible overpressure enhancement. Development of an MTW specific model is in its final stages of development, with testing and implementation expected to occur by end of June 2021.
Sch 3 Cond 28	The condition requires retirement of the required biodiversity credits within 3 years of the development commencing (i.e. by 14 February 2019). Although correspondence with regulators has occurred regarding progress to date, including issues with changing biodiversity legislation, possible timelines to complete, and correspondence on impending administrative non-compliance with this condition, there is no evidence available that the timelines proposed for the retirement of biodiversity credits has been achieved. No formal extension to the 3 year timeframe can be granted by DPIE as the condition does not allow the Secretary to grant one.	At next modification consider to request amendment to condition to facilitate extension to time by adding "or with the agreement of the Secretary" after "approval" consistent with other contemporary approvals.	MTW agree with this recommendation if next modification occurs prior to credits being retired for biodiversity areas. MTW will continue to progress current engagement path with Biodiversity Conservation Division regarding this condition as detailed in the IEA report. DPIE Sydney is also being consulted and has also been advised of progress with BCD. Estimated completion date for establishment of Biodiversity Stewardship Agreements and retirement of credits from the various Biodiversity Areas, is 30 November 2021.
Sch 3 Cond 30	No evidence that offset areas listed in Table 12 have been secured under an in-perpetuity conservation mechanism in accordance with the relevant provisions of the *Threatened Species Conservation Act.*	Continue to progress long term security mechanism for ecology offset areas with relevant regulators.	MTW will continue to progress current engagement path with Biodiversity Conservation Division regarding this condition as detailed in the IEA report. DPIE Sydney is also being consulted and has also been advised of progress with BCD.

NON-COMPLIANCE RECOMMENDATIONS AND RESPONSES			
Ref	**Non-Compliance**	**Hansen Bailey Recommendation**	**MTW Progress**
			Estimated completion date for establishment of Biodiversity Stewardship Agreements and retirement of credits from the various Biodiversity Areas is 30 November 2021.
Sch 3 Cond 34	2017 audit confirmed it sighted evidence of consultation with neighbouring mines and OEH. OEH has not confirmed whether the Integrated Management Plan for the Warkworth Sands Woodland EEC is to their satisfaction.	Follow up with OEH to confirm that Integrated Management Plan for the Warkworth Sands Woodland EEC is to their satisfaction.	OEH has not approved this plan yet despite being submitted for approval within 12 months. Follow up with Biodiversity Conservation Division has occurred during April-May 2020 which indicated this item has moved up BCD priority list. MTW to follow up with BCD on the status of the Integrated Management Plan for the Warkworth Sands Woodland EEC during site visit planned for 27 October 2020 with the intention to resolve during the 2020 Annual Review period. Approval status of the Integrated Management Plan for the Warkworth Sands Woodland EEC raised during the site visit on 27 October 2020 however no response has been received from BCD on approval of this plan.
Sch 3 Cond 43(c)	The research program as part of the AHMP has not been progressed and was due to be implemented in August 2017.	Access to the sand bodies with HVO should be resolved. If access cannot be granted, discussions should occur with relevant regulators and modify the ACHMP to relocate the Research Program requirement. The Research Program on MTW should be progressed.	The main delay associated with this project has been the access arrangements for research areas that are not located on land owned/managed by Yancoal. Timing to resolve access issues for parts of the currently proposed program located on non-MTW owned land to understand if access may be granted: By 31 July 2021. Within 3 months of understanding land access position, MTW is proposing to consult with the relevant regulators and its registered Aboriginal parties (RAP's) regarding a revised scope of works for the research program which will be tailored for research areas that are currently located on land that is currently owned or is under agreement with MTW. This will allow for the program to proceed without further delays associated with legal agreements for access.
Sch 3 Cond 57	There were ongoing delays in the progression of rehabilitation areas identified by the Resources Regulator for which MTW received a Section 240 notice.	Complete undertaking actions described in Section 240 notice issued by the Resource Regulator. Actions are being processed as described in Appendix E.	MTW do not agree that this is not compliant regarding progressive rehabilitation. Rehabilitation progress on Woodlands Dump area has been delayed by move to partially back fill South Pit Void. Autobahn Haul road will be required to be kept open for longer to allow access for waste trucks to dump into South Pit Void. Closure of the Autobahn Haul road is required to progress rehabilitation on the south facing slope of Woodlands Dump. Alternative rehabilitation areas have been found in other parts of Warkworth Pit to allow rehabilitation progress to keep pace with EIS projections. Confirmation received from Resources Regulator on 24 January 2020 that the directions of section 240 notices NTCE0003219 and NTCE 0003168 had been satisfactorily addressed by the submission of the Emergent Ecology Report into rehabilitation progress at MTW. The requirements of subsequent section 240

NON-COMPLIANCE RECOMMENDATIONS AND RESPONSES			
Ref	**Non-Compliance**	**Hansen Bailey Recommendation**	**MTW Progress**
			notices NTCE0004831 and NTCE0004858 have been addressed through the submission of the MTW MOP Amendment C on 31 March 2020. MTW MOP Amendment C was approved by Resources Regulator on 24 November 2020.
SSD 6465			
Sch 3 Cond 27	No evidence that the Loders Creek Aboriginal Cultural Heritage Conservation Area has been entered into a Conservation Agreement.	Progress establishment of the Loders Creek Heritage Conservation Area Agreement with relevant regulators.	MTW has provided BCD with a draft Conservation Agreement for the WBACHCA for its consideration and continues to engage with BCD on the process for registering the WBACHCA conservation agreement. Once BCD has approved the WBACHCA conservation agreement it is MTW's intention to use the approved agreement as a template to draft and submit the LCACHCA conservation agreement for approval. Estimated timing for submission of LCACHCA conservation agreement to BCD post the WBACHCA process being completed is 30 August 2021.

CONTINUAL IMPROVEMENT RECOMMENDATIONS		
Ref	**Hansen Bailey Recommendation**	**MTW Progress**
SSD 6464		
Sch 3 Cond 6(d)	Recommend toolbox talk (or similar) distributed to relevant personnel in relation to reminder for need for sound suppression on mobile fleet.	MTW agrees with this recommendation and have distributed a toolbox talk on mobile fleet sound suppression to all site personnel.
Sch 3 Cond 7(e)	Undertake a regular comparison of real time monitoring as part of regular, external noise monitoring to validate real time monitoring results and discuss in Annual Review which is the intent of this condition. Recommend showing maximum monitored result from the three quarterly readings (LAeq 15 min) in all tables in section 6.5 of the Annual Reviews, instead of an average of the three. The link in the AR should also be updated to facilitate ease of finding detailed noise results to https://insite.yancoal.com.au/document-library/monthly-reporting-mtw.	MTW are undertaking a regular comparison of real time and external noise monitoring. This comparison was undertaken in quarter four 2020 and will be discussed in Annual Reviews going forward. MTW have shown maximum values in Table 6.5 of the 2020 Annual Review and in Annual Review's going forward and the link in the AR has also be updated to facilitate ease of finding detailed noise results, as recommended.
Sch 3 Cond 16(c)	Add statement in Road Closure Management Plan at next update that occupancy licences are updated annually.	A statement has been included in the main text of the revised Blast Management Plan that occupancy licences will be included in Appendix D (Road Closure Management Plan) of the BMP as they are updated and that an update to the Road Occupancy Licences in Appendix D will not trigger submission of an updated BMP to DPIE, but rather enable the current licences to be viewed. This revised Blast Management Plan was submitted for approval to DPIE on 28 July 2020, with approval pending.
Sch 3 Cond 18(a)	Tenant and landowner on mine owned land be re-notified of any health risks associated with such exceedances in accordance with the notification requirements under schedule 4 of this consent; at least 5 yearly (i.e. 2020).	MTW will review notification methods, when last notification was undertaken, and where this is not already addressed in residential tenancy agreements, will develop a system to schedule re-notification of tenants and landowners as every 5 years by the end of Q2 2021.
Sch 3 Cond 18(c)	MTW's TEOM's are located in positions that are representative of privately owned properties. The TEOM results should be utilised to calculate results for the closest tenant to be available should a regulator, tenant or landholder request this data.	MTW has engaged an air quality consultant to clarify whether extrapolation from the current air quality monitoring network data provides representative data to inform tenants of the particulate emissions at their residence or if additional monitoring is required. This engagement and review have occurred and any outcomes will be assessed and implemented where required in 2021.
Sch 3 Cond 19(c)	Ensure equipment downtime logging includes all environmental alerts.	Equipment downtime is currently categorised for "Dust" and "Environment". MTW have investigated the need for additional downtime categories in 2020 and although not deemed required, consider that it would be beneficial for increased clarity in reporting and for internal tracking purposes. MTW will look to implement an additional "Noise" category in 2021.
Sch 3 Cond 19(d)	Process to co-ordinate the air quality management on site with the air quality management at nearby mines (including the Mt Thorley, Bulga, Wambo and Hunter Valley Operations mines) to minimise any cumulative air quality impacts is formalised and included in next revision to AQMP as per condition Sch 3 Cond 20f below.	MTW has updated the inter-site communications protocol for environmental management within the AQMP, to minimise the cumulative air quality impacts with neighbouring mines and has submitted to DPIE for approval on 13 November 2020.
Sch 3 Cond 19(d)	Document protocols to minimise the cumulative air quality with neighbouring mines within the AQMP	MTW has updated the inter-site communications protocol for environmental management within the AQMP, to minimise the cumulative air quality impacts with neighbouring mines and has submitted to DPIE for approval on 13 November 2020.
Sch 3 Cond 27(b)(ii)	Progress the SLR recommendations in the annual Stream Health and Channel Stability report.	MTW is committed to progressing the recommendations in the annual Stream Health and Channel Stability report regarding observed erosion near monitoring points. This will commence with a preliminary environmental constraints review (cultural heritage, ecology, works near watercourse) during the 2021 Annual Review period to inform the scope of any further works.

CONTINUAL IMPROVEMENT RECOMMENDATIONS		
Ref	**Hansen Bailey Recommendation**	**MTW Progress**
Sch 3 Cond 27(b)(iii)	The recommendations in the 2019 Annual Groundwater Review conducted by SLR Consulting should be progressed: • MTW changed its sampling methodology during the 2019 reporting period following recommendations in the 2018 review. It is recommended that a review of the trigger be undertaken in light of the revised sampling methodology. • Further investigation into the ground conditions, bore construction and loggers at PZ7S and PZ7D is recommended. • Grab samples have been taken for monitoring bores WOH1239A, WOH2141A, WOH2153A, WOH1254A, WOH2155A, WOH2156A, WD622P, MBW02 and MBW03 within the network. This approach is not in line with industry standards and may not provide a representative water quality sample. The justification for this methodology should be reviewed to determine if more suitable methods (i.e. full purge or low flow) can be applied. A review into the requirement of these bores for the collection of water quality data for the WMP should be undertaken. If it is found that the continued collection of water quality data is required from a bore and suitable sampling methods cannot be adopted, then bore rectification works should be considered. • A review of the construction details and lithological logs for each bore should be undertaken to confirm that each bore is targeting the Blakefield Seam." At the next Annual Groundwater Review, bore GW98MTCL2 is reviewed and discussed in the AR.	MTW has reviewed the triggers and submitted the changes in the 2020 Water management Plan revision. This plan is yet to be formally approved. A consultant has been engaged to complete a monitoring network review which will address the other comments. Work has commenced and is scheduled for completion in the first half of 2021.
Sch 3 Cond 28	Adding a table to Section 4 of the Biodiversity MP summarising the specific ecosystem/species credit obligations and where they are being met across each offset property to confirm all credit obligations are being met by the offset package. At next modification, to ensure compliance, consider seeking to amend the mechanism as NSW Biodiversity Offsets Policy for Major Projects no longer applies (in this and subsequent relevant conditions).	MTW agree with the recommendation. A table will be added to BMP when agreement is reached with BCD on retirement of credits. Estimated completion date for establishment of Biodiversity Stewardship Agreements and retirement of credits from the various Biodiversity Areas is 30 November 2021.MTW will consult with DPIE on this matter if a modification occurs prior to credits being retired for biodiversity areas.
Sch 3 Cond 32	Collect attributes as part of monitoring include additional measures such as stem classes and groundcovers. Given data is available, suggest adding some of these to the performance criteria or provide discussion on using data to aid in adaptive mgt e.g. stem class count threshold to aid in determining whether future thinning actions are required to increase vegetation in groundcover.	MTW added detail to the Trigger, Response and Action table in a draft update to the BMP by 13 November 2020. The updated BMP will be submitted post the AER 2021 submission.

CONTINUAL IMPROVEMENT RECOMMENDATIONS		
Ref	**Hansen Bailey Recommendation**	**MTW Progress**
Sch 3 Cond 36(e)	Implement the monitoring reports recommendations for the restoration of WSW and generally the Biodiversity Offset Area (BOA)s including: Habitat restoration monitoring for the southern and northern BOAs (Niche 2018). • A more finely detailed assessment of management zones (Warkworth Sands Grassland (Management Zones 2 and 4) be undertaken in order to target management works appropriately; • Direct seeding of grassland areas may be required; and • An assessment of the canopy recruitment at each transition site should be undertaken to determine if further planting or seeding is required. Vegetation and habitat monitoring for the Goulburn and Condon View BOAs (Niche 2016 and 2018). • Management intervention involving increased weed management should be considered to prevent weed incursions impacting on vegetation; and • F\or intensive management including intensive weed would be needed to assist in regeneration. Provide information relating to salinity in Biodiversity Management Plan or link to Plan where this is addressed.	Monitoring report recommendations to be implemented in monitoring period 2022 (2020 monitoring already completed). BMPs were updated to include salinity information by 13 November 2020.
Sch 3 Cond 39	Progress and complete conservation agreement relating to Wollombi Brook Aboriginal Cultural Heritage Conservation Area prior to entering the area beyond the "Proposed Initial Mining Area" west of Lot 1/2 DP 124545.	The Aboriginal Heritage Conservation Agreement (CA) is in progress. Yancoal MTW met with BCD on 11/3/20 to discuss. In order to register the CA on relevant land titles, a standard form (Form 13NP) is required to be signed by all relevant landowners and the Minister (being progressed during current Annual Review period). Updated survey sketch plans of the land to be included in the CA have since been prepared, with an update to the CA schedule of land and the associated Plan of Management is to be prepared for submission to BCD prior to end of 2021.
Sch 3 Cond 42	No reports were available for the first and second salvages (defined in Table A of **Appendix E**) were available at the time of this IEA. Recommend these are finalised asap and submitted to BCD to update AHIMS Register.	While formal salvage reports were not developed for these salvages, MTW can confirm that the salvages were undertaken in accordance with the methodology outlined in the sites ACHMP. All salvage activities were undertaken in consultation with the CHWG. During the 2020 Annual Review period, MTW engaged a suitably qualified archaeologist to complete the salvage reports and ensured the site cards associated with the above-mentioned works were updated with AHIMS.
Sch 3 Cond 43(b)	• Original GDP forms and spreadsheet are updated following field inspection by Environmental team to confirm that all GDPs actions are completed and signed off. • A requirement of the AHMP is for the long-term management of Aboriginal Objects. The objects are in storage at HVO. A new care agreement has been approved with OEH, 26 April 2019, and communicated to the Registered Aboriginal Parties in October 2019, however the objects are yet to be relocated. Recommend this is progressed.	During the 2020 Annual Review period, MTW relocated the Aboriginal Objects in accordance with the recent Care Agreement from OEH.
Sch 3 Cond 46(d)	• Add labels for the RAAF Base Bulga, Great Northern Road, the Brickhouse and Springwood Homestead to figures in the HHMP at next review. • Action recommendations from '*Archaeological Investigations of the Former RAAF Base Bulga*' report dated March 2018 and report on in Annual Review. • Action recommendations from '*Mount Thorley Warkworth Historic Heritage Management Plan 2019 Compliance Audit Inspection'* in the next period and report on in Annual Review.	MTW will include the labels for the relevant historic heritage sites in the next review of the sites Historic Heritage Management Plan. MTW has developed a project schedule and budget to progress the recommendations outlined in the sites Historic Heritage Management Plan and each Conservation Management Plan for its known heritage sites during the 2020 and the 2021 Annual Review period

CONTINUAL IMPROVEMENT RECOMMENDATIONS		
Ref	**Hansen Bailey Recommendation**	**MTW Progress**
Sch 3 Cond 52(a)	Amend internal Procedures and CRO Work Instruction to refer to revised '*Lighting and Management Leaders document*' and training rolled out to relevant personnel.	The *Lighting and Management - Leaders and Mining Supervisors* procedure is available on the MTW document control system for use at MTW.
Sch 3 Cond 52(b)	Additional plantings designed and undertaken to reduce view at the third crossing into Mt Thorley.	MTW will review the location of this recommendation for additional plantings, and action if visual screening is deemed necessary. The location will be reviewed by 30 November 2020 and plantings completed by Autumn (May) 2021.
Sch 3 Cond 56	Update rehabilitation procedures to include requirements of biosolids guidelines. Recommend fly ash and other waste conditions from EPL are also included. As per **Appendix F**, the current weed management controls on site is generally acceptable and in accordance with key guidelines. However, successfully management and tracking of improvement in these areas against performance and long term completion criteria may require more intensive control actions. Potential options for investigation may include: Additional trials areas and analysis of spoil compost Vs no compost VS topsoils in weed cover and density;	MTW is already progressing adding the requirements of Biosolids Guideline to rehabilitation procedures. Requirements for other wastes listed in EPL will be added to rehabilitation procedures as required. Update rehabilitation procedures to include the requirements of the Biosolids Guidelines and requirements for other wastes listed in the EPL as required. Completion date 30 June 2021.
Sch 3 Cond 58(d)	The TARP is shown in Table 44 of the MOP, and does not clearly delineate between tier one and tier two trigger values, recommend this is amended to clarify. Within the MOP, it is also unclear how the rehabilitation of the site is integrated with the implementation of the biodiversity offset strategy, the next amendment should clarify this.	MTW will review TARP during next MOP update to provide guidance on delineation for trigger values between Tier One and Tier Two responses. MTW will also consider how the biodiversity offset comments can be included in the next MOP amendment. Update MOP to provide guidance on delineation for trigger values between Tier One and Tier Two responses; and to clarify how the rehabilitation of the site is integrated with the implementation of the biodiversity offset strategy. Completed 13 November 2020. MOP Amendment C Sections 5.2.2 and 9.
Sch 3 Cond 58(g)	Although the MOP is approved, no relevant level of mine closure strategy is included. Recommend this is undertaken and included at next Amendment.	Include mine closure strategy items listed in Sch 3 Cond 58(g) in the next Rehabilitation Management Plan (MOP) amendment. Update MOP to Include mine closure strategy items listed in Sch 3 Cond 58(g). Completed 13 November 2020. MOP Amendment C Section 1.6.
Sch 4 Cond 2(a)	Tenants are advised of the potential health and amenity impacts associated with living on the land, and provided a copy of the NSW Health fact sheet regularly (e.g. five yearly).	MTW will review notification methods, when last notification was undertaken, and where this is not already addressed in residential tenancy agreements, will develop a system to schedule re-notification of tenants and landowners as every 5 years by the end of Q2 2021.
Sch 5 Cond 1	As proposed, prepare a risk based environmental training program focusing on high priority areas. Program should be completed regularly as toolbox talks (or other preferred methods) and training recorded.	MTW undertakes environmental training for new starters and at induction and maintains records of that training. MTW is looking to extend the environmental training based on risk for particular roles. This will include tool box talks, keeping a record of personnel attendance. A more formal training program will be developed and distributed to relevant site personnel. The formal environmental training program currently being developed will be rolled out prior to the end Q2 2021.

CONTINUAL IMPROVEMENT RECOMMENDATIONS		
Ref	**Hansen Bailey Recommendation**	**MTW Progress**
Sch 5 Cond 9(d)	Northern Biodiversity Area The current weed management controls on site is generally acceptable and in accordance with key guidelines. However, successfully management and tracking of improvement in these areas against performance and long term completion criteria may require more intensive control actions. Potential options for investigation may include: • A digitised register of application area linked to proposed return frequency prior to consecutive seed set may further assist in medium to long term planning of weed control on site; • Trials of dedicated repeat control Vs non control to determine effort reward improvements; and • Trail areas of scalping, burning and or supplementary native seeding in BOAs with significant pasture and understorey weed infestations. To ensure year 15 performance targets of 75% survival and minimum number of tube stock are met, increased number of plantings are proposed. These additional plantings should reflect the survival rates for species diversity across each of the different structural layers of the WSW.	Scalping trials have been included in the 2020 planting strips at the NBA. Native grass seeding has also been included prior to tube stock planting at the NBA to increase species diversity in the groundcover. Increased number of planting are planned, draft BMP was updated to include this updated mapping by 13 November 2020.
EPL 1376		
P1.3	Update Water and Land Table as follows: Location Description for Discharge to pipe (EPA Identification No. 24), is required by Special Condition E2, not E3. Include mine name where discharge of mine water will occur to.	MTW will request that this table be updated in the next revision to EPL1376.
O4	Inspection / maintenance forms required under this condition be updated to specifically refer to ponding (O4.3).	MTW will review and update the sites effluent management system quarterly inspection checklist to include ponding by 30 June 2021.