Memorandum

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From:	Maxime Philibert/ Will Minchin	At:	SLR Consulting Australia Pty Ltd
Date:	23 September 2021	Ref:	665.10010.00507-M01-v3.0-20210923.docx
Subject:	IAPUM Advice re: North Western Domain Longwalls W3 and W4 Extraction Plan Response to Groundwater Recommendations		

The Independent Advisory Panel for Underground Mining (IAPUM) provided advice regarding the Tahmoor Coal Mine North Western Domain Longwalls W3 and W4 – Extraction Plan. Section 4.2 of the Advice discusses Potential Impact to Watercourses, with two recommendations provided (Section 4.2.1) pertaining to groundwater. The following two sections provide a description of each relevant recommendation and the subsequent technical response to address.

1 IAPUM Advice, Section 4.2.1, Point 1

1.1 Recommendation

Performance indicators for Surface Water and Groundwater Resources and/or for Aboriginal and heritage sites should be adjusted to encompass possible environmental consequences related to baseflow loss not associated with visible fracturing.

1.1.1 Related text from IAPUM (Section 4.2)

Loss of baseflow at rockbar SR17 that is not associated with visible fracturing or subsidence movement is not captured under the proposed performance indicators for Surface Water and Groundwater Resources or in the proposed indicators for Aboriginal and heritage sites.

The Panel considers that mining-induced baseflow loss which causes visible reductions to water levels of pools adjacent to the grinding groove sites may lead to the performance measure of negligible environmental consequences not being met. This is not something that can be fully addressed by the Management Plan for SR17 due to the potentially long time-lags between baseflow and extraction.

The subsidence performance indicators relating to the performance measure "Negligible subsidence impacts or environmental consequences" should cover the possibility of mining-induced baseflow losses at SR17. A suitable additional performance indicator would be: *This performance measure will be considered to be exceeded if mining impacts lead to a cessation of flow over the SR17 rockbar*.

1.2 Response

In reference to 'negligible subsidence impacts or environmental consequences', the IAPUM advice states that "This is not something that can be fully addressed by the Management Plan for SR17 due to the potentially long time-lags between baseflow and extraction". The TARPs and monitoring regime related to aboriginal heritage and potential subsidence effects on the SR17 rockbar are detailed in the Stonequarry Creek Rockbar Management Plan (SCRMP v7, Tahmoor Coal, 2021).

To address the recommendation specifically as it relates to baseflow loss not associated with visible fracturing, an approach for adaptive management in the form of a groundwater – surface water interaction TARP has been provided, in addition to the current management strategy outlined in the Water Management Plan (Tahmoor Coal, 2021a).

As part of the Groundwater Technical Report for the Extraction Plan of LW W3 and LW W4 (SLR, 2021) and the groundwater quarterly review for May-July 2021 (SLR, 2021b), an analysis was presented to understand the change in the interaction between groundwater and surface water during the pre-mining period and post post-mining of LW W1 and LW W2.

SLR developed a methodology to infer groundwater levels at surface water monitoring sites using observed groundwater levels and a series of interpolation methods. For further details, the methodology is presented and described in the Appendix G of the Groundwater Technical Report (SLR, 2021). The aim of this was to allow or improve the comparison of surface water levels (at pools) with groundwater levels at monitoring bores that might not be co-located with the pool.

To consider the potential changes to groundwater-surface water (GW-SW) interaction, and particularly with respect to potential baseflow loss upstream and downstream of the SR 17 rock bar, the proposed GW-SW TARP will be based on this method.

It is proposed that the surface water monitoring site to be considered in the TARP to identify baseflow loss at SR 17 rock bar is:

- SB (pool SR17) - 155 m from LW W3.

This surface water site has been selected due to its proximity to pool SR 17 and LW W3-W4, and the available record/available data (i.e. automated surface water level). Observed groundwater levels at sites P15 and P14 are considered to infer groundwater levels at these surface water locations given their proximity to them.

Figure 1 presents

- hydrographs for SB;
- The automated and manual surface water level measurement of creek/pool level;
- The elevation of the base of the pool; and
- The calculated and inferred groundwater levels using the Z-adjustment and the distance weighted average methods (see Section 3 of Appendix G for methodology definition, (SLR, 2021)). Where it is shown, the black chart series is the series that is used to show the best estimate of inferred groundwater level adjacent to a surface water site, while the range between blue and red series provides an estimate of the range or uncertainty in groundwater levels, given that we are comparing groundwater levels from sites that are not exactly co-located with the surface water site.

Site SB

Groundwater site P14 is 170 m west of site SB, while P15 is 90 m to the south of SB, and therefore closer to LW W3. The base of the pool at SB was surveyed by SIMEC (2021) at 163.9 mAHD. Inferred groundwater levels, using the distance weighted average (with Z-adjustment) method (black series on Figure 1), at SB are estimated to be 2 m above the base of pool, however are 1.8 m below recorded pool water level suggesting losing conditions during May-July 2021 (SLR, 2021a; SLR, 2021b). Despite the apparent losing conditions, the basis for the proposed TARP is that groundwater (as measured at P14B and P15A) is more likely to support baseflow to Stonequarry Creek whilst groundwater levels are above the base of the pool (163.9 mAHD) (SLR, 2021b).

The TARP levels proposed to monitor and assess the potential for mining-related baseflow loss were developed using the base of the pool as the point for comparison. The TARP Level at SB was calculated as the follows:

- TARP Level 2 = base of the pool [mAHD] +1.1m = 165.0 mAHD.
- TARP Level 3 = base of the pool [mAHD] +0.6 m = 164.5 mAHD.
- TARP Level 4 = base of the pool [mAHD] +0.1 m = 164.0 mAHD.

Figure 1 presents these proposed TARP Levels (Levels 2, 3 and 4) in comparison with the base of the pool.

The following text is for descriptive purposes only, included here because of the shorter record at P15 sites. If considering only the groundwater levels at P14B (red series on the chart), inferred groundwater levels declined to a minimum elevation of 165.3 mAHD in late January 2021, interpreted as the cumulative effect of the extraction of LW W1 and LW W2. Since February 2021, as LW W2 has moved away, inferred groundwater levels at SB recovered near baseline level. Note however that we are recommending that the TARP be based on the *black series* on Figure 1, which despite its shorter record, is considered a more appropriate estimate of groundwater levels beneath the pool at SB.

TARP Level 2 is proposed at 165.0 mAHD, which is approximately 0.3 m below the inferred minimum groundwater level using the black series (165.3 mAHD), and below the recent (August-2021) groundwater level. TARP Level 2 is designed to inform whether the groundwater level at (beneath) SB has declined to a level that is similar to the previous minimum groundwater level inferred during extraction of LW W2.

TARP Level 3 and 4 are designed to inform Tahmoor Coal and the Technical Committee that inferred groundwater levels have declined to approximately 0.6 m and 0.1 m above the base of the pool and provide progressive signs that potential baseflow discharge to Stonequarry Creek has reduced in magnitude or will do so. This has been proposed in order to address the issue identified by IAPUM regarding baseflow loss *in the absence* of measurable ground movement (e.g. valley closure), where subsidence and ground movements are addressed in the SCRMP (Tahmoor Coal, 2021b). We note that effects on surface water flows at site SB are already monitored and assessed on a monthly basis by Tahmoor Coals' consultant hydrologists.

These TARPs are proposed above the base of the pool at SB due to the likely time-lags between panel extraction and baseflow loss . It aims to give sufficient time for Tahmoor Coal and the Technical Committee to appropriately respond before inferred groundwater levels decline below the base of the pool at SB which in turn influences the groundwater-surface water interactions along this section of Stonequarry Creek.

The proposed Groundwater – Surface Water TARP is provided in Table 1, which summarises the trigger levels as discussed above, noting the assessment frequency of fortnightly up to the point at which LW W3 reaches 400 m, with accompanying response and action plans.

Other surface water sites downstream of pool SR17 were also considered in the proposed GW-SW TARP. However multiple variables, including the greater distance between the installed groundwater monitoring bores (P14, P15) to downstream surface water sites (e.g. SC, SD), weakens the ability to estimate local groundwater levels and diminishes the value of any TARP Level relying on that.

The morphology of the pool at SD (being very shallow) and the assumptions of using the same groundwater levels at SD (i.e. P14B and P15A) as site SB could result in inappropriate TARP Level and meant that this comparative analysis and TARP would not add any value beyond that of the TARP proposed (above) for SB.

In summary, it is proposed that the SB site, which is directly relevant to pool SR 17 and in relatively close proximity to groundwater monitoring bores, be incorporated into the proposed Groundwater – Surface Water TARP.

Further, groundwater monitoring data in the area should be available in the medium-term (i.e. P41) to allow similar monitoring relevant to LW W4.

SLR (2021a) included predictions of groundwater drawdown at P14B and P15A. The model predicted groundwater levels of 166 mAHD at P14B and 162.5 mAHD after extraction of LW W3, but noting that pre-mining groundwater levels were over-estimated by the groundwater model. The model predicted drawdown of approximately 7 m (P14B) and 5 m (P15A) from the end of LW W2 to the end of LW W3/early LW W4 at these sites. Based on these predicted drawdowns, it is likely that groundwater levels will be drawn down to or below the base of the pool at SB after LW W3 extraction (i.e. there is an expectation that these TARPs will be triggered).

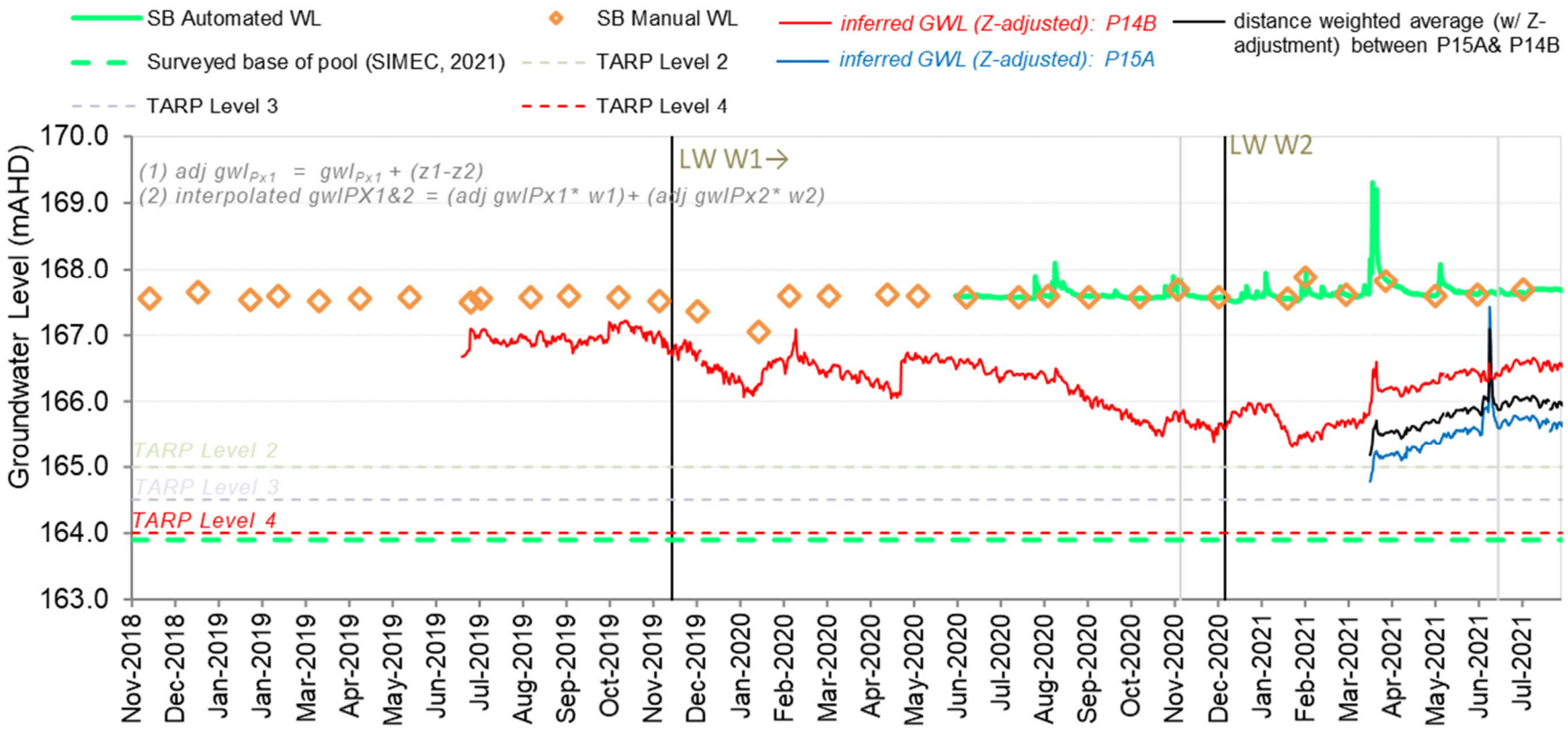

Figure 1 Site SB – Inferred Groundwater Level and Measured Surface Water Level

Table 1 Proposed Groundwater – Surface Water Interaction TARP

Feature	Trigger	Action	Responses
GROUNDWATER-SURFACE WATER INTERACTION Locations Impact sites: site SB Frequency Pre-mining GW - Minimum continuous 24-hourly readings with monthly logger download and dip meter. Baseline data available since May 2019 (P14) and since March 2021 (P15). SW - Continuous record, data downloaded monthly. Baseline data recorded since October 2018 in the Western Domain at the majority of Western Domain sites. During mining to 400 m (LW W3): GW - Minimum continuous 24-hourly readings with fortnightly logger download and dip meter. SW - Continuous record, data downloaded monthly. Post mining GW - Minimum continuous 24-hourly readings with monthly logger download and dip meter for 12 months following the completion of LW W4. SW- Continuous record, data downloaded monthly for 12 months following the completion of LW W4.	Level 1		
	•Inferred groundwater and surface water interaction remains consistent with baseline variability and/ pre-mining trends with weakening of gaining or strengthening of losing condition not persisting after significant rainfall recharge events.	•Continue monitoring program. •Ongoing review of water level data.	•No response required.
	Level 2		
	•Inferred groundwater levels at surface water monitoring site decline below the TARP Level 2 following the commencement of extraction at LW W1 (and LW W2, W3, W4) AND •The reduction in water level is determined not to be controlled by climatic or external anthropogenic factors.	•Continue monitoring program. •Ongoing review of water level data. •Convene Tahmoor Coal Environmental Response Group to review response.	•As defined by Environmental Response Group.
	Level 3		
	•Inferred groundwater levels at surface water monitoring site decline below the TARP Level 3 following the commencement of extraction at LW W1 (and LW W2, W3, W4) AND •The reduction in inferred groundwater water level is determined not to be controlled by climatic or external anthropogenic factors.	•Continue monitoring program. •Ongoing review of water level data and consideration of mining and external stresses (in impact report). •Compare against base case and deterministic model scenarios. •Convene Tahmoor Coal Environmental Response Group to review response.	•As defined by Environmental Response Group. •Review manual water level measurements for additional monitoring sites to identify potential spatial trends in water level decline. •Report to DPIE

Feature	Trigger	Action	Responses
This period may be extended as per the decision by the Environmental Response Group (refer to Section 5.2 for further details).	Level 4		
	•Inferred groundwater levels at surface water monitoring site decline below the TARP Level 4 following the commencement of extraction at LW W1 (and LW W2, W3, W4) AND •The reduction in inferred groundwater water level is determined not to be controlled by climatic or external anthropogenic factors.	•Continue monitoring and review as per monitoring program. •Ongoing review of water level data and consideration of mining and external stresses (in impact report). •Convene Tahmoor Coal Environmental Response Group to review response. •Compare against base case and deterministic model scenarios.	•Report to DPIE and relevant government agencies within 7 days of investigation completion (according to Table 6-1 of the Extraction Plan Main Document). •Review surface water data to assess for surface water level decline at SB (SR17). •Review manual water level measurements for additional monitoring sites to identify potential spatial tends in water level decline. • If it is concluded that there has been a mining-related impact then implement a corrective management action plan in accordance with a timeframe as recommended by the Environmental Response Group in consultation with the Resources Regulator (refer to Section 6.2.2 of the WMP).

2 IAPUM Advice Section 4.2.1, Point 3

2.1 Recommendation

Aspects of the groundwater TARP noted in this advice should be refined or further justified by the Applicant

2.1.1 Related text (Section 4.2)

The Panel recognises the challenges of developing groundwater TARPs that are applicable over multiple sites and generally support the approach taken. However, the Panel has concerns about the deduction of the nominated drawdowns from the minimum observed groundwater levels prior to extraction at LW W1: the deduction from the minimum can lead to a large margin for greater-than-predicted drawdowns to occur. Also, for TARP level 4, the maximum predicted drawdowns may be longer-term and larger drawdowns than those relevant for adaptive management during mining, again potentially providing large margin for drawdowns prior to a trigger. These aspects of the groundwater TARP should be refined or further justified by the Applicant prior to approval of the Extraction Plan.

2.2 Response

In response to the comment, firstly the methodology used to define the TARP will be clarified, followed by a proposed amendment to the TARPs to address the concerns raised.

Clarification of Method

Initially, to clarify the methodology used to set TARPS please see the following summary, as presented in Tahmoor Coal Mine North Western Domain Longwalls W3 and W4 – Extraction Plan (SLR,2021a).

Please note:

- Trigger Level 2, 3 and 4 is a calculated groundwater elevation [mAHD] for each bore/piezometer.
- Reference Level: this was set as the minimum groundwater observed during pre-mining of LW W1.

TARP LEVEL 2

TARP Level 2 methodology: Based on the approved groundwater TARP using a 2 m drawdown for “P” open standpipe bores and 5 m drawdown for shallow VWPs.

TARP Level 2 calculations: Subtract the 2 m and 5 m drawdown respectively from the Reference Level (see above) at each bore/piezometer.

TARP LEVEL 3

TARP Level 3 methodology: Based on the average between trigger level for TARP level 2 and Level 4.

TARP LEVEL 4

TARP level 4 methodology: Based on the maximum modelled drawdown (base case model) between the start of LW W1 and the end of the prediction period (year 2500).

TARP Level 4 calculations: Maximum modelled drawdown subtracted from the Reference Level at each bore/piezometer .

Discussion of Proposed Amendments

A revision to the methodology used to define the triggers and the associated TARP Level to address the IAPUM recommendations is proposed. The following was amended:

We have considered and accepted the IAPUM's comments regarding the use of the minimum observed pre-mining groundwater level for the Reference Level. On this basis, the deduction of nominated drawdowns from the *minimum* observed groundwater levels prior to extraction at LW W1 has been revised and taken from the *maximum* observed groundwater levels prior to extraction at LW W1. This is believed to be a more conservative and appropriate approach. Table 2 (on following pages) presents the revised proposed TARP Level at each monitoring bores/piezometers.

The point raised by IAPUM regarding the TARP Level 4 (in which "*the maximum predicted drawdowns may be longer-term and larger drawdowns than those relevant for adaptive management during mining, again potentially providing large margin for drawdowns prior to a trigger*") is acknowledged in the context of short-term adaptive management as has been stipulated for LW W3.

The proposed Trigger Actions Response Plan for groundwater developed by SLR (2021a) was designed to assess medium-term (months to 1-2 years, approximately) impacts on shallow and deep aquifers (i.e. drawdown and groundwater quality) and groundwater users (i.e. yield, drawdowns, and groundwater quality) rather than short-term impacts as considered in the Adaptive Management Plan such as in the LW W3-W4 Stonequarry Creek Rockbar Management Plans. This Adaptive Management Plan is primarily focussed on a few hundred metres of longwall progression (i.e. weeks, perhaps 1-2 months).

Effects of mining/post-mining on groundwater levels and quality are assessed and reported monthly by SLR in combination with monthly surface water reporting conducted by HEC to assess effect of mining on streamflow, pool water level (automated and visual inspection), flood levels and stream water quality. The Environmental Response Group meetings held monthly between Tahmoor and the relevant consultants (i.e. a technical committee) are on-going and will continue in the future to consider trends in both groundwater and surface water levels / quality (as well as subsidence and other environmental disciplines) and develop appropriate responses where a mining effect is identified.

Consequently, whilst the groundwater regime is reviewed continuously (i.e. monthly) and as such would identify any early signs of a mining effect at private bores and monitoring bores during the development of LW W3 and LW W4 (i.e. groundwater depressurisation etc), no further changes are proposed to the current groundwater TARP.

However, to fill the gap in terms of assessing short-term effects with respect to potential impacts to Stonequarry Creek, and to refine the TARP to align with development of an adaptive management approach during mining, it is suggested an additional TARP which aims to monitor and assess the potential for any loss of baseflow due to groundwater depressurisation along Stonequarry Creek, with a particular focus on the upstream and downstream reach of SR17, is implemented. Further details of this Groundwater-Surface water interaction TARP are described in Section 1.2.

Table 2 Summary of Proposed Trigger Levels for Groundwater Level TARPs (revised from Groundwater Technical Report – Table 6-1 SLR, 2021a)

Bore	Groundwater Trigger Level (mAHD)		
	TARP Level 2	TARP Level 3	TARP Level 4
Shallow OSP			
P12A	168.6	See table 6.11 (GTR)	See table 6.11 (GTR)
P12B	169.1	See table 6.11 (GTR)	See table 6.11 (GTR)
P12C	179.5	175.0	170.4
P13A	165.7	163.7	161.6
P13B	165.0	163.0	161.1
P13C	168.5	163.1	157.7
P14A	167.2	165.0	162.9
P14B	165.2	159.8	154.3
P14C	165.2	159.9	154.6
P14D	163.6	158.3	152.9
P15A	163.4	156.4	149.4
P15B	163.9	156.9	149.9
P15C	163.3	156.3	149.4
P16A	209.9	209.3	208.8
P16B	205.9	202.3	198.7
P16C	200.6	193.9	187.2
P17	169.7	170.6	171.6
Shallow VWPs (<200m)			
TNC036 - HBSS-65	204.5*	See table 6.12 (GTR)*	See table 6.12(GTR)*
TNC036 - HBSS-97	191.3*	185.7*	180*
TNC036 - BGSS-169	192.5*	135.7*	79.0*
TNC040 - WNFM-27	203.3	198.2	193.1
TNC040 - HBSS-65	182.1	175.8	169.5
TNC040 - HBSS-111	#	#	#
TNC043 - HBSS-65	153.7	152.5	151.3
TNC043 - HBSS-111.5	150.6	148.5	146.5
WD01- HBSS - 70	206.2	202.4	198.6
WD01- HBSS - 90	191.4	186.7	182.0
WD01- HBSS - 190	F	F	F
Deep VWPs (>200m)			
TNC036 - BGSS-214	See table 6.13 (GTR)	See table 6.13 (GTR)	See table 6.13
TNC036 - BGSS-298.5	*	*	*
TNC036 - BGSS-412.5	See table 6.13 (GTR)	See table 6.13 (GTR)	See table 6.13 (GTR)
TNC036 - BUSM-463.5	*	*	*
TNC040 - HBSS-225	#	#	#
TNC040 - BHCS-252	#	#	#

Bore	Groundwater Trigger Level (mAHD)		
	TARP Level 2	TARP Level 3	TARP Level 4
TNC040 - BGSS-352	#	#	#
TNC040 - SCSS-482	#	#	#
TNC040 - BUCO-501.9	#	#	#
TNC043 - HBSS-213	#	#	#
TNC043 - BGSS-240	#	#	#
TNC043 - BGSS-332.6	#	#	#
TNC043 - BGSS-405.2	#	#	#
TNC043 - BUCO-476.3	#	#	#
WD01- HBSS - 210	see Table 6.13 (GTR)	see Table 6.13 (GTR)	see Table 6.13 (GTR)
WD01- HBSS - 230	F	F	F
WD01- BGSS - 300	F	F	F
WD01- BGSS - 330	F	F	F
WD01- BGSS - 350	F	F	F
Notes: "#" no data after LW W1.			
"*" groundwater data not reliable, but will still be reported on.			
"F" Sensors failed during mining of LW W1 and LW W2.			

3 Reference List

SLR, 2021a. Tahmoor Coal LW W3-W4 Extraction Plan: Groundwater Technical Report. Prepared for Tahmoor Coal Pty Ltd, Report No: 665.10010.00006-R01-v3.0.

SLR, 2021b. Memo: Tahmoor Western Domain (W1-W2) Quarterly Groundwater Monitoring Report, May to July 2021, report no. 665.10010.00707-M01-v1.0-200210912.pdf

Tahmoor Coal, 2021a. Water Management Plan: Tahmoor North – Western Domain Longwalls West 3 and West 4. Document TAH-HSEC-328 (v2). September 2021.

Tahmoor Coal, 2021b. Stonequarry Creek Rockbar Management Plan: Tahmoor North – Western Domain Longwalls West 3 and West 4. Document TAH-HSEC-352 (v7). September 2021.

Checked/
Authorised by: WM/SH