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SIX MONTHLY SUBSIDENCE IMPACT REPORT

Tahmoor North, Western Domain Longwalls West 1 and West 2

13 October 2020 – 21 April 2021

Report 3 – May 2021

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Document Control

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Executive Summary

This report is the third six-monthly report to be submitted since the commencement of extraction of Longwall West 1 (LW W1), in accordance with the requirements of the Longwall West 1 and West 2 (LW W1-W2) Extraction Plan. The reporting period of this report is from 13 October 2020 to 21 April 2021.

LW W1 extraction was completed on 6 November 2020, and the extraction of Longwall West 2 (LW W2) commenced on 7 December 2020. As of 21 April 2021, 1236 metres of LW W2 had been extracted.

During the reporting period, observed subsidence along the centreline of LW W2 is greater than LWW1 but current trends indicate that observed subsidence will be less than predicted subsidence and no trends of definitive valley closure have been evident.

There were ten (10) occurrences where Trigger Action Response Plans (TARPs) triggers occurred and further actions were required, as well as a number of impacts to roads and built structures that required remediation. These TARP triggers included:

- Pool Water Level TARP – Level 2, 3 and 4 triggered due to Pool water level reduction and atypical surface water behaviour in Cedar Creek. Various pools were triggered including Site CA, CB, CD, CF and CG. Fortnightly monitoring and analysis of surface water level data will continue for sites CA, CB, CC1A, MR45 and MR46 until confirmed otherwise and further investigation into the feasibility of implementing additional surface water monitoring is being conducted;
- Natural Drainage Behaviour TARP trigger due to gas emissions at Pool MR45. Minor gas emissions occurred in December 2020. Previous gas samples indicated that the gas originated from the shallow Hawkesbury Sandstone stratas and/or shallow anoxic muds. No further action required – continuation of existing monitoring program;
- Groundwater Bore Level TARP trigger due to reduced water level elevation below the baseline range for a number of open standpipe piezometers (P12, P13 and P16). Monitoring frequency increased from monthly to fortnightly for P12C as requested by DPIE. As the results are within predictions and are not connected with any surface water impacts, no actions are required other than the continuation of the existing monitoring program;
- Shallow Groundwater Pressures TARP triggered due to depressurisation below the baseline range for shallow vibrating wire piezometer TNC036 and WD01. Monitoring frequency increased from monthly to fortnightly for TNC036 as requested by DPIE. As the results are within predictions and are not connected with any surface water impacts, no actions are required other than the continuation of the existing monitoring program;
- Deep Groundwater Pressures TARP trigger due to a trend of depressurisation below baseline range for TNC036 in April 2021. Monitoring frequency increased from monthly to fortnightly for TNC036 as requested by DPIE. Groundwater monitoring will continue under the existing monitoring program.
- Historical Heritage TARP – Level 2 Trigger for Sandstone Culvert impacts at 89.629km as a result of a small traverse crack up to 2mm. This cracking is related to the minor

opening of an existing crack (previously reported and not adversely affecting the structural integrity of the culvert);

- Historical Heritage TARP – Level 2 Trigger for Sandstone Culvert Impacts at 88.44 km – crack up to 7 mm at the crest, crack on the upside headwall up to 6 mm, and minor spalling on the obvert headwall showing evidence of outward movement up to 7 mm of the headwall and wingwall relative to the culvert (not adversely affecting the structural integrity of the culvert);
- Historical Heritage TARP – Level 2 Trigger for Sandstone Culvert Impacts at 88.980 km – minor separation and circumferential cracking. These cracks are noted to be minor and are not adversely affecting the structural integrity of the culvert;
- Main Southern Railway TARP – Blue Trigger at Ballast Top Subway (86.838 km). Minor closure across the abutments of the structure related to a continuation of pre-existing conditions and were unlikely to be mining induced. Trigger resolved following track adjustments in March 2021; and
- Picton-Mittagong Loop Line TARP – Blue Trigger for Joint Closure (87.9 – 88.5 km). Adjustments of the track were completed in April 2021, resolving the TARP trigger.

During the reporting period, there were no exceedances of environmental performance measures or indicators, as adopted from DA 67/98 Modification 4 or the LW W1-W2 Extraction Plan Approval conditions.

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1 Introduction

This Six-Monthly Subsidence Impact Report fulfils the reporting requirement of the Extraction Plan approved for Longwall West 1 and West 2 (LW W1-W2) and covers the period of 13 October 2020 to 21 April 2021.

This report provides the Secretary of NSW Department of Planning, Industry and Environment (DPIE) with a summary of subsidence and environment monitoring results, subsidence impacts and management actions undertaken during the reporting period.

1.1 Background

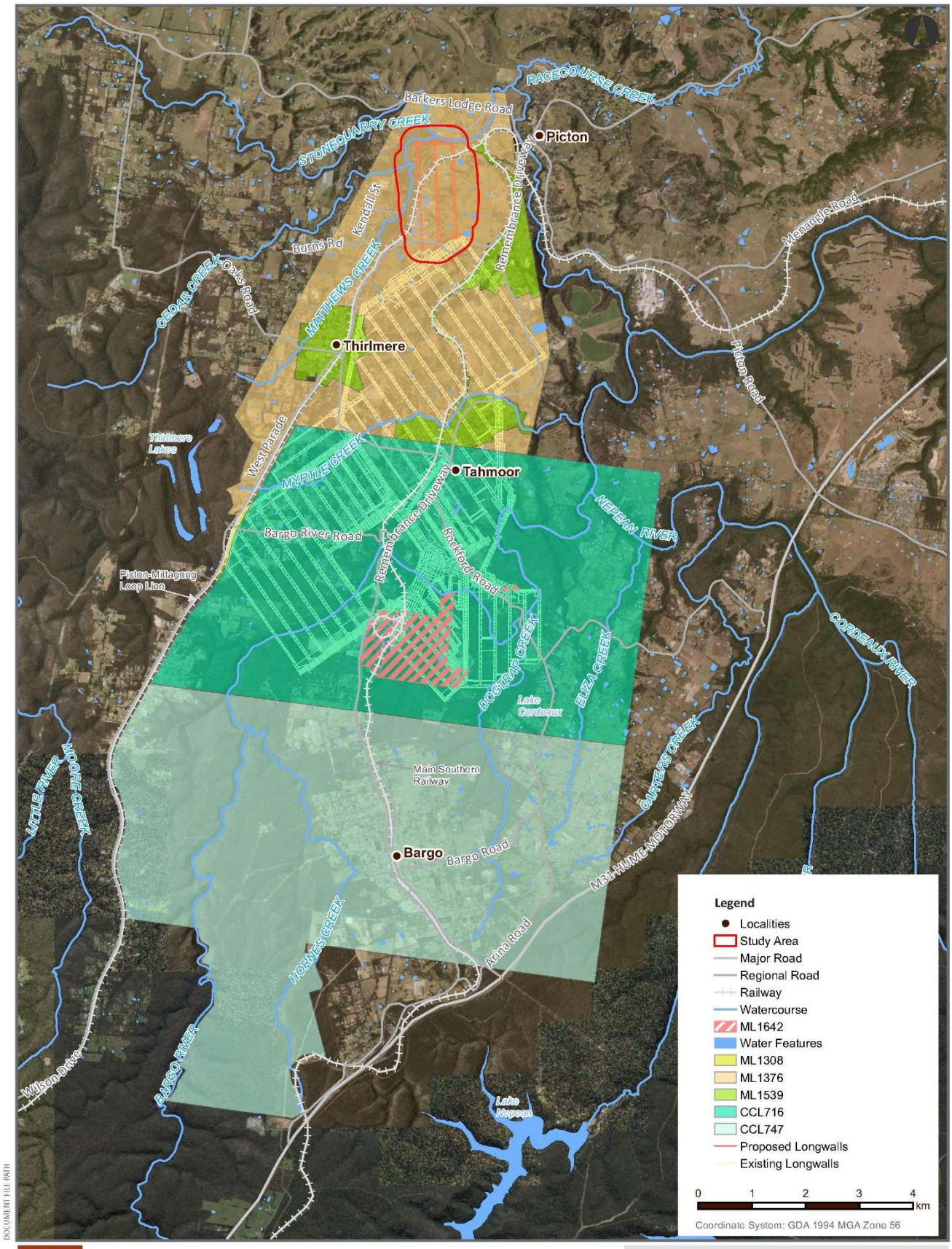
Tahmoor Coal Mine (Tahmoor Mine) is an underground coal mine located approximately 80 kilometres (km) south-west of Sydney between the towns of Tahmoor and Bargo, New South Wales (NSW) (refer to **Figure 1-1**). Tahmoor Mine produces up to three million tonnes of Run of Mine coal per annum from the Bulli Coal Seam. Tahmoor Mine produces a primary hard coking coal product and a secondary higher ash coking coal product that are used predominantly for coke manufacture for steel production. Product coal is transported via rail to Port Kembla for Australian domestic customers and export customers.

Tahmoor Mine has been operated by Tahmoor Coal Pty Ltd (Tahmoor Coal) since Tahmoor Mine commenced in 1979 using bord and pillar mining methods, and via longwall mining methods since 1987. Tahmoor Coal is a wholly owned entity within the SIMEC Mining Division of the GFG Alliance group.

Tahmoor Coal has previously mined 33 longwalls to the north and west of Tahmoor Mine's current pit top location. The current mining area, the 'Western Domain', is located north-west of the Main Southern Rail between the townships of Thirlmere and Picton (**Figure 1-1**). The Western Domain is within the Tahmoor North mining area and is within Mining Lease (ML) 1376 and ML 1539.

Tahmoor Coal prepared an Extraction Plan for the first two longwalls in the Western Domain (LW W1-W2), as illustrated in **Figure 1-2**. Extraction Plan approval was granted by DPIE on 8 November 2019. A copy of the Project Approval is available on the Tahmoor Coal website (http://www.simec.com/mining/tahmoor-coking-coal-operations/).

Longwall West 1 (LW W1) was the first longwall to be extracted in the Western Domain. LW W1 extraction was completed on 6 November 2020, and the extraction of Longwall West 2 (LW W2) commenced on 7 December 2020. As of 21 April 2021, 1236 metres of LW W2 had been extracted. The active subsidence area of LW W2 for 19 April 2021 is illustrated in **Figure 1-3**.



DOCUMENT FILE PATH

TAHMOOR MINING AREA AND TENURE

Tahmoor North Western Domain Longwalls West 1 and West 2 Extraction Plan

FIGURE 1-1

Date 27/05/2019

Data Sources:
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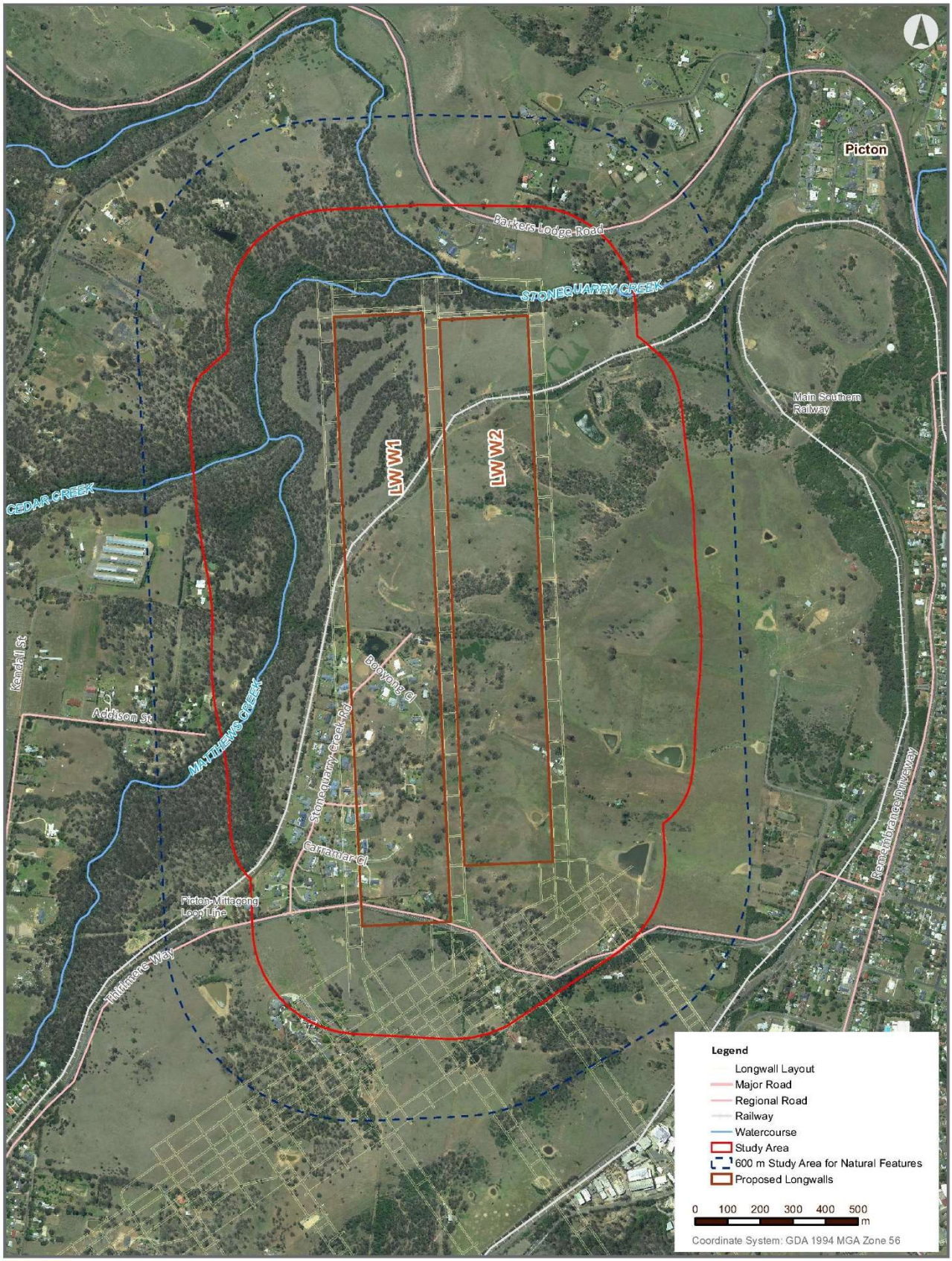
Aerial Imagery: NSW DFSI MapServer (2019)



EXTRACTION PLAN STUDY AREA

Tahmoor North Western Domain Longwalls West 1 and West 2 Extraction Plan

FIGURE 1-2

Date 4/07/2019

Data Sources:
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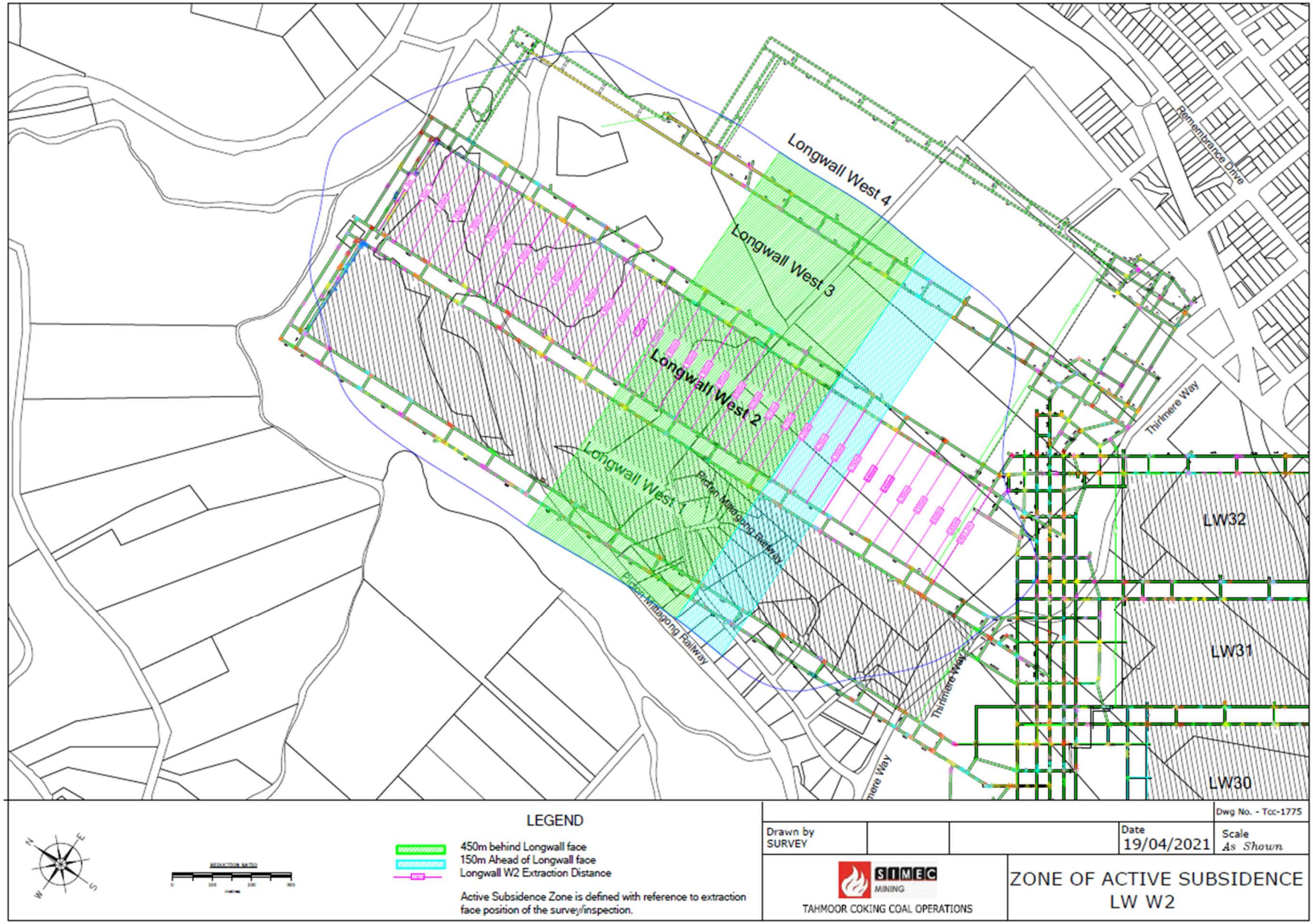

Figure 1-3 LW W2 Zone of Active Subsidence for 19 April 2021

1.2 Purpose

The purpose of this report is to address the requirements for six-monthly reporting on impacts and environmental monitoring results associated with the extraction of LW W1 and LW W2. These requirements are outlined in **Section 6.1.4** of the LW W1-W2 Extraction Plan, which are derived from the Section 6 of the DPIE *Draft Guidelines for the Preparation of Extraction Plans V5* (DPE, 2015).

The requirements for this report are listed in **Table 1-1** below, together with the cross-reference where the requirements are addressed in this report.

Table 1-1 Six Monthly Subsidence Impact Report Requirements

Requirement No.	Requirement Description (as per Section 6.1.2 of the LW W1-W2 Extraction Plan)	Section Addressed
1	A comprehensive summary of all impacts, including a revised characterisation according to the relevant TARP(s);	Section 2.1
2	Any proposed actions resulting from triggers being met in the TARP, or other actions;	Section 2.2
3	An assessment of compliance with all relevant performance measures and indicators; and	Section 3
4	A comprehensive summary of all quantitative and qualitative environmental monitoring results, including landscape monitoring, water quality data, water flow and level data, piezometer readings.	Section 4

This report will be distributed to the stakeholders listed in **Section 5.4**.

1.3 Scope

The Tahmoor Coal Environmental Management Structure is shown in **Figure 1-4**.

The Extraction Plan Study Area is defined as the surface area that is likely to be affected by the extraction of LW W1-W2 from the Bulli Coal Seam. This Study Area has been calculated by combining the areas bound by the following limits:

- The predicted limit of vertical subsidence, taken as the 20 millimetre (mm) subsidence contour resulting from the extraction of LW W1-W2; and
- A 35° angle of draw line from the limit of proposed extraction for LW W1-W2.

The Study Area is illustrated in **Figure 1-1** and **Figure 1-2**.

As part of the LW W1-W2 Extraction Plan, a set of management plans have been prepared to manage particular environment or built features with the LW W1-W2 Study Area, which consists of the following:

- Water Management Plan;
- Land Management Plan;
- Biodiversity Management Plan;
- Heritage Management Plan;
- Built Features Management Plan, with a number of sub-plans to manage potential environmental consequences to infrastructure and specific building structures as a result of secondary extraction; and

- Public Safety Management Plan.

The overall framework for subsidence monitoring and management of impacts of the LW W1-W2 Extraction Plan is provided in the Subsidence Monitoring Program.

It is noted that the management requirements for public safety are covered in the Built Features Management Plan and the Land Management Plan.

Monitoring of environmental and built features has been completed by Tahmoor Coal and its consultants in accordance with management plans listed above.

This report is the third six-monthly report to be submitted since the commencement of extraction of LW W1, in accordance with the requirements of the LW W1-W2 Extraction Plan. The reporting period of this report is from 13 October 2020 to 21 April 2021.

Table 1-2 summarises the monitoring and reporting completed during the reporting period, as well as the timeframe of data reviewed for each monitoring component.

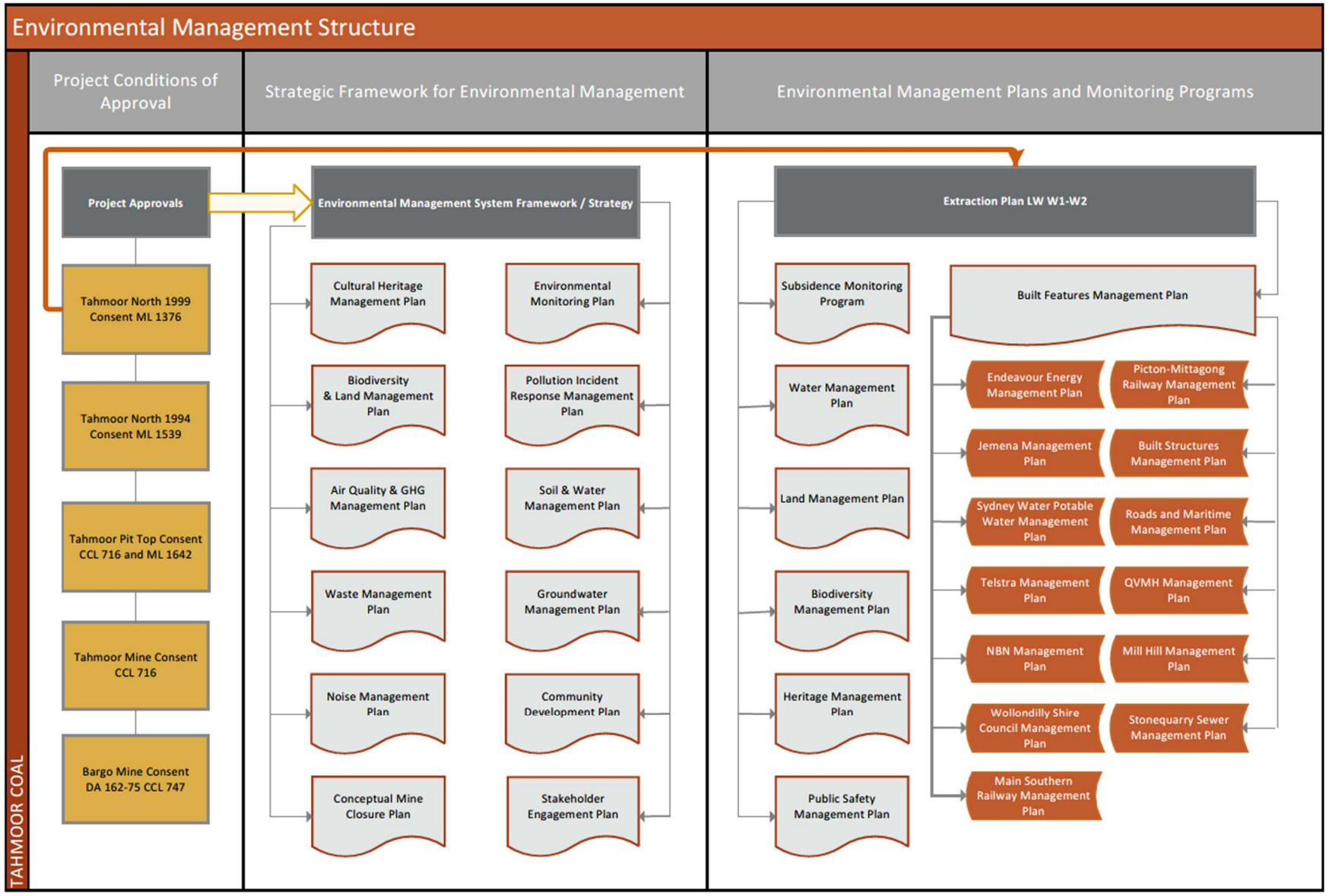

Figure 1-4 Overview of Environmental Management Structure for Tahmoor Coal

Table 1-2 Monitoring and Reports Reviewed for this Reporting Period

Management Plan	Aspect	Feature	Monitoring Completed By	Monitoring Reported by	Monitoring Reports Completed during this Reporting Period	Reporting Frequency	Reference
Subsidence Monitoring Program	Subsidence	General subsidence	• SMEC • Building Inspection Service • Comms Network Solutions	Mine Subsidence Engineering Consultants (MSEC)	Subsidence Monitoring Reports for LW W1 (30-34) and LW W2 (1-15) reviewing data collected from 7 November 2020 to 21 April 2021.	Weekly	Appendix A (referenced reports only)
Water Management Plan	Surface Water	Stonequarry Creek flow	• WaterNSW	• Hydro Engineering and Consulting (HEC)	Surface Water Monitoring Report reviewing data collected from 12 October 2020 to 31 March 2021.	Monthly, summarised in a 6-monthly report	Appendix B
		Pool water level	• Hydrometric Consulting Service (HCS)				
		Stream water quality					
		Natural drainage behaviour	• GeoTerra	• GeoTerra	Creek Monitoring Reports reviewing data collected from 30 November 2020 to 31 March 2021.	Monthly	Appendix C (referenced reports only)
	Groundwater	Groundwater quality	• GeoTerra	• GeoTerra	Groundwater Monitoring Report reviewing data collected from 1 November 2020 to 30 April 2021.	Monthly, summarised in a 6-monthly report	Appendix D
		Groundwater bore level	• GeoTerra				
		Shallow groundwater pressures					
		Deep groundwater pressures	• Groundwater Exploration Services				
		Groundwater Inflow	• GeoTerra		Included in 6-monthly Groundwater Monitoring Report reviewing data collected from 2 November 2020 to 22 April 2021.	6-Monthly	

Land Management Plan	Landscape	Cliff lines	• Douglas Partners	• Douglas Partners	Geotechnical Monitoring Reports reviewing data collected from 30 November 2020 to 23 March 2021.	Monthly	(Available on request)
		Steep Slopes					
		Surface cracking (excluding railway corridor)					
		Dams					
		Dams	• Bloor Rail • Newcastle Geotechnical	• MSEC • Bloor Rail • Newcastle Geotechnical	Picton-Mittagong Loop Line (PMLL) Weekly Detailed Reports for LW W1 (51-55) and LW W2 (1-20) reviewing data collected from 28 October 2020 to 20 April 2021.	Weekly	Appendix E (referenced reports only)
		Dams	• Building Inspection Service (BIS)	• BIS	Dam inspection reports reviewing data collected from 9 November 2020 to 23 April 2021.	Weekly	(Available on request)
	Agricultural Land	Agricultural Land	• Tahmoor Coal • BIS	• BIS	Agricultural Subsidence Monitoring Reports reviewing data collected from 25 November 2020 to 29 March 2021.	Monthly	(Available on request)
Biodiversity Management Plan	Aquatic Ecology	Macroinvertebrates	• Niche	• Niche	Aquatic Ecology Monitoring Letter Report – Preliminary Survey Results for Autumn 2021 AUSRIVAS Monitoring. The full Aquatic Ecology Monitoring Report for Autumn 2021 was not available in time for this report. However, sufficient information was provided in the letter report to report on TARP for this six month period.	Six Monthly	Appendix I
	Terrestrial Ecology	Amphibians	• Niche	• Niche	Spring 2020 Terrestrial Ecology Monitoring Report and Autumn 2021 Terrestrial Ecology Monitoring Report.	Six Monthly	Appendix I
		Riparian Vegetation					

Heritage Management Plan	Aboriginal heritage	Rock shelters	• GeoTerra	• GeoTerra	Creek Monitoring Reports reviewing data collected from 30 November 2020 to 31 March 2021.	Monthly	Appendix C (referenced reports only)
			• EMM Consulting	• EMM Consulting	LW W1 End of Panel Report.	Once after LW W1 Extraction completed.	Appendix G
		Grinding Grooves	• SMEC	• MSEC	Subsidence Monitoring Reports for LW W1 (30-34) and LW W2 (1-15) reviewing data collected from 7 November 2020 to 21 April 2021.	Weekly	Appendix A (referenced reports only)
			• EMM Consulting	• EMM Consulting	LW W1 End of Panel Report.	Once after LW W1 Extraction completed.	Appendix G
	Historical heritage	Railway culverts	• Newcastle Geotechnical	• Newcastle Geotechnical	Picton-Mittagong Loop Line (PMLL) Weekly Detailed Reports for LW W1 (51-55) and LW W2 (1-20) reviewing data collected from 28 October 2020 to 20 April 2021.	Weekly	Appendix E (referenced reports only)
			• EMM Consulting	• EMM Consulting	LW W1 End of Panel Report.	Once after LW W1 Extraction completed.	Appendix G
Built Features Management Plan	Built Features	Electricity Infrastructure	• SMEC • BIS • Comms Network Solutions	• MSEC	Subsidence Monitoring Reports for LW W1 (30-34) and LW W2 (1-15) reviewing data collected from 7 November 2020 to 21 April 2021.	Weekly	Appendix A (referenced reports only)
		Gas Infrastructure					
		Potable Water					
		Sewerage Infrastructure					
		Telecommunications					
		Local roads, bridges and culverts					
		Built Structures					

		Picton-Mittagong Loop Line	• Southern rail Services • Bloor Rail	• MSEC	PMLL Weekly Status Reports for LW W1 (52-55) and LW W2 (1-20) reviewing data collected from 4 November 2020 to 20 April 2021.	Weekly	Appendix F (referenced reports only)
		Roads and Maritime Services (RMS) Infrastructure	• SMEC • Southern Rail Services • BIS	• MSEC	RMS Status Reports for LW W1 (10) and LW W2 (1-5) reviewing data collected from 14 October 2020 to 20 April 2021.	Monthly	(Available on request)
		Main Southern Railway (MSR)	• SMEC • Southern rail Services • Bloor Rail • BIS • Comms Network Solutions • Newcastle Geotech	• MSEC	MSR Weekly Status Reports for LW W1 (48-51) and LW W2 (1-R20) reviewing data collected from 4 November 2020 to 20 April 2021.	Weekly	Appendix H (referenced reports only)
		Queen Victoria Memorial Home (QVMH)	• Veris • ENRS	• MSEC	QVMH Status Reports 5-10 reviewing data collected from 21 October 2020 to 2 December 2020.	Weekly (till end of LW W1)	(Available on request)
		Mill Hill	• SMEC • BIS	• MSEC	Mill Hill Status Reports 5-7 reviewing data collected from 29 October 2020 to 18 November 2020.	Weekly (till end of LW W1)	(Available on request)

2 Overview of Impacts and Actions

2.1 Summary of Impacts

This section provides a comprehensive summary of all impacts during the reporting period, including a revised characterisation according to the relevant Trigger Action Response Plan (TARP)(s) (if required).

A summary of monitoring results for relevant TARP's is given in **Table 2-3**. Triggers that were activated are denoted in **Table 2-3** with colours defined in **Table 2-1** and **Table 2-2**. A full list of TARPs for environmental features that are applicable is provided in Appendix D of the LW W1-W2 Extraction Plan.

Table 2-1 Risk Levels for Environmental Feature TARPs

Risk Level	Trigger Description
Level 1	Normal – Operations within predicted impacts.
Level 2	Within Prediction - Operations within predicted impacts but exceeds or potentially exceeds predictions.
Level 3*	Almost Exceeds Prediction - Operations within predicted impacts but are likely to almost exceed predictions.
Level 4	Exceeds Prediction - Operations exceed predicted impact.

Note: * Level 3 is only used in the Water Management Plan TARPs.

Table 2-2 Trigger Levels for Railway Features (applicable to Picton-Mittagong Loop Line and Main Southern Railway features)

Trigger Level	Trigger Description
Green	Observations within predictions. Operate as normal.
Blue	Observations outside predictions but within operating tolerance. Investigate cause. Some action may be required to prevent operating restrictions.
Yellow	Restrictions on operations. Action required. Appropriate speed restriction applied until altered to Green or Blue level.
Red	Stop trains until altered to Green or Blue level.

As all results during this report period are consistent with the current TARPs, a revision of the TARPs for environmental features is not considered necessary at this point in time.

Table 2-3 Summary of TARP Triggers for the Current Reporting Period

Aspect	Feature	Corresponding Management Plan and TARP	October 2020	November 2020	December 2020	January 2021	February 2021	March 2021	April 2021
Surface Water	Stonequarry Creek flow	Water Management Plan - Downstream reduction in catchment flow rate in Stonequarry Creek at Picton Gauging Station (GS212053)	NA Assessment unable to be completed due to invalidation of current model calibration.[1]	NA Assessment unable to be completed due to invalidation of current model calibration.[1]	NA Assessment unable to be completed due to invalidation of current model calibration.[1]	NA Assessment unable to be completed due to invalidation of current model calibration.[1]	NA Assessment unable to be completed due to invalidation of current model calibration.[1]	NA Assessment unable to be completed due to invalidation of current model calibration.[1]	NA Monitoring data for April 2021 to be summarised in next report.
	Pool water level	Water Management Plan - Impact to pool water level	LEVEL 2 TRIGGERED[2] Surface water level triggers occurred at monitoring site CD (pool CR23) between 13-25 October 2020.[2]	No pool water level triggers occurred.	LEVEL 3 TRIGGERED[3] Surface water level triggers occurred at monitoring site CB (pool CR14) between 1-5 December 2020 and 7-18 December 2020. LEVEL 2 TRIGGERED[2] Surface water level triggers occurred at: • Monitoring site CA (pool CB10) between 1-5 December 2020 and 9-17 December 2020. • Monitoring site CD (pool CR23) between 1-4 December 2020.	LEVEL 4 TRIGGERED[4] Water level trigger occurred at Monitoring Site CB (Pool CR14) between 12-29 January 2021. LEVEL 3 TRIGGERED[3] Surface water level triggers occurred at Monitoring site CA (pool CB10) between 17-29 January 2021. LEVEL 2 TRIGGERED[2] Surface water level triggers occurred at: • Monitoring site CD (pool CR23) between 16-26 January 2021. • Monitoring site CF (pool CR26) on 20 January 2021. • Monitoring site CG (pool CR31) between 21-26 January 2021.	LEVEL 2 TRIGGERED[2] Surface water level triggers occurred at monitoring site CB (pool CR14) between 11-12 February 2021.	LEVEL 3 TRIGGERED[3] Surface water level triggers occurred at monitoring site CB (pool CR14) between 3-13 March 2021.	NA Monitoring data for April 2021 to be summarised in next report.
	Stream water quality	Water Management Plan - Stream water quality impact	No surface water quality triggers occurred.	No surface water quality triggers occurred.	No surface water quality triggers occurred.	No surface water quality triggers occurred.	No surface water quality triggers occurred.	No surface water quality triggers occurred.	NA Monitoring data for April 2021 to be summarised in next report.
	Natural drainage behaviour	Water Management Plan - Impact to pool level, natural drainage behaviour or overland connected flow	No impacts to natural drainage behaviour observed.	LEVEL 3 TRIGGERED Gas emissions were observed in pool MR45 downstream of monitoring site MG.[5]	LEVEL 3 TRIGGERED Gas emissions were observed in pool MR45 downstream of monitoring site MG.[5]	LEVEL 4 TRIGGERED[6] Pool conditions are likely to have triggered at pools CB10, CR12, CR13, CR14, CR15, MR45 and MR46. However, a Level 4 trigger was unconfirmed as similar observations were not observed upstream of the site (outside of mining effects).	No impacts to natural drainage behaviour observed.	No impacts to natural drainage behaviour observed.	NA Monitoring data for April 2021 to be summarised in next report.
	Flood levels	Water Management Plan - Impact to flood levels	NR Flood modelling required after completion of LW W2.	NR Flood modelling required after completion of LW W2.	NR Flood modelling required after completion of LW W2.	NR Flood modelling required after completion of LW W2.	NR Flood modelling required after completion of LW W2.	NR Flood modelling required after completion of LW W2.	NR Flood modelling required after completion of LW W2.
Groundwater	Groundwater quality	Water Management Plan – Groundwater quality at monitoring bores and private groundwater bores	LEVEL 2 TRIGGERED Groundwater quality triggers occurred in P12A (pH), P12B (pH),	LEVEL 2 TRIGGERED Groundwater quality triggers occurred in P16C (Mn)		LEVEL 2 TRIGGERED Groundwater quality triggers occurred in P13A (Li), P13B (Fe), P13C (Li), P16B (Fe), P16C (Fe),	LEVEL 2 TRIGGERED Groundwater quality triggers occurred in P13A (pH and Li),	LEVEL 2 TRIGGERED Groundwater quality triggers occurred in P12A (pH), P12B (pH), P12C (pH), P13A (pH and Li),	LEVEL 4 TRIGGERED Groundwater quality triggers occurred in P13C (Li)

Aspect	Feature	Corresponding Management Plan and TARP	October 2020	November 2020	December 2020	January 2021	February 2021	March 2021	April 2021
			P13A (pH), P13B (pH), P16A (zinc), and P16B (pH and zinc).			GW105228 (Fe, Li, Ba, Sr), GW10546 (Ba) and GW72402 (Sr)	P13B (Li), P13C (Li), P16C (pH), P17 (Al)	P13B (pH and Li), P13C (Li) P16A (pH) and P16C (Fe).	LEVEL 2 TRIGGERED Groundwater quality triggers occurred in GW105546 (Li)
	Groundwater bore level	Water Management Plan – Groundwater levels at monitoring bores and private groundwater bores	LEVEL 3 TRIGGERED Water level trigger occurred at piezometers P12 (intake P12), P13 (intake P13C) and P16 (intakes P16B and P16C).[5]	LEVEL 4 TRIGGERED Water level trigger occurred at piezometers P12C, P13C, P16B and P16C.	LEVEL 4 TRIGGERED Water level trigger occurred at piezometers P12C, P13C, P16B and P16C.	LEVEL 4 TRIGGERED Water level trigger occurred at piezometers P12C, P13C, P16B and P16C.	LEVEL 4 TRIGGERED Water level trigger occurred at piezometers P12C, P13C, P16B and P16C.	LEVEL 4 TRIGGERED Water level trigger occurred at piezometers P12C, P13C, P16B and P16C.	LEVEL 4 TRIGGERED Water level trigger occurred at piezometers P12C, P13C, P16B and P16C.
	Shallow groundwater pressures	Water Management Plan – Shallow groundwater pressures at VMPs TNC036, TNC040, and TNC034	LEVEL 3 TRIGGERED Depressurisation trigger occurred at TNC36 (intakes 65, 97 and 169 mbgl).[8]	LEVEL 3 TRIGGERED Depressurisation trigger occurred at TNC36 (intakes 65, 97 and 169 mbgl) and WD01.[8]	LEVEL 4 TRIGGERED Depressurisation trigger occurred at TNC36 (intakes 65, 97 and 169 mbgl) and WD01.[9]	LEVEL 4 TRIGGERED Depressurisation trigger occurred at TNC36 (intakes 65, 97 and 169 mbgl) and WD01.[9]	LEVEL 4 TRIGGERED Depressurisation trigger occurred at TNC36 (intakes 65, 97 and 169 mbgl) and WD01.[9]	LEVEL 4 TRIGGERED Depressurisation trigger occurred at TNC36 (intakes 65, 97 and 169 mbgl) and WD01.[9]	LEVEL 4 TRIGGERED Depressurisation trigger occurred at TNC36 (intakes 65, 97 and 169 mbgl) and WD01.[9]
	Deep groundwater pressures	Water Management Plan – Deep groundwater pressures at VMPs TNC036, TNC040, and TNC043	No observable mining induced change at VWP intakes below 200 m depth.	LEVEL 2 TRIGGERED Depressurisation triggers occurred in TNC36 (intake 214 and 412.5) and WD01 (intakes 210 and 230)	LEVEL 2 TRIGGERED Depressurisation triggers occurred in TNC36 (intake 214 and 412.5) and WD01 (intake 230)	LEVEL 2 TRIGGERED Depressurisation triggers occurred in TNC36 (intake 214 and 412.5) and WD01 (intake 230)	LEVEL 2 TRIGGERED Depressurisation triggers occurred in TNC36 (intake 214 and 412.5) and WD01 (intake 230)	LEVEL 2 TRIGGERED Depressurisation triggers occurred in TNC36 (intake 214 and 412.5) and WD01 (intake 230)	LEVEL 3 TRIGGERED Depressurisation trigger occurred at TNC36 (intakes 214) LEVEL 2 TRIGGERED Depressurisation triggers occurred in TNC36 (intake 412.5) and WD01 (intake 230)
Landscape	Cliff lines	Land Management Plan – Cliff line damage or instability	NR No steep slopes close to structures in the active subsidence zone this month.	NR No steep slopes close to structures in the active subsidence zone this month.	No signs of distress or change in the areas inspected that could be attributed to mine subsidence.	No signs of distress or change in the areas inspected that could be attributed to mine subsidence.	No signs of distress or change in the areas inspected that could be attributed to mine subsidence.	NR No steep slopes close to structures in the active subsidence zone this month.	NA Monitoring data for April 2021 to be summarised in next report.
	Steep Slopes	Land Management Plan – Steep slope damage or instability	No signs of cracking or movement on steep slopes near structures in the areas inspected that could be attributed to mine subsidence.	No signs of cracking or movement on steep slopes near structures in the areas inspected that could be attributed to mine subsidence.	No signs of cracking or movement on steep slopes near structures in the areas inspected that could be attributed to mine subsidence.	No signs of cracking or movement on steep slopes near structures in the areas inspected that could be attributed to mine subsidence.	No signs of cracking or movement on steep slopes near structures in the areas inspected that could be attributed to mine subsidence.	No signs of cracking or movement on steep slopes near structures in the areas inspected that could be attributed to mine subsidence.	NA Monitoring data for April 2021 to be summarised in next report.
	Surface cracking	Land Management Plan – Surface cracking (excluding railway corridor)	No signs of change in the areas inspected that could be attributed to mine subsidence.	No signs of change in the areas inspected that could be attributed to mine subsidence.	No signs of change in the areas inspected that could be attributed to mine subsidence.	No signs of change in the areas inspected that could be attributed to mine subsidence.	No signs of change in the areas inspected that could be attributed to mine subsidence.	No signs of change in the areas inspected that could be attributed to mine subsidence.	NA Monitoring data for April 2021 to be summarised in next report.
	Dams (monthly)	Water Management Plan – Impacts to dams	No signs of change to farm dams inspected that could be attributed to mine subsidence.	No signs of change to farm dams inspected that could be attributed to mine subsidence.	No signs of change to farm dams inspected that could be attributed to mine subsidence.	No signs of change to farm dams inspected that could be attributed to mine subsidence.	No signs of change to farm dams inspected that could be attributed to mine subsidence.	No signs of change to farm dams inspected that could be attributed to mine subsidence.	NA Monitoring data for April 2021 to be summarised in next report.
	Dams (weekly)	Water Management Plan – Impacts to dams	No signs of change to farm dams inspected that could be attributed to mine subsidence.	No signs of change to farm dams inspected that could be attributed to mine subsidence.	No signs of change to farm dams inspected that could be attributed to mine subsidence.	No signs of change to farm dams inspected that could be attributed to mine subsidence.	No signs of change to farm dams inspected that could be attributed to mine subsidence.	No signs of change to farm dams inspected that could be attributed to mine subsidence.	No signs of change to farm dams inspected that could be attributed to mine subsidence.
Agricultural Land	Agricultural Land	Land Management Plan – Agricultural land	No signs of change since baseline at sites inspected.	No signs of change since baseline at sites inspected	No signs of change since baseline at sites inspected	No signs of change since baseline at sites inspected	No signs of change since baseline at sites inspected	No signs of change since baseline at sites inspected	NA Monitoring data for April 2021 to be summarised in next report.
Aquatic Ecology	Macroinvertebrates	Biodiversity Management Plan – Decline or significant negative change in	NR	NR	NR	NR	NR	Monitoring macroinvertebrate indicators are within range of	NR

Aspect	Feature	Corresponding Management Plan and TARP	October 2020	November 2020	December 2020	January 2021	February 2021	March 2021	April 2021
		macroinvertebrate indicators.	Monitoring next required in Autumn 2021.	Monitoring next required in Autumn 2021.	Monitoring next required in Autumn 2021.	Monitoring next required in Autumn 2021.	Monitoring next required in Autumn 2021.	baseline data as supported by statistical analysis.	Monitoring next required in Spring 2021.
		Biodiversity Management Plan – Reduction in aquatic habitat through loss of pools or associated reduction in water quality (AURIVAS habitat assessment)	NR Monitoring next required in Autumn 2021.	NR Monitoring next required in Autumn 2021.	NR Monitoring next required in Autumn 2021.	NR Monitoring next required in Autumn 2021.	NR Monitoring next required in Autumn 2021.	Monitoring macroinvertebrate indicators are within range of baseline data as supported by statistical analysis.	NR Monitoring next required in Spring 2021.
Terrestrial Ecology	Amphibians	Biodiversity Management Plan – Decline in amphibian populations within watercourses of the Study Area	Monitoring indicates amphibian population parameters are predominantly within a reasonable range of baseline data as supported by statistical analysis (Spring 2020 results).	NR Monitoring next required in Autumn 2021.	NR Monitoring next required in Autumn 2021.	NR Monitoring next required in Autumn 2021.	NR Monitoring next required in Autumn 2021.	Monitoring indicates amphibian population parameters are predominantly within a reasonable range of baseline data as supported by statistical analysis (Autumn 2021 results).	NR Monitoring next required in Spring 2021.
	Riparian Vegetation	Biodiversity Management Plan – Dieback of riparian vegetation within watercourses of the Study Area	Monitoring indicates riparian vegetation parameters are predominantly within a reasonable range of baseline data as supported by statistical analysis (Spring 2020 results).	NR Monitoring next required in Autumn 2021.	NR Monitoring next required in Autumn 2021.	NR Monitoring next required in Autumn 2021.	NR Monitoring next required in Autumn 2021.	Monitoring indicates riparian vegetation parameters are predominantly within a reasonable range of baseline data as supported by statistical analysis (Autumn 2021 results).	NR Monitoring next required in Spring 2021.
Aboriginal Heritage	Rock shelters and grinding grooves	Heritage Management Plan – Aboriginal heritage	No subsidence related rock face cracking or spalling. No signs of change at SR17 (grinding groove site).	No subsidence related rock face cracking or spalling. No signs of change at SR17 (grinding groove site).	No subsidence related rock face cracking or spalling. No signs of change at SR17 (grinding groove site).	No subsidence related rock face cracking or spalling. No signs of change at SR17 (grinding groove site).	No subsidence related rock face cracking or spalling. No signs of change at SR17 (grinding groove site).	No subsidence related rock face cracking or spalling. No signs of change at SR17 (grinding groove site).	NA Monitoring data for April 2021 to be summarised in next report.
Historical Heritage	Railway Culverts	Heritage Management Plan – Historical heritage (culverts only)	LEVEL 2 TRIGGERED[10] Cracking noted in sandstone culvert at 89.629 km.	LEVEL 2 TRIGGERED[10] Increased width of cracking noted in sandstone culvert at 89.629 km.	No signs of change to culverts inspected.	No signs of change to culverts inspected.	LEVEL 2 TRIGGERED[10] Cracking noted in sandstone culvert at 88.44 km and impacts at sandstone culvert at 88.980 km.	LEVEL 2 TRIGGERED[10] Increased width of cracking noted in sandstone culvert at 88.44 km and impacts at sandstone culvert at 88.980 km.	LEVEL 2 TRIGGERED[10] Increased width of cracking noted in sandstone culvert at 88.44 km and impacts at sandstone culvert at 88.980 km.
Built Features	Picton-Mittagong Loop Line	Picton-Mittagong Railway Management Plan	**BLUE TRIGGER** Track between 88.5 km and 88.6 km - More than 50% of joints have closed where ground shortening has occurred.	Results are within survey tolerance. Visual inspections did not identify any issues.	Results are within survey tolerance. Visual inspections did not identify any issues.	Results are within survey tolerance. Visual inspections did not identify any issues. *Note: Track geometry survey of railway track noted a blue trigger, however this was not related to mining.*	Results are within survey tolerance. Visual inspections did not identify any issues.	BLUE TRIGGER Rail joint gaps between 87.9 km and 88.1 km - More than 50% of joints have closed. Rail joint gaps between 88.4 km and 88.5 km - More than 50% of joints have fully opened.	Results are within survey tolerance. Visual inspections did not identify any issues.
	Main Southern Railway	Main Southern Railway Management Plan	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	BLUE TRIGGER Minor changes across the abutments of Ballast Top Subway (86.838 km).
	Electricity Infrastructure	Endeavour Energy Management Plan	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.
	Gas Infrastructure	Jemena Management Plan	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.
	Potable Water	Sydney Water Potable Water Management Plan	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	NR Weekly surveys and inspections commence after 800 metres of extraction.	NR Weekly surveys and inspections commence after 800 metres of extraction.	NR Weekly surveys and inspections commence after 800 metres of extraction.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.

Aspect	Feature	Corresponding Management Plan and TARP	October 2020	November 2020	December 2020	January 2021	February 2021	March 2021	April 2021
	Sewerage Infrastructure	Stonequarry Creek Sewer Management Plan	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.
	Telecommunications	Telstra Management Plan	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.
		NBN Co Management Plan	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.
	Local roads, bridges and culverts	Wollondilly Shire Council Management Plan	**Further impacts to stormwater drains near Pegs S39, S40 and S41 (Report 26).**	**Impacts to road on Carramar Close (Report 29).**	NR - Ground surveys and visual inspections commence after 800 metres of extraction	NR - Ground surveys and visual inspections commence after 800 metres of extraction	NR - Ground surveys and visual inspections commence after 800 metres of extraction	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.
	Built Structures	Built Structures Management Plan	**Impacts to houses on Stonequarry Creek Road and Attunga Close (Report 25 and Report 28), and a pool gate on Carramar Close (Report 26).**	**Impacts to houses on Stonequarry Creek Road, Attunga Close and Carramar Close (Report 29), and pool pavers at a property on Carramar Close (Report 29).**	NR There are no structures located above the commencing end of LW W2	NR There are no structures located above the commencing end of LW W2	NR There are no structures located above the commencing end of LW W2	No impacts observed in areas monitored this month.	**Impacts to houses on Stonequarry Creek Road. Impacts to house and pool gate and pool pavers on Booyong Close (Report 15)**
	RMS Infrastructure	RMS management Plan	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.
	Queen Victoria Memorial Home (QVMH)	QVMH Management Plan	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	NR QVMH is not required to be monitored this month.	NR QVMH is not required to be monitored this month.	NR QVMH is not required to be monitored this month.	NR QVMH is not required to be monitored this month.
	Mill Hill	Mill Hill Management Plan	No impacts observed in areas monitored this month.	No impacts observed in areas monitored this month.	NR Mill Hill is not required to be monitored this month.	NR Mill Hill is not required to be monitored this month.	NR Mill Hill is not required to be monitored this month.	NR Mill Hill is not required to be monitored this month.	NR Mill Hill is not required to be monitored this month.

Notes:

NR – Monitoring not required this month.

NA – Monitoring data not available as monitoring not completed this month.

[1] Stonequarry Creek flow assessment unable to be completed due to invalidation of current model calibration as a result of revision of the rating curve for Stonequarry Creek at Picton (GS 212053) in July 2020 and change of streamflow records from December 2015.

[2] Level 2 TARP description: The recorded water level has dropped below the previously recorded minimum level (for more than one 24 hour period for automated pool water level) AND the above has occurred at one of the upstream pools (beyond mining effects) AND visual monitoring of pools has not noted any mining related impacts.

[3] Level 3 TARP description: The recorded water level has dropped below the previously recorded minimum level (for more than one 24 hour period for automated pool water level) AND the above has occurred at one of the upstream pools (beyond mining effects) AND visual monitoring of pools has noted mining related impacts.

[4] Level 4 TARP description: The recorded water level has dropped below the previously recorded minimum level (for more than one 24 hour period for automated pool water level) AND similar behaviour has not occurred at one of the upstream pools (beyond mining effects) AND visual monitoring of pools has noted mining related impacts.

[5] Level 3 TARP description: Rock bar and/or stream base cracking, or gas release, or iron precipitation noted during visual inspection AND no reduction in pool water level, drainage or overland connected flow, taking into account climatic conditions and observations during baseline monitoring period.

[6] Level 4 TARP description: There appears to be impacts to natural drainage behaviour such that visually observed reduction in pool water level, drainage or overland connective flow AND the above change has not occurred at one of the upstream pools (beyond mining effects).

[7] Level 3 TARP description: Up to 2 m water level reduction over a period of up to 3 months following the commencement of extraction at LW W1. Negligible water level rise in response to a significant rainfall recharge event AND/OR the reduction in water level is determined not to be controlled by climatic or external anthropogenic factors.

[8] Level 3 TARP description: Up to 5 m water level reduction in VWP intakes located at or around (i.e. shallower than) 200 m depth over a period of up to 3 months following the commencement of extraction at LW W1. Negligible response following a significant rainfall recharge event AND/OR the reduction in water level is determined not to be controlled by climatic or anthropogenic factors.

[9] Level 4 TARP description: Greater than 5m water level reduction over a period of up to 6 months following the commencement of extraction at LW W2. Negligible water level rise in response to a significant rainfall recharge event AND/OR the reduction in water level is determined not to be controlled by climatic or external anthropogenic factors.

[10] Historical Heritage TARP descriptions:

- Level 1 and Level 2 TARP description: Historical heritage site monitoring indicates no detectable environmental consequences.
- Level 3 TARP description: Historical heritage site monitoring indicates environmental consequences exceeds predictions.

2.2 Summary of Actions

During the reporting period, there were eight (8) TARP triggers that required further actions, as well as a number of impacts to roads and built structures that required remediation, however Level 2 TARP notifications for groundwater and surface water do not require further discussion.

This section provides a summary of actions resulting from triggers being met in the TARPs, as well as required remediation actions.

2.2.1 Pool Water Level TARPs – Levels 2, 3 and 4 Triggers for Pool Water Level Reduction

Background

Pools in Cedar Creek triggered water level TARP significance above Level 1 during this reporting period. As summarised below:

- October 2020 to March 2021 - CB recorded atypical surface water behaviour (refer to Surface Water Review; **Appendix B**);
- December 2020 and January 2021 – CA recorded atypical surface water behaviour (refer to Surface Water Review; **Appendix B**);
- December 2020 – CD recorded

The following TARP triggers occurred during the current reporting period for water level:

- In December 2020, a Level 2 TARP trigger for site CA and CD and Level 3 TARP trigger for site CB;
- In January 2021, a Level 4 TARP trigger occurred at site CB, a Level 3 TARP trigger occurred at CA and Level 2 occurred at site CD, CF and CG;
- In February 2021, a Level 2 TARP trigger occurred at site CB; and
- In March 2021, a Level 3 TARP trigger occurred at site CB.

A summary of the surface water level TARP significance triggers during the mining period of LW W1 and W2 is presented in **Table 6**. Site CB appears to have been impacted by mining activities however further TARP notification other than including in the 6 monthly reports is not required.

Actions Completed

Actions completed include the discussion of the TARP triggers at the Monthly Tahmoor Coal Environmental Response Group (ERG) with increased monitoring from monthly to fortnightly undertaken for sites CA, CB, CC1A, MR45 and MR46.

Given that the water level at monitoring site CB (pool CR14) declined below the previously recorded minimum water level for a period in excess of 24 hours, and as similar behaviour did not occur at reference site CC1A and visual monitoring of pool CR14 noted potential mining related impacts on 19 January 2021, this equated to a Level 4 TARP significance in relation to pool water level at monitoring site CB (pool CR14) for the period 19 to 29 January 2021. Accordingly, a Subsidence Event Notification was submitted to the NSW Department of Planning, Industry and Environment (DPIE), NSW Infrastructure – Land and Water – Natural Resources Access Regulator (NRAR) and the Department of Regional NSW – Resources Regulator (Resources Regulator) on 23 February 2021 in relation to surface water level decline at monitoring site CB (pool CR14) in Cedar Creek.

The water level recorded at monitoring site CB (pool CR14) again declined below the baseline minimum water level from 3 to 13 March 2021. This corresponded to a 10-day consecutive period

of zero rainfall recorded at the Rail Site rainfall station (between 28 February and 10 March). The minimum water level recorded at monitoring site CB during this period was 270 mm below the baseline minimum. From 11 to 24 March, 356.6 mm of rainfall was recorded at the Rail Site rainfall station. The water level recorded at monitoring site CB rose above the CTF level and above the baseline minimum water level on 14 March and remained above this level until 30 March (end of available data period).

Proposed Actions

Fortnightly monitoring and analysis of surface water level data will continue for sites CA, CB, CC1A, MR45 and MR46 until confirmed otherwise and further investigation into the feasibility of implementing additional surface water monitoring is being conducted.

2.2.2 Natural Drainage Behaviour TARP - Level 3 Trigger for Gas Emissions

Background

As discussed in the previous Six-Monthly Subsidence Impact Report, gas bubbling has been observed at Stonequarry Creek (Pool SR17) and Matthews Creek (Pool MR45) as detailed below:

- 24 February 2020 - Stonequarry Creek (Pool SR17) and Matthews Creek (Pool MR45):
  - Air bubbles rising to the surface along sections of Stonequarry Creek and Mathews Creek. In Stonequarry Creek, there were 7 – 8 locations where bubbles were observed rising at intervals of 1 – 3 minutes. At the junction of Matthews Creek and Cedar Creek, continuous streams of bubbles were observed at 4 – 5 locations;
- 27 February 2020 - Matthews Creek (Pool MR45):
  - Evidence of three adjacent, reasonably persistent, although small, gas emissions were observed in Pool MR45;
  - Gas bubbling in Pool SR17 (Stonequarry Creek) was not noted by GeoTerra. It is also noted that gas bubbling was observed in Pool SR17 (Stonequarry Creek) by Tahmoor Coal on 6 June 2019 prior to the commencement of LW W1 extraction. Gas bubbling in Pool SR17 was therefore concluded to most likely be as a result of gas release from anoxic muds rather than as a result of longwall mining.
- 24 March 2020 – Matthews Creek (Pool MR45):
  - Evidence of at least six adjacent, reasonably persistent, although small, gas emissions were observed in Pool MR45.
- 24 April 2020, 26 May 2020 and 25 June 2020 – Matthews Creek (Pool MR45):
  - Gas bubbling has decreased to two small and infrequent sites
- 24 July 2020 – Matthews Creek (Pool MR45):
  - No observed discharge of gas.

A Level 3 TARP trigger for gas bubbling occurred due to gas release in Matthews Creek (Pool MR45) from February to June 2020.

During the current reporting period, the following observations of gas bubbling have been made:

- December 2020 – Gas bubbling observed at MR45 resulting in a Level 3 TARP trigger – monitoring is continuing(refer to Creek Monitoring Reports **Appendix C)**.

Actions Completed

As discussed in previous Six-Monthly Subsidence Impact Reports, monthly monitoring is conducted at Pool MR45 and results discussed at the monthly Tahmoor Coal Environmental Response Group (ERG)

As gas bubbling frequency did not increase during the current reporting period, the ERG determined no further actions (e.g. further gas sampling) were required.

Proposed Actions

If gas bubbling is noted to restart, further gas sampling at Pool MR45 (or any other affected pools) may be completed. The purpose of future gas sampling would be to determine the composition of gases, a change in which could indicate a change in gas source and/or impacts from longwall mining.

As a consent condition for the commencement of Longwall West 2 (LW W2) extraction, DPIE have requested that the frequency of visual inspection of MR45 is increased from monthly to fortnightly during the active subsidence period of LW W2 extraction. In addition, DPIE have also requested that the frequency of flow monitoring in proximity to MR45 to increase from monthly to fortnightly. Tahmoor Coal have proposed that this increase in flow monitoring occur at the site 'MG'. These requirements have been incorporated into the Water Management Plan and the existing monitoring program.

Monitoring of flow and visual inspection of pools will continue under the existing monitoring program.

2.2.3 Groundwater Bore Level TARP – Level 4 Trigger for Open Standpipe Piezometer Groundwater Levels

Background

During this reporting period, a number of groundwater intakes in open standpipe piezometers (OSPs) have recorded a trend of reducing water level elevation below the baseline range. This trend has been noted in the following OSP intakes, as summarised below:

- November 2020 to April 2021 – deepest intake at P12 (intake P12C), deepest intake at P13 (intake P13C), as well as two deepest intakes at P16 (intakes P16B and P16C) (refer to Groundwater Six-Month Review; **Appendix D**).

This trend has resulted in the triggering of a Level 4 TARP trigger for OSP groundwater level from November 2020 to April 2021. On 30 December 2020, this Level 4 TARP was notified to DPIE and NRAR in relation to mining induced depressurisation of deeper groundwater aquifer, however this also correlated to a reduction in rainfall recharge events (refer to **Appendix D** for further details).

Actions Completed

This TARP trigger was initially discussed during the ERG meeting on 14 July 2020. As the results for OSP groundwater levels are within predictions and are not connected with any surface water impacts, it was concluded that the current groundwater monitoring frequency would be maintained, and future results monitored closely.

As a consent condition for the commencement of LW W2 extraction, DPIE have requested that the monitoring frequency of OSP groundwater level at P12C is increased from monthly to fortnightly for the duration of LW W2 extraction. This requirement has been included in the Water Management Plan and the existing monitoring program.

Proposed Actions

Groundwater monitoring will continue under the existing monitoring program.

2.2.4 Shallow Groundwater Pressures TARP – Level 3 and Level 4 Trigger for Shallow Vibrating Wire Piezometer Groundwater Pressure

Background

During this reporting period, a number of groundwater intakes in shallow (<200 mbgl) Vibrating Wire Piezometers (VWPs) have recorded a trend of depressurisation below the baseline range. This trend has been noted in the following VWP intakes, as summarised below:

- November 2020 – intake at 190mbgl in WD01 triggered a Level 3 TARP significance (refer to Groundwater Six-Month Review; **Appendix D**);
- December 2020 to April 2021 - intake at 190mbgl in WD01 triggered a Level 4 TARP significance (refer to Groundwater Six-Month Review; **Appendix D**); and
- November 2020 to April 2021 - intakes at 65, 97 and 169mbgl in TNC036 triggered a Level 4 TARP significance (refer to Groundwater Six-Month Review; **Appendix D**).

This trend has resulted in the triggering of a Level 3 and Level 4 TARP triggers for shallow VWP groundwater pressure in November 2020 to April 2021.

Actions Completed

This TARP trigger was initially discussed during the ERG meeting on 14 July 2020. As the results for VWP groundwater pressure are within predictions and are not connected with any surface water impacts, it was concluded that the current groundwater monitoring frequency would be maintained, and future results monitored closely.

Proposed Actions

As a consent condition for the commencement of LW W2 extraction, DPIE have requested that the monitoring frequency of VWP groundwater pressure at TNC36 is increased from monthly to fortnightly for the duration of LW W2 extraction. This requirement has been included in the Water Management Plan and the existing monitoring program.

Groundwater monitoring will continue under the existing monitoring program.

2.2.5 Deep Groundwater Pressures TARP – Level 3 Trigger for Deep Vibrating Wire Piezometer Groundwater Pressure

Background

During this reporting period, a groundwater intake in deep (>200 mbgl) Vibrating Wire Piezometers (VWPs) have recorded a trend of depressurisation below the baseline range. This trend has been noted in the following VWP intakes, as summarised below:

- April 2021 – intakes at 214 mbgl in TNC36 (refer to Groundwater Monitoring Reports; Appendix D); and

This trend has resulted in the triggering of a Level 3 TARP trigger for deep VWP groundwater pressure in April 2021.

Actions Completed

As a consent condition for the commencement of LW W2 extraction, DPIE have requested that the monitoring frequency of VWP groundwater pressure at TNC36 is increased from monthly to fortnightly for the duration of LW W2 extraction. This requirement has been included in the Water Management Plan and the existing monitoring program.

Proposed Actions

Groundwater monitoring will continue under the existing monitoring program.

2.2.6 Historical Heritage TARP – Level 2 Trigger for Sandstone Culvert Impacts

Background

Visual inspections during the reporting period noted a number of minor cracks have been noted to develop on sandstone culverts along the Picton-Mittagong Loop Line. These included:

- Sandstone culvert at 89.629 km – small traverse crack up to 2 mm;
- Sandstone culvert at 88.44 km – crack up to 7 mm at the crest, crack on the upside headwall up to 6 mm, and minor spalling on the obvert headwall showing evidence of outward movement up to 7 mm of the headwall and wingwall relative to the culvert; and
- Sandstone culvert at 88.980 km – minor separation and circumferential cracking.

The impact to the sandstone culvert at 89.629 km was discussed in detail during the previous Six-Monthly Subsidence Impact Report. A small traverse crack up to 1 mm in width was observed in late August to early September 2020 (refer **Figure 2-1**), and was noted to be a minor pre-existing crack that was likely formed due to lateral loading from the retaining wall and steep batter slope. It is possible that the recent minor subsidence effect may have resulted in slight opening of the crack.

The crack was noted to have slightly opened up to 2 mm during subsidence effects on 17 November 2020 (refer to PMLL Detailed Monitoring Report 53; **Appendix E**). No further changes were noted for the remainder of the reporting period.

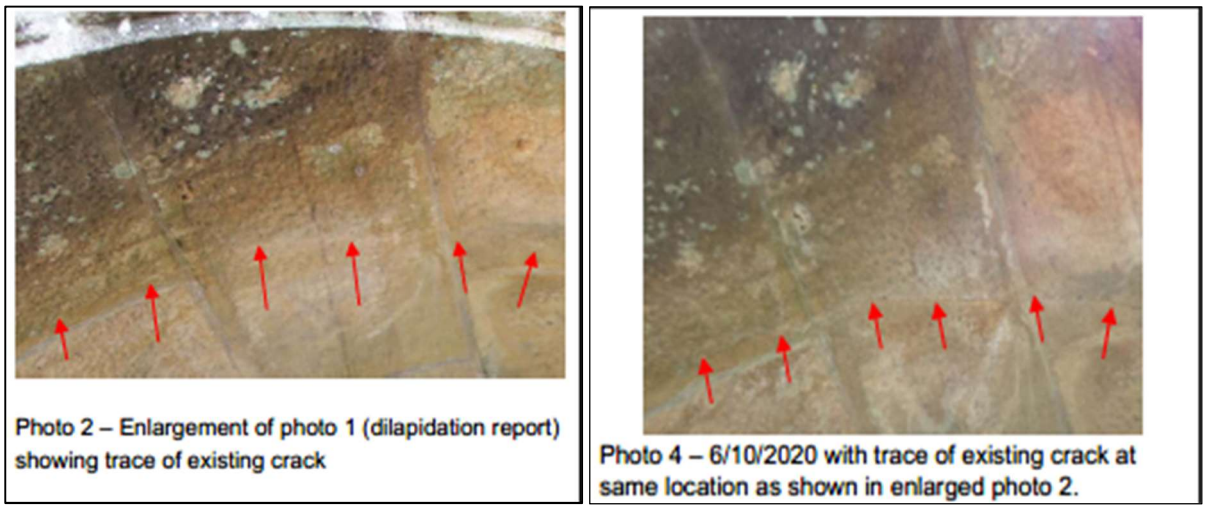

Figure 2-1 Pre-mining and current photos of the crack at culvert 89.629 km (source: PMLL Detailed Monitoring Report 47, **Appendix E**).

A vertical 1 mm wide crack was first noted on 1 February 2021 along a mortar joint at the downside inlet headwall of the sandstone culvert at 88.44 km (PMLL Detailed Monitoring Report 9; **Appendix E**). This cracking increased to up to 2 mm on 1 March 2021, 3 mm on 15 March 2021, and 7 mm at the crest on 12 April 2021 (PMLL Detailed Monitoring Report 19; **Appendix E**; refer **Figure 2-2**). No further movement was noted during the reporting period.

During an inspection of the sandstone culvert at 88.44 km on 14 February 2021, hairline cracking on the upside headwall were first observed, together with minor spalling of sandstone blocks (PMLL Detailed Monitoring Report 11; **Appendix E**). Crack width was noted to increase to 2 mm on 1 March 2021, and on 12 April 2021 the crack was noted to be up to 6 mm with minor spalling on the obvert headwall showing evidence of outward movement up to 7 mm of the headwall and wingwall relative to the culvert (PMLL Detailed Monitoring Report 19; **Appendix E**; refer **Figure 2-2**). No further movement was noted during the reporting period.

Figure 2-2 Cracking at culvert 88.44 km (source: PMLL Detailed Monitoring Report 19, **Appendix E**).

Impacts to the sandstone block culvert headwall of the culvert at 88.980 km was first noted on 25 February 2021 (PMLL Detailed Monitoring Report 12; **Appendix E**). This impact included minor separation and circumferential cracking of the sandstone block arch obvert, minor hairline crack along mortar, and minor spalling of sandstone block facing.

Minor changes to this cracking was noted on 12 April 2020, such that it comprised:

- Minor separation and circumferential cracking of the sandstone block arch obvert predominantly along mortar bed indicative of outward rotation of the headwall up to 4mm with some associated spalling of sandstone block facing.
- Vertical crack along mortar up to 4mm at city side junction between wingwall and headwall with outward rotation of the wingwall up to 4mm.

These changes were noted in the PMLL Detailed Monitoring Report 19 (**Appendix E**) and are illustrated in **Figure 2-3**. No further movement was noted during the reporting period.

Figure 2-3 Cracking at culvert 88.980 km (source: PMLL Detailed Monitoring Report 19, **Appendix E**).

These cracks are noted to be minor and are not adversely affecting the structural integrity of the culverts. However, these observations triggered a Level 2 TARP trigger for historical heritage in October 2020, November 2020, February 2021, March 2021 and April 2021.

Actions Completed

This TARP trigger for the culvert ay 88.400km was discussed during the ERG meeting on 13 April 2021 and culverts at 88.400km and 88.980km were discussed during the weekly Picton to Mittagong Loop Line Rail Management Group (RMG) meetings from February 2021 to April 2021. As the subsidence is within predictions, the cracking is minor and does not appear to impact on structural integrity of the culverts, it was concluded that the current rail monitoring program would be maintained, and future results monitored closely.

A desktop review of impacts to the sandstone culvert at 88.44 km was completed by a heritage consultant (refer **Appendix G**). From this review, it was concluded that as the cracks are in the mortar joints and are not impacted the structural integrity of the culvert, and as they are relatively small, the impacts to heritage values can be considered negligible.

Proposed Actions

Visual inspection of the location will continue under the existing monitoring program. Following the completion of LW W2 extraction, an inspection by a heritage consultant will be completed of all culverts impacted by LW W2 mining. Remediation measures (if appropriate) can be considered at this time.

2.2.7 Main Southern Railway TARP – Blue Trigger at Ballast Top Subway (86.838 km)

Background

On 12 April 2021, local 3D survey of the Ballast Top Subway (86.838 km) noted minor changes across the abutments of the structure. This change entailed additional closure between the abutment wall on the Upside where movements have been previously observed after rain events. This change triggering a blue TARP trigger (refer to MSR Status Report 20; **Appendix H**).

Actions Completed

Adjustments of the track between 88.0 km and 88.5 km were completed on 5 March 2021, resolving the TARP trigger.

Proposed Actions

Visual inspection of the location will continue under the existing monitoring program.

2.2.8 Picton-Mittagong Loop Line TARP – Blue Trigger for Joint Closure (87.9 – 88.5 km)

Background

On 1 March 2021, detailed measurements were completed between 87.9 km and 88.5 km where expected ground shortening and widening has occurred. More than 50% of joints had closed between 88.0 km and 88.1 km, while more than 50 % of joints had opened between 87.9 km and 88.0 km. These changes triggering a blue TARP trigger (refer to PMLL Status Report 13; **Appendix F**).

Actions Completed

Rail joint gaps were adjusted and remeasured during the week of the 10 April 2021 with no additional adjustments recommended (Refer Report R14 Appendix E).

Proposed Actions

All monitoring activities of the location will continue under the existing monitoring program.

2.2.9 Impacts to Built Structures and Local Roads

Background

A number of impacts to local roads and built structures occurred during November 2020 to April 2021 as a result of subsidence from LW W1 and LW W2 extraction. These impacts are focused within the Stonequarry Estate and can be summarised as:

- Impacts to road pavement on Carramar Close (November 2020);
- Impacts to houses on Stonequarry Creek Road (November 2020, April 2021);
- Impacts to houses on Attunga Close (November 2020);
- Impacts house on Carramar Close (November 2020);
- Impacts to a pool gate and pool pavers on Carramar Close (November 2020);
- Impacts to houses on Booyong Close (April 2021); and
- Impacts to inground pool and surrounding pavers on Booyong Close (April 2021).

Actions Completed

Where appropriate, Tahmoor Coal has completed temporary repairs to roads and built structures within the Stonequarry Estate. All residential impacts have been referred to SA NSW.

Proposed Actions

Visual inspection of the roads and structures will continue under the existing monitoring program, and repair of damages and interaction with SA NSW will also continue as required.

3 Assessment of Environmental Performance

This section provides an assessment of compliance with all relevant performance measures and indicators.

3.1 Environmental Performance Measures and Indicators

The following development consents include subsidence impact performance measures as conditions for the extraction of LW W1-W2:

- DA 67/98 Modification 4:
  - Condition 13A – Performance Measures for Natural and Heritage Features;
  - Condition 13E – Performance Measures for Built Features;
- LW W1-W2 Extraction Plan Approval:
  - Condition 1 – Performance Measures for Stonequarry Creek, Cedar Creek and Matthews Creek.

The subsidence impact performance measures were adopted as part of the LW W1-W2 Extraction Plan and associated management plans. To assist in defining the performance measures, each measure has been assigned subsidence performance indicator(s).

These performance measures and indicators are provided in **Table 3-1**, as well as an assessment of performance.

Table 3-1 Assessment of Environmental Performance

Feature	Subsidence Performance Measure	Subsidence Performance Indicator	Subsidence Performance Measure Exceeded?	Section Discussed
Water Management				
Stonequarry Creek, Cedar Creek and Matthews Creek (LW W1-W2 Extraction Plan Approval)	No subsidence impact or environmental consequence greater than minor*	This performance indicator will be considered to be exceeded if mining-induced fracturing in a rockbar or stream bed results in a reduction in pool water level below historically recorded water levels, taking into account rainfall and observations during the baseline monitoring period, for: • More than 10% of pools located within the 600 m Study Area for Natural Features; and/or • Pool SR17.	**No**	Sections 4.2.2 and 4.2.3
	No connective cracking between the surface, or the base of the alluvium, and the underground workings.	This performance indicator will be considered to be exceeded if analysis of inflow data suggests high correlation to rainfall events and significant departure from recent groundwater model predictions. This would be supported by analysis of pre- and post-mining goaf centreline bore data.	**No** *Note: Pre-mining and post-mining goaf centreline bore data not yet available.*	Section 4.2.8
Public Safety (DA 67/98 Condition 13E)	Negligible additional risk***.	Flooding This performance indicator will be considered to be exceeded if subsidence results in the post-mining 1% AEP flood level being above the floor level of one or more dwelling.	**No** *Note: LW W1-W2 mining is still in progression, and therefore post-mining flood modelling has not been completed.*	Not applicable
Land Management				
Public Safety (DA 67/98 Condition 13E)	Negligible additional risk***.	Landscape Features This performance indicator will be considered to be triggered if subsidence impacts to landscape features result in the collapse of cliffs, rock outcrops or steep slopes in proximity to members of the public.	**No**.	Section 4.3.1 and 4.3.2

Biodiversity Management				
Threatened species, threatened populations, or endangered ecological communities (DA 67/98 Condition 13A)	Negligible environmental consequences***.	This performance indicator will be considered to be triggered if: • Changes in macroinvertebrate and stream health indicators are statistically significant; • If visual assessment of aquatic habitat identifies mining subsidence induced impacts. • Statistically significant changes in amphibian diversity is detected toward baseline attributed to mining, as detected during amphibian monitoring; and/or • Statistically significant changes in riparian vegetation is detected toward baseline attributed to mining, as detected during riparian monitoring.	**No** *Note: AUSRIVAS results indicate that the performance indicators for aquatic ecology have not been triggered. Riparian vegetation and amphibian monitoring has not been completed during this reporting period and will be confirmed in the next Six Monthly Subsidence Impact Report.*	Section 4.4.1 and 4.4.2
Heritage Management				
Heritage sites show in the figures in Appendix 7** (DA 67/98 Condition 13A)	Negligible subsidence impacts or environmental consequences***.	<u>Isolated finds/artefact scatters (AHIMS items)</u> No performance indicators are currently established as impacts are predicted to be negligible.	**No** *Note: The LW W1-W2 Heritage Management Plan assessed the probability of impacts to isolated finds / artefact scatters from the proposed longwall mining as very unlikely. Impacts to open sites, such as artefact scatters, are limited to cracking in the surface soils which is unlikely to affect the artefacts. Therefore monitoring of these sites have not been included in the monitoring program.*	Not applicable
		<u>Scarred tree (AHIMS item)</u> This performance indicator will be considered to be triggered if: • subsidence monitoring identifies a perceptible tilt increase that places the tree at risk of falling; and/or	**No** *Note: The LW W1-W2 Heritage Management Plan assessed the probability of impacts to the scarred tree from the proposed longwall mining as very unlikely.*	Not applicable

		• subsidence monitoring identifies a perceptible cracking in the tree unrelated to natural weathering or trauma damage	*Impacts to open sites, such as scar trees, are limited to cracking in the surface soils which is unlikely to affect the item. Therefore monitoring of this item has not been included in the monitoring program.*	
		<u>Grinding grooves (AHIMS item)</u> This performance indicator will be considered to be triggered if: • subsidence monitoring identifies visible perceptible impacts such as subsidence induced cracking; and • these subsidence impacts result in impacts to the heritage values of the site.	**No**	Section 4.5.1
		<u>Rockshelters (AHIMS items)</u> This performance indicator will be considered to be triggered if: • subsidence monitoring identifies visible perceptible change, e.g. rockfall, cracking, or toppling within rockshelters; and • these subsidence impacts result in impacts to the heritage values of the sites.	**No** *Note: It should be noted that only external visual inspections of rockshelters has been able to be completed during the reporting period due to safety concerns. Internal inspections of the rockshelters will be completed following the completion of the longwalls.*	Section 4.5.1
	Negligible loss of heritage value***.	<u>Queen Victoria Memorial Hospital (local heritage significance)</u> This performance indicator will be considered to be triggered if subsidence monitoring identifies cracking of external brick work or other physical impacts to the historical heritage values of the building, measurable tilt and internal damage, or cracks in foundations.	**No**	Section 4.5.2 and 4.6
		<u>Mill Hill, Miller's House and archaeological relics (local heritage significance)</u> This performance indicator will be considered to be triggered if subsidence monitoring identifies damage to external cladding or internal finishes.	**No**	Section 4.5.2 and 4.6

		Harmony House archaeological site (local heritage significance) No performance indicators are currently established as impacts are predicted to be negligible. However, if the pre-mining assessment identifies that the cistern is located within the Study Area, this may need to be re-evaluated.	**No** *Note: The LW W1-W2 Heritage Management Plan assessed the probability of impacts to this heritage item from the proposed longwall mining as very unlikely. Therefore monitoring of this site has not been included in the monitoring program.*	Not applicable
		Rural landscape – Thirlmere Way (local heritage significance) No performance indicators are currently established as impacts are predicted to be negligible.	**No** *Note: The LW W1-W2 Heritage Management Plan assessed the probability of impacts to this heritage item from the proposed longwall mining as very unlikely. Therefore monitoring of this site has not been included in the monitoring program.*	Not applicable
Other Aboriginal and heritage sites (DA 67/98 Condition 13A)	Negligible subsidence impacts or environmental consequences***.	Sandstone culverts (local heritage significance) This performance indicator will be considered to be triggered if subsidence monitoring identifies visible perceptible impacts such as subsidence induced cracking, exfoliation, block movement or block fall.	**No**	Section 4.5.2 and 4.6
		Brick culverts (local heritage significance) This performance indicator will be considered to be triggered if subsidence monitoring identifies visible perceptible impacts such as subsidence induced cracking, exfoliation, brick movement or brick fall.	**No**	Section 4.5.2 and 4.6

Built Feature Management				
Key Public Infrastructure: • Main Southern Railway; • Picton-Mittagong Loop Line; and • Electricity transmission lines and towers. (DA 67/98 Condition 13E)	Always safe and serviceable.	None allocated.	**No**	Section 4.6
	Damage that does not affect safety or serviceability must be fully repairable, and must be fully repaired.	None allocated.	**No**	Section 4.6
Other Infrastructure: • Electricity distribution lines, poles and associated towers; • Unsealed roads and road culverts, fire trails, fences and other built features; and • Other public infrastructure. (DA 67/98 Condition 13E)	Always safe.	None allocated.	**No**	Section 4.6
	Serviceability should be maintained wherever practicable.	None allocated.		
	Loss of serviceability must be fully compensated.	None allocated.		
	Damage must be fully repairable, and must be fully repaired or else replaced or fully compensated.	None allocated.	**No**	Section 4.6
Privately-owned residences (DA 67/98 Condition 13E)	Always safe.	None allocated.	**No**	Section 4.6
	Serviceability should be maintained wherever practicable.	None allocated.		
	Loss of serviceability must be fully compensated.	None allocated.		
	Damage must be fully repairable, and must be fully repaired or else replaced or fully compensated.	None allocated.	**No**	Section 4.6
Other privately-owned built features and improvements, including farm dams, swimming pools, tennis	Always safe.	None allocated.	**No**	Section 4.6
	Serviceability should be maintained wherever practicable.	None allocated.		
	Loss of serviceability must be fully compensated.	None allocated.		

courts, roads, tracks and fences (DA 67/98 Condition 13E)	Damage must be fully repairable, and must be fully repaired or else replaced or fully compensated.	None allocated.	**No**	Section 4.6
Public Safety (DA 67/98 Condition 13E)	Negligible additional risk***.	None allocated.	**No**	Section 4.6
Mine workings				
First workings (DA 67/98 Condition 13A)	To remain long term stable and non-subsiding.	None allocated.	**No**	Not applicable
Second workings (DA 67/98 Condition 13A)	To be carried out only within the approved mine plan, in accordance with an approved Extraction Plan.	None allocated.	**No**	Not applicable

NOTES:

* minor is defined as *not very large, important or serious* by DPIE.

** As there is no Appendix 7 in DA 67/98 Modification 4, it is interpreted that this refers to the Aboriginal heritage sites listed on the Aboriginal Heritage Information Management System, *Wollondilly Local Environmental Plan 2011*, State Heritage Register, and the Australian Heritage Database.

*** For the purpose of this Extraction Plan and associated documents, 'negligible' is defined as being 'so small and insignificant as to not be worth considering'. A negligible impact is viewed with regards to a long term context, causing little or no impact. If a short term impact causes a greater than negligible impact, the impact can still be considered negligible if the impacts are of a limited duration and are considered negligible when considered over the long term.

4 Summary of Environmental Monitoring Results

This section provides a comprehensive summary of all quantitative and qualitative environmental monitoring results.

4.1 Subsidence Monitoring

4.1.1 General Subsidence Observations

During the reporting period, the LW W1-W2 Subsidence Monitoring Program has been implemented to monitor subsidence impacts within the Study Area. The details of the Subsidence Monitoring Program are illustrated in **Figure 4-1**. The Subsidence Monitoring Program includes sixteen (16) Global Navigation Satellite System (GNSS) units measuring absolute horizontal and vertical positions in real time installed directly above and adjacent to LW W1 and LW W2.

A summary of all surveys and inspections completed during the reporting period is provided in Figure A and Table A of the MSEC1149 LW W2 Subsidence Monitoring Report 15 (refer **Appendix A**). A weekly review of the subsidence survey results during the reporting period has been completed by MSEC.

As of 21 April 2021 (the end of this reporting period), 1236 m of LW W2 had been extracted and extraction of LW W1 has been completed. The active subsidence area of LW W2 for 21 April 2021 is illustrated in **Figure 1-3**.

Table 4-1 summarises the maximum observed ground movements within the active subsidence zone at the start and end of this reporting period. During the reporting period LWW2 recorded a maximum of 485 mm of vertical subsidence within the active subsidence zone at Picton Mittagong Loop Line.

Table 4-1 Subsidence Monitoring Observations for the start and end of this Reporting Period (source: MSEC, Subsidence Monitoring Reports 29 and 15, Appendix A)

	Report 29 (MSEC 1073)		Report 15 (MSEC 1149)	
General Information				
Monitoring Period	29/10/2020 – 6/11/2020 (weekly reporting)		15/04/2021 – 21/04/2021 (weekly reporting)	
Length of extraction	1876 m (LW W1)		1236 m (LW W2)	
Distance travelled by longwall since previous report	7 m since 28/10/2020		74 m since 14/040201	
Observed Ground Movement Parameters	**Maximum Observed**	**Location**	**Maximum Observed**	**Location**
Subsidence (mm)	233	Stonequarry Creek Road	485	PMLL
Tilt (mm/m)	1.9	Stonequarry Creek Road	3.5	PMLL
Hogging Curvature (km^{-1})	0.12	Booyong Close	0.20	PMLL
Sagging Curvature (km^{-1})	-0.08	Booyong Close	-0.14	PMLL
Tensile Strain (mm/m)	0.6	PMLL	1.2	PMLL
Compressive Strain (mm/m)	-1.2	LW W1-W2 Crossline	-4.3	PMLL
Subsidence since previous survey (mm)	5	PMLL	36	Peg WX-11

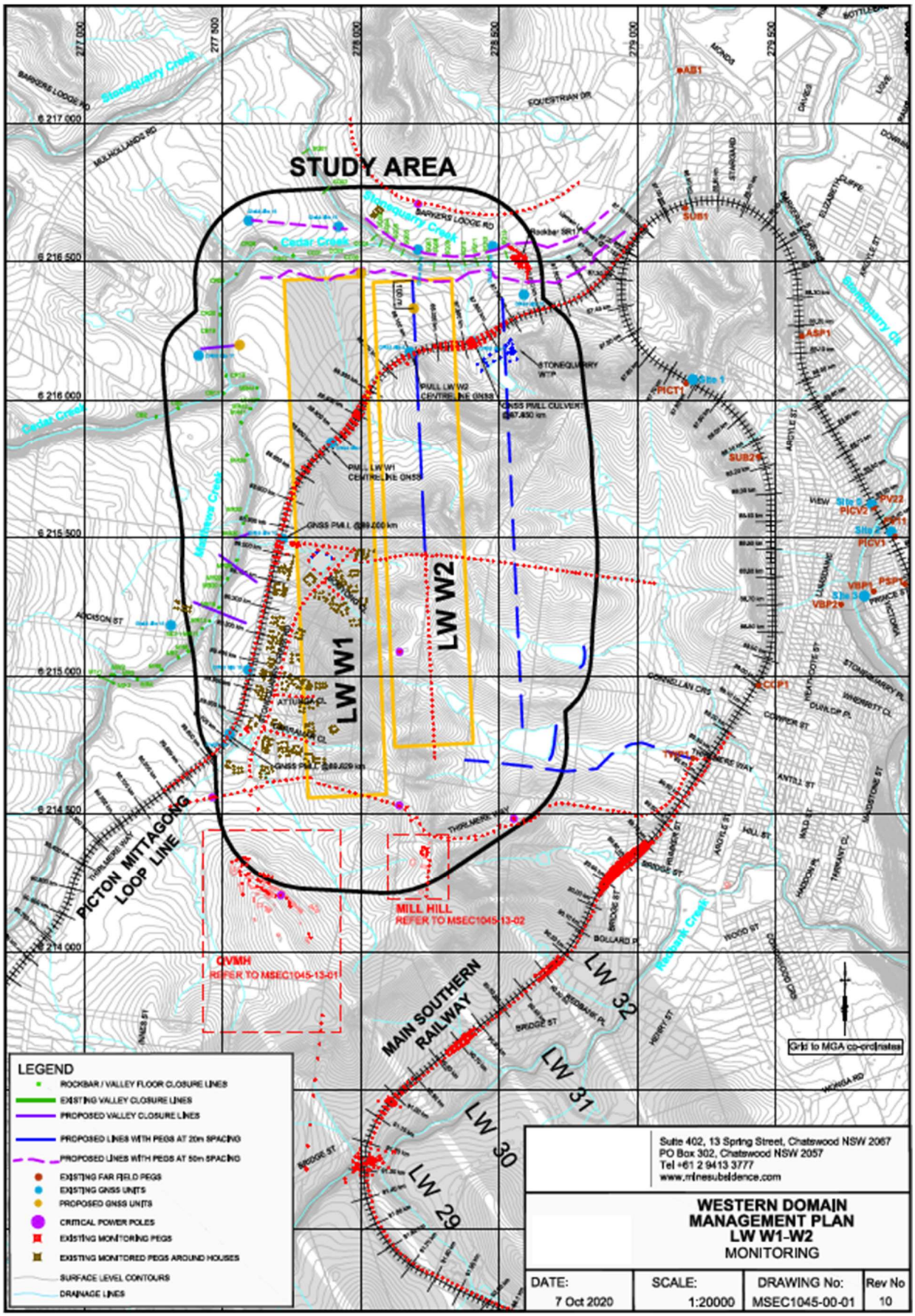

Figure 4-1 LW W1-W2 Subsidence Monitoring Program (source: LW W1-W2 Subsidence Monitoring Program)

The development of subsidence at pegs and GNSS units located on the LW W2 centreline that have been mined directly beneath by LW W2 are illustrated in **Figure 4-2**. This figure shows that subsidence currently observed along the centreline of LW W2 is greater than LWW1 but current trends indicate that observed subsidence will be less than predicted subsidence.

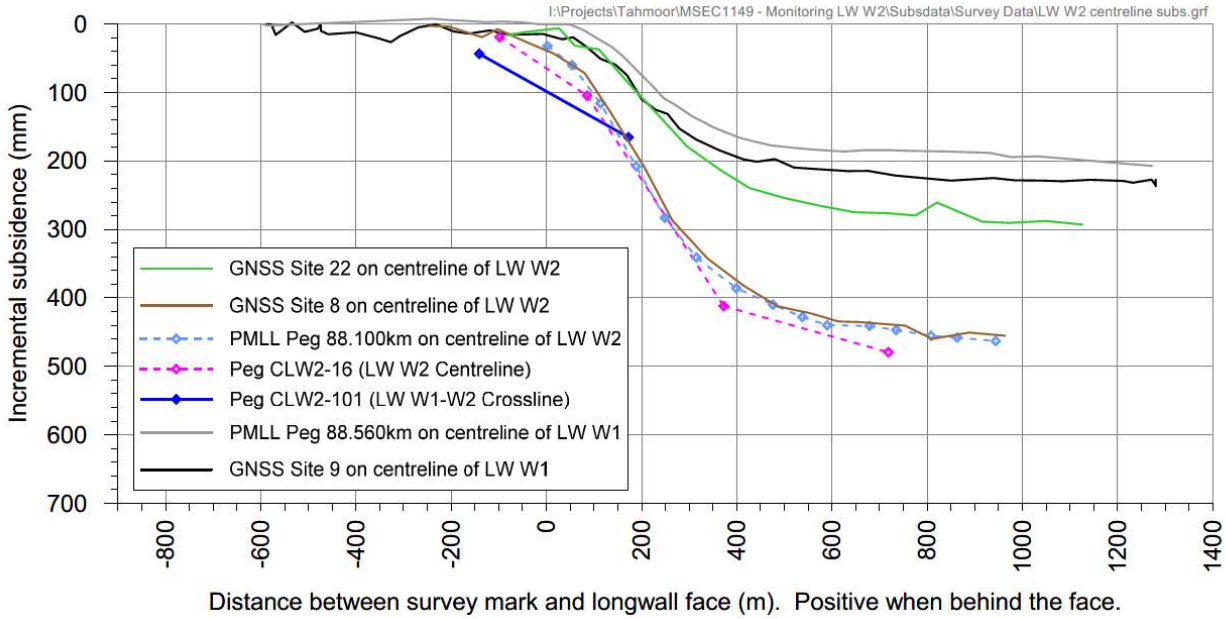

Figure 4-2 Development of subsidence along centreline of LW W2 compared to previously extracted single panels (source: MSEC, Subsidence Monitoring Report 15, Appendix A).

LWW2 has passed beneath the Picton to Mittagong Loop line at 88.13km on 12/01/2021. At the culvert at 88.400 km, a 7 mm wide crack in the vertical mortar joint at the Down side headwall and a 6 mm wide crack in a mortar joint at the Up side headwall have been observed. Minor spalling of sandstone was also noted and a minor outward movement up to 7 mm of the headwall and wingwall relative to culvert. Compressive strains continue to develop at 88.400 km to the side of the culvert, within the embankment fill.

The first surveys along Attunga Close in the Stonequarry Estate were conducted on 20 April. Additional subsidence up to 35 mm was measured since the final survey for LW W1.
Small compressive strains are developing in the active subsidence zone, and some minor impacts to stormwater drains and built structures have been noted in the Stonequarry Estate during the current monitoring period (refer to **Table 2-3** for more details).

A comparison between assessed and observed impacts to surface features is summarised in Table 2 of the MSEC Subsidence Monitoring Report 15 (refer to **Appendix A**).

4.1.2 GNSS Monitoring Observations

Some trends can be seen in the results of the observed GNSS movements with the closest GNSS units generally moving towards the extracted panel as expected. Results from all GNSS units, including incremental horizontal movements, are presented in the MSEC Subsidence Monitoring Reports (refer **Appendix A**).

Changes in horizontal distances between GNSS units stationed near each other and on opposite sides of a waterway as a result of the extraction of LW W2 are shown in **Figure 4-3**.

Site 12 and Site 13 are located across Stonequarry Creek at Rockbar SR17. As previously reported, Site 12 appeared to have been affected by the heavy rainfall event between 7 and 9 February 2020, resulting in swelling of clay soils around the unit and movement of the sensor. If the movements during the week after the wet weather event on 7 and 9 February 2020 are removed from the results, the resultant movements at Site 12 would be similar in magnitude to the movements measured at Site 13.

Site 13 moved south more than Site 12, resulting in closure of approximately 15 mm since the commencement of LW W2. Very little change is, however, measured across the rockbar itself and rates of change have reduced. Site 12 was observed to rise in height in response to the heavy rainfall event in late March and has stopped rising (refer **Figure 4-3**).

The LW W1 face passed Site 18 in early August 2020 and passed Site 19 in late August 2020, resulting in Site 18 moving towards LW W1 earlier than Site 19. This resulted in an apparent closure between the two sites between June and late August 2020, and an apparent reduction in closure between September to mid-October 2020 (refer **Figure 4-3**).

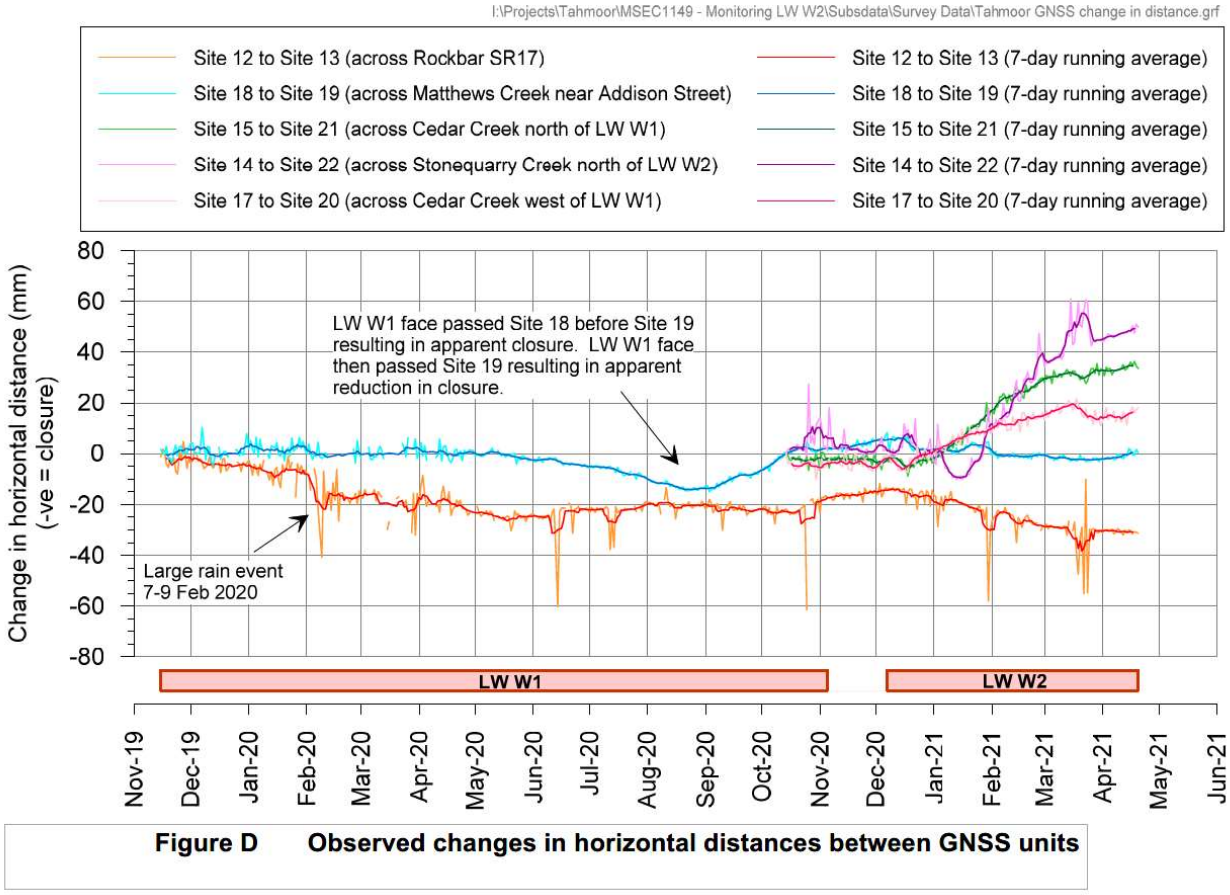

Figure 4-3 Observed changes in horizontal distances between GNSS units (source: MSEC, Subsidence Monitoring Report 15, Appendix A).

4.1.3 Valley Closure in Creeks

Sites 15 and 21 are located across Cedar Creek to the north of LW W1. Sites 17 and 20 are located across Cedar Creek to the west of LW W1. Both pairs of units are recording similar changes, with minor opening observed across the creek. Rates of change are reducing.

Sites 14 and 22 are located across Stonequarry Creek to the north of LW W2. The units moved towards each other by approximately 10 mm during early January, but have since moved apart approximately 60 mm, as the longwall face moves away to the south. Rates of change are reducing.

Survey marks installed across rockbars in Stonequarry Creek, Cedar Creek and Matthews Creek prior to the commencement of LW W1 are illustrated in **Figure 4-1**. During the current reporting period rates of changes in minor opening have reduced.

4.2 Water Monitoring

The Tahmoor Coal LW W1-W2 Water Management Plan was prepared to manage the potential environmental consequences of LW W1-W2 extraction on surface water and groundwater systems in accordance with Condition 13H(vii)(c) of DA 67/98.

During this reporting period, the LW W1-W2 Water Management Plan has been implemented to monitor the following surface water and groundwater systems:

- **Surface Water:**
  - Flow, pool water level and surface water quality monitored for Stone quarry Creek, Cedar Creek and Matthews Creek – monitoring data reviewed and reported by Hydro Engineering & Consulting (refer to **Appendix B** for referenced reports).
  - Creek monitoring for natural drainage behaviour – visual inspections and reporting by GeoTerra (refer to **Appendix C** for referenced reports);
- **Groundwater:**
  - Shallow groundwater levels, quality and pressures, and deep groundwater levels / pressures – monitoring data reviewed and reported by SLR (refer to **Appendix D** for Six Monthly Report); and
  - Mine water intake – data for this reporting period reviewed and reported by SLR (refer to **Appendix D** for Six Monthly Report).

Performance against all Water Management Plan TARPs for the reporting period are summarised in **Table 2-3**. The following sections summarise the observations made during the reporting period for each surface water and groundwater category.

4.2.1 Stonequarry Creek Flow

Streamflow data has been analysed to assess whether a statistically significant reduction in the quantity of water recorded at Stonequarry Creek at Picton (GS212053) in the period post-mine commencement relative to the pre-mine period has occurred, that has not also occurred in the control catchment(s). The locations of GS212053 is illustrated in **Figure 4-5**.

In addition to surface water extraction, changes in streamflow rating at Stonequarry Creek at Picton (GS 212053) have occurred due to the mobile nature of the stream bed and major flooding in the Stonequarry Creek catchment, notably the 2016 Picton Flood. Licensed groundwater extraction in the Stonequarry Creek catchment also has the potential to influence streamflow characteristics at this site due to changes in baseflow characteristics and baseflow contribution.

Streamflow data has previously been analysed (HEC, 2020) to assess whether a statistically significant reduction in the quantity of water recorded at Stonequarry Creek at Picton (GS 212053) has occurred, in the period post commencement of LW W1 relative to the pre-mining period, that

has not also occurred in the reference catchment(s). This assessment relies on a calibrated streamflow model. However, as the rating curve for Stonequarry Creek at Picton (GS 212053) was revised by WaterNSW in July 2020, and is subject to further change, the streamflow records from December 2015 have changed thereby invalidating the current model calibration. As such, the assessment of whether a statistically significant reduction in the quantity of water recorded at Stonequarry Creek at Picton (GS 212053) has occurred, in the period post commencement of LW W1 relative to the pre-mining period, has not been conducted for the review period, October 2020 to March 2021 (refer to **Section 2.2** of **Appendix B** for further details).

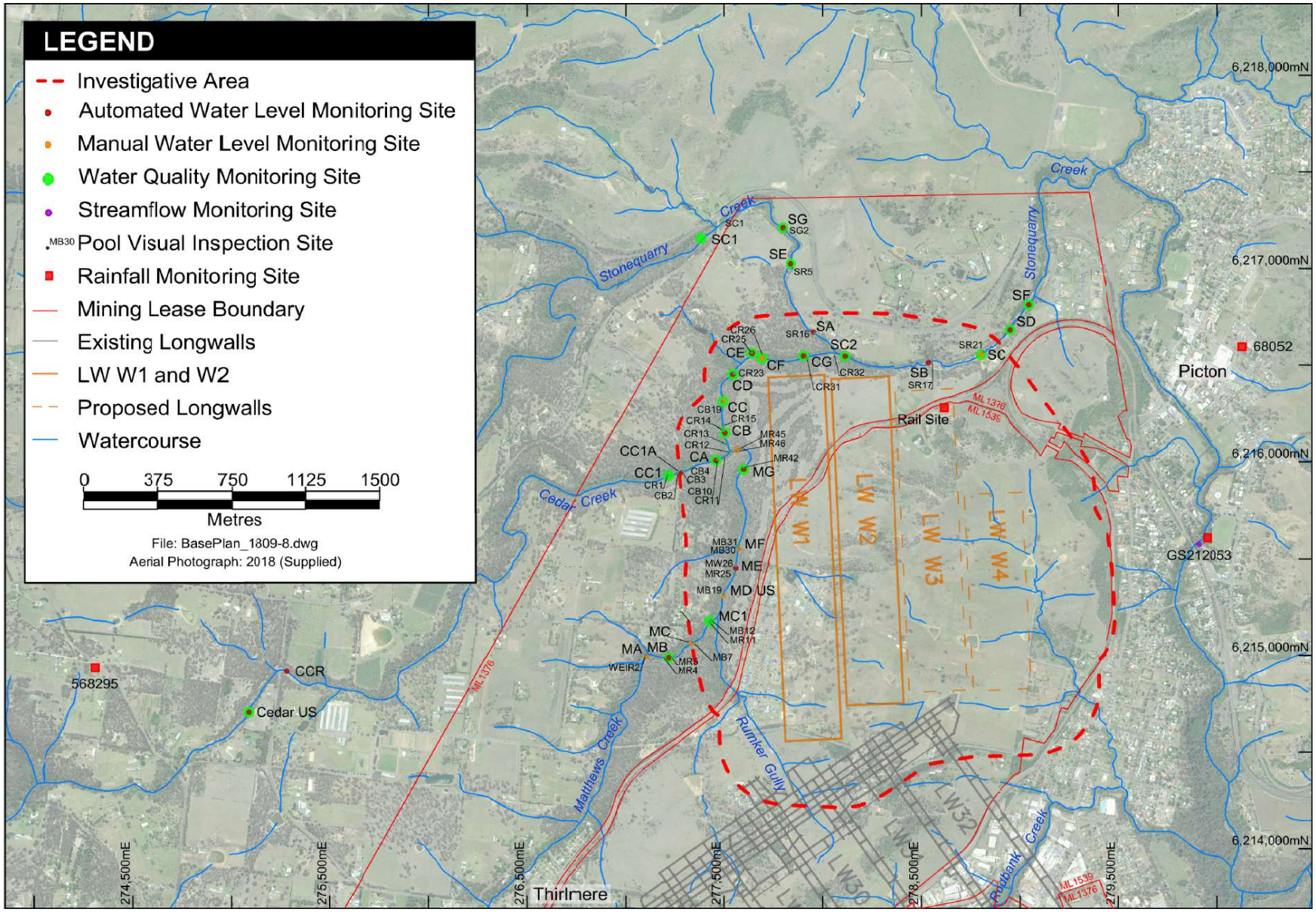

Figure 4-4 LW W1-W2 Surface Water Monitoring Locations (source: HEC, Surface Water Review, Appendix B)

4.2.2 Pool Water Level

Surface water level data has been recorded at the pool monitoring sites on Matthews Creek, Cedar Creek and Stonequarry Creek as shown in **Figure 4-5**. Continuous surface water level data has been recorded at three pool monitoring sites on Matthews Creek, eight monitoring sites on Cedar Creek and seven monitoring sites on Stonequarry Creek. Manual water level measurements have also been undertaken monthly at the sites shown in **Figure 4-5**.

One additional water level monitoring site has recently been installed in December 2020 on Cedar Creek – Cedar US (Upstream).

During the reporting period, monitoring sites on Matthews Creek, Stonequarry Creek, and Cedar Creek water levels remained above minimum baseline levels and/or consistent with baseline conditions. However, sites CA, CB, CD, CE, CG and CC1A recorded a decline in water level during early to mid-December 2020 and mid-January 2021 inconsistent with pre-mining LW W1 behaviour (refer to **Appendix B**).

At Site CA, a rapid and significant decline in water level was recorded at this site in early December 2020, mid-December 2020 and mid to late-January 2021. However, the water level did not decline below the baseline minimum water level during these periods (refer to **Appendix B**).

Site CB recorded additional water level reduction during late-January 2021 and early-March 2021, with water level decline below baseline minimum for short periods in October 2020, early to mid-December 2020, mid to late-January 2021 and early March 2021. Pool CR14 (site CB) has likely been impacted by mining LW W1-W2 and a detailed investigation has been undertaken (refer to **Appendix B**).

At Site CD, the water level declined slightly below the CTF level and the baseline minimum for a short period in October 2020, December 2020 and January 2021. For Site CE, the water level remained above the Cease To Flow (CTF) level and above the baseline minimum for the majority of the review period, except for a short period in late January 2021 when the water level declined to the baseline minimum. For Site CG, the water level remained above the CTF level and above the baseline minimum for the majority of the review period, except for a short period in late January 2021 when the water level declined to the baseline minimum (refer to **Appendix B**).

At Site CC1A, the water level was above the CTF level from October to early December 2020. A water level decline occurred in early to mid-December 2020, inconsistent with pre-mining LW W1 behaviour. The water level declined slightly below the CTF level for a short period in mid-January 2021, however, following a subsequent rainfall event the water level rose and remained above the CTF level for the remainder of the review period (refer to **Appendix B**).

Charts illustrating monitored pool water level hydrographs for pools on Matthews Creek, Cedar Creek and Stonequarry Creek are presented in Charts A1-23 in Attachment A of the Surface Water Monitoring Reports (refer to **Appendix B**).

4.2.3 Natural Drainage Behaviour

Visual and photographic surveys for subsidence impacts on creeks have been completed monthly for all monitoring pools on Stonequarry Creek, Cedar Creek and Matthews Creek within the active subsidence zone of LW W2 (refer to **Appendix C**) with additional monitoring conducted fortnightly on pool monitoring sites CA, CB, CC1A, MR45 and MR46 from January 2021. The purpose of these surveys is to note whether change has occurred to pool level, drainage or overland flow, and to assist in determining if any change can be attributed to mining impacts. Surveys are carried out to identify rock bar and/or stream base cracking, gas release, or increased iron precipitation.

Creek monitoring locations are illustrated on **Figure 4-6**.

During the reporting period, pool water level and overland connective flow was influenced by rainfall events through-out November 2020 to March 2021 and resulting catchment base-flow recharge.

All pools along Cedar Creek and Matthews Creek observed maintained pool level and overland connective flow except for pools CB10 and CB12 to CR15 which exhibited pool level reduction and lack of overland connective flow observed on the 19 January 2021, returning to pre-existing conditions following rain events in late-January 2021. Pools MR45 and MR46 in Matthews Creek were also observed to have reduced water levels on the 19 January 2021, returning to pre-existing conditions following rain events in late-January 2021 (refer to **Appendix C**).

One instance during the reporting period of gas emissions were observed occurred on 24 December 2020 at MR45 in Matthews Creek which triggered a TARP Level 3 significance. Previous gas emissions were tested, and the gas analysis received indicated that the gas originated from shallow Hawkesbury Sandstone and/or shallow anoxic muddy alluvium rather than deeper Hawkesbury Sandstone strata. The data does not enable a definitive assessment to be made of the potential linkage between LW W1 extraction and subsidence impacts in the area (refer to **Appendix C**).

To date, there have been no creek bed cracking evident in Cedar Creek, Matthews Creek or Stonequarry Creek.

On 19th January 2021, significant iron oxy-hydroxide precipitates were noted in Pools CR13-CR15 in Cedar Creek. However, the degree of iron precipitates did not exceed baseline survey observations, returning to pre-existing conditions following rain events in late-January to early-February 2021. Minor Iron oxy-hydroxide precipitates were noted in various pools during the March survey in Cedar and Matthews Creek, however the precipitates were swamped by the high turbidity in the streams as a result of high rainfall events and creek flooding (refer to **Appendix C**).

A summary of creek observations for the reporting period is provided in **Table 4-2**.

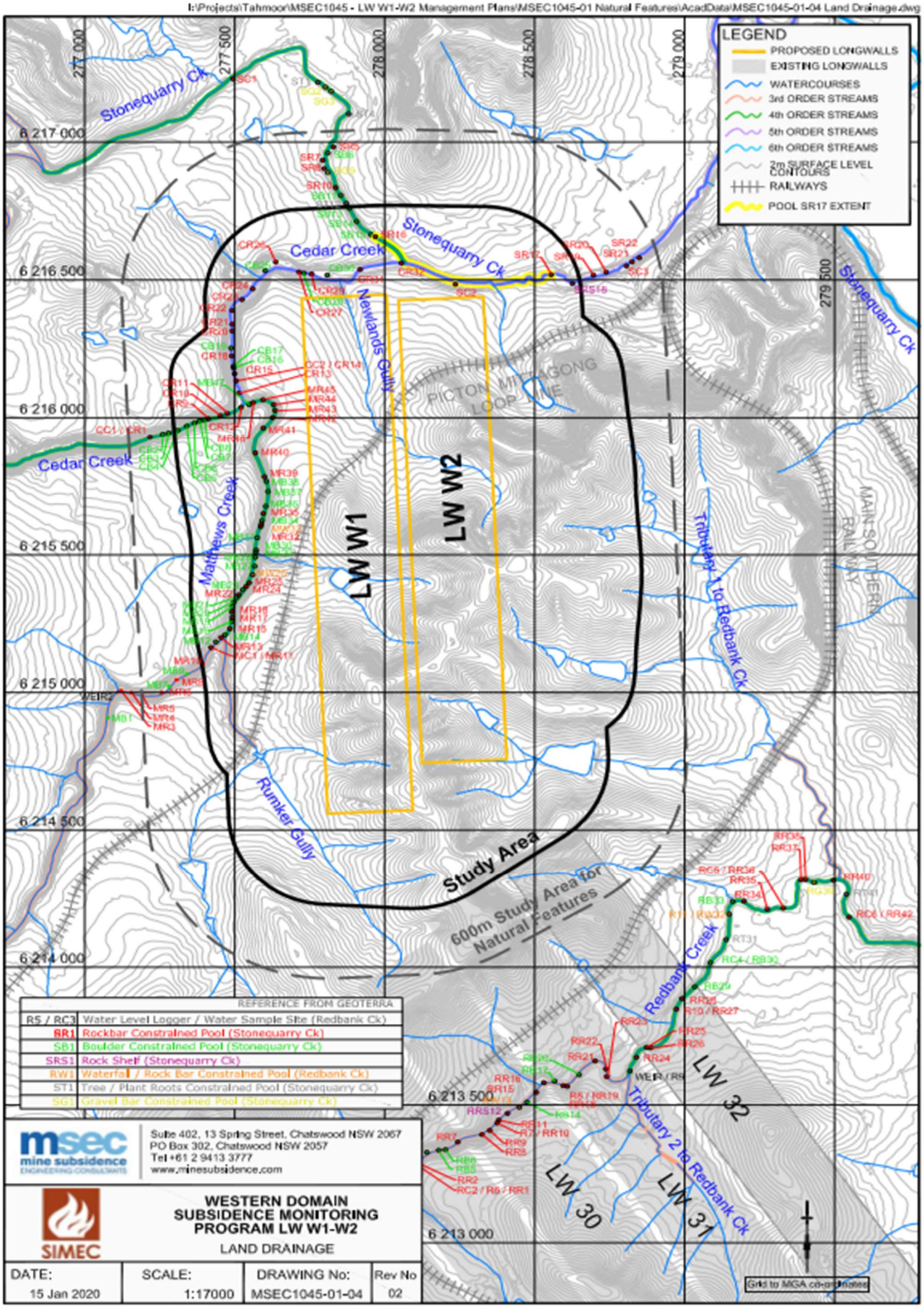

Figure 4-5 LW W1-W2 Creek Monitoring Locations (source: MSEC, 2019; LW W1-W2 Subsidence Predictions and Impact Assessment Report)

Table 4-2 Creek Monitoring Observations for the Reporting Period (source: GeoTerra, Creek Monitoring Reports, Appendix C)

	Report 12 30 November 2020	Report 13 23-24 December 2020	Report 14 19 January 2021	Report 15 1, 18, 22 February 2021	Report 16 15, 31 March 2021	Report 17 19, 28 April 2021
Stonequarry Creek (SC2, SR16/SA monitored during the reporting period)						
Observations of individual pool water level and flow	• No observable mining induced related impacts such as reduction in pool level or connective overland flow	• No observable mining induced related impacts such as reduction in pool level or connective overland flow	•No observable mining induced related impacts such as reduction in pool level or connective overland flow	• No observable mining induced related impacts such as reduction in pool level or connective overland flow	• No observable mining induced related impacts such as reduction in pool level or connective overland flow	• No observable mining induced related impacts such as reduction in pool level or connective overland flow
Surface cracking	No surface cracking was reported during the review period.					
Iron hydroxide precipitation	No increase in iron hydroxide precipitation was observed during the review period.					
Gas Releases	No gas releases were observed in pools on Cedar Creek.					
Cedar Creek (CR1-CR32 monitored during the reporting period)						
Observations of individual pool water level and flow		• Slightly higher pool levels and more overland connective flow following a rain event. • Pool CR14 logged lowest water level between 2-18 December 2020	• Slightly lower pool levels and less overland connective flow observed in Pools CB10, CB12 to CR15 • Pool CR14 logged lowest water level between 17-30 January 2021	• Pool levels and overflow returned to TARP Level 1 conditions following rain events.	• All pools within TARP Level 1 for pool level and flow following significant rain events. • Elevated flows and pool levels following significant rain event	• All pools within TARP Level 1 for pool level and flow following significant rain events. • Elevated flows and pool levels following significant rain event
Surface cracking	No surface cracking was reported during the review period.					
Iron hydroxide precipitation	No increase in iron hydroxide precipitation was observed	No increase in iron hydroxide precipitation was observed	Significant Iron oxy-hydroxide precipitates were noted in Pools CR13-CR15. However, degree below baseline survey observations	Iron oxy-hydroxide precipitates returned to previous conditions following rain events.	Minor Iron oxy-hydroxide precipitates noted	No increase in iron hydroxide precipitation was observed
Gas Releases	No gas releases were observed in pools on Cedar Creek.					

	Report 12 30 November 2020	Report 13 23-24 December 2020	Report 14 19 January 2021	Report 15 1, 18, 22 February 2021	Report 16 15, 31 March 2021	Report 17 19, 28 April 2021
Matthews Creek (MB1-MR46 monitored during the reporting period)						
Observations of individual pool water level and flow	• Pools had elevated pool levels and overland connective flow due to catchment base-flow recharge following a rain event. • MB9-MB28 had generally higher water levels and flow • Pools MR11-MB12, MB14 and MB19-MB23 were either very low or dry	• Slightly higher pool levels and more overland connective flow following a rain event. • MR1-MR46 had generally variable water levels, with similar to or slightly higher pool depths and connective overland flow compared to last month • Pools MB20-21, MB23, MB32 and MB38 were either very low or dry	• Reduced water levels observed in Pools MR45 and MR46	• Pool levels and overflow returned to TARP Level 1 conditions following rain events.	• All pools within TARP Level 1 for pool level and flow following significant rain events. • Elevated flows and pool levels following significant rain event	• All pools within TARP Level 1 for pool level and flow following significant rain events. • Elevated flows and pool levels following significant rain event
Surface cracking	No surface cracking was reported during the review period.					
Iron hydroxide precipitation	No increase in iron hydroxide precipitation was observed during the review period.					
Gas Releases	• Minor Gas releases were observed in Pool MR45 – approximately 30sec intervals	• None observed.	• None observed.	• None observed.	• None observed.	• None observed.

4.2.4 Surface Water Quality

Surface water quality data has been recorded at the following sites (refer to **Figure 4-5**):

- Cedar Creek: CC1, CA, CB and CG;
- Matthews Creek: MB, MC1 and MG; and
- Stonequarry Creek: SC1, SC2, SC, SD, SE, SF and SG.

Field analyses are undertaken for pH, electrical conductivity (EC), dissolved oxygen, temperature and oxidation reduction potential. Laboratory analyses are undertaken for pH, EC, total dissolved solids, alkalinity, sulphate, chloride, calcium, magnesium, sodium, potassium, fluoride, nitrate and nitrite, total kjeldahl nitrogen, phosphorus and the following total and dissolved metals: aluminium, arsenic, barium, copper, lead, lithium, manganese, nickel, selenium, strontium, zinc and iron.

To date, there has been negligible evidence of an influence of mining LW W1 or LW W2 on surface water quality in Matthews Creek, Cedar Creek or Stonequarry Creek. The water quality characteristics of monitoring sites following commencement of mining LW W1 and LW W2 have been consistent with baseline conditions and / or consistent with reference site conditions.

Although isolated occurrences of elevated water quality constituents were recorded at some monitoring sites on Matthews Creek, Cedar Creek and Stonequarry Creek during the period October 2020 to March 2021 (refer Section **Error! Reference source not found.**, **Appendix B**), the elevated levels were either not in excess of baseline conditions or were also elevated at an upstream reference site.

A summary of observations for the reporting period is provided in **Table 4-3**.

Charts illustrating water quality results for monitored pools on Matthews Creek, Cedar Creek and Stonequarry Creek are presented in Charts B1-11 in Appendix B of the Surface Water Review (refer to **Appendix B**).

Table 4-3 Summary of Notable Results for Key Water Quality Parameters for the Reporting Period

Parameter	Matthews Creek	Cedar Creek	Stonequarry Creek
pH	Slightly acidic to near neutral pH conditions for the duration of the review period, consistent with baseline values.	Slightly acidic to near neutral pH conditions for the duration of the review period, consistent with baseline values.	near neutral to slightly alkaline pH conditions for the duration of the review period, consistent with baseline values.
Electrical Conductivity	Consistent with baseline values for the duration of the review period (less than 450 µS/cm at all sites).	Consistent with baseline values for the duration of the review period (less than 540 µS/cm at all sites).	Consistent with baseline values for the duration of the review period (less than 1,000 µS/cm at all sites).
Dissolved Aluminium	Concentrations recorded at each monitoring site were equal to or less than 0.14 mg/L and consistent with baseline values.	A historically elevated dissolved aluminium concentration was recorded at monitoring site CG on 2 February 2021 (0.06 mg/L) and 30 March 2021 (0.09 mg/L) following above average rainfall. The dissolved aluminium concentrations were also elevated at the upstream reference sites (Cedar US and CC1). All other sites were consistent with baseline values.	A historically elevated dissolved aluminium concentration was recorded at monitoring sites SD (0.08 mg/L), SC (0.08 mg/L) and SF (0.09 mg/L) on 31 March 2021 following above average rainfall. The dissolved aluminium concentrations were also elevated at the upstream reference sites (SC1, SG and SE) on this date.
Dissolved Iron	Concentrations recorded at each monitoring site were equal to or less than 1.34 mg/L and consistent with baseline values.	Concentrations recorded at each monitoring site were equal to or less than 1 mg/L and consistent with baseline values.	Concentrations recorded at each monitoring site were equal to or less than 2 mg/L and consistent with baseline values.
Dissolved Manganese	Concentrations were less than 0.9 mg/L at all sites during the review period and consistent with baseline values.	Concentrations were less than 1.25 mg/L at all sites during the review period and consistent with baseline values.	Concentrations were less than or equal to 1.8 mg/L at all sites and consistent with baseline values.
Dissolved Zinc	Concentrations were low (equal to or less than 0.01 mg/L) at all sites and consistent with baseline values.	Concentrations were low (equal to or less than 0.01 mg/L) at all sites and consistent with baseline values.	Concentrations were equal to or less than 0.02 mg/L at all sites and consistent with baseline values.
Sulphate	Historically elevated sulphate concentrations were recorded at all monitoring sites in Matthews Creek including at MB (reference site) on 3 November 2020. The sulphate concentrations recorded since 3 November 2020 have been consistent with baseline concentrations.	Slightly elevated sulphate concentrations were recorded at all monitoring sites in Cedar Creek including at CC1 (reference site) on 3 November 2020 and 2 January 2021 following above average rainfall. The sulphate concentrations recorded since this time have been consistent with baseline concentrations.	Concentrations recorded at monitoring sites in Stonequarry Creek were consistent with baseline concentrations.

4.2.5 Groundwater Quality

A total of 17 open standpipe piezometers (OSPs) have been installed at six locations in the Western Domain – P12 to P17. A number of private groundwater bores also form part of the groundwater monitoring program for LW W1-W2. The locations of these groundwater bores are illustrated in **Figure 4-9**.

As of November 2020, no exceedances were triggered for Salinity and remained stable during the reporting period. All monitoring bores and private bores are within the level 1 TARP criteria over the reporting period for Salinity.

Short-term fluctuations for pH were recorded for most sites (P12A, B, C and sites P14 and P17) however remained within trigger levels. The gradual increase in pH observed at P12 (A, B and C), P13A and P13B result in a single exceedance in the upper pH trigger level between March and April 2021 triggering the Level 2 TARP criteria (refer to **Figure 4-6** and **Figure 4-7**). At site P16B, pH records from January 2021 to March 2021 were omitted due to on-site operation (addition of oxalic acid in monitoring bore P16B to release the monitoring pump in January 2021). In April 2021, pH at P16B sits marginally above the lower pH trigger value at 5.9 (0.03 above the proposed trigger level). In April 2021 a short-term decrease (<3 months) in pH results in the exceedance in the lower pH at P16A (TARP Level 2) (pH = 4.85 and 0.02pH unit below the proposed trigger level) (refer to **Figure 4-8**). The private bores showed stable pH over the reporting period, within baseline level (refer to **Appendix D** for further details).

All the monitoring bores and private bores at Western Domain triggered the TARP level 2 criteria for specific metals since completion of LW W1 and commencement of LW W2, with the exceptions of P12A, P12B, P12C, P14C, GW115860 and GW104090 that are within the TARP level 1 criteria. Single short-term (<3 months) exceedance in dissolved Iron (Fe) triggered TARP Level 2 at P13B, P16B and P16C in November 2020 and April 2021 and possibly due to natural fluctuations. P13B presents fluctuations in Fe with two exceedances occurring for less than three months in October 2020 and January 2021. Dissolved iron concentrations decline back to baseline levels in April 2021 for locations P13B and P16B but not for P16C where a single exceedance is observed in April 2021 (refer to **Figure 4-9**).

A Single short-term (< 3 month) exceedance (TARP Level 2) in Manganese (Mn) was recorded at P16C in November 2020 and reverted to baseline and below the trigger levels in December 2020 further returning to non-exceedance levels in April 2021 (refer to **Figure 4-10**).

There were no exceedances recorded in Copper (Cu), Lead (Pb), Zinc (Zn), Nickel (Ni), Arsenic (As), Strontium (Sr) and Selenium (Se) over the reporting period, with all monitoring sites within the TARP Level 1. In January 2021, an increase in Zn concentrations were recorded at P16A with 0.052 mgl/L remaining below the proposed trigger level.

In February 2021, Aluminium (Al) concentrations triggered a Level 2 TARP at P17 and during January to March 2021, a Level 2 TARP was triggered for Lithium (Li) at P13 (intakes A and B) and a Level 4 TARP was triggered in April 2021 at P13C for Lithium (Li) concentrations consistently above the proposed trigger level (refer to **Figure 4-11 and 4-12**).

At the private bores, some metal exceedances triggering TARP level 2 may be influenced by the commencement of LW W2 but are likely attributed to natural fluctuation in groundwater quality (refer to **Appendix D** for further details). These include the following:

- Dissolved Fe at GW105228 in January 2021;
- Dissolved Li at GW105546 in April 2021 and at GW105228 in January 2021;
- Dissolved Ba at GW10546 and GW105228 in January 2021;
- Dissolved Sr at GW105228 and GW72402 in January 2021;

Graphs showing progressive groundwater quality results for pH, electrical conductivity and selected metals are presented in the SLR Groundwater Six-month Review (**Appendix D**) and **Figures 4-6 to 4-12**.

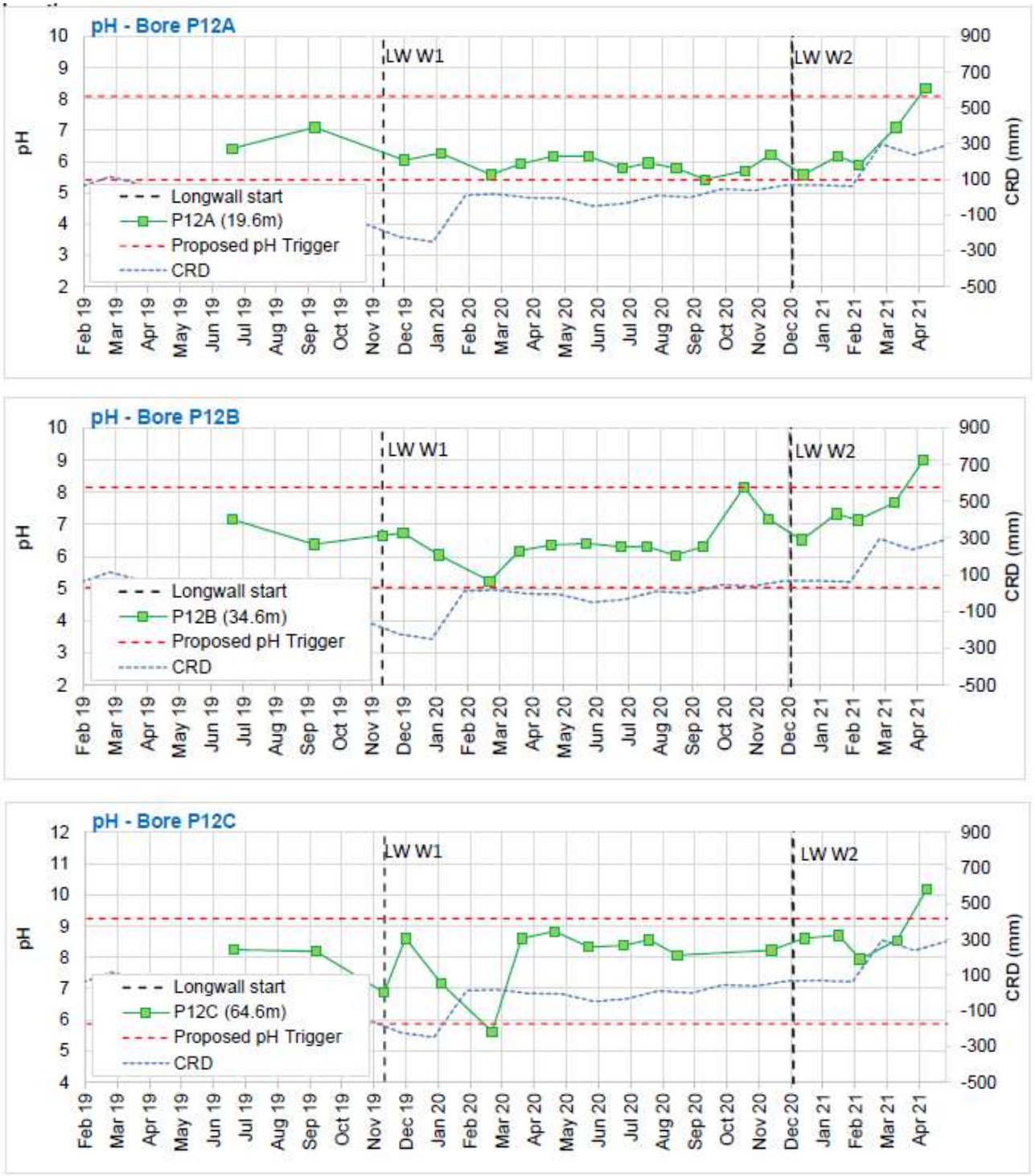

Figure 4-6 Groundwater quality for reporting period – pH at P12 intakes A, B and C (source: SLR, Groundwater Six-Month Review, Appendix D)

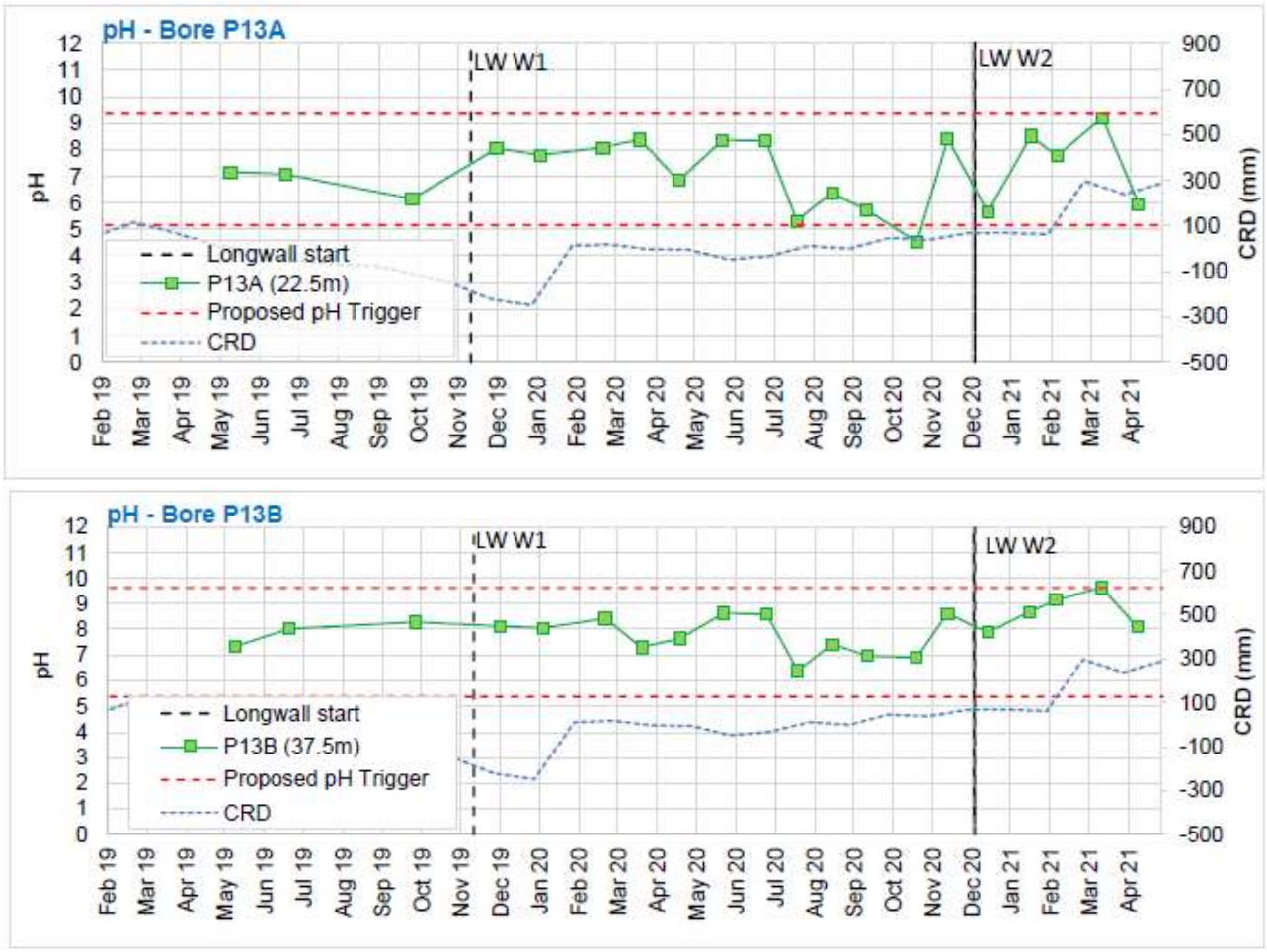

Figure 4-7 Groundwater quality for reporting period – pH at P13 intakes A and B (source: SLR, Groundwater Monitoring Report, Appendix D)

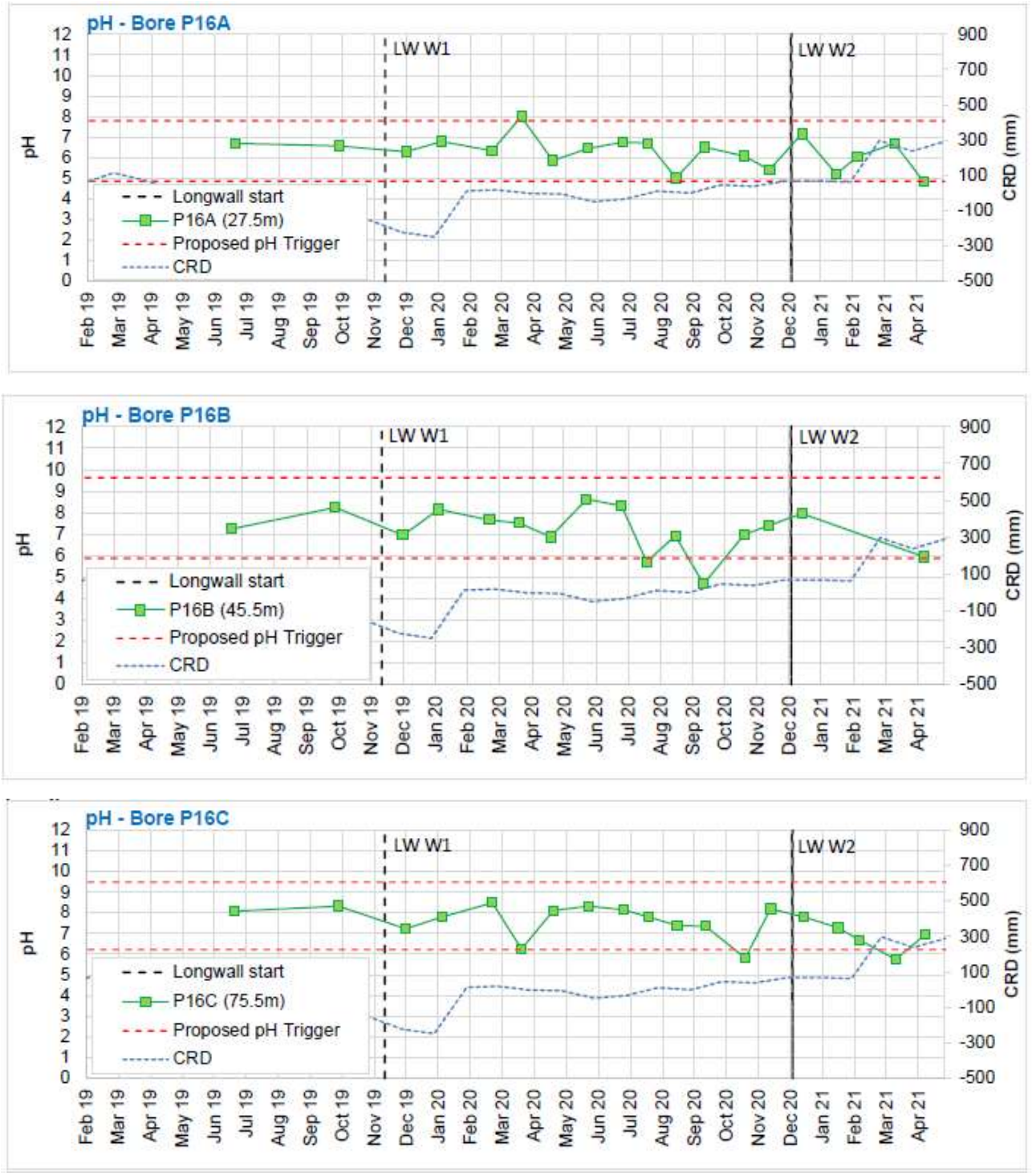

Figure 4-8 Groundwater quality for reporting period – pH at P16 intakes A,B and C (source: SLR, Groundwater Monitoring Report, Appendix D)

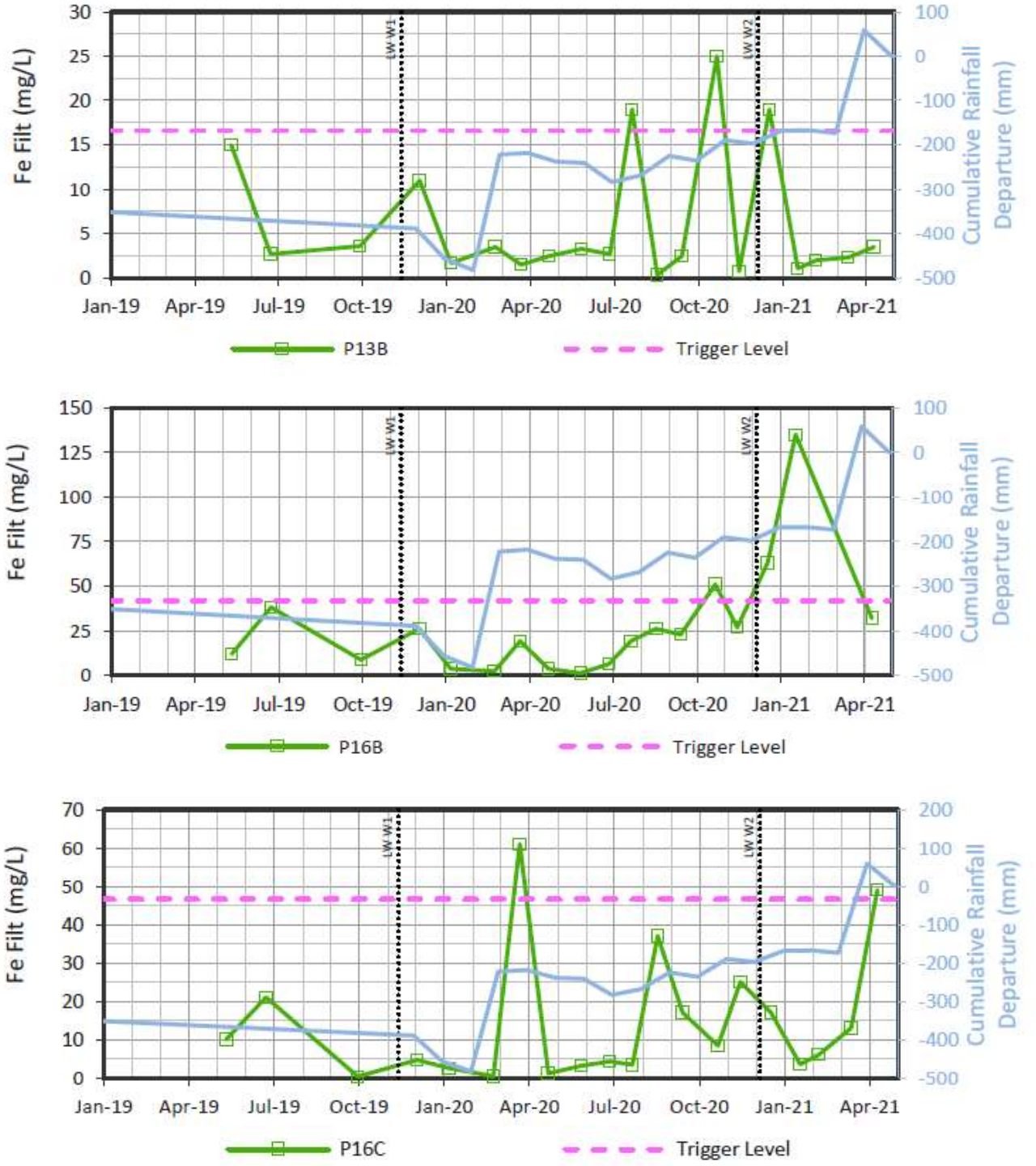

Figure 4-9 Groundwater quality for reporting period – Dissolved Iron at P13 intake B, and P16 intakes B and C (source: SLR, Groundwater Monitoring Report, Appendix D)

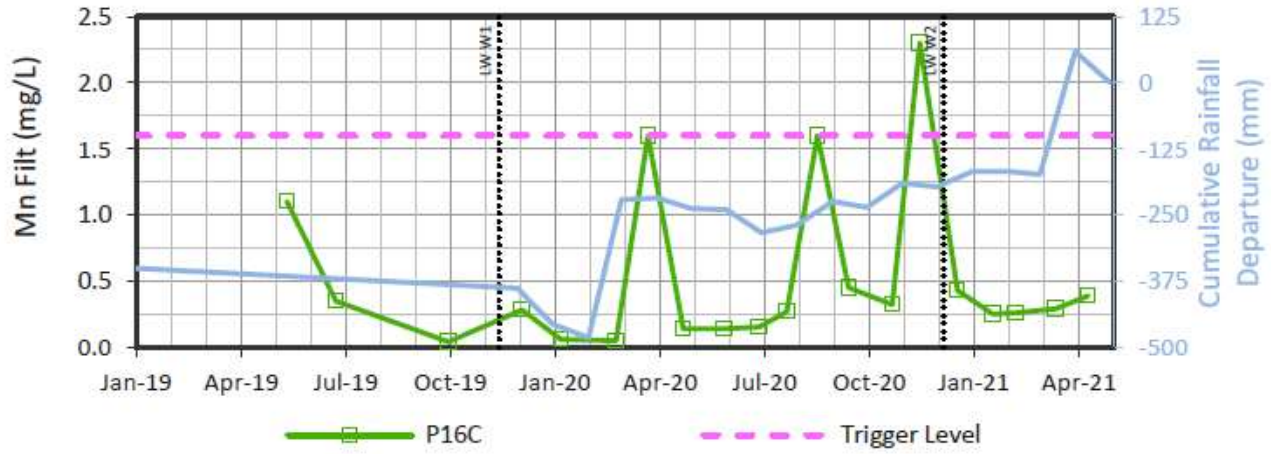

Figure 4-10 Groundwater quality for reporting period – Manganese at P16C (source: SLR, Groundwater Monitoring Report, Appendix D)

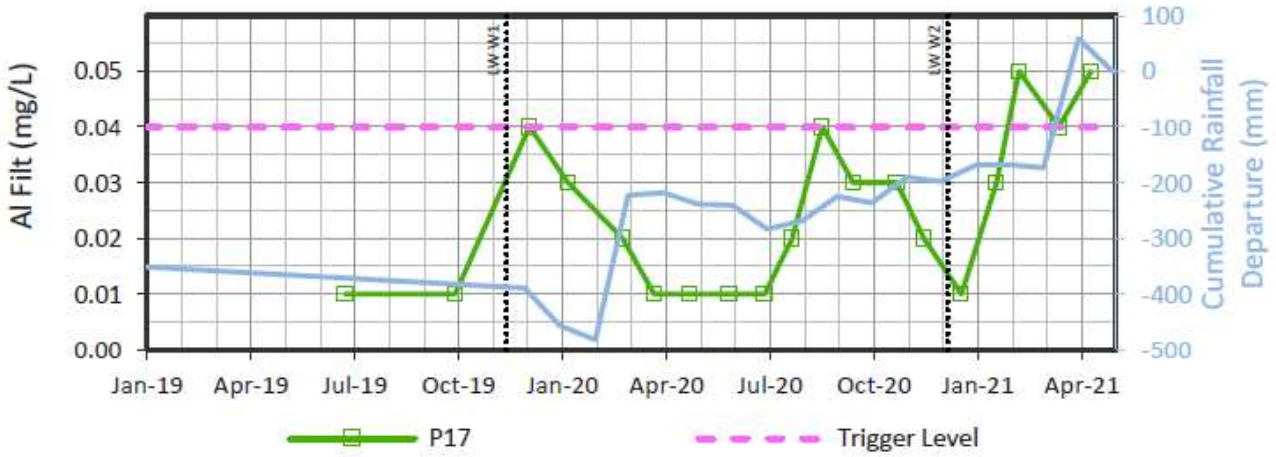

Figure 4-11 Groundwater quality for reporting period – Dissolved Aluminium at P17(source: SLR, Groundwater Monitoring Report, Appendix D)

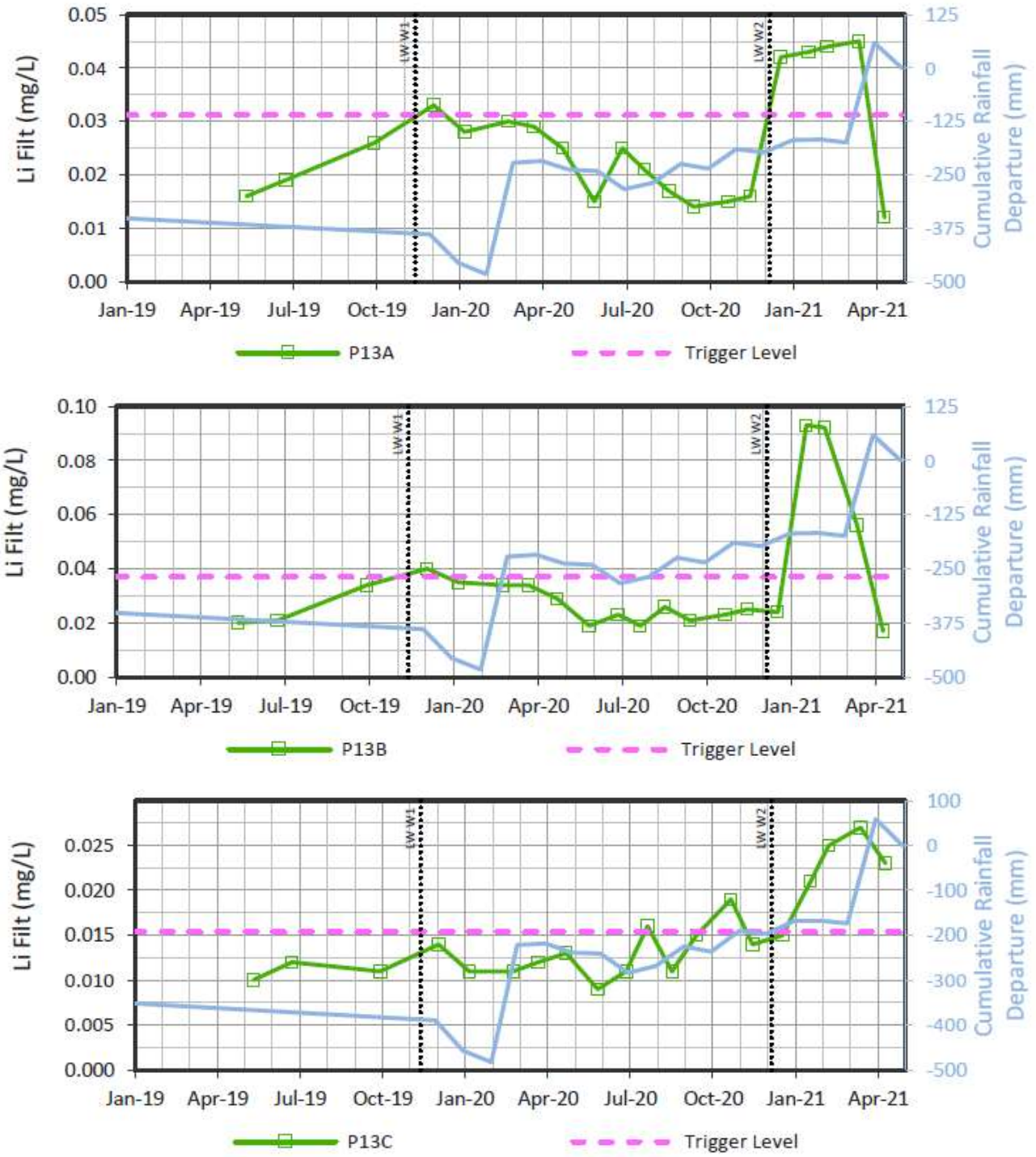

Figure 4-12 Groundwater quality for reporting period – Dissolved Lithium at P13 intakes A,B and C (source: SLR, Groundwater Monitoring Report, Appendix D)

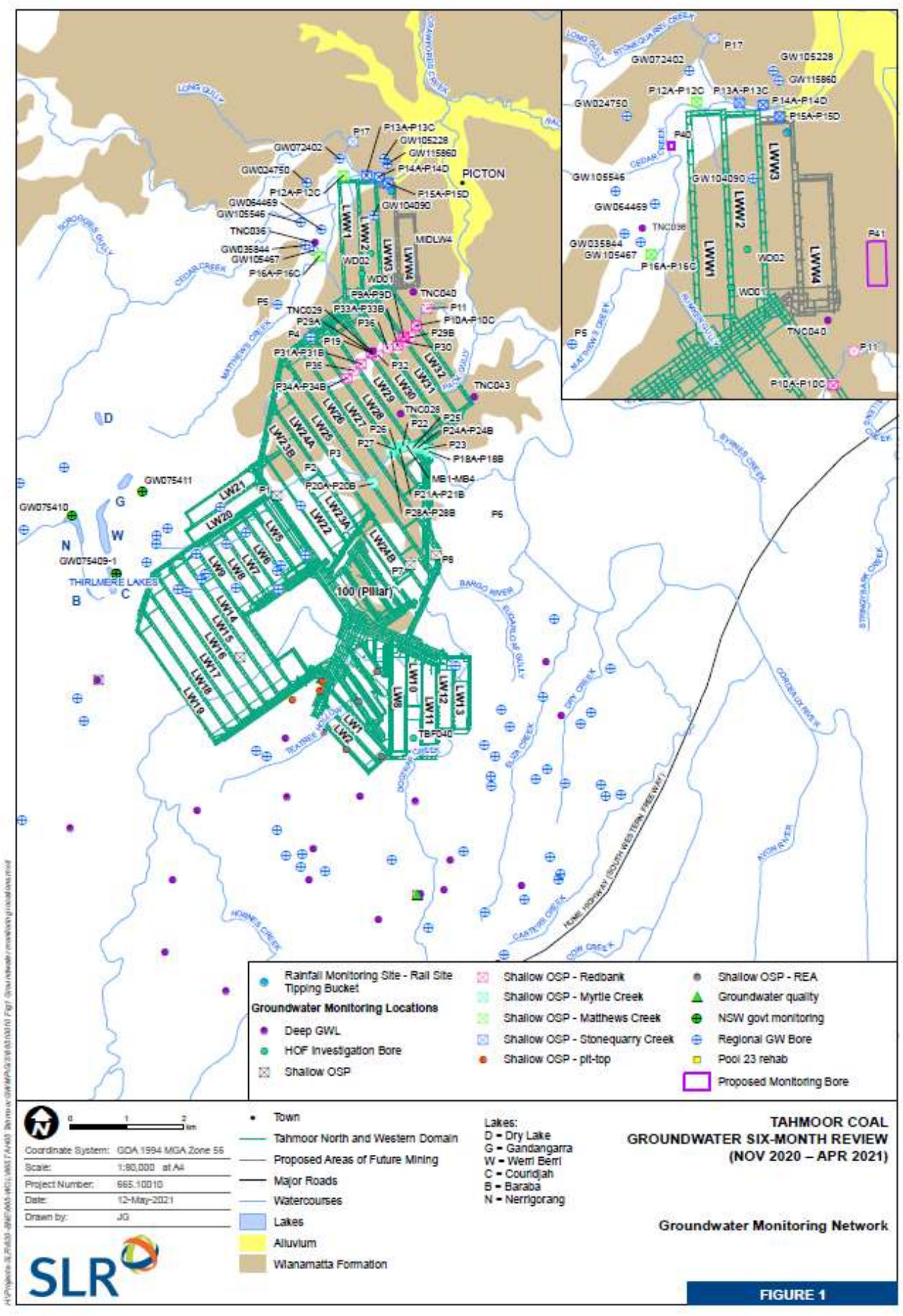

Figure 4-13 LW W1-W2 Groundwater Monitoring Bores (source: SLR, Groundwater Six-Month Review, Appendix D)

4.2.6 Groundwater Bore Levels

A total of 17 open standpipe piezometers (OSPs) have been installed at six locations in the Western Domain – P12 to P17. A number of private groundwater bores also form part of the groundwater monitoring program for LW W1-W2. The locations of these groundwater bores are illustrated in **Figure 4-9**.

During this reporting period, a number of groundwater intakes in open standpipe piezometers (OSPs) initially recorded a trend of reducing water level elevation below the baseline range, however, all have responded to rainfall events in recent months with all experiencing some degree of recovery.

Following the cessation of LW W1 in November 2020, groundwater levels at P12C have started to recover in mid-December 2020. The Level 4 Significance Level was notified to DPIE and NRAR on 30 December 2020 and was attributed to mining induced depressurisation of the deeper groundwater aquifer but also correlated to a reduction in rainfall recharge events. Early 2021, groundwater levels have been fluctuating between 1 and 2m possibly in response to rainfall or to the commencement of LW W2. Following significant rainfall events in February/March 2021, groundwater levels have gradually increased by 2.3 m in April 2021. As of April 2021, the Level 4 TARP criteria still applies at P12C (refer to Groundwater Six-Month Review in **Appendix D**).

In November 2020, groundwater levels at P13C were almost 5 m below the baseline minimum. Following the cessation of LW W1, groundwater levels at P13C have started to stabilise and recover in late December 2020, still below the baseline level. In accordance with the Water Management Plan (WMP), a TARP Level 4 Significance Level was notified to DPIE and NRAR on 30th December 2020. The decline in groundwater level was attributed to mining induced regional depressurisation of deeper aquifers. The lowest groundwater level at P13C was recorded in late January 2021 in response to rainfall deficit and possibly to the commencement of LW W2. Water levels at P13C have gradually increased due to above average rainfall conditions from February/March 2021. As of April 2021, groundwater levels at P13C stand at 1.5 m above the post-mining minimum water level and 3.5 m below baseline minimum; the Level 4 TARP criteria still applies at the end of the monitoring period (refer to Groundwater Six-Month Review in **Appendix D**).

In November 2020, following wetter conditions and cessation of LW W1, groundwater levels at P16B and P16C have stabilised. By December 2020, groundwater levels at P16B and P16C have recovered by 1 m and stand approximately 4 m and 11 m below the minimum baseline water level. A Level 4 TARP trigger at P16B and P16C was notified to DPIE and NRAR on 30th December 2020. P16B and P16C exhibited some mild drawdown in the range of 2 m over short periods after the commencement of LW W2 but stabilised in March 2021 to similar level as December 2020. From 16 March 2020, no groundwater levels are recorded at P16B due to the loss of the logger, it was replaced in late April 2021. As of April 2021, water levels at P16C are observed at 0.7 m above water levels recorded in November 2020 but remain 11.5 m below baseline levels. Actions for the Level 4 TARP level criteria will be on-going at P16B and P16C (refer to Groundwater Six-Month Review in **Appendix D**).

Graphs showing progressive groundwater bore levels are presented in the SLR Groundwater Six-Month Review (**Appendix D**).

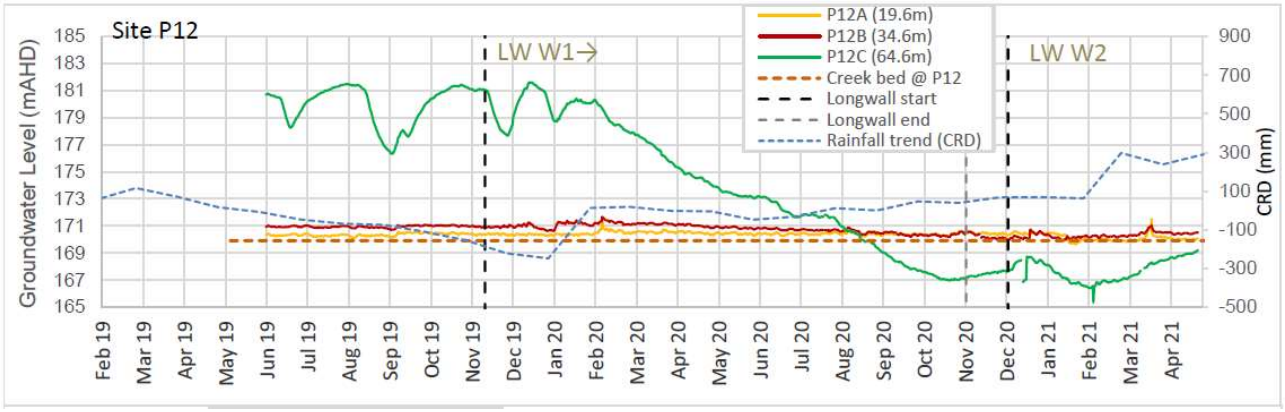

Figure 4-14 Groundwater bore levels during the reporting period – P12 (source: SLR, Groundwater Six-Month Review , Appendix D)

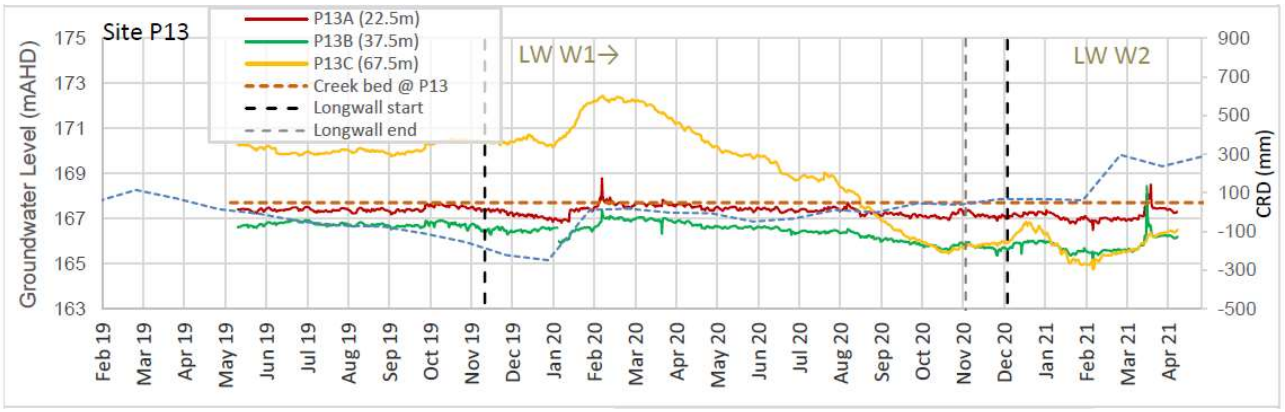

Figure 4-15 Groundwater bore levels during the reporting period – P13 (source: SLR, Groundwater Six-Month Review , Appendix D)

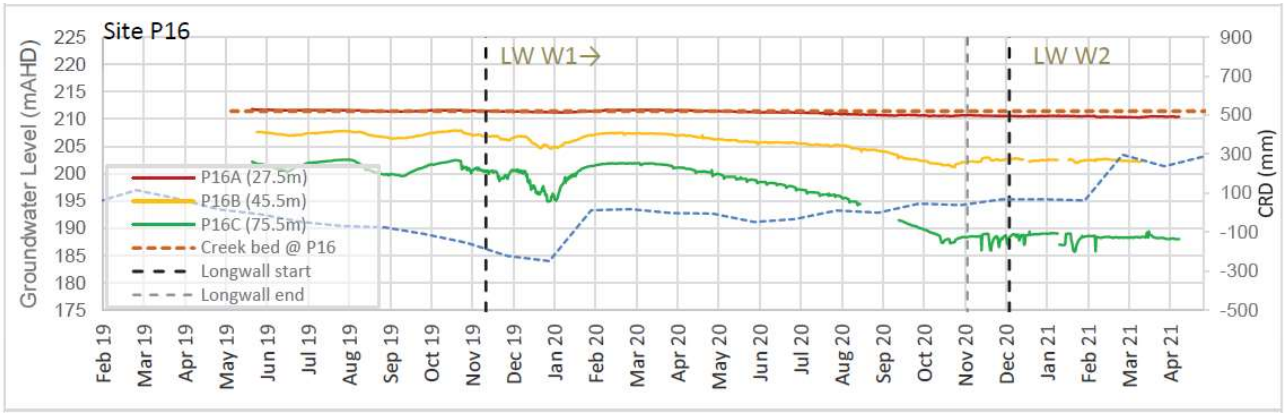

Figure 4-16 Groundwater bore levels during the reporting period – P16 (source: SLR, Groundwater Six-Month Review , Appendix D)

4.2.7 Groundwater Pressures

Three Vibrating Wire Piezometers (VWP) arrays have been installed at locations TNC36, TNC40, TNC43 and WD01. The locations of these groundwater bores are illustrated in **Figure 4-9**.

During the reporting period, groundwater trends at monitoring sites equipped with shallow VWPs (<200m) were within the Level 1 Significance Level except at TNC036 (HBSS-65m, HBSS-97m and BGSS-169m) and WD01 (HBSS-190m) triggering the Level 3 Significance Level throughout 2020 and Level 4 Significance Level from December 2020 to April 2021 (refer to Groundwater Six-monthly Review (**Appendix D**).

The triggering of Level 3 Significance Level at TNC036 and WD01 was attributed to mining induced depressurisation of deeper aquifer throughout the passage of LW W1 and exacerbated by a reduction in rainfall recharge events in late 2020 (refer to Groundwater Six-monthly Review (**Appendix D**).

Following the completion of LW W1 in November 2020, groundwater levels started to stabilise and recover in all shallow TNC036 sensors and in WD01-HBSS-190m. In November 2020, a TARP Level 4 Significance Level was attributed to TNC036 (HBSS-65m, HBSS-97m and BGSS-169m) and WD01 (HBSS-190m) due to a greater than 5 m depressurisation over a period of six months (refer to Groundwater Six-monthly Review (**Appendix D**).

At TNC036, the progression of mining at LW W2 induced a minor drawdown in HBSS-65m and HBSS-169m while water levels at HBSS-97m are stable. As of April 2021, water levels in HBSS-65m, HBSS-97m and HBSS-169m still record a reduction greater than 5m due to the passage of both LW W1 and LW W2 and within the Level 4 TARP criteria (refer to Groundwater Six-monthly Review (**Appendix D**).

Recovery has occurred in recent months due to wetter conditions in February-March 2021.

Graphs showing progressive groundwater pressures are presented in the SLR Groundwater Six-monthly Review (**Appendix D**).

4.2.8 Mine Water Intake

Tahmoor Coal have a Groundwater Licence to extract 1642 ML/year of groundwater make from underground.

The inferred water make (groundwater that has seeped into the mine from the strata) is calculated from the difference between total mine inflows and total mine outflows. This calculation is assisted by input from flow meters installed on fresh water supply lines that pump water into the mine (mine inflow from Sydney Water supply to underground workings), and flow meters on three pipelines that extract water from underground (mine outflow). In addition, mine inflow and outflow also includes a measurement of water that enters and exits the mine through other means such as moisture in air vented in and out of the mine (water in vented air), and moisture in coal extracted from the mine.

SLR completed an analysis of water make for Tahmoor Mine recorded between 1 January 2009 to 21 April 2021 (results summarised in Groundwater Six-Month Review (**Appendix D**)). Although this water make calculation does not just measure water make from the Western Domain, it provides an indication of the groundwater pumped out of the total Tahmoor Mine underground workings.

The period between mid-2020 shows an increase in inflows to greater than 5 ML/day at the end of July 2020 likely due to the extraction of LW W1. Inflows declined in late 2020, before rising in February 2021 (early in LW W2), with the recent peak at marginally over 6 ML/d in March/ April 2021 and have recently begun to decline (refer to Groundwater Six-Month Review, **Appendix D).** Analysis of longwall extraction rate (in metres/day) versus inflow rate (ML/d or m_3/d) indicates that the consistently higher extraction rates that have been achieved in LW W1 and W2 are at least partly responsible for higher inflows.

In addition, **Figure 4-18** illustrates that there does not appear to be a definitive correlation between rainfall and the increased pump out from the mine.

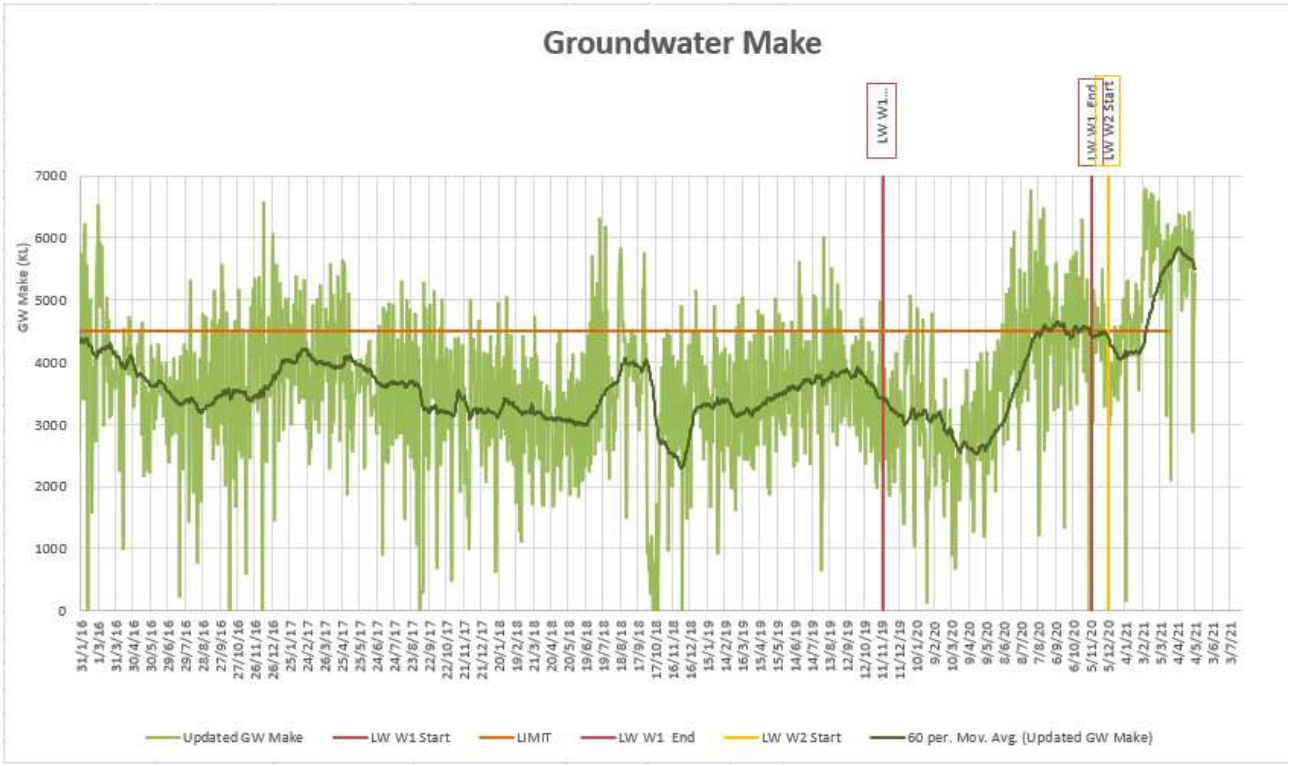

Figure 4-17 Tahmoor Mine daily water make with LW W1 and W2 commencement dates and LW W1 end date (source: courtesy of Tahmoor Coal)

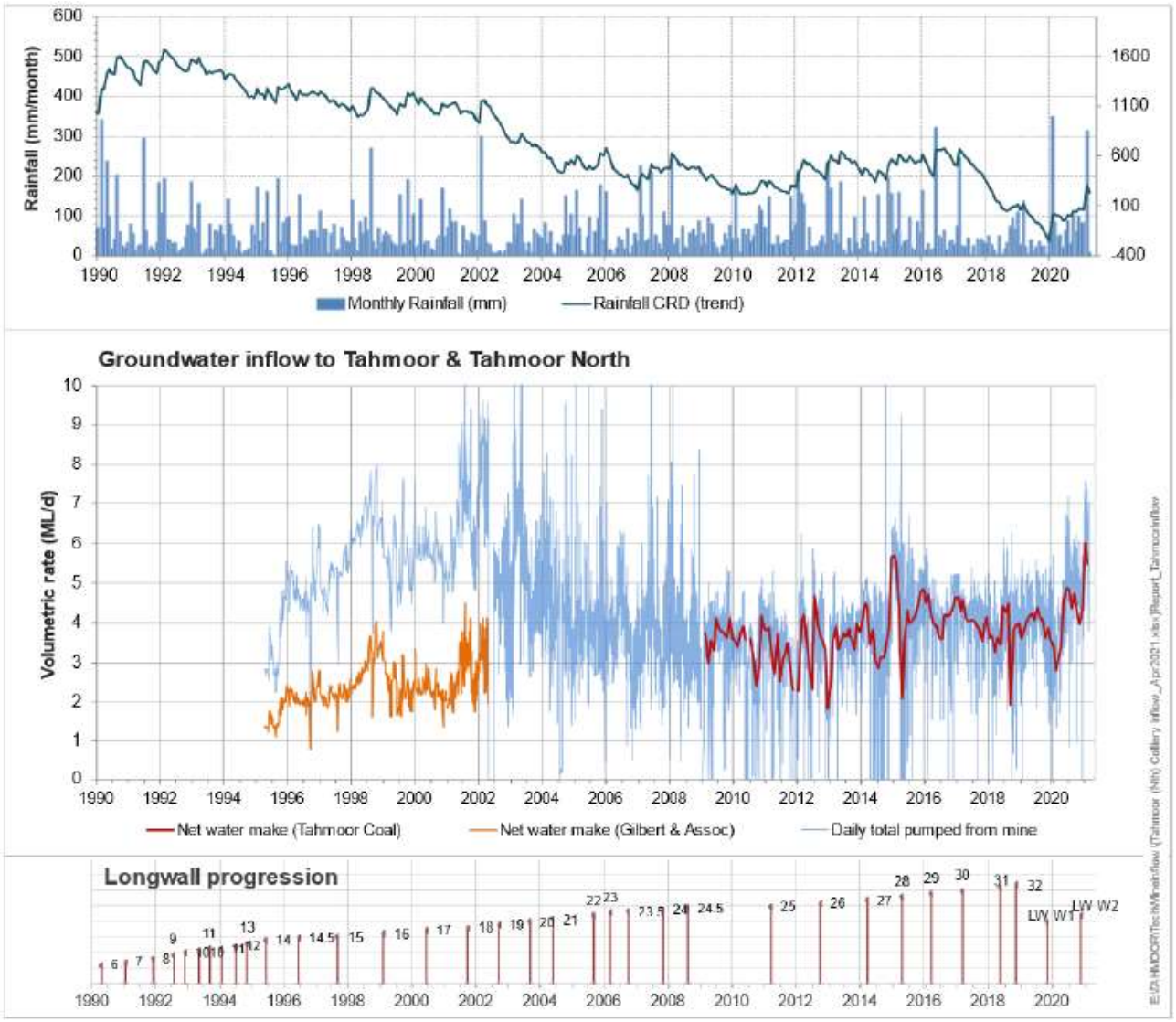

Figure 4-18 Tahmoor Mine Groundwater Inflow and Rainfall Residual comparison (source: SLR, Groundwater Monitoring Report, Appendix D)

4.3 Land Monitoring

The Tahmoor Coal LW W1-W2 Land Management Plan was prepared to manage the potential environmental consequences of LW W1-W2 extraction on cliffs, rock outcrops, steep slopes, dams, agricultural land, and land in general in accordance with Condition 13H(vii)(e) of DA 67/98.

During this reporting period, the LW W1-W2 Land Management Plan has been implemented to monitor the following landscape features:

- Cliffs, rock outcrops, steep slopes, and dams – monthly visual inspections and reporting by geotechnical engineers from Douglas Partners;
- Stonequarry Sewage Treatment Plan retention basin (Dam FD7) – weekly visual inspections and reporting by Newcastle Geotechnical (refer to **Appendix E**);
- Dams in active subsidence zone – weekly visual inspections and reporting by Building Inspection Services; and
- Agricultural land – monthly visual inspections and reporting by Building Inspection Service.

Performance against all Land Management Plan TARPs for the reporting period are summarised in **Table 2-3**. The following sections summarised the observations made during the reporting period for each landscape feature.

4.3.1 Cliffs and Rock Outcrops

Visual and photographic surveys for subsidence impacts on cliffs have been completed monthly for features within the LW W1-W2 active subsidence zone. The purpose of the surveys is to note any new instabilities in the cliff structures that have occurred since the commencement of LW W1-W2 mining, including freshly exposed rock face, debris scattered around the base of a cliff or overhang, and tension cracks. Surveys were completed by a walk through along the valley bed was conducted from Stonequarry Creek to the intersection of Cedar Creek and Matthew Creek.

The locations of cliffs and rock outcrops within the Study Area are illustrated in Figure 4-15.

During the reporting period, cliffs C03 to C09 along Cedar Creek and M01 and M02 along Matthews Creek were inspected, and there were no indications of recent rockfalls or signs of stress relief (tension cracking) along the sections of cliff monitored.

4.3.2 Steep Slopes

Visual and photographic surveys for subsidence impacts on structures near steep slopes have been completed monthly for features within the LW W1-W2 active subsidence zone. The locations of steep slopes within the Study Area are illustrated in **Figure 4-15**.

During the reporting period, structures located on Stonequarry Creek Road, Booyong Close, Attunga Close and Waste Water Treatment Plant (WWTP) were inspected. There were no signs of distress or changes in the areas inspected that could be attributed to mine subsidence.

4.3.3 Dams

Visual and photographic surveys for subsidence impacts on dams were completed on a weekly and monthly basis of dams within the LW W1-W2 active subsidence zone. Heavy rainfall was recorded during February and March 2021 resulting in some pooling and minor scouring.

The location of dams within the Study Area are illustrated on **Figure 4-16**.

During the reporting period, the dams within the active subsidence zone are considered to be within the normal ranges as defined in the TARP.

4.3.4 Agricultural Land

Visual and photographic surveys for subsidence impacts on agricultural land have been completed monthly at inspection points within the LW W1-W2 Study Area. Inspections points were set up prior to the commencement of LW W1 mining to provide vantage of agricultural land within the Study Area. The purpose of the surveys is to note whether change has occurred to agricultural land, and to assist in determining if any change can be attributed to mining impacts. Surveys noted the presence of erosion, condition of boundary and internal fencing components, paddock gate condition, out-building condition, paddock dam condition, presence of any surface slumping or cracking, and the presence of vegetation dieback.

Agricultural land identified within the Study Area is illustrated on **Figure 4-17**.

During the reporting period, it was noted that above average rainfall had resulted in increased vegetation growth, however there were no observable changes to agricultural land in comparison to pre-mining baseline data.

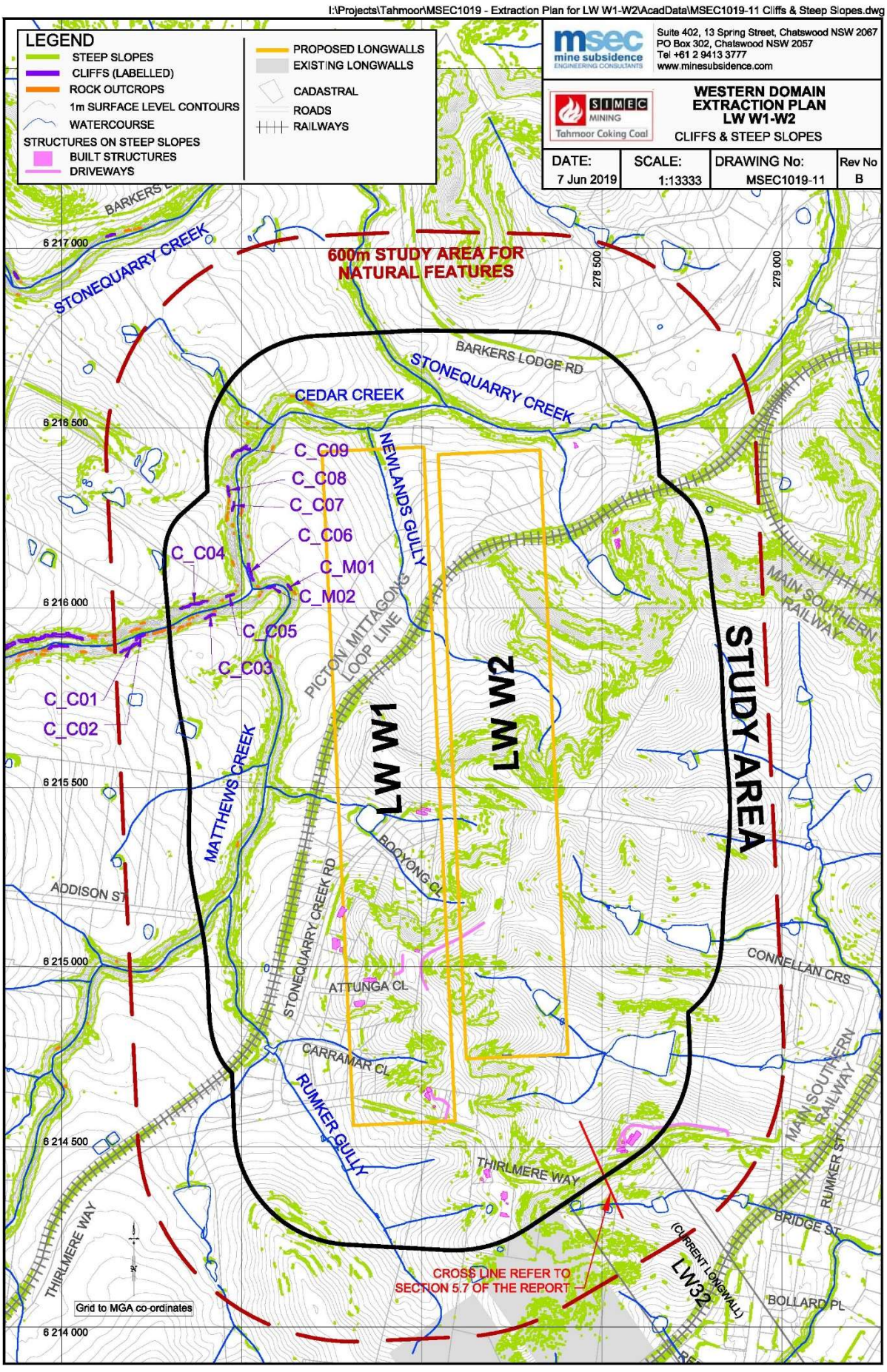

Figure 4-19 Cliffs, rock outcrops and steep slopes within the LW W1-W2 Study Area (source: LW W1-W2 Subsidence Predictions and Impact Assessment Report)

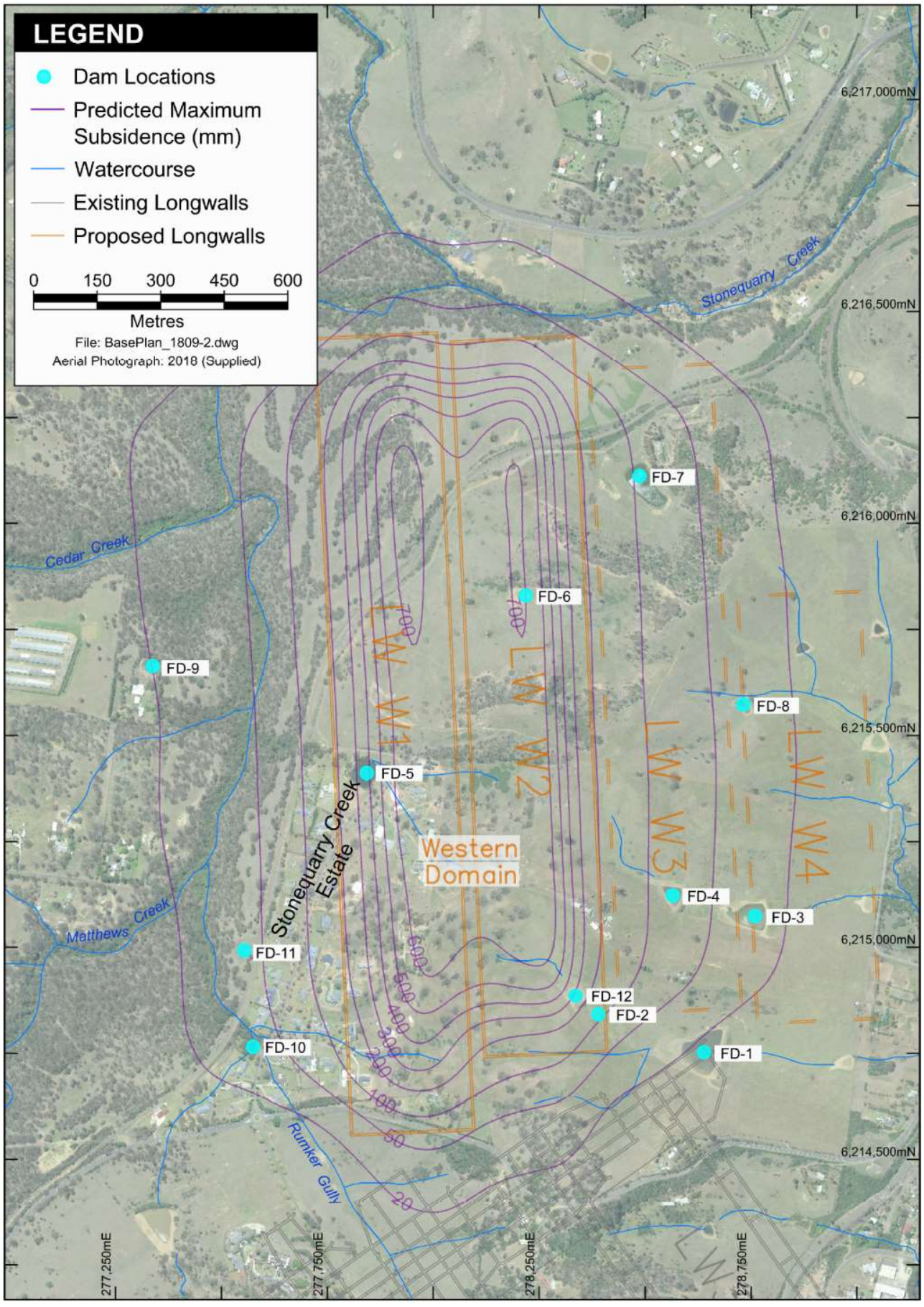

Figure 4-20 Dams within the LW W1-W2 Study Area (source: LW W1-W2 Surface Water Technical Report)

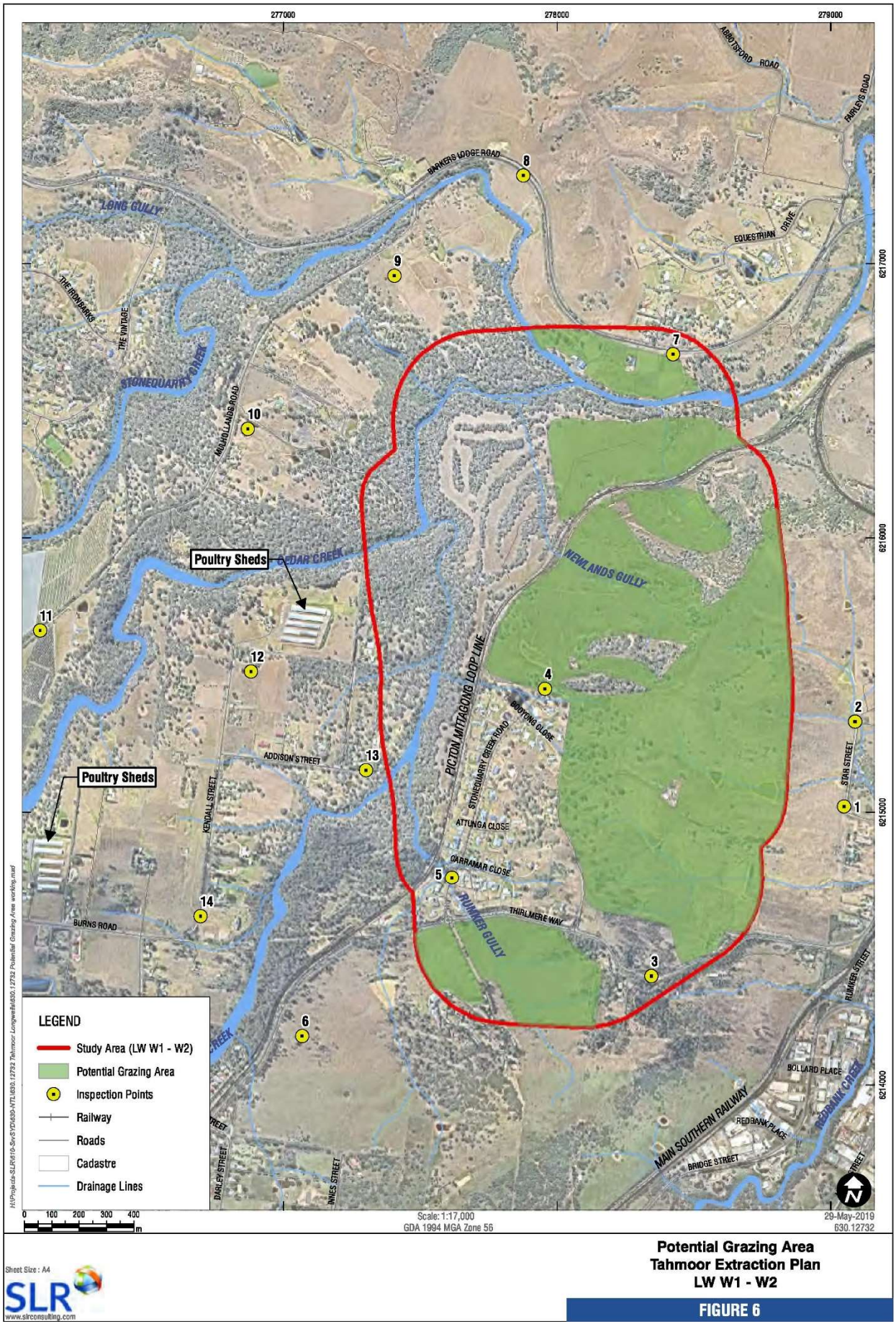

Figure 4-21 Agricultural land and inspection points within the LW W1-W2 Study Area (source: LW W1-W2 Land and Agricultural Resource Assessment)

4.4 Biodiversity Monitoring

The Tahmoor Coal LW W1-W2 Biodiversity Management Plan was prepared to manage the potential environmental consequences of LW W1-W2 extraction on aquatic and terrestrial flora and fauna in accordance with Condition 13H(vii)(d) of DA 67/98.

During the reporting period, the LW W1-W2 Biodiversity Management Plan has been implemented to monitor ecology in the Study Area, as outlined below:

- Aquatic ecology – macroinvertebrate monitoring during Autumn 2021 by Niche Environment and Heritage. A letter report summarising AUSRIVAS results for Autumn 2021 has been provided by Niche, with the full report to be provided in the next month; and
- Terrestrial ecology – amphibian and riparian vegetation monitoring during Spring 2020 and Autumn 2021 by Niche Environment and Heritage.

Performance against all Biodiversity Management Plan TARPs for the reporting period are summarised in **Table 2-3**. The following sections summarised the observations made during the reporting period.

4.4.1 Aquatic Ecology

The aquatic ecology monitoring program for LW W1-W2 has been designed to monitor subsidence-induced impacts on aquatic ecology. The following survey methods have been completed during baseline and during mining monitoring sampling:

- Aquatic habitat assessment:
  - The Australian River Assessment System (AUSRIVAS);
  - Riparian Channel and Environment (RCE) Inventory;
- Macroinvertebrate survey:
  - AUSRIVAS macroinvertebrate sampling;
  - Quantitative benthic macroinvertebrate monitoring program; and
- Water quality sampling.

The aquatic ecology monitoring program is primarily focused on macroinvertebrate monitoring regimes including AUSRIVAS and quantitative using Before After Control Impact (BACI) design. A total of fifteen locations were sampled within Stonequarry Creek, Cedar Creek and Matthews Creek comprised of seven impact sites and eight control sites (refer to **Appendix I**). The locations of monitoring sites are illustrated in **Figure 4-18**.

A letter report summarising AUSRIVAS results for Autumn 2021 monitoring has been prepared by Niche Environment and Heritage (refer to **Appendix I)**. Although only AUSRIVAS monitoring results were provided in this letter report, enough information is available to interpret whether there have been any triggers in accordance with the TARP and to determine whether associated actions were required.

During Autumn 2021, it is unlikely that any Aquatic Ecology Biodiversity TARPs have been triggered. The following results were observed:

- Aquatic habitats were similar at most sites when compared to previous survey;
- AUSRIVAS results showed sites scoring in Band A and Band B.
- AUSRIVAS scores in Autumn 2021 were either comparable to previous results or higher than any previous monitoring surveys for the corresponding Autumn periods.

To date, there have been no observable mining subsidence related impacts to aquatic ecology of Cedar Creek, Matthews Creek or Stonequarry Creek.

4.4.2 Terrestrial Ecology

The terrestrial ecology monitoring program for LW W1-W2 has been designed to monitor subsidence-induced impacts on terrestrial ecology including riparian vegetation and amphibian monitoring. The following survey methods have been completed during baseline and during mining monitoring sampling:

- Riparian vegetation monitoring involving floristic surveys within established vegetation monitoring plots;
- Amphibian monitoring along established transects:
  - Spotlighting;
  - Call provocation;
  - Listening for diagnostic frog calls; and
  - Tadpole identification.

In particular, two threatened frog species – the Giant Burrowing Frog (*Heleioporus australiacus*) and the Red-crowned Toadlet (*Pseudophryne australis*) – were targeted in the amphibian monitoring.

A total of eight locations were sampled within Stonequarry Creek, Cedar Creek and Matthews Creek comprised of three impact sites and five control sites. The locations of monitoring sites are illustrated in **Figure 4-19**. Riparian Vegetation Monitoring was conducted by NICHE on the 9 and 10 November 2020 and amphibian monitoring conducted on 28 to 30 September 2020 in the reporting period (refer to **Appendix I)**.

The following results were observed for Spring 2020 monitoring:

Riparian monitoring:

- River-flat Eucalypt Forest, which is listed as an Endangered Ecological Community under the BC Act, was recorded at control Site 9 with a high level of weed infestation (119.7% cover across the combined growth stratums).
- Floristic composition and vegetation cover at each Site increase by 15 percent at the impact Sites and 14% at control Sites, this may be due to the weather and increased rainfall across 2020.
- Impact Sites had a slightly lower mean species richness and percentage vegetation cover than control Sites, although the exotic cover in the control Sites it high at approximately 28.9 percent compared to one percent at impact Sites.
- Anthropogenic influences were observed at Sites that had been impacted by human disturbance, particularly weeds and altered flow regimes.
- Sites 7, 8 and 9 tended to have higher fertility and nutrient loads, which lead to higher species diversity and generally more exotic species. These Sites appeared to be more influenced by seasonal changes than Sites further up the catchment (Sites 4, 5, 6 and 10), which tended to be protected in deep gullies and canyons.

Amphibian monitoring:

- Frog detection rates were variable between Before monitoring events and impact monitoring event 2020, for most Sites. There was a significant difference between control Sites and impact Sites, with the reduction in control Sites. One impact site had an increase in individuals of one species. This may be due to the recent rainfall and triggered a breeding event at Site 4.
- The targeted threatened frog species were not detected. The 6 species detected represent an otherwise normal array of common and robust species for the study environments and conditions.
- The targeted threatened frog species appear not to be present in the Study Area, at least not in a population that can be meaningfully monitored. While the study environment contains superficially suitable habitat, it is possible that the species would no longer be able to survive in the area due to predation pressures from two introduced predators: the Plague Minnow (*Gambusia holbrooki*) and the Yabby (*Cherax destructor*), both of which were detected at all Sites. The frog community present contains at least 12 species which are likely still viable indicators of impending or current environmental change.
- Frog detection rates were variable between monitoring events for most Sites, most likely due to the highly variable weather and climatic conditions across the survey periods. There was a significant difference between control Sites and impact Sites (detection being greater at impact Sites).

No thresholds within the Trigger Action Response Plan (TARP) in the Biodiversity Management Plan (SIMEC2019) have been triggered for Spring 2020 monitoring, and therefore, no remedial management actions are required.

The following results were observed for Autumn 2021 monitoring:

Riparian monitoring:

- River-flat Eucalypt Forest, which is listed as an Endangered Ecological Community under the BC Act, was recorded at control Site 9, with a high level of weed infestation (147.4% cover across the combined growth forms, see Plate 25 Autumn 2021 Site 09 Plate 25).
- Floristic composition and vegetation cover average at each Site increased by 5 percent at the impact Sites and 29 percent at control Sites compared to pre-mining values, most likely due to increased rainfall across 2020 and early 2021.
- Impact Sites had a slightly lower mean species richness and percentage vegetation cover than control
- Sites, although the exotic cover in the control Sites is relatively high at approximately 38 percent compared to nine percent at impact Sites.
- Anthropogenic influences were observed at Sites, particularly weeds and altered flow regimes.
- Sites 7, 8 and 9 tended to have higher soil fertility and organic matter loads, which lead to higher species diversity and generally more exotic species. These Sites appeared to be more influenced by seasonal changes and stochastic flooding events (e.g., witnessed in 2020 and 2021) than Sites further up the catchment (Sites 4, 5, 6 and 10), which tended to be somewhat protected in deep gullies and canyons.

Amphibian monitoring:

- Frog detection rates were variable between before monitoring events and impact monitoring event 2021 for most Sites. There was a significant difference in species diversity between control Sites and impact Sites, with the reduction in control Sites. One control Site (Site 6) and impact Site (Site 4) had an increase in Stony Creek Frog (*Litoria lesueurii*) individuals. This may be due to the recent rainfall which likely triggered a breeding event at both Sites.
- The targeted threatened frog species were not detected. Six common frog species (Table 4) were detected during the monitoring event, which represents an otherwise normal assemblage that may be expected to be present in the Study Area under the current climatic conditions.
- The targeted threatened frog species appear not to be present in the Study Area, at least not in a population size that can be meaningfully monitored. While the study environment contains superficially suitable habitat, it is possible that these species would no longer be able to survive in the area due to a number of factors such as:
    - Absence of suitable non-breeding habitat for Giant Burrowing Frog at most monitoring Sites (due to heavy weed encroachment and erosion)
    - Increased urban encroachment
    - Changes in hydrological flows, water quality and nutrient loads
    - Climatic variability
    - Predation pressures from two introduced predators: Eastern Gambusia (*Gambusia holbrooki*) and the Yabby (*Cherax destructor*), both of which were detected at all Sites.
- Frog detection rates were variable between monitoring events for most Sites, most likely due to the highly variable weather and climatic conditions across the survey periods. However, results show that there was a significant difference between control Sites and impact Sites (detection being greater at impact Sites).

No thresholds within the Trigger Action Response Plan (TARP) in the Biodiversity Management Plan (SIMEC 2019) have been triggered for Autumn 2021 monitoring, and therefore, no remedial management actions are required.

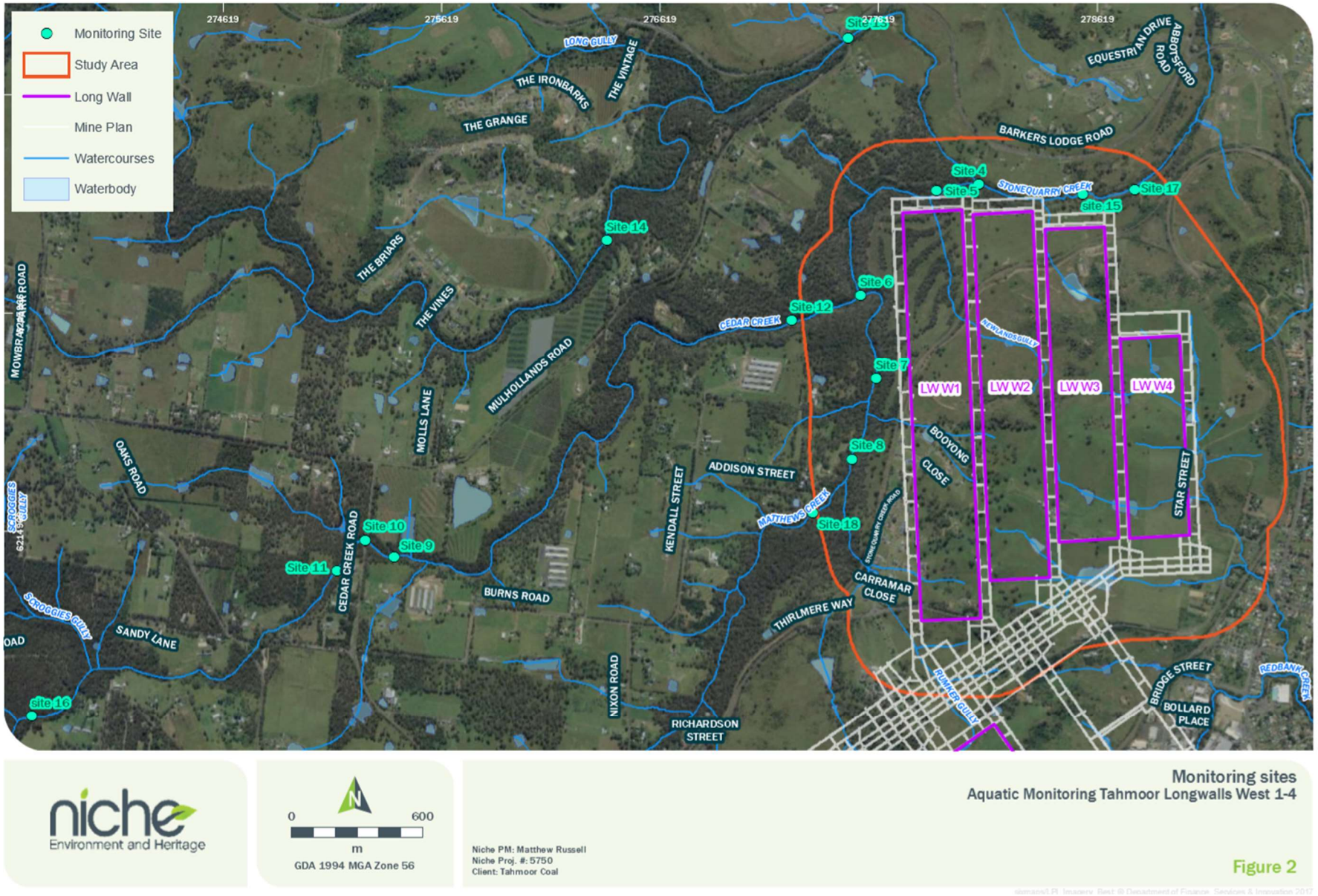

Figure 4-22 LW W1-W2 Aquatic Ecology Monitoring Locations (source: Niche, LW W1-W2 Biodiversity Management Plan)

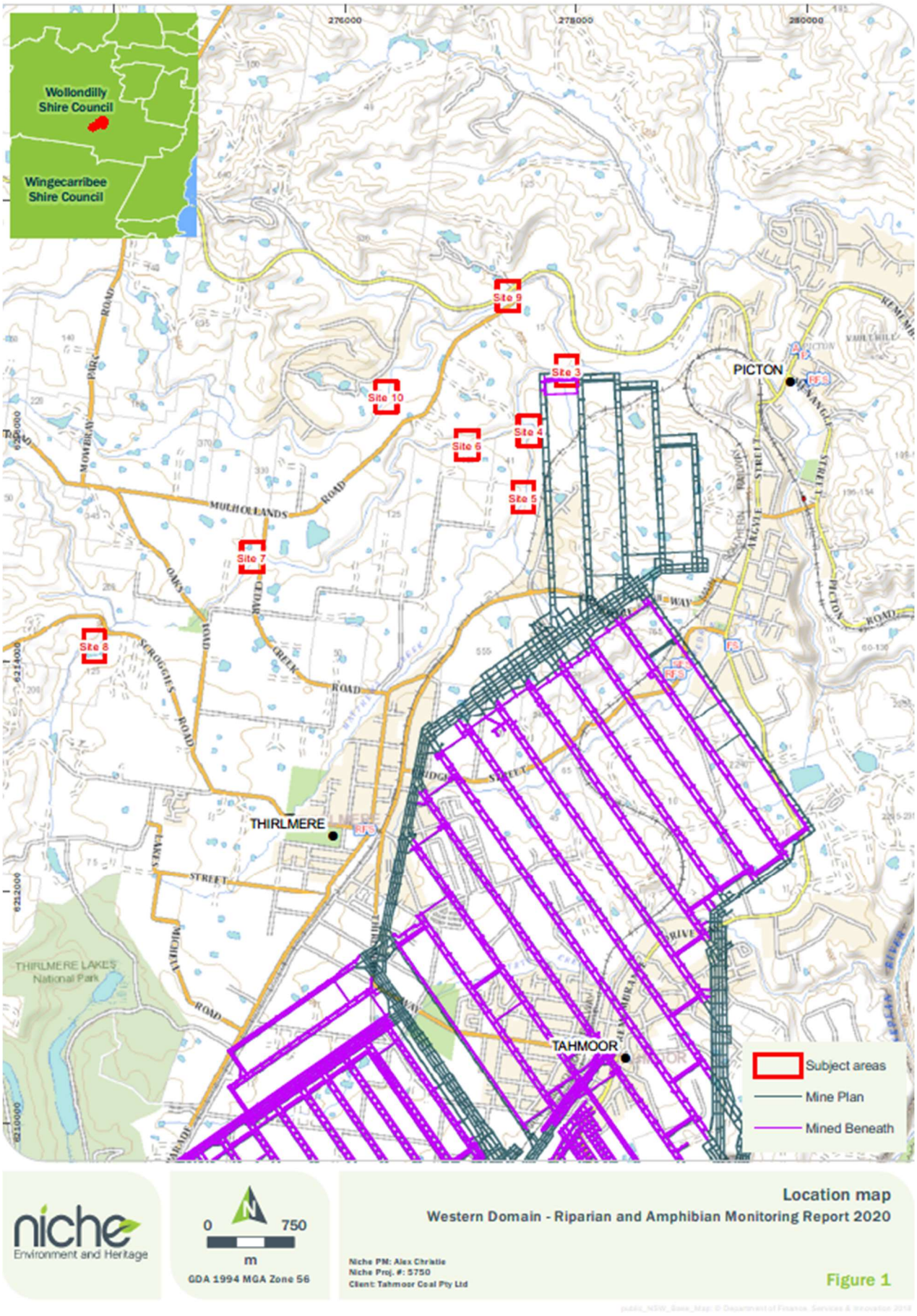

Figure 4-23 LW W1-W2 Terrestrial Ecology Monitoring Locations (source: Niche Environment and Heritage, LW W1-W2 Biodiversity Management Plan)

4.5 Heritage Monitoring

The Tahmoor Coal LW W1-W2 Heritage Management Plan was prepared to manage the potential environmental consequences of LW W1-W2 extraction on Aboriginal heritage and historical heritage sites and values in accordance with Condition 13H(vii)(f) of DA 67/98.

During this reporting period, the LW W1-W2 Heritage Management Plan has been implemented to monitor subsidence impacts for the following heritage items:

- Aboriginal heritage:
  - Rock shelters – monthly external visual inspections of rock shelters by GeoTerra (refer to **Appendix C** for referenced reports);
  - Grinding grooves – monthly review of GNSS unit movements by MSEC (refer to **Appendix A** for referenced reports);
  - Rock shelters and grinding grooves – end of panel review of items by an EMM Archaeologist and a RAP representative;
- Historical heritage:
  - Sandstone and brick culverts along the PMLL:
    - Weekly visual inspection by Newcastle Geotechnical (refer to **Appendix E**); and
    - End of panel review of items by an EMM Archaeologist.

Performance against all Heritage Management Plan TARPs for the reporting period are summarised in **Table 2-3**. The following sections summarised the observations made during the reporting period.

4.5.1 Aboriginal Heritage

Further to the inspection of Aboriginal heritage items in the Study Area by an EMM archaeologist and a RAP representative on 19 August 2020, an end of panel monitoring inspection was caried out by EMM consultants (Appendix G) on the 23-24 November 2020.

The focus of the fieldwork was to conduct archaeological monitoring of Aboriginal sites associated with the underground coal mining of Longwall West 1 (LW W1) after completion of its panel extraction in the Tahmoor Mine Western Domain. The locations of Aboriginal heritage items within the Study Area of LW W1-W2 are illustrated in **Figure 4-20**.

In accordance with the subsidence monitoring program, the inspection relates to 25 Aboriginal sites including 17 rock shelters, one grinding groove site and one modified tree, the remaining six open artefact sites do not require monitoring.

The grinding groove site (AHIMS #52-2-2068) has been monitored during extraction through the GNSS units and monthly ground surveys of rock bar during the period of active subsidence for the longwall. The rock shelters in the project area have been subject to monthly visual inspections by subsidence experts from a safe location during extraction. As a “safe location” does not allow physically entering each rock shelter, these prior inspections for rock shelters have been taken from a distance to observe toppling, cracking, or collapse of the cliff lines where the rock shelters occur. Overall, no subsidence related impacts have been observed to any of the Aboriginal sites inspected as part of the monitoring program. No changes were observed for the modified tree (AHIMS #52-2-2100).

In summary, observations during the site inspection revealed no evidence of impacts from subsidence and as such no additional management strategies are required. A further monitoring inspection of Aboriginal Heritage Items will be carried out at the end of LW W2.

4.5.2 Historical Heritage

EMM consultants completed an end of panel monitoring inspection on the 23-24 November 2020 focused on the five historical brick and sandstone culverts within the Study Area of LW W1-W2 (Appendix G). The locations of historical heritage items are illustrated in **Figure 4-21**.

In summary EMM noted no subsidence related impacts at any of the inspected heritage sites as part of the end of panel monitoring program. Importantly, the culverts are continuously monitored at weekly intervals by Mark Delaney, principal engineering geologist at Newcastle Geotech as part of the subsidence monitoring program.

Visual inspections during the reporting period noted a number of minor cracks that developed in sandstone culverts along the Picton-Mittagong Loop Line. These included:

- Sandstone culvert at 89.629 km – small traverse cracks up to 2 mm;
- Sandstone culvert at 88.44 km – crack up to 7 mm at the crest, crack on the upside headwall up to 6 mm, and minor spalling on the obvert headwall showing evidence of outward movement up to 7 mm of the headwall and wingwall relative to the culvert; and
- Sandstone culvert at 88.980 km – minor separation and circumferential cracking.

The cracking noted in the sandstone culvert at 88.44 km and impacts at sandstone culvert at 88.980 km trigged Level 2 TARPS in February 2021, March 2021 and April 2021. These cracks are noted to be minor and are not adversely affecting the structural integrity of the culverts. As a result, and with subsidence remaining within predictions, it was concluded that the current rail monitoring program would be maintained, and future results monitored closely.

A desktop review of impacts to the sandstone culvert at 88.44 km was completed by a heritage consultant (refer **Appendix G**). From this review, it was concluded that as the cracks are in the mortar joints and are not impacted the structural integrity of the culvert, and as they are relatively small, the impacts to heritage values can be considered negligible.

A further monitoring inspection of Historical Heritage Items will be carried out at the end of LW W2.

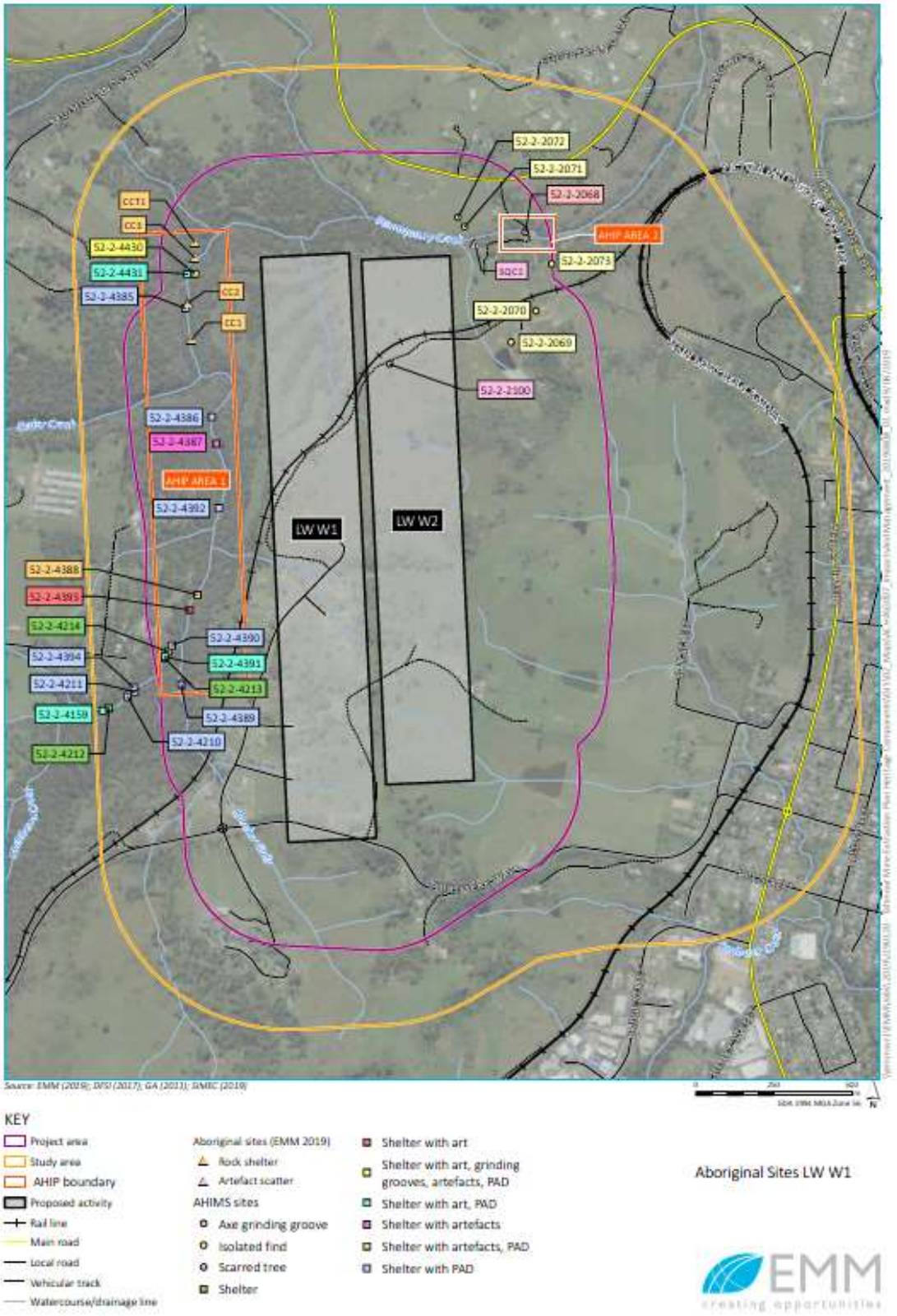

Figure 4-24 Aboriginal heritage and historical heritage items within the LW W1-W2 Study Area (source: EMM, 2020a; Tahmoor Mine Longwall West 1 (LW W1) End Of Panel Monitoring Inspection)

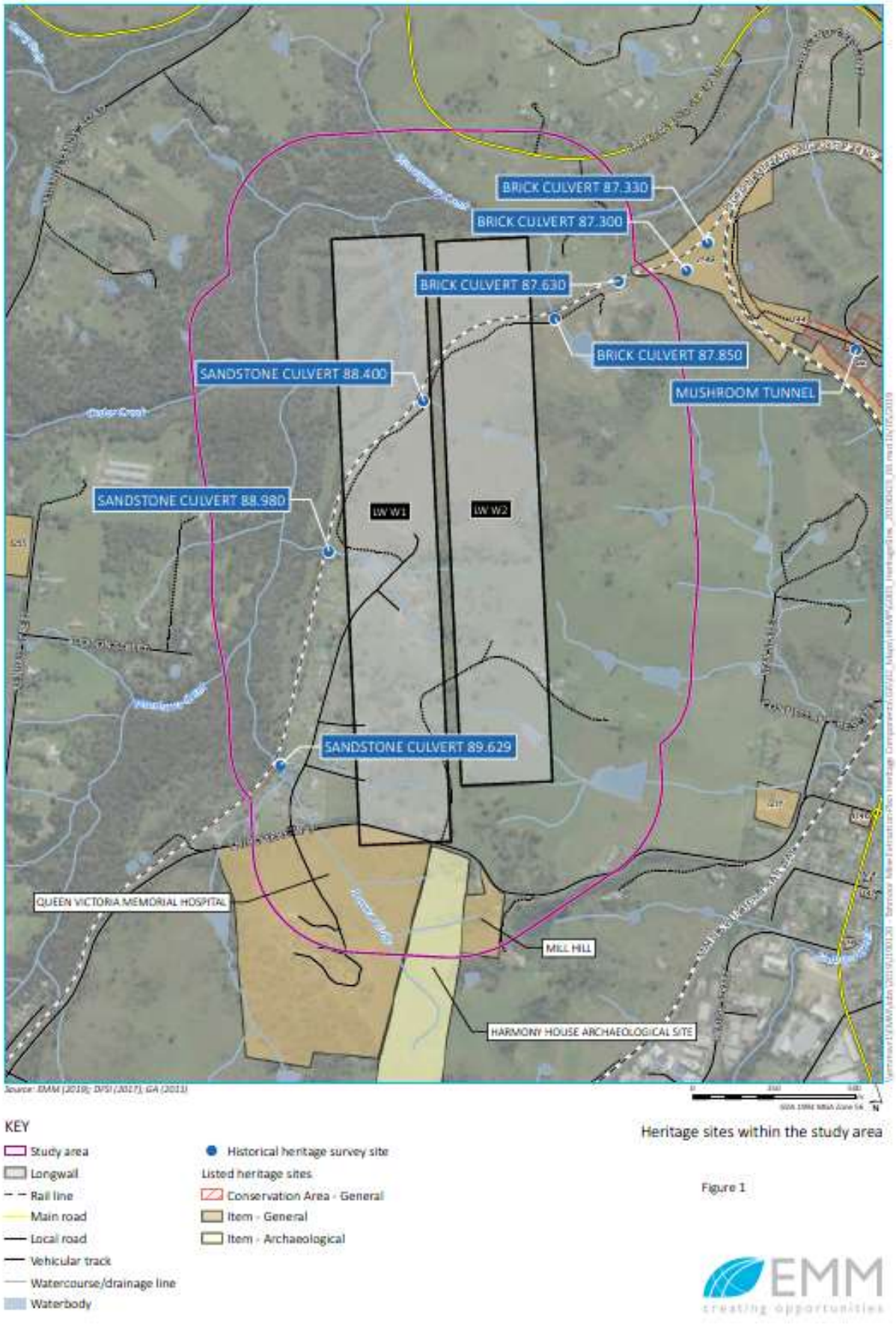

Figure 4-25 Historical Heritage Sites in the Study Area and Surrounds (Source EMM 2020b: Tahmoor Mine Longwall West 1 (LW W1) End of Panel Monitoring Inspection).

4.6 Built Features Monitoring

The Tahmoor Coal LW W1-W2 Built Features Management Plan and associated sub-plans were prepared to manage the potential environmental consequences of LW W1-W2 extraction on built features in accordance with Condition 13H(vii)(b) of DA 67/98.

During this reporting period, the LW W1-W2 Subsidence Monitoring Program has been implemented to monitor subsidence impacts on infrastructure owned by Endeavour Energy (electrical infrastructure), Sydney Water (potable water infrastructure), Bradcorp (sewer infrastructure), Jemena (gas infrastructure), Wollondilly Shire Council (roads, bridges and culverts), Telstra (telecommunications infrastructure), NBN (telecommunications infrastructure), ARTC (rail infrastructure), Transport Heritage NSW (rail infrastructure), Queen Victoria Memorial Home (historical building and nursing home), Mill Hill (historical building), and private property owners. The details of the Subsidence Monitoring Program are illustrated in **Figure 4-1**.

A weekly review of the subsidence survey results during the reporting period has been completed by MSEC (refer **Appendix A**). Monitoring observations for built infrastructure from the weekly and monthly reports, as well performance against all Infrastructure Management Plan TARPs for the reporting period have been summarised in **Table 2-3**.

A comparison between assessed and observed impacts to surface features is summarised in Table 2 of the MSEC Subsidence Monitoring Report 15 (refer to **Appendix A**).

A number of impacts to local roads and built structures occurred during November 2020 to April 2021 as a result of subsidence from LW W1 and LW W2 extraction. These impacts are focused within the Stonequarry Estate and can be summarised as:

- Impacts to road pavement on Carramar Close (November 2020);
- Impacts to houses on Stonequarry Creek Road (November 2020, April 2021);
- Impacts to houses on Attunga Close (November 2020);
- Impacts house on Carramar Close (November 2020);
- Impacts to a pool gate and pool pavers on Carramar Close (November 2020);
- Impacts to houses on Booyong Close (April 2021); and
- Impacts to inground pool and surrounding pavers on Booyong Close (April 2021).

Where possible, Tahmoor Coal has repaired damages to roads and built structures within the Stonequarry Estate in consultation with SA NSW where appropriate.

Impacts to rail infrastructure including the Main Southern Rail and the Picton to Mittagong Loop Line because of subsidence from LW W1 and LW W2 can be summarised as follows:

- Minor closure across the abutments of the MSR Ballast Top Subway at 86.838 km (April 2021); and
- Opening and closing of rail joints between 87.9 km and 88.5 km requiring gap adjustment (March 2021).

Closure at the Ballast Top Subway was reviewed by the RMG and investigated by Structural Engineer (John Matheson). It was determined that the movements were associated with rain events and not subsidence related (refer to MSR Status Report 20; Appendix H). Monitoring to continue as per the Rail Subsidence management plans.

Rail joint gaps were adjusted and remeasured during the week of the 10 April 2021 with no additional adjustments recommended (Refer Report R14 Appendix E).

No other subsidence impacts to built features were observed during this reporting period.

4.7 Public Safety Monitoring

The Tahmoor Coal LW W1-W2 Public Safety Management Plan was prepared to manage the potential consequences as a result of LW W1-W2 extraction on public safety within the Study Area in accordance with Condition 13H(vii)(g) of DA 67/98.

As noted in **Section 1.3** of this report, management requirements for public safety are covered in the Built Features Management Plan and the Land Management Plan. Monitoring of cliffs, rock outcrops and steep slopes and other landscape features has been conducted for the reporting period in accordance with the LW W1-W2 Land Management Plan (refer to **Section 4.3.1** for a summary of monitoring results). In addition, monitoring of infrastructure items has also been conducted for the reporting period in accordance with the LW W1-W2 Built Features Management Plan (refer to **Section 4.6** for a summary of monitoring results).

No subsidence impacts were identified during the reporting period that were considered to pose a risk to public safety.

5 Document Information

5.1 References

Department of Planning and Environment (DPE) (2015), Draft Guidelines for the Preparation of Extraction Plans V5.

EMM Consulting (2019a), Tahmoor Mine Extraction Plan: Longwalls West 1 – West 2 – Aboriginal Heritage Technical Report, report for Tahmoor Coal.

EMM Consulting (2020a), Aboriginal heritage monitoring report: Tahmoor Mine Longwall West 1 (LW W1) End Of Panel Monitoring Inspection.

EMM Consulting (2020b), EMM 2020: Historical heritage monitoring report: Tahmoor Mine Longwall West 1 (LW W1) End of Panel Monitoring Inspection).

Mine Subsidence Engineering Consultants (MSEC) (2019), Tahmoor Coking Coal Operations – Longwalls W1 and W2, Subsidence Predictions and Impact Assessments for Natural and Built Features due to the Extraction of the Proposed Longwalls W1 and W2 in Support of the Extraction Plan Application. Prepared for Tahmoor Coal, May 2019, document MSEC1019.

Tahmoor Coal Documents:

- Extraction Plan LW W1-W2 Extraction Plan Main Document, TAH-HSEC-00248
- Extraction Plan LW W1-W2 Water Management Plan, TAH-HSEC-00244
- Extraction Plan LW W1-W2 Land Management Plan, TAH-HSEC-00247
- Extraction Plan LW W1-W2 Biodiversity Management Plan, TAH-HSEC-00246
- Extraction Plan LW W1-W2 Heritage Management Plan, TAH-HSEC-00242
- Extraction Plan LW W1-W2 Subsidence Monitoring Program, TAH-HSEC-00249

5.2 Glossary of Terms

Terms references to this document are provided below in **Table 5-1**.

Table 5-1 Glossary of Terms

Term	Definition
Active Subsidence Zone	The active subsidence zone for each longwall is defined by the area bounded by the predicted 20 mm subsidence contour for the active longwall and a distance of 150 m in front of the active longwall face and 450 m behind the active longwall face or following 500 m of longwall extraction.
Angle of draw	The angle of inclination from the vertical of the line connecting the goaf edge of the workings and the limit of subsidence (which is usually taken as 20 mm of subsidence)
Cliffs	Continuous rockfaces having minimum heights of 10 m, minimum lengths of 20 m and minimum slopes of 2 to 1, i.e. having minimum angles to the horizontal of 63°.
Closure	The reduction in the horizontal distance between the valley sides. The magnitude of closure, which is typically expressed in the units of mm, is the greatest reduction in distance between any two points on the opposing valley sides. It should be noted that the observed closure movement across a valley is the total movement resulting from various mechanisms, including conventional mining

Term	Definition
	induced movements, valley closure movements, far-field effects, downhill movements and other possible strata mechanisms.
Longwall	A system of mining coal in which the seam is extracted on a broad front or long face using a coal shearer and the roof is supported by hydraulic roof supports.
Reporting period	15 November 2019 to 5 May 2020
Run of mine (ROM)	Raw coal production; the unprocessed mined coal that is conveyed to the CPP. ROM may consist of coal and rock.
Study Area	Study Area as defined in the LW W1-W2 Extraction Plan
Subsidence	The vertical movement of a point on the surface of the ground as it settles above an extracted panel, but, 'subsidence of the ground' in some references can include both a vertical and horizontal movement component. The vertical component of subsidence is measured by determining the change in surface level of a peg that is fixed in the ground before mining commenced and this vertical subsidence is usually expressed in units of mm. Sometimes the horizontal component of a peg's movement is not measured, but in these cases, the horizontal distances between a particular peg and the adjacent pegs are measured.
Subsidence impacts	The physical changes or damage to the fabric or structure of the ground, its surface and environmental features, or built structures that are caused by the subsidence effects. These impacts considerations can include tensile and shear cracking of the rock mass, localised buckling of strata, bed separation, rock falls, collapse of overhangs, failure of pillars, failure of pillar floors, dilation, slumping and also include subsidence depressions or troughs.
Upsidence	Upsidence results from the dilation or buckling of near-surface strata at or near the base of the valley. The term uplift is used for the cases where the ground level is raised above the pre-mining level, i.e. when the upsidence is greater than the subsidence. The magnitude of upsidence, which is typically expressed in the units of mm, is the difference between the observed subsidence profile within the valley and the conventional subsidence profile which would have otherwise been expected in flat terrain.
Western Domain	Area to the north-west of the Main Southern Railway.

5.3 Abbreviations

Abbreviations used in this document are provided below in **Table 5-2**.

Table 5-2 Abbreviations

Abbreviation	Definition
AHIMS	Aboriginal Heritage Information System
ARTC	Australian Rail Track Corporation
AUSRIVAS	The Australian River Assessment System
BACI	Before After Control Impact design
DA	Development Approval
DRNSW	Department of Regional NSW
DPE	NSW Department of Planning and Environment (now DPIE)

Abbreviation	Definition
DPIE	NSW Department of Planning, Industry and Environment
EC	Electrical conductivity
ERG	Environmental Response Group
EPA	NSW Environment Protection Authority
GFG	GFG Alliance
GNSS	Global Navigation Satellite System units
HEC	Hydro Engineering and Consulting
Km	Kilometres
LW W1	Longwall West 1
LW W1-W2	Longwalls West 1 to West 2
LW W3-W4	Longwalls West 3 to West 4
m	metres
mbgl	Metres below ground level
mg/L	Milligrams per litre
ML	Mining Lease
mm	millimetre
MSEC	Mine Subsidence Engineering Consultants
NRAR	NSW Industry – Land & Water – Natural Resources Access Regulator – East
NSW	New South Wales
OSP	Open Standpipe Piezometers
pH	pH units
PMLL	Picton-Mittagong Loop Line railway
RCE	Riparian Channel and Environment Inventory
RMG	Rail Management Group
Tahmoor Coal	Tahmoor Coal Pty Ltd
Tahmoor Mine	Tahmoor Coal Mine
TARP	Trigger Action Response Plan
TCCO	Tahmoor Coking Coal Operations
VMP	Vibrating Wire Piezometer

5.4 Document Distribution

This report and associated documents have been distributed according to **Table 5-3**.

Table 5-3 Distribution List for Six Monthly Subsidence Impact Report

Agency	Contact Person	Position	Electronic Copy
DPIE - Planning	Stephen O'Donoghue	Director – Resource Assessments	Stephen.ODonoghue@planning.nsw.gov.au
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	Andrew Rode	Senior Environmental Assessment Officer	Andrew.Rode@planning.nsw.gov.au
DPIE - Resources Regulator (Subsidence)	Dr. Gang Li	Principal Subsidence Engineer	subsidence.monitoring@planning.nsw.gov.au
DRNSW – Mining Exploration and Geoscience	(none assigned)	(none assigned)	resource.operations@planning.nsw.gov.au
DPRNSW – Resources Regulator – Mining Act Inspectorate	Greg Kininmonth	Manager Environmental Operations (Southern)	greg.kininmonth@planning.nsw.gov.au nswresourcesregulator@service-now.com
Wollondilly Shire Council	David Henry	Environmental Assessment Planner	david.henry@wollondilly.nsw.gov.au
	Bruce Davenport	Environmental Services Team Leader	bruce.devonport@wollondilly.nsw.gov.au
Subsidence Advisory NSW	Matthew Montgomery	Infrastructure Manager	matthew.montgomery@finance.nsw.gov.au
NRAR	Heather Dewson	Water Regulation Officer	heather.dewson@dpie.nsw.gov.au
EPA	Andrew Couldridge	Senior Operations Officer - Metropolitan Illawarra	andrew.couldridge@epa.nsw.gov.au
TCCCC Committee Members	Documents sent to TCCCC Committee Members at private email addresses.		

Appendix A – Subsidence Monitoring Reports

Appendix B – Surface Water Monitoring Report

Appendix C – Creek Monitoring Reports

Appendix D – Groundwater Monitoring Report

Appendix E – Picton-Mittagong Loop Line Detailed Reports

Appendix F – Picton-Mittagong Loop Line Status Report

Appendix G – Aboriginal Heritage End of Panel Reports

Appendix H – Main Southern Railway Status Report

Appendix I – Ecology Monitoring Reports