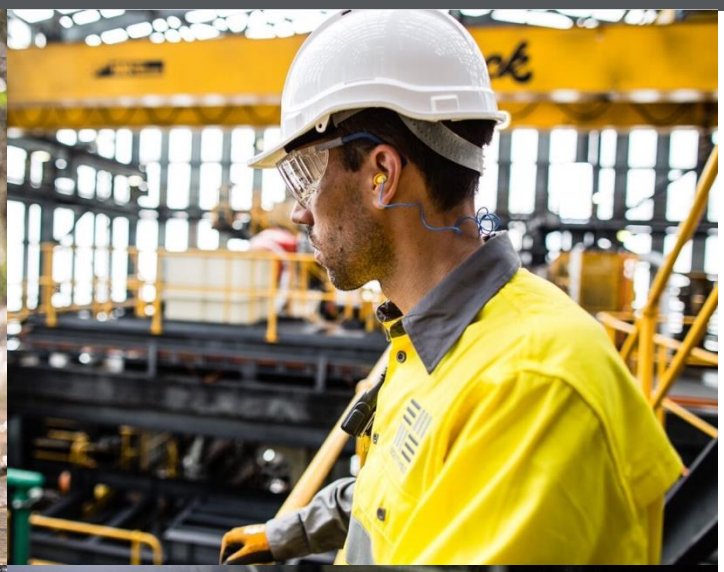
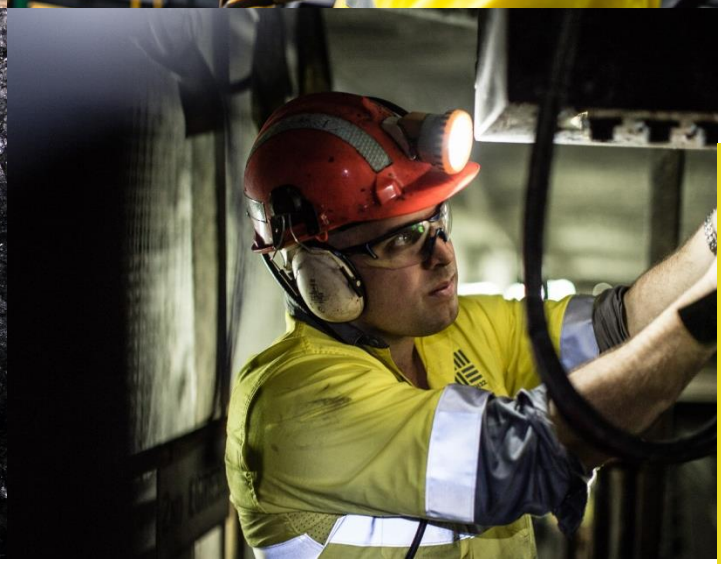
Illawarra Metallurgical Coal
End of Panel Report



Dendrobium Area 3B Longwall 16 End of Panel Report

March 2021

EXECUTIVE SUMMARY

This End of Panel (EoP) report has been prepared in accordance with Schedule 3 Condition 9 of the Dendrobium Development Consent (DA 60-03-2001). The EoP report outlines the measured and observed impacts during the extraction of Dendrobium Area 3B (DA3B) Longwall 16, and presents monitoring results and analyses compared to relevant impact assessment criteria and predictions in the DA3B Subsidence Management Plan (SMP).

Dendrobium Longwall 16 is located within Consolidated Coal Lease 768 and is the eighth panel to be extracted in DA3B. Extraction of Longwall 16 commenced on 26 February 2020 and was completed on 4 November 2020. The extracted longwall has a length of 1864 metres (m), a void width of 305m (including first workings) and a maximum cutting height up to 3.9m

The extraction of underground coal reserves from DA3B provides benefits at international, national, state and local levels. Illawarra Metallurgical Coal (IMC) provides an essential supply of coking coal to BlueScope Steel for its steelmaking production, and for export to overseas customers. Operations at Dendrobium Mine represent continuing significant capital and operating investments in the Southern Coalfield of New South Wales.

Continuing benefits occur through continuity of employment, export earnings and government revenue. From the operations of Dendrobium Mine, IMC paid approximately $44 million in government royalties during the 2019/2020 financial year.

Subsidence movements resulting from the extraction of Longwall 16 were monitored along lines and points within the SMP Area. The measured total vertical subsidence and closure at all monitoring lines are less than or similar to the predicted values at the completion of Longwall 16.

During the extraction of Longwall 16, fifty-two new surface impacts were identified. These impacts are labelled as "*DA3B_LW16_001*" to "*DA3B_LW16_052*". Twenty-eight of these impacts were observed on natural features. The remaining twenty-four impacts were observed on built features such as fire roads and other access tracks, which were remediated (or observed as self-remediated) in accordance with Corrective Management Actions (CMAs).

At *LA4_S1*, a Trigger Action Response Plan (TARP) Level 1 was recorded for Dissolved Oxygen (DO) and TARP Level 2 was recorded for Electrical Conductivity (EC) and pH. At *Donalds Castle Creek (FR6)*, a TARP Level 3 was recorded for EC. Elevated EC at LA4 and Sandy Creek reflect subsidence impacts on the watercourses, whereas mining effects at Donalds Castle Creek are not clear.

TARP triggers for surface water hydrology were identified at Donalds Castle Creek (*DCS2; DCU*); DC13 (*DC13S1*); WC21 (*WC21S1*); WC15 (*WC15S1*), LA4 (*LA4S1*), LA3 (*LA3S1*) and LA2 (*LA2S1*). Water flow performance measures were met for Longwall 16.

Analysis of available surface water flow observation records for Wongawilli Creek triggered a Level 2 TARP in February 2020 (the month in which Longwall 16 commenced, although specifically, this occurred two weeks prior to Longwall 16). Assessment of data indicated that flow reductions due to mining were in the order of 0.005 to 0.01 ML/d.

The average daily inflow to DA3B during Longwall 16 extraction was 3.82 megalitres per day (ML/day) which represents approximately 60 % of total mine inflow for the period. Compared with the previous longwall, the total mine inflow increased by 15% whereas the inflow in Area 3B decreased by approximately 5%.

Seepage losses from Avon Dam have been estimated by regional and local scale numerical models to be in the range 0.09 to 0.51 ML/day following the extraction of Longwall 16. The estimates are within the tolerable loss limit of 1 ML/day prescribed by Dams Safety NSW.

Shallow groundwater triggers were recorded in Swamp 11, 14 and 23 during the extraction of Longwall 16.

Reduction in aquatic habitat for over 2 years at Donalds Castle Creek constitutes a Level 3 TARP trigger. No TARPs have been triggered with respect to Wongawilli Creek.

Three out of the six Aboriginal cultural heritage sites located within the Subject Area were visited. No impacts were observed as a result of the extraction of Longwall 16.

This EOP report will be resubmitted to agencies with the terrestrial ecology component included once complete.

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Attachment B – Subsidence Monitoring Report (MSEC)

Attachment C1 – Landscape Report (IMCEFT)

Attachment C2 – Longwall 16 Impact Reports (IMCEFT)

Attachment D – Surface Water and Shallow Groundwater Assessment (HGEO)

Attachment E – Groundwater Assessment (HGEO)

Attachment F – Aquatic Ecology Assessment (Cardno)

Attachment G – Heritage Assessment (Niche)

1 INTRODUCTION

1.1 Approval and Legislative Requirements

Dendrobium Longwall 16 is located within Consolidated Coal Lease 768 and is the eighth panel to be extracted in DA3B. Extraction of Longwall 16 commenced on 26 February 2020 and was completed on 4 November 2020. The extracted longwall had a length of 1864m, a void width of 305m (including first workings) and a maximum cutting height up to 3.9m.

This EoP report has been prepared in accordance with Schedule 3 Condition 9 of the Development Consent (DA60-03-2001 – MOD 8) (Table 1). The EoP report outlines the measured and observed impacts of Longwall 16 and the analyses of monitoring results compared to relevant impact assessment criteria and predictions made in the SMP and associated management plans and reports.

The DA3B SMP was approved by the then Department of Trade and Investment, Regional Infrastructure and Services NSW (DTI) on the 5 February 2013 and the then Department of Planning and Environment (DP&E) on the 6 February 2013. Subsequent approval for Longwall 16 SMP was granted on the 30 May 2018 by DPE, which is provided as **Attachment A**.

Schedule 3 Conditions 9 and 10 of the Development Consent are provided in Table 1.

Table 1: Approval conditions excerpt from the Dendrobium Development Consent (DA60-03-2001 – MOD 8).

Development Consent Approval Condition	Relevant Section in EoP Report
Schedule 3 of Development Consent DA60-03-2001 – MOD 8 **9.** Within 4 months of the completion of each longwall panel, or as otherwise permitted by the Director-General, the Applicant shall: 1. prepare an end-of-panel report – reporting all subsidence effects (both individual and cumulative) for the panel and comparing subsidence effects with predictions; – describing in detail all subsidence impacts (both individual and cumulative) for the panel; – discussing the environmental consequences for watercourses, swamps, water yield, water quality, aquatic ecology, terrestrial ecology, groundwater, cliffs and steep slopes; and – comparing subsidence impacts and environmental consequences with predictions; and 2. Submit the report to the Department, DPI, SCA, DECC, DWE and any other relevant agency to the satisfaction of the Director-General	*Sections 4 to 8, Attachments B to F* *The AEMR (July to June) is submitted in August each year*

10. The Applicant shall include a comprehensive summary, analysis and discussion of the results of monitoring of subsidence effects, subsidence impacts and environmental consequences in each AEMR	

The impact predictions for Longwall 16 are described in the following reports:

- Dendrobium Area 3B Subsidence Management Plan (SMP);
- Dendrobium Area 3B Watercourse Impact, Monitoring, Management and Contingency Plan (WIMMCP) (February 2020);
- Dendrobium Area 3B Swamp Impact, Monitoring, Management and Contingency Plan (SIMMCP) (February 2020); and
- Dendrobium Subsidence, Landscape Monitoring and Management Plan (SLMMP) (November 2012).

Impacts have been reported by the Illawarra Metallurgical Coal Environmental Field Team (IMCEFT) and specialist consultants during and following mining.

1.2 Economic Benefits

The extraction of underground coal reserves from DA3B provides benefits at international, national, state and local levels. IMC provides an essential supply of coking coal to BlueScope Steel for its steelmaking production, and for export to overseas customers. Mining operations at Dendrobium Mine represents continuing significant capital and operating investments in the Southern Coalfield of New South Wales.

Continuing benefits occur through continuity of employment, income, export earnings and government revenue. From the operations of Dendrobium Mine, IMC paid approximately $44 million in government royalties during the 2019/2020 financial year.

1.3 Stakeholder Consultation

Provision of monitoring data and ongoing information to the community has been undertaken during the extraction of DA3B. Information on South32 operations is provided to the community through the following mechanisms:

- Community information sheets and letter box drops;
- Media releases and other media activities;
- General community surveys and reports;
- Dendrobium Community Newsletter – distributed to the community;
- Internet site http://www.south32.net/our-operations/australia/illawarra-coal/regulatory-document;
- Dendrobium Community Consultative Committee (DCCC) Meetings;
- Landholder relations program;
- Annual review reports; and

- Information days.

IMC aims to mitigate the potential impacts subsidence may cause on individuals through various means outlined in Table 2.

Table 2: Social Impact Variables Associated with Subsidence

Potential Impact	Monitoring Variables	Mechanism
Subsidence Impacts	• Level of community concern relating to subsidence • Awareness of subsidence, its effects and management • Level of perceived community risk associated with subsidence • Level of satisfaction with the company's subsidence management practices • The extent to which the community attributes environmental, social and economic change within the community to mining activities	• The DCCC meetings including presentations and explanations of how and why subsidence occurs, and its potential impacts • A biennial telephone survey of residents in the communities in which IMC operates. The survey aims to determine the community's perception of the company's overall performance

2 PREDICTED AND OBSERVED SUBSIDENCE

Subsidence movements resulting from the extraction of Longwall 16 were monitored along lines and points within the SMP Area. A comparison of the observed and predicted movements has been prepared by Mine Subsidence Engineering Consultants (MSEC) and is included as **Attachment B**.

Monitoring points and lines associated with Longwall 16 include (Figure 1):

- Wongawilli Creek Closure Lines;
- Avon Dam Closure Lines;
- Wongawilli Creek and Avon Dam Tributary Cross Lines;
- Swamp 23 Lines;
- DA3B 3D and Avon Dam 3D Monitoring Points; and
- Airborne Laser Scans (ALS) of the area.

The predicted subsidence parameters have been obtained using the re-calibrated subsidence model presented in Reports Nos. MSEC792 and MSEC865.

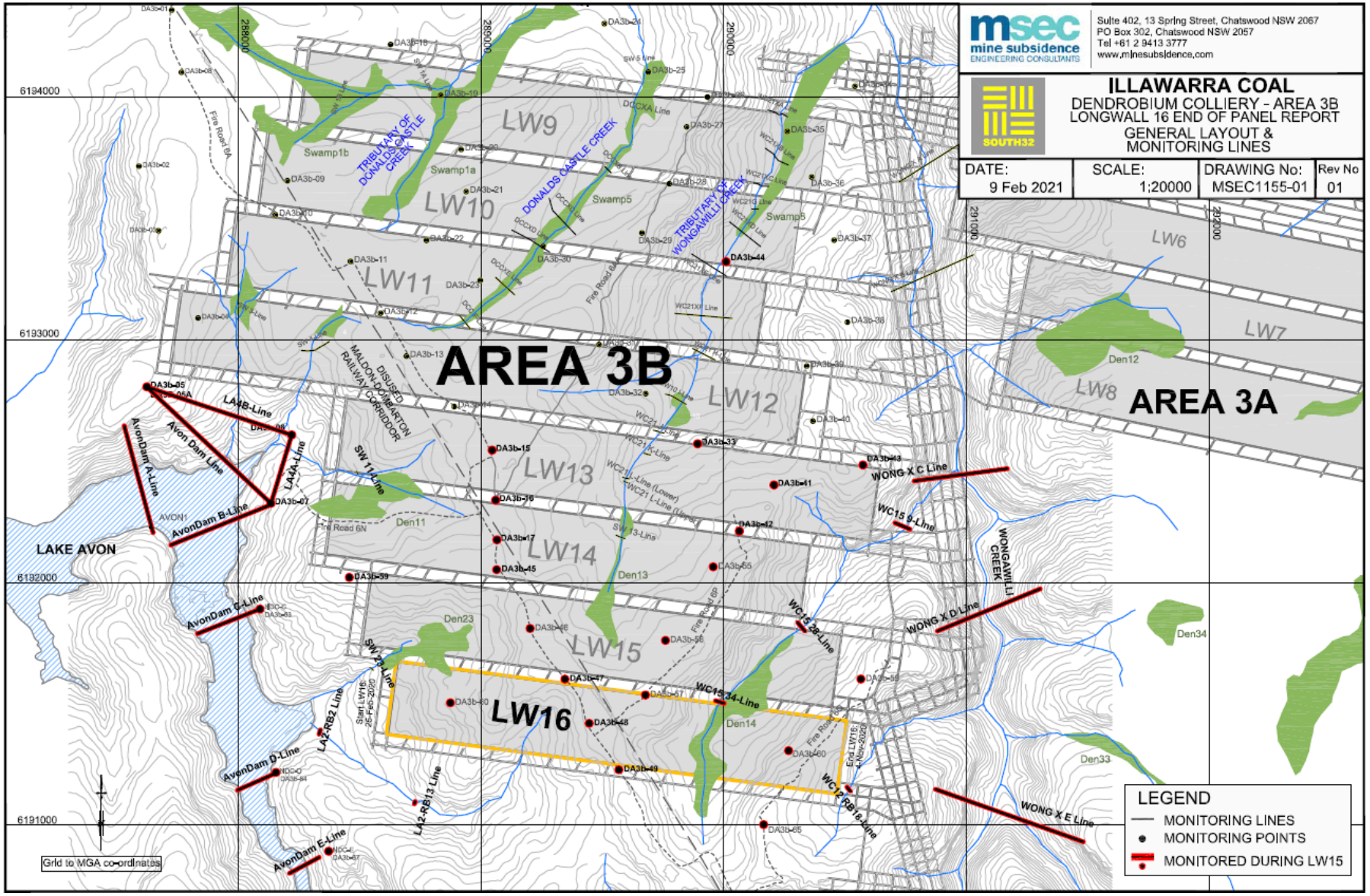

Figure 1: Overview of subsidence monitoring sites, comprised of monitoring lines and monitoring points.

2.1 Wongawilli Creek Closure Lines

The closure movements across Wongawilli Creek have been measured using 2D survey techniques at the Wong X C-Line, Wong X D-Line and the Wong X E-Line. The Wong X A-Line and Wong X B-Line were not required to be measured at the completion of Longwall 16.

The maximum measured total closure at each of the Wongawilli Creek closure lines are similar to or less than the predictions after the completion of Longwall 16 (Figure 2).

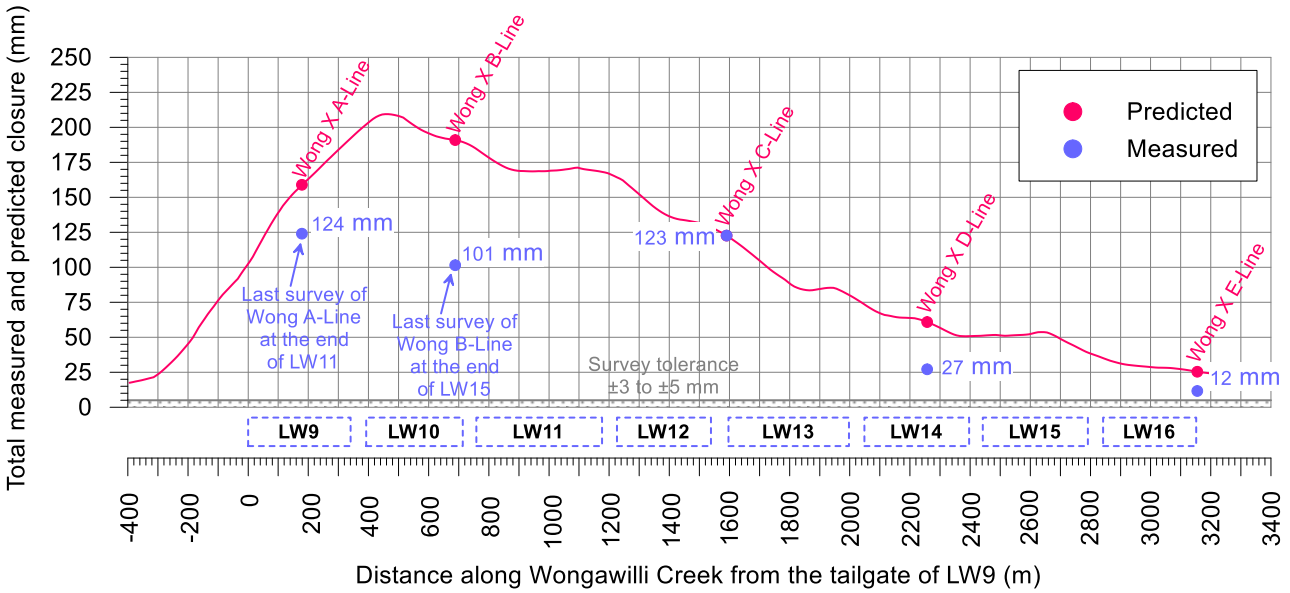

Figure 2: Measured and predicted total closure along Wongawilli Creek after the extraction of Longwall 16. (Source: Attachment B).

2.2 Avon Dam Closure Lines

The baseline surveys of Avon Dam closure lines were carried out prior to the commencement of Longwall 12 (in February 2016) and, therefore, the closure lines have measured the accumulated movements due to the extraction of Longwall 12 through to Longwall 16 only.

The maximum measured total movements at the Avon Dam monitoring lines are similar to or less than the predictions at the completion of Longwall 16. The extraction of Longwall 16 has only resulted in a small decrease in the closure measured at the A-Line and small increases in the openings measured at each of the other monitoring lines (Figure 3).

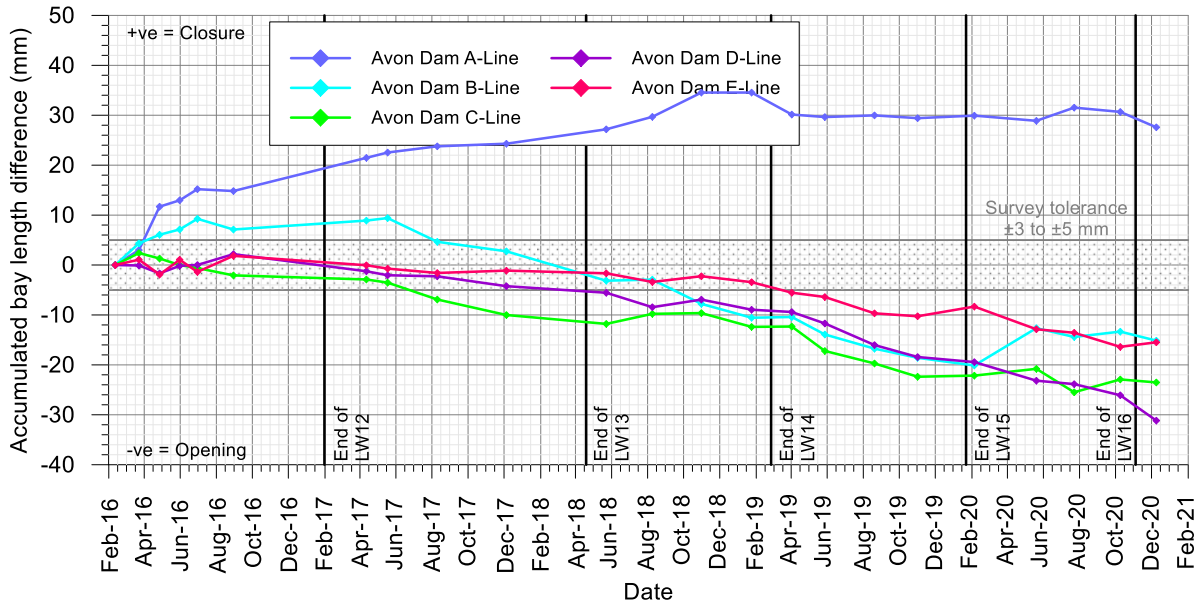

Figure 3: Measured accumulated closure for the Avon Dam closure lines. (Source: Attachment B).

2.3 Wongawilli Creek Tributaries and Avon Dam Tributary Cross Lines

The mine subsidence movements across WC15, a tributary to Wongawilli Creek, have been measured using 2D survey techniques. These monitoring lines were established in December 2018 during the mining of Longwall 14. The subsidence and closure (Figure 4) measured at WC15 RB9-Line, WC15 RB28-Line and WC15 RB34-Line are less than the predicted values.

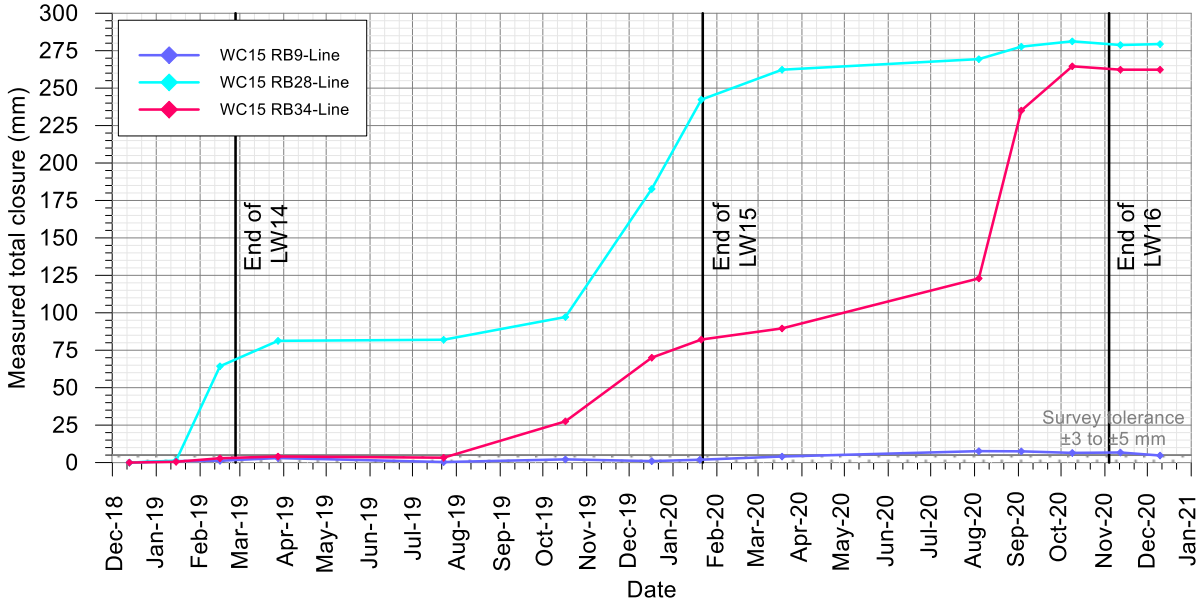

Figure 4: Measured accumulated closure for the WC15 cross lines. (Source: Attachment B).

The mine subsidence movements across WC12, a tributary to Wongawilli Creek, have been measured using 2D survey techniques at the WC12 RB18-Line. The monitoring line was established during the mining of Longwall 15 and, therefore, it does not include the effects of Longwall 9 to Longwall 14 and part of Longwall 15. The subsidence and closure (Figure 5) measured at WC12 RB28-Line are less than the predicted values.

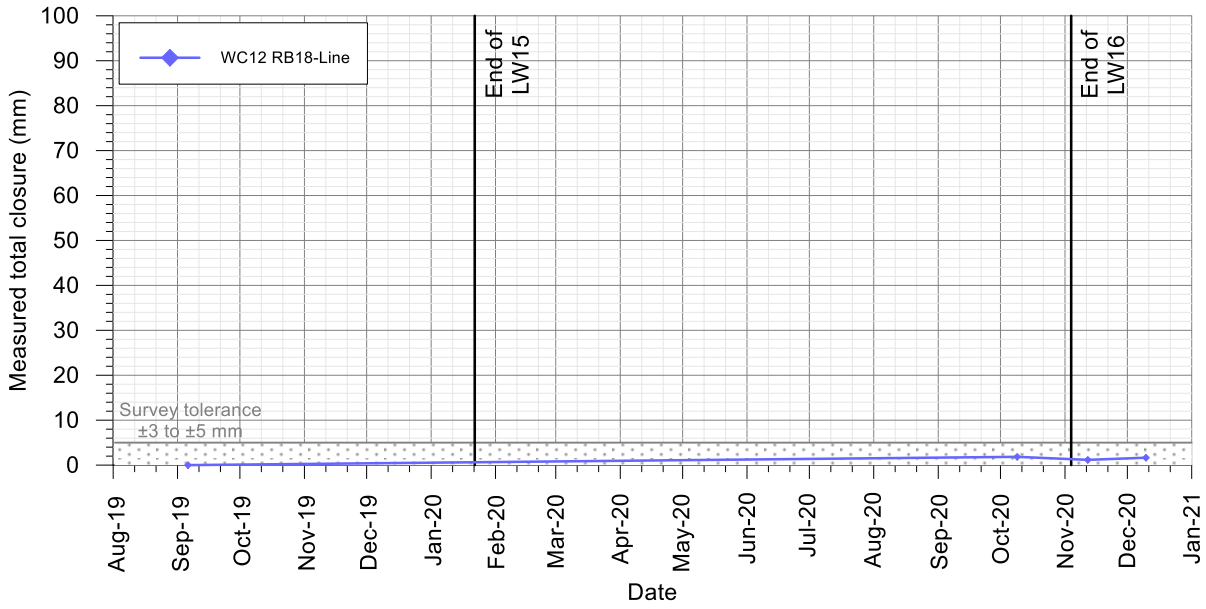

Figure 5: Measured accumulated closure for the WC12 cross line. (Source: Attachment B).

The mine subsidence movements across LA2, a tributary to Lake Avon, have been measured using 2D survey techniques at the LA2 RB2-Line and LA2 RB13-Line. These two monitoring lines were established during the mining of Longwall 15 and, therefore, they do not include the effects of Longwall 9 to Longwall 14 and part of Longwall 15. The subsidence and closure (Figure 6) measured at the LA2 RB2-Line and LA2 RB13-Line are less than the predicted values.

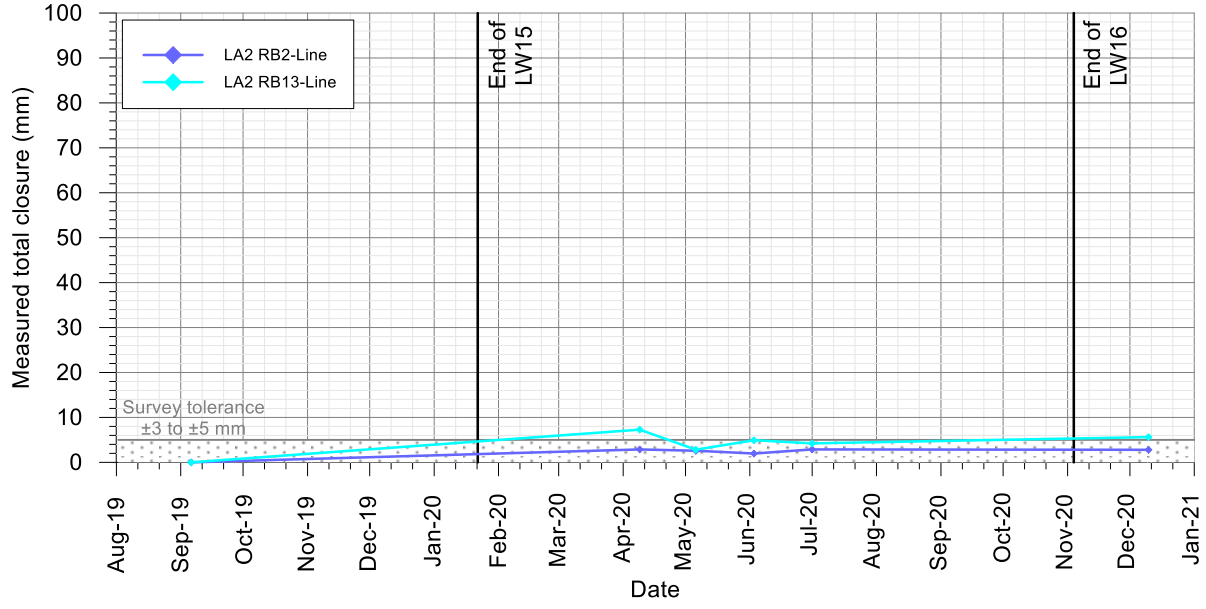

Figure 6: Measured total closure for the LA2 cross lines. (Source: Attachment B).

The closure across Avon Dam and two tributaries to Avon Dam (LA4A and LA4B), were measured using the Avon Dam GPS (Figure 7). The measured total closure at the LA4A monitoring line is less than the predicted value at the completion of Longwall 16. Net opening movements have been measured at the LA4B and Avon monitoring lines due to the conventional subsidence effects being greater that the valley-related effects. The magnitudes of the measured opening movements are less than the magnitudes of the predicted closure movements.

The maximum measured total closure across Lake Avon is less than the maximum predicted value at the completion of Longwall 16. It is considered that the ground movements measured using these monitoring lines are consistent with the predictions.

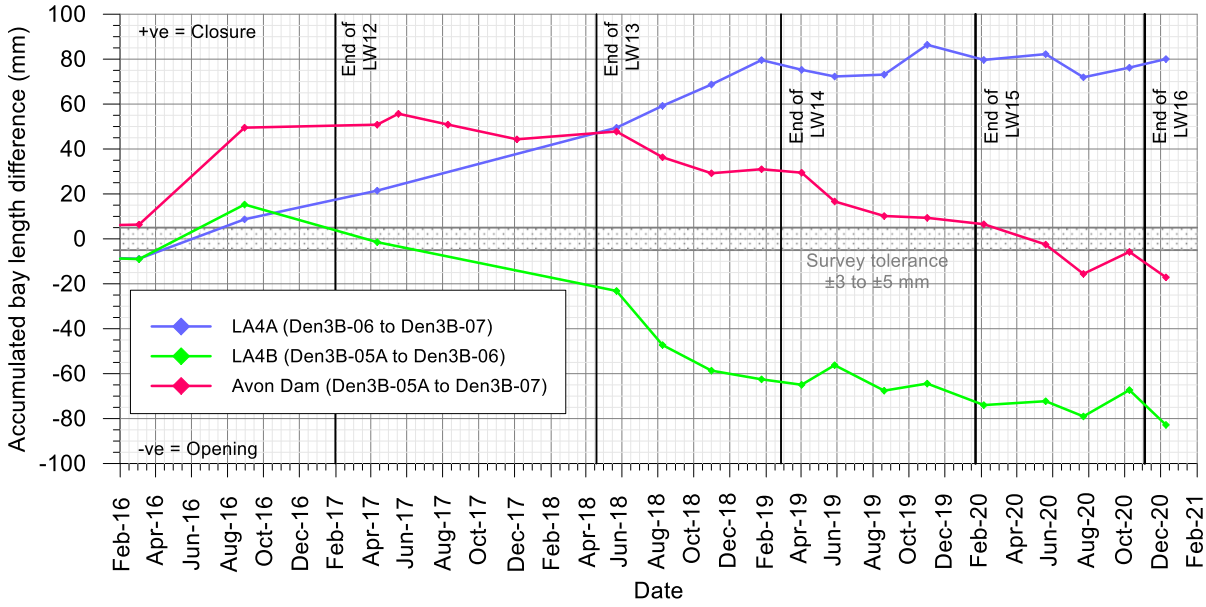

Figure 7: Measured accumulated closure for Tributaries LA4A, LA4B and the Avon Dam. (Source: Attachment B).

2.4 Swamp 23 Cross Line

The mine subsidence movements across swamps 23 have been measured using 2D survey techniques. The remaining swamp cross lines were not measured during Longwall 16. The total closure measured using the SW23-Line is considerably less than the predicted value. The vertical subsidence was not measured at this monitoring line.

2.5 Dendrobium Area 3B 3D and the Avon Dam 3D monitoring points

The far-field horizontal movements near Longwall 16 have been measured using DA3B 3D monitoring points and the Avon Dam 3D monitoring points (Figure 1). The accuracies of the measured absolute positions (i.e. Eastings and Northings) are in the order of ±20 mm.

The vectors of incremental horizontal movement are typically orientated towards Longwall 16 and skewed towards the east, i.e. towards the longwall finishing end, or in the downslope direction (Figure 8). The greatest movements have been measured directly above Longwall 16 and, to lesser extents, above the previously

extracted Longwall 15. Only low level incremental horizontal movements have been measured outside the extents of the mining area.

The comparison between the maximum measured incremental horizontal movements at the DA3B 3D and Avon Dam 3D monitoring points with those previously measured in Dendrobium Area 1 (DA1 3D) and Dendrobium Area 2 (DA2 3D), Dendrobium Area 3A (DA3A 3D), as well as other collieries in the Southern Coalfield, is provided in Figure 9. The mean and the 95 % confidence level for the 3D monitoring data at Dendrobium Mine are also shown in Figure 9.

The measured incremental horizontal movements resulting from the extraction of Longwall 16 are typically within the range of those measured at similar distances from previously extracted longwalls at Dendrobium Mine and elsewhere in the Southern Coalfield (i.e. grey triangles).

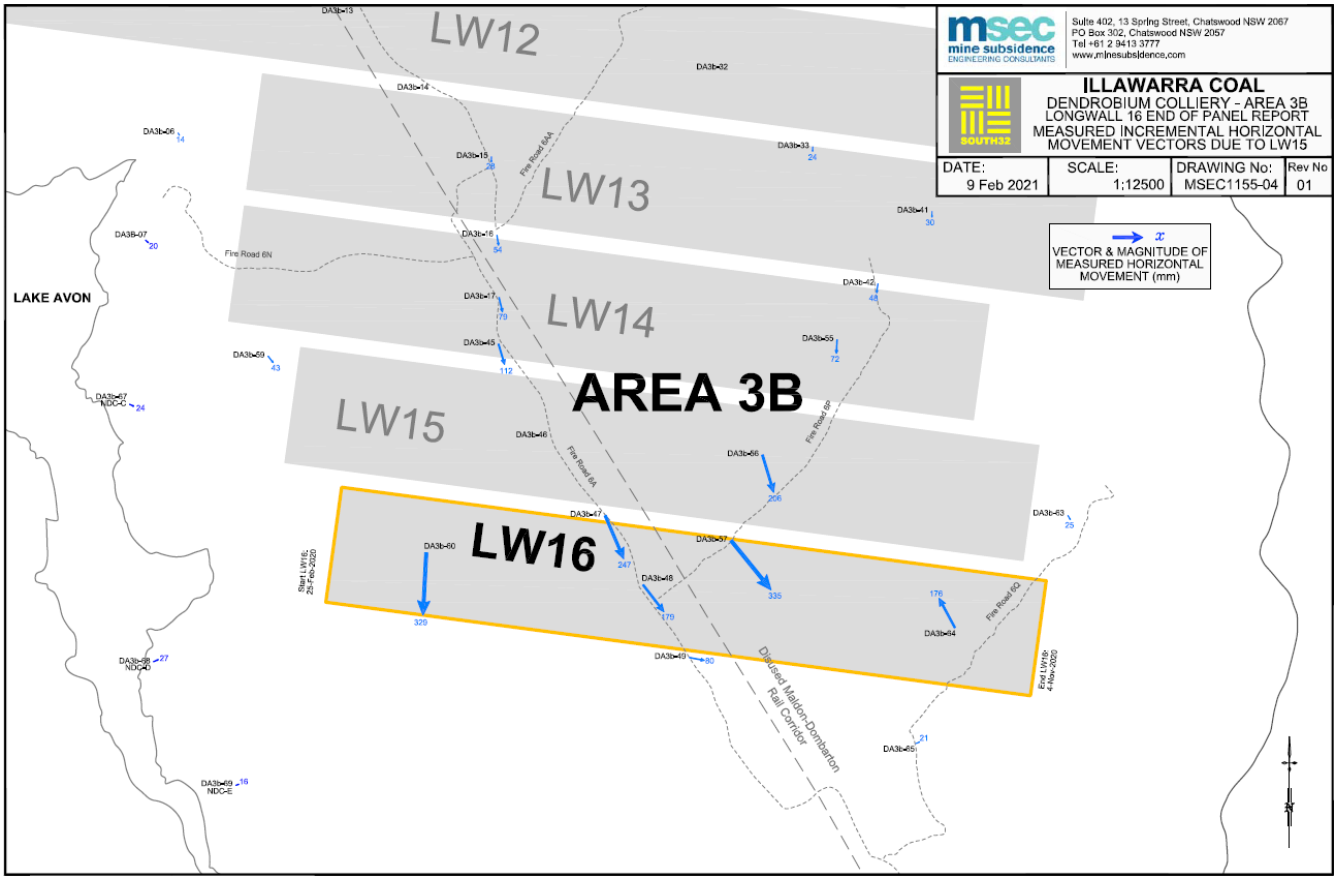

Figure 8: Incremental horizontal movement vectors following the extraction of Longwall 16. (Source: Attachment B).

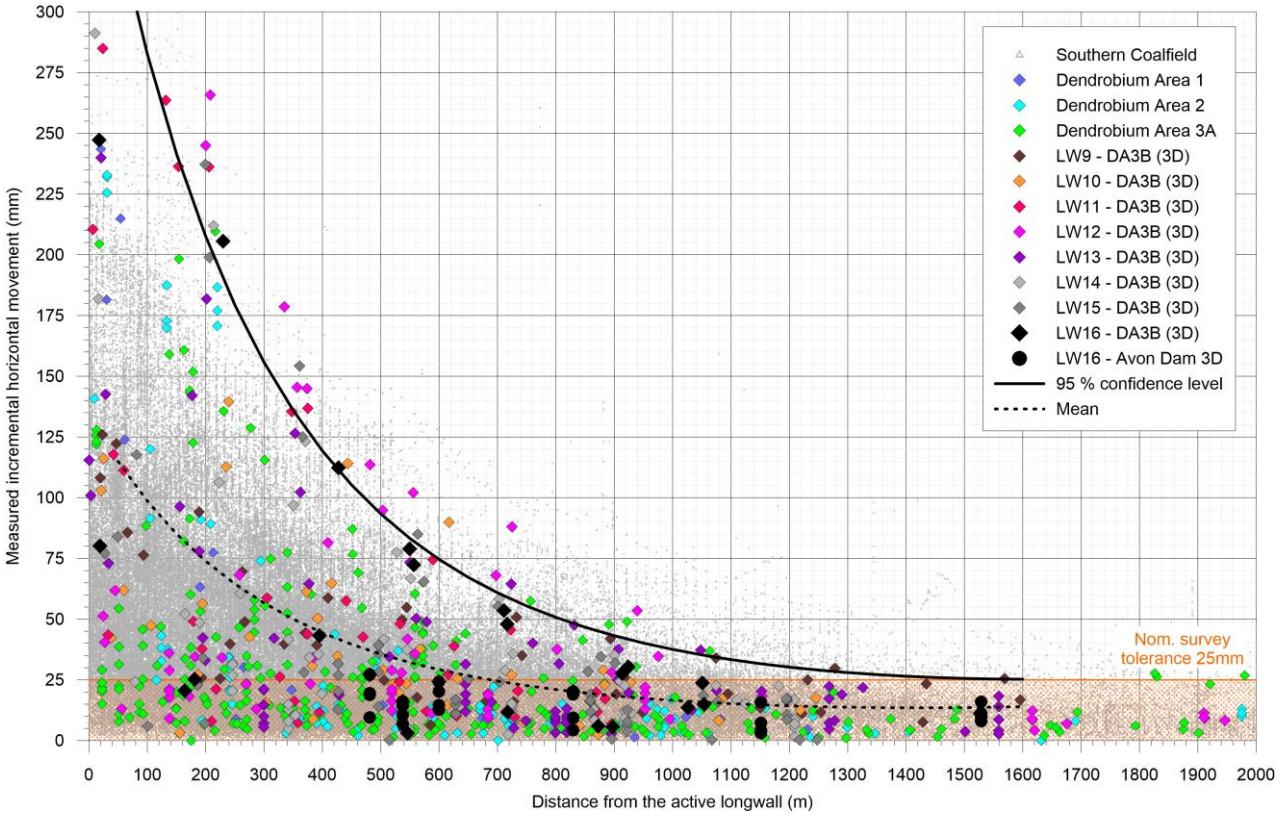

Figure 9: Measured incremental horizontal movements at Dendrobium Mine. (Source: Attachment B).

2.6 Airborne Laser Scanner (ALS) / LiDAR Surveys

The changes in surface level due to the extraction of Longwall 9 to Longwall 16 have been measured using Airborne Laser Scanning (ALS) / Light Detection and Ranging (LiDAR) surveys. The original survey carried out in January 2013 (prior to the extraction of Longwall 9) does not cover the full extent of Longwall 16. Hence, the survey carried out in January 2016 (i.e. prior to the mining of Longwall) has been adopted as the base survey. The post mining surface level contours have been determined from the subsequent surveys carried out after the completion of each longwall. The changes in surface level were determined by calculating the differences between pre-mining surface levels and post-mining surface levels, incrementally (Figure 10), and cumulatively (Figure 11).

The profiles of the measured changes in surface level reasonably match the predicted profiles of vertical subsidence along each of the cross-sections and long-section (Figure 12, Figure 13, Figure 14 and

Figure 15). The maximum measured changes in surface level above each of the longwalls are similar to or less than the maximum predicted values. Also, the measured changes in surface level above each of the chain pillars are similar to or less than the predicted values in these locations.

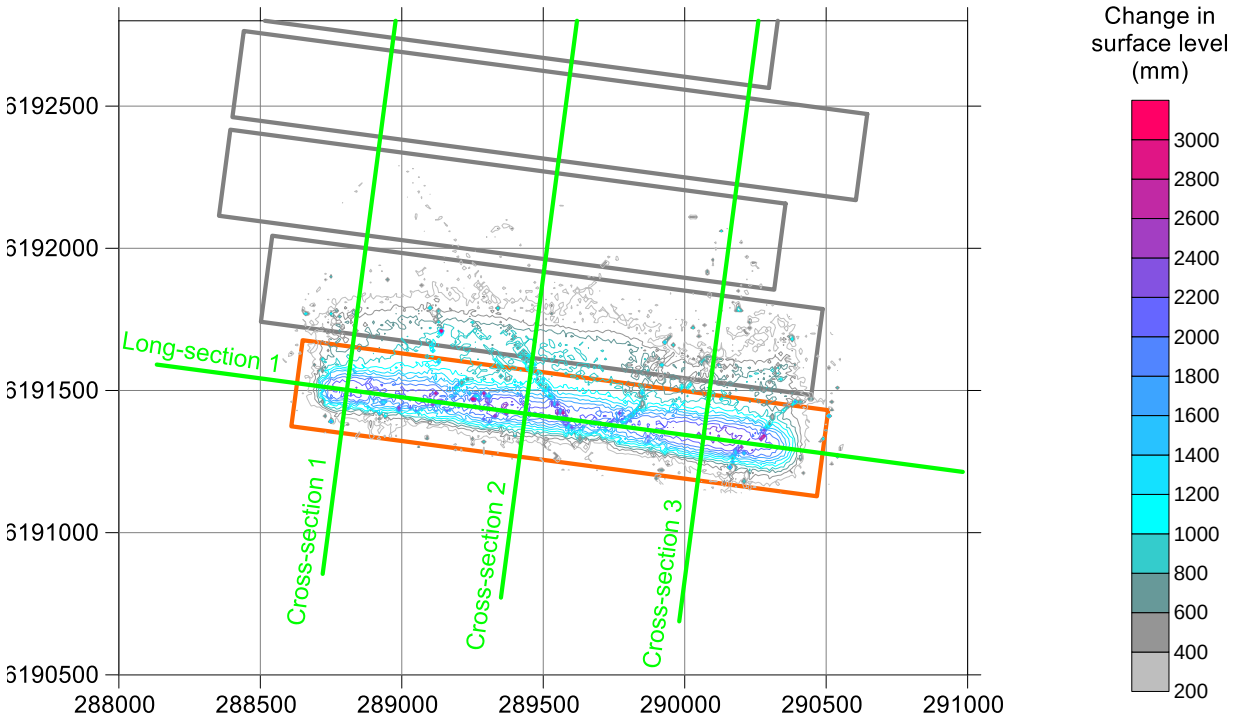

Figure 10: Measured incremental changes in surface level due to the extraction of Longwall 16. (Source: Attachment B).

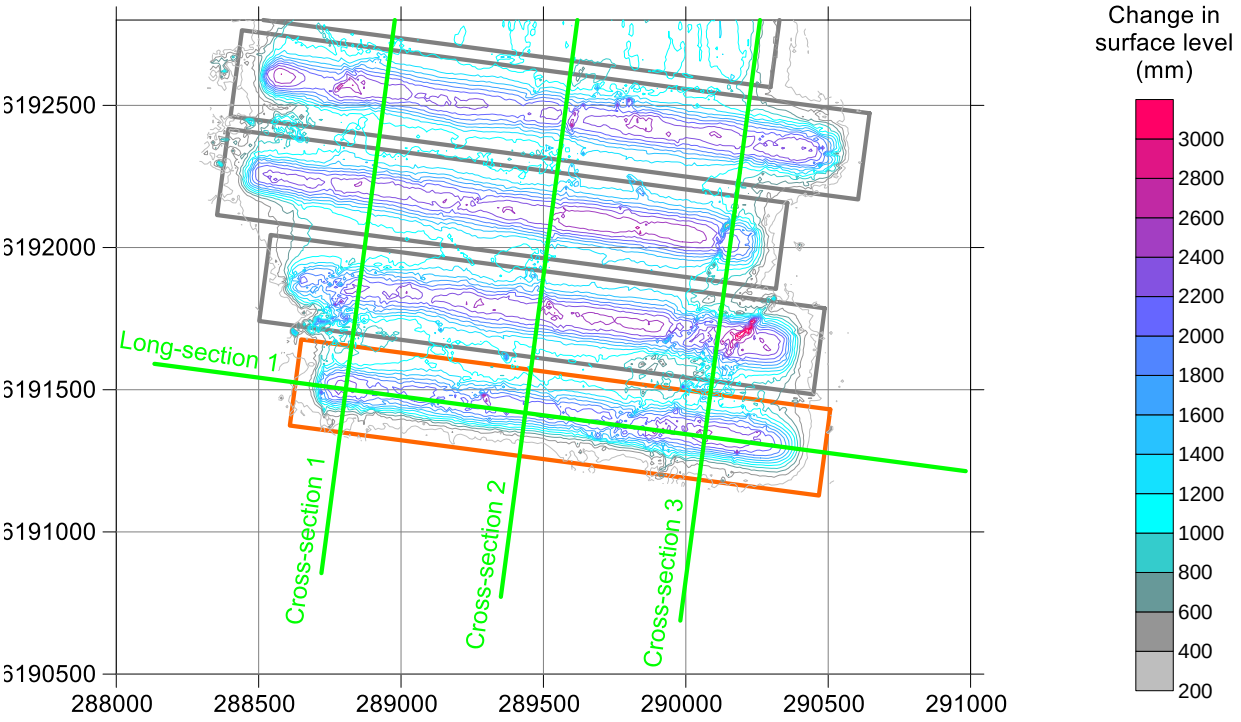

Figure 11: Measured cumulative changes in surface level due to the extraction of DA3B Longwalls. (Source: Attachment B).

The measured change in surface level along Long-section 1 (Figure 15) is greater than the predicted vertical subsidence above the commencing end of Longwall 16 (i.e. left side of figure). However, this may be partly due to the surveying tolerance and the effects of the horizontal movements and sloping terrain on the ALS surveys. The ground directly above the commencing end of Longwall 16 has moved towards the longwall (i.e. following

the extraction face). The natural surface dips towards the west in this location (i.e. towards Avon Dam). The mining-induced horizontal movement, therefore, results in the measured changes in level at a fixed position to be greater than the true vertical subsidence above the commencing end of Longwall 16. There are localised areas outside of the longwalls where the measured changes in surface level exceed the predicted vertical subsidence. However, these are artefacts of the ALS surveys and are not real movements. Elsewhere, the low-level movements are in the order of accuracy of the measurement method. It is considered that the subsidence movements measured using the ALS surveys are consistent with the predicted subsidence movements.

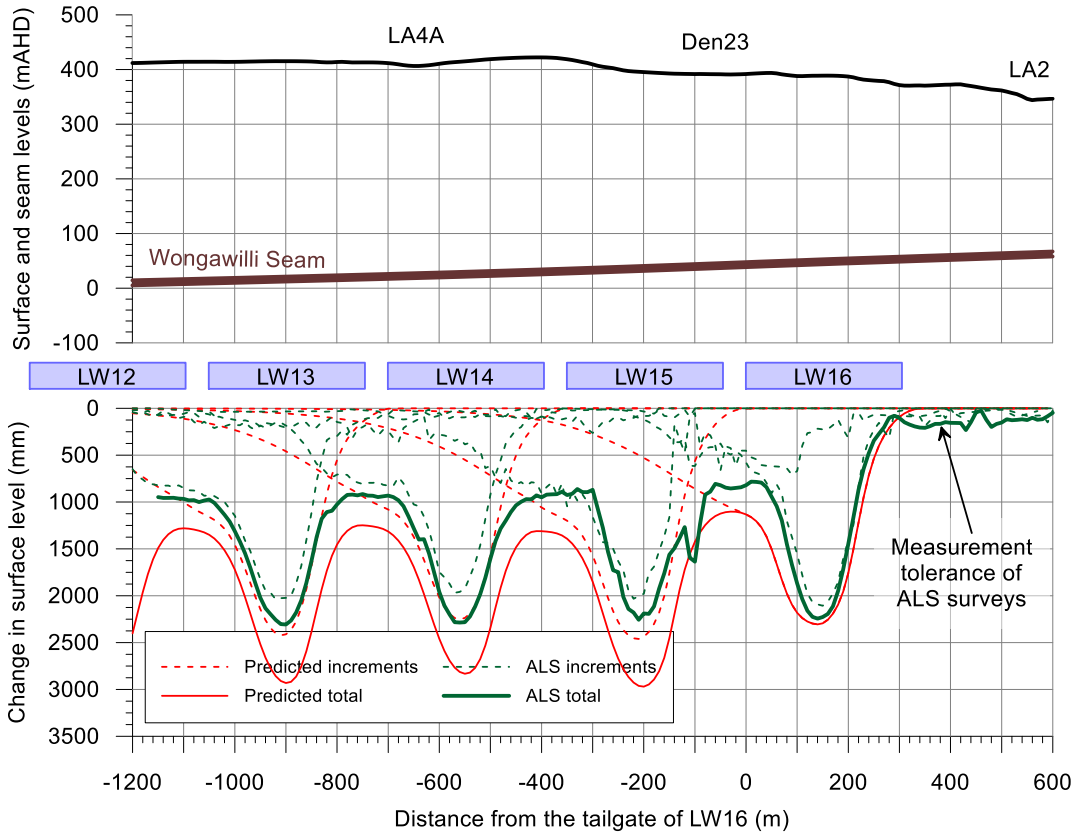

Figure 12: Measured changes in surface level and predicted vertical subsidence along Cross-section 1. (Source: Attachment B).

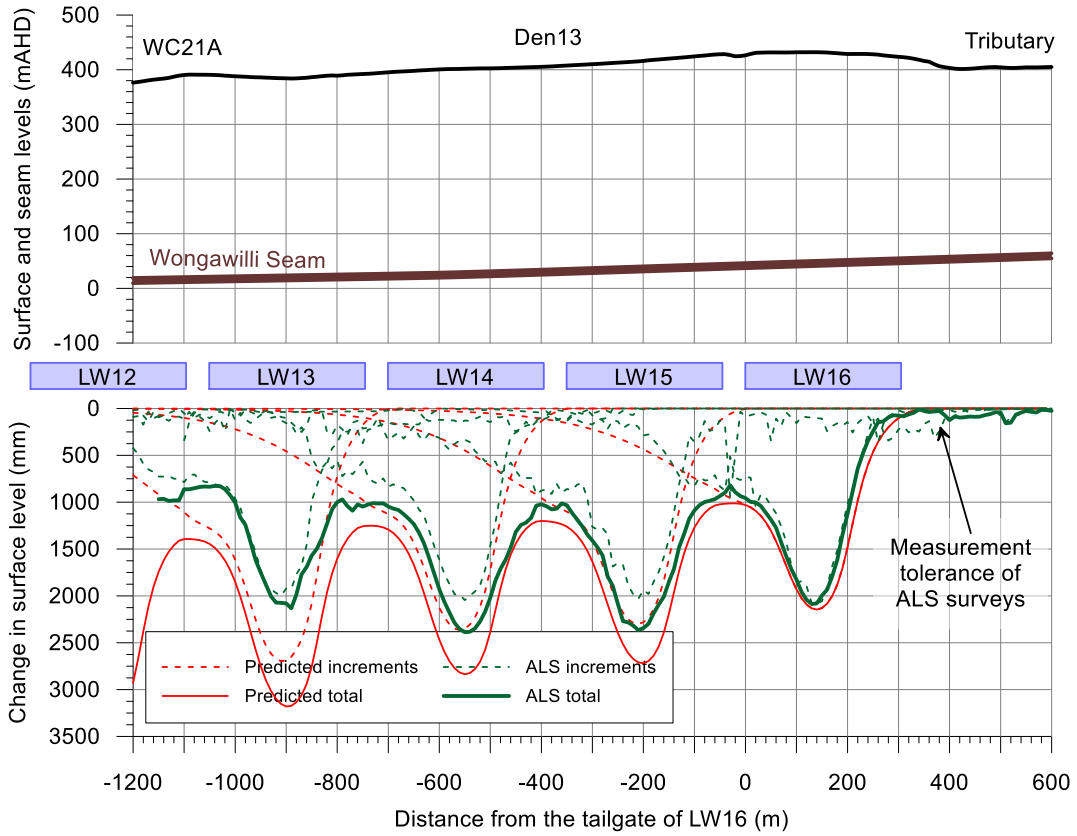

Figure 13: Measured changes in surface level and predicted vertical subsidence along Cross-section 2. (Source: Attachment B).

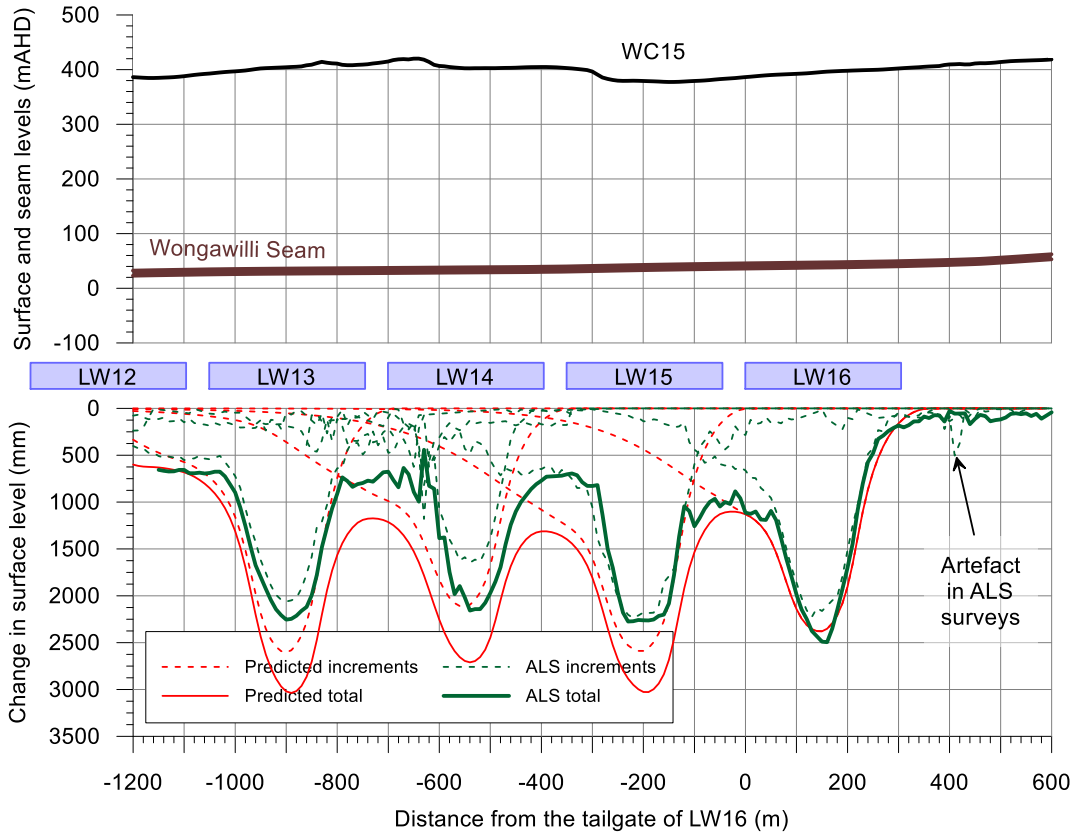

Figure 14: Measured changes in surface level and predicted vertical subsidence along Cross-section 3. (Source: Attachment B).

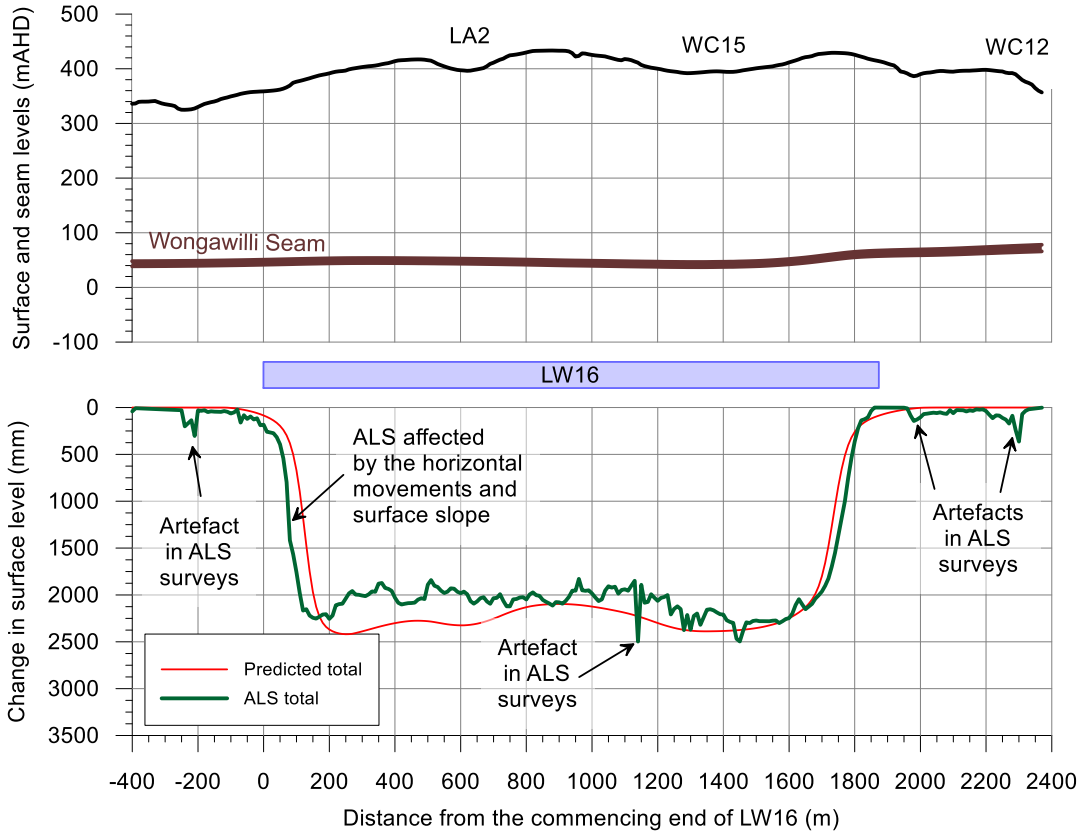

Figure 15: Measured changes in surface level and predicted vertical subsidence along Long section 1. (Source: Attachment B).

3 IMPACTS TO NATURAL FEATURES

During the extraction of Longwall 16, Fifty-two new surface impacts were identified. These impacts are labelled as *DA3B_LW16_001* to *DA3B_LW16_052*. Updates are provided for two existing Longwall 14 impacts; these impacts are labelled as *DA3B_LW14_017 (Update)* and *DA3B_LW14_019 (Update).* Updates are provided for three existing Longwall 15 impacts; these impacts are labelled as *DA3B_LW15_002 (Update)*, *DA3B_LW15_008 (Update)* and *DA3B_LW15_026 (Update).* An update is provided for a Longwall 8 impact, this impact is labelled as *DA3_LW8_158 (Update)*. Other triggers are addressed in their respective sections, with further detail in the attached specialist assessments.

The monitoring program for Longwall 16 was conducted in accordance with the SMP, Watercourse Impact Monitoring Management and Contingency Plan (WIMMCP) and Swamp Impact Monitoring Management and Contingency Plan (SIMMCP). The monitoring program is outlined in Section 6. The results of the IMCEFT monitoring are provided in **Attachment C1**; the impact reports submitted during the extraction of Longwall 16 are provided in **Attachment C2**. The results of monitoring undertaken by specialist consultants are provided in **Attachments D to G**. Figure 18 illustrates the location of surface impacts identified during the extraction of Longwall 16.

3.1 Landscape Features

Subsidence includes vertical and horizontal movement of the land surface, which can result in surface and subsurface cracking, uplifting, buckling, dilation and tilting. These impacts can affect watercourse hydrology and morphology, swamp hydrology and ecological function, and other landscape features by means of surface cracking, which can lead to erosion and rockfalls. Potential mine subsidence impacts within DA3B are discussed in the DA3B SMP, WIMMCP and SIMMCP.

An overview of impacts observed during the extraction of Longwall 16 is provided in the following sections. For specific details on the impacts, refer to the relevant impact reports (**Attachment C2**).

3.1.1 Impacts to First and Second Order Streams

Eight first and second order streams were monitored as part of the Longwall 16 monitoring program; LA2, LA3, LA4A, LA4A1, WC21, WC15, WC15A and WC12. Impacts observed at watercourses during Longwall 16 are described in Table 3, with Photo 1 to Photo 6 showing the impacts recorded.

Table 3: Summary of impacts to first and second order streams.

Site ID	Easting	Northing	Impact Type	Feature Affected	Identification Date	Trigger Level	Description	Refer to Impact Report/s Dated
DA3B_LW16_028 Photo 1	289985	6191502	Rock Fracturing	*WC15*	31/08/2020	2	Rock fracture to rockbar/step above *WC15_Pool 34.*	1/09/2020
DA3B_LW16_030 Photo 2	290215	6191727	Erosion	*WC15*	31/08/2020 & 9/9/2020	1	Localised erosion on tributary *WC15.*	1/09/2020 & 14/09/2020
DA3B_LW16_038 Photo 3	289169	6191319	Iron Staining	*LA2*	14/09/2020	1	Ironing staining present at *LA2_Pool34.*	30/09/2020
DA3B_LW14_017 *(Update)* Photo 4	290276	6191786	Rock Fracturing & Displacement	*WC15*	9/09/2020	2	Additional rock fracturing and displacement on tributary WC15.	14/09/2020
DA3B_LW14_019 *(Update)* Photo 5	290312	6191805	Rock Fracturing, Uplift & Displacement	*WC15*	9/09/2020	2	Additional rock fracturing, uplift and displacement near tributary *WC15*.	14/09/2020
DA3_LW8_158 *(Update)* Photo 6	293300	6192455	Iron Staining	*Sandy Creek*	14/10/2020	2	Increase in iron staining for >2 consecutive months in *Sandy Creek.*	19/10/2020

Photo 1: *DA3B_LW16_028,* rock fracture across rockbar. Taken on 31/08/2020.

Photo 2: *DA3B_LW16_030,* localised erosion observed on tributary *WC15*. Taken on 31/08/2020.

Photo 3: *DA3B_LW16_038*, iron staining at *LA2_Pool 34*, looking upstream. Taken on 14/09/2020.

Photo 4: *DA3B_LW14_017*, looking at the rock fracturing and displacement. Taken on 9/09/2020.

Photo 5: *DA3B_LW14_019*, looking at a section of rock fracturing and uplift. Taken on 9/09/2020.

Photo 6: *SCk_Rockbar 5*, looking upstream at the increase in iron staining. Taken on 14/10/2020**.**

3.1.2 Impacts to Other Landscape Features

Impacts recorded on steep slopes, steps and general landscape features are presented below (Table 4).

Table 4: Summary of Impacts to other landscape features

Site ID	Easting	Northing	Impact Type	Feature Affected	Identification Date	Trigger Level	Description	Refer to Impact Report/s Dated
DA3B_LW16_010 Photo 7	289001	6191423	Rock Fracturing	*Rock Outcrop*	27/04/2020	2	Rock fracturing to rock outcrop between *Lake Avon* and *Fire Road 6A*.	30/04/2020
DA3B_LW16_011 Photo 8	289034	6191253	Rockfall	*Steep Slope/ Step*	27/04/2020	1	Small rock fall at steep slope/step between *Lake Avon* and *Fire Road 6A*.	30/04/2020
DA3B_LW16_012 Photo 9	289001	6191423	Rock Fracturing	*Steep Slope/ Step*	28/04/2020	1	Rock fracturing at a steep slope/step between *Fire Road 6P* and *Swamp 14.*	30/04/2020
DA3B_LW16_015 Photo 10	288719	6191497	Rock Fracturing	*Steep Slope/ Step*	15/05/2020	1	Rock fracturing at a steep slope/step between *Lake Avon* and *Fire Road 6A*.	18/05/2020
DA3B_LW16_016 Photo 11	289183	6191508	Rock Fracturing and Rockfall	*Steep Slope/ Step*	15/05/2020	1	Rock fracturing and rockfall at a steep slope/step between *Lake Avon* and *Fire Road 6A*.	18/05/2020
DA3B_LW16_017 Photo 12	289075	6191396	Rock Fracturing	*Rock Outcrop*	16/06/2020	1	Rock fracturing to outcrop between *Swamp 23* and *LA2.*	19/06/2020
DA3B_LW16_018 Photo 13	289206	6191509	Rock Fracturing	*A3B-SS16*	16/06/2020	1	Rock fracturing to SLMMP site *A3B-SS16*.	19/06/2020
DA3B_LW16_021 Photo 14	289366	6191418	Rock Fracturing	*Steep Slope/ Step*	30/06/2020	2	Rock fracturing to step with small rockfall.	2/07/2020
DA3B_LW16_022 (Update) Photo 15	289564	6191418	Rock Fracturing	*Railway Corridor*	7/07/2020 & 6/08/2020	3	Rock fracturing to cut-through of railway corridor.	10/07/2020 & 10/08/2020

Site ID	Easting	Northing	Impact Type	Feature Affected	Identification Date	Trigger Level	Description	Refer to Impact Report/s Dated
DA3B_LW16_025 Photo 16	289732	6191382	Rock Fracturing	*Steep Slope/ Step*	6/08/2020	1	Rock fracturing to steep slope between *Swamp 14* and *Fire Road 6A.*	10/08/2020
DA3B_LW16_026 Photo 17	289839	6191445	Rock Fracturing	*Steep Slope/ Step*	6/08/2020 & 24/08/2020	1	Rock fracturing to steep slope between *Swamp 14* and *Fire Road 6P.*	10/08/2020 & 27/08/2020
DA3B_LW16_029 Photo 18	290169	6191756	Rockfall	*Steep Slope/ Step*	31/08/2020	1	Rockfall to step on western slope of *WC15* valley.	1/09/2020
DA3B_LW16_031 Photo 19	290041	6191714	Rock Fracturing and Rockfall	*Cliffline*	14/09/2020	1	Rock fracturing on cliff line to the north-west of *WC15.*	30/09/2020
DA3B_LW16_032 Photo 20	290071	6191701	Soil Cracking	*Bushland*	28/09/2020	1	Soil cracking to the north-west of *WC15.*	30/09/2020
DA3B_LW16_035 Photo 21	290172	6191282	Soil Cracking and Displacement	*Steep Slope/ Step*	28/09/2020	1	Soil cracking and displacement near SLMMP site *A3B-SS17.*	30/09/2020
DA3B_LW16_036 Photo 22	290164	6191269	Rock Fracturing	*A3B-SS17*	28/09/2020	1	Rock fracturing to a cliff line at SLMMP site *A3B-SS17*.	30/09/2020
DA3B_LW16_044 Photo 23	290234	6191201	Soil Cracking, Rock Fracturing & Displacement	*Steep Slope*	10/11/2020	2	Soil cracking, rock fracturing and displacement on steep slope east of *Swamp 14.*	16/11/2020
DA3B_LW16_045 Photo 24	290204	6191177	Rock Fracturing	*Steep Slope*	10/11/2020	1	Rock fracturing to a steep slope east of *Swamp 14*.	16/11/2020
DA3B_LW16_046 Photo 25	290173	6191245	Rock Fracturing	*Steep Slope/ Step*	25/11/2020	1	Rock fracture to a steep slope/step east of *Swamp 14.*	27/11/2020
DA3B_LW16_047 Photo 26	290168	6191200	Rock Fracturing	*Steep Slope/ Step*	30/11/2020	1	Rock fracturing to steep slope east of *Swamp 14*.	2/12/2020

Site ID	Easting	Northing	Impact Type	Feature Affected	Identification Date	Trigger Level	Description	Refer to Impact Report/s Dated
DA3B_LW16_048 Photo 27	289783	6191423	Rock Fracturing	Rock Outcrop	30/11/2020	1	Rock fracture to rock outcrop west of Swamp 14.	2/12/2020
DA3B_LW16_049 Photo 28	289755	6191395	Rock Fracturing & Fragmentation	Steep Slope/ Step	30/11/2020	2	Rock fracturing and fragmentation to steep slope west of Swamp 14.	2/12/2020
DA3B_LW16_050 Photo 29	289800	6191455	Rock Fracturing	Steep Slope/ Step	30/11/2020	1	Rock fracture to steep slope west of Swamp 14.	2/12/2020
DA3B_LW16_051 Photo 30	289758	6191471	Rock Fracturing and Soil Cracking	Rock Outcrop & Bushland	30/11/2020	2	Rock fracturing and soil cracking to rock outcrop and bushland west of Swamp 14.	2/12/2020
DA3B_LW16_052 Photo 31	289916	6191759	Soil Cracking	Bushland	1/12/2020	1	Soil cracking in bushland to the west of Swamp 14.	2/12/2020
DA3B_LW15_002 (Update) Photo 32	288651	6191771	Rock Fracturing and Rockfall	Steep Slope/ Step	05/05/2020	1	Rock fracturing and rockfall at step adjacent to Swamp 23.	18/05/2020
DA3B_LW15_026 Update Photo 33	289839	6191445	Rock Fracturing	Steep Slope/ Step	24/08/2020	1	Rock fracturing to steep slope between Swamp 14 and Fire Road 6P.	27/08/2020

Photo 7: *DA3B_LW16_010*, an overview of the rock fracture. Taken on 27/04/2020.

Photo 8: *DA3B_LW16_011*, overview of the rockfall. Taken on 27/04/2020.

Photo 9: *DA3B_LW16_012*, looking at a section of rock fracturing. Taken on 28/04/2020.

Photo 10: *DA3B_LW16_015*, overview of the rock fracturing. Taken on 15/05/2020.

Photo 11: DA3B_LW16_016, overview of the rockfall. Taken on 15/05/2020.

Photo 12: *DA3B_LW16_017*, looking at width of rock fracturing. Taken on 16/06/2020**.**

Photo 13: *DA3B_LW16_018*, looking at a section of rock fracturing. Taken on 16/06/2020.

Photo 14: *DA3B_LW16_021*, looking at fracture on step. Taken on 30/06/2020.

Photo 15: *DA3B_LW16_022,* fracturing down face of cut-through. Taken on 6/08/2020.

Photo 16: *DA3B_LW16_025*, looking at a section of rock fracturing. Taken on 06/08/2020.

Photo 17: *DA3B_LW16_026*, looking at a section of rock fracturing. Taken on 06/08/2020.

Photo 18: *DA3B_LW16_029*, rockfall from step, looking at main large rock fragment. Taken on 31/08/2020.

Photo 19: *DA3B_LW16_031*, looking at the rock fracturing. Taken on 28/09/2020.

Photo 20: *DA3B_LW16_032,* looking at the width of soil cracking. Taken on 28/09/2020.

Photo 21: *DA3B_LW16_035*, looking at a section of displacement. Taken on 28/09/2020.

Photo 22: *DA3B_LW16_036,* looking at a section of rock fracturing. Taken on 28/09/2020.

Photo 23: *DA3B_LW16_044*, looking at width of rock fracturing. Taken on 10/11/2020.

Photo 24: *DA3B_LW16_045*, looking at length of rock fracturing. Taken on 10/11/2020.

Photo 25: *DA3B_LW16_046*, looking at the rock fracture. Taken on 25/11/2020.

Photo 26: *DA3B_LW16_047*, looking at the rock fracture. Taken on 25/11/2020.

Photo 27: *DA3B_LW16_048*, looking at the length of rock fracturing. Taken on 30/11/2020.

Photo 28: *DA3B_LW16_049*, looking at a section of rock fracturing. Taken on 30/11/2020.

Photo 29: *DA3B_LW16_050*, looking at the length of the rock fracture. Taken on 30/11/2020.

Photo 30: DA3B_LW16_051, looking at a section of soil cracking and rock fracturing. Taken on 30/11/2020.

Photo 31: *DA3B_LW16_052*, looking at a section of soil cracking. Taken on 1/12/2020.

Photo 32: *DA3B_LW15_002*, looking at a section of rock fracturing. Taken on 2/12/2020.

Photo 33: *DA3B_LW15_026*, looking at fracture to boulder. Taken on 24/08/2020.

3.2 Surface Water Quality

The monitoring of water quality parameters provides a means of detecting and assessing the effects of streambed fracturing or induction of ferruginous springs. Monitoring includes measurement of field parameters such as pH, EC, DO, oxygen reduction potential (ORP) and a suite of laboratory-tested analytes. At *LA4_S1*, a TARP Level 1 was recorded for DO and TARP Level 2 was recorded for EC and pH (Table 5). At *Donalds Castle Creek (FR6)* a Level 3 TARP trigger was recorded for EC (Table 5).

Table 5: Summary of water quality TARP triggers during the extraction of DA3B Longwalls.

Monitoring Site	Observation	Longwall 16 Water Quality Trigger
Donalds Castle Creek (FR6)	EC	3
LA4_S1	EC	2
	DO	1
	pH	2

Rainfall in 2020 totalled 1436mm, well above the long-term average and the highest rainfall year since the start of mining at Dendrobium. Rainfall was relatively consistent throughout the year with two large events in February and August. The high rainfall in 2020 marks the end of a severe drought period between 2017 and 2019 and has resulted in significant recovery of stream flows, shallow groundwater and soil moisture levels, and improvements in stream water quality.

At many stream monitoring sites including reference sites, water EC declined during 2020 following a period of increased EC during the 2017-2019 drought period. Water EC remained elevated at several locations on Donalds Castle Creek, LA4 and in Sandy Creek tributaries SC10C and SC10. Elevated EC at LA4 and Sandy Creek reflect subsidence impacts on the watercourses, whereas mining effects at Donalds Castle Creek are not clear.

TARP triggers for Donalds Castle Creek relate to the first half of 2020, after which EC levels declined. Elevated EC conditions were observed in the upper tributaries of Donalds Castle Creek during 2018 and 2019. The high EC was accompanied by low DO and elevated sulfate, Zn and Mn compared with baseline concentrations. A longitudinal survey of pools along Donalds Castle Creek has been carried out quarterly since May 2019. The last two surveys (Sept 2020, Jan 2021) show that EC in all pools has returned to within the baseline range as a result of higher rainfall in 2020.

Fracturing of the creek bed near *LA4_S1* associated with previous longwalls resulted in the diversion of flows just upstream of the *LA4_S1* such that sampling was not possible since 2017. Higher rainfall in 2020 resulted in intermittent filling of *LA4_S1.* EC was elevated and pH and DO low compared with baseline, likely as a result of flow diversion through fractures. The water quality in Lake Avon remains unaffected.

On 19/10/2020 iron staining was noted in Sandy Creek tributary SC10C (Level 2 TARP), extending downstream to Sandy Creek. Staining was first reported at SC10C on 11/3/2013, following the extraction of Longwall 8. The recent recurrence of staining at SC10C seven years after the first occurrence is likely the result of recovering groundwater flooding previously drained fractures in the vicinity of SC10C. This is supported by groundwater monitoring data.

Further details are presented in **Attachment D.**

3.3 Surface Water Hydrology

The four surface water hydrology assessment methods are as follows:

(A) General hydrological behaviour compared to Reference Sites,

(B) The frequency and duration of ecologically-significant cease-to-flow events compared with Reference Sites;

(C) Changes to median flow compared with Reference Sites which is now the agreed measure of the water resource availability in each sub-catchment; and

(D) Comparison of qualitative flow data from gauging stations and semi-quantitative field observations by IMCEFT along the "middle reach" of Wongawilli Creek.

Table 6 summarises these surface water hydrology assessments at monitoring sites against the TARPs.

The assessments indicate that sub-catchments in the upper part of the Donalds Castle Creek catchment (i.e. *DC13S1* and *DCS2*) have been and continue to be affected by mining, as is tributary LA4 of Avon Dam (at *LA4S1*) and in the neighbouring tributary LA3. The findings for *DC13S1* and *DCS2* are similar to those for the EoP report for Longwall 15, as presented in Watershed HydroGeo (2019). LA2 has been affected by mining for the first time by Longwall 16.

Similarly, the flow characteristics at *WC21S1* and *WC15S1* within the Wongawilli Creek catchment have altered as a result of mining. The effects at WC21 and WC15 are similar to those for the previous longwall. Despite Longwall 16 terminating within 50 m of WC12, no mining effects are discernible beyond natural variability/method accuracy.

As in recent EoP reports, analysis indicates that mining effects are probable at the Donalds Castle Creek downstream monitoring site (*DCU*). Specifically, the TARP assessments indicate that the general pattern of flow and the median flows do not trigger, which suggest that any mining effects or impacts on those indicators are of similar magnitude or less than natural variability. However, Assessment B, which examines cease-to-flow duration and frequency, indicates that the watercourse at *DCU* has been experiencing a mild increase in the number of cease-to-flow days compared to the Reference Sites.

Changes to stream flow characteristics are not evident at the downstream gauge on Wongawilli Creek Lower (*WWL*), despite mining-related effects being clear and significant at upstream tributaries (e.g. WC21, WC15). This is even more relevant at *DCU*, where the losses identified in upstream sites *DC13S1* and *DCS2* are 40-

60% of median flow at Q50. Such losses should be clearly apparent at *DCU* if they were transmitted downstream, but the assessment has not detected a change in median flow at Q50 beyond natural variability. This suggests that some or all flow lost in headwater catchments is returned downgradient, or that upstream diversions or losses are not significant in relation to the larger catchment water balance given the natural variability and the accuracy of flow measurements.

Analysis of available surface water flow observation records for Wongawilli Creek triggered a Level 2 TARP in February 2020 (the month in which Longwall 16 commenced, although specifically, this occurred two weeks prior to Longwall 16). Assessment D was carried out, and indicated that flow reductions due to mining were in the order of 0.005 to 0.01 ML/d.

Water flow performance measures were met for Longwall 16 (Table 7).

Further details are presented in **Attachment D.**

Table 6 : Summary of Surface Water TARPS for Longwall 16.

Site	Watercourse	Catchment Mined Under	Position of sub-catchment relative to mining	A) Low flow Q%ile outside Reference Site Q%ile	B) Change in cease-to-flow frequency (beyond natural)	C) Change in median flow, Q50 (beyond natural)	Comment
DC13S1	DC13	Yes	Above Longwalls	Level 3	Level 2	Level 3	Effects are similar to those following Longwall 14 and Longwall 15.
DCS2	Donalds Castle Creek	Yes	Above Longwalls	Level 3	Level 3	Level 3	Effects are similar to those following Longwall 14 and Longwall 15.
DCU	Donalds Castle Creek	Yes	Downstream	Not triggered	Level 1	Not triggered	Effects are similar to those following Longwall 14 and Longwall 15. This is consistent with findings from rainfall-runoff model.
WC21S1	WC21	Yes	Above Longwalls	Level 3	Level 2	Level 3	Effects are similar to those following Longwall 14 and Longwall 15.
WC15S1	WC15	Yes	Above Longwalls	Level 3	Not triggered* (Level 1)	Level 3	Effects are similar to those following Longwall 15. * However, changes to low flow accuracy means that Method B not completely reliable. Level 1 is likely.
WC12S1	WC12	Yes	50m adjacent to Longwall 16	Not triggered	Not triggered	Not triggered	First longwall under WC12 catchment. No discernible effect. This is consistent with findings from rainfall-runoff model.
WWL	Wongawilli Creek	Yes	Downstream	Not triggered	Not triggered	Not triggered	Effects are similar to those following Longwall 14 and Longwall 15. Rainfall-runoff model suggests possible small effect, but insufficient to trigger former TARP – in agreement.
WWLA	Wongawilli Creek	Yes	Downstream				No pre-mining baseline record. To be used in future EoP report.
LA4S1	LA4	Yes	Above Longwalls	Level 1	Not triggered* (Level 3)	Level 3	Logger failed, not yet replaced. Effects are similar to those following Longwall 15. *Low flows are reported to greater accuracy in post-mining period, so Method B not treated as completely reliable →Level 3 is likely.
LA3S1	LA3	Yes	Above Longwalls	Level 3	Level 3	Level 3	Effects are similar to those following Longwall 15, however an increase in cease to flow frequency is evident..
LA2S1	LA2	Yes	Headwater	Not triggered	Not triggered	Level 3	Longwall 16 mined beneath upper extent of watercourse
ND1S1	ND1	No	Headwater				To be assessed in future EoP report.

Site Watercourse	Position of sub-catchment relative to mining	D) Surface flow observations		Comment
Wongawilli Creek	Between DA3A and DA3B	February 2020 (Two weeks prior to commencement of Longwall 16)	Level 2	Refer to Performance Measures

Table 7: Summary of surface water Performance Measures for Longwall 16.

Wongawilli Creek – minor environmental consequences	**This Performance Measure is met.**
Donalds Castle Creek – minor environmental consequences	**This Performance Measure is met.**
Avon Dam – negligible reduction in the quantity of surface water inflows to Avon Dam	**This Performance Measure is met.**
Cordeaux River – negligible reduction in the quantity if surface water inflow to the Cordeaux River at its confluence with Wongawilli Creek.	**This Performance Measure is met.**

Further details are presented in **Attachment D.**

3.4 Deep Groundwater Hydrology

Groundwater monitoring at Dendrobium Mine is conducted in accordance with the "Dendrobium Mine Area 3B SMP Groundwater Management Plan" (South32 2012) and the DA3B Subsidence Management Plan (BHP Billiton 2015). The aims of the Groundwater Management Plan are to:

- Monitor groundwater levels and quality, commencing at least one year prior to mining affecting the system;
- Project potential groundwater changes during mining (short term) and post-mining (long term) with particular attention to the effect of changes to groundwater regime, impact on the catchment yield and interaction with the stored waters;
- Identify hydraulic characteristics of overlying and intercepted groundwater systems, and determine changes to groundwater systems due to coal extraction and dewatering operations;
- Report any pumping tests and groundwater/surface water simulation studies; and
- Collect water level data from all agreed groundwater-monitoring locations.

Further details are presented in **Attachment E.**

3.4.1 Mine Water Balance

The System Control and Data Acquisition (SCADA) system calculates a daily Mine Water Balance. The Water Balance is an accurate measure of all water that enters, circulates and leaves the mine, including via air moisture and coal moisture content. Mine water seepage (groundwater inflow), which cannot be directly measured, is determined by mass balance for each goaf and is therefore known to a reasonable accuracy. Key metrics of the Mine Water Balance are reported against TARP levels to Dams Safety NSW fortnightly.

The average daily inflow to DA3B during Longwall 16 extraction was 3.82 ML/day which represents approximately 60 % of total mine inflow for the period (compared with 70% for Longwall 15). Compared with the previous longwall, the total mine inflow increased by 15% whereas the inflow in Area 3B decreased by ~ 5%. As noted in the Groundwater EOP assessment, the mine water balance shows a large peak in groundwater inflow to Area 3B in late November 2020 (~6 ML/day) (Figure 16). The peak resulted from an upgrade of the pump in Area 3B (Tailgate 9), after which excess water stored in Area 3B was pumped down. Underground staff reported no additional groundwater inflow or wetter conditions at the time.

Groundwater ingress to DA3B has increased steadily since the start of mining (2013), initially correlating with the total area mined. However, the rate of increase has declined (flattened) during the mining of Longwalls 12 and 13 and the water balance decreased during the extraction of Longwall 14 and Longwall 15 (Figure 16). This overall trend reflects a declining groundwater inflow per unit area mined due to progressive depressurisation of the surrounding strata by previous mining (a decline in driving head). The decline in groundwater inflow to Area 3B during Longwall 14 and Longwall 15 is likely to be partly due to the unusually dry

conditions during 2018-2019. As of longwall 12, peaks in inflow to Area 3B appear to correlate with periods of high rainfall with a lag time of between two and three months. Prior to Longwall 12, the influence of rainfall on the water balance was less distinct.

The presence of modern water in mine inflow is monitored by analysing tritium. Samples are collected from goaf inflow and development seepage. The results are reported monthly to Dams Safety NSW.

Tritium is an isotope of hydrogen (^{3}H), which decays exponentially according to its half-life (12.32 years) and is typically only detectable in surface water samples and in groundwater that recharged within 4 to 5 half-lives (50 to 70 years). Detection of tritium above deep groundwater baseline levels in mine inflow samples would indicate a component of modern water in the sample (as it does for samples from Area 2). The concentration of tritium in DA3B mine inflow water remains low and consistent with a negligible or minor modern water component. The laboratory processing time for tritium analysis can take 6 to 12 months. The most recent analysis is from a sample collected on 18/11/2019, therefore samples collected during Longwall 16 are pending.

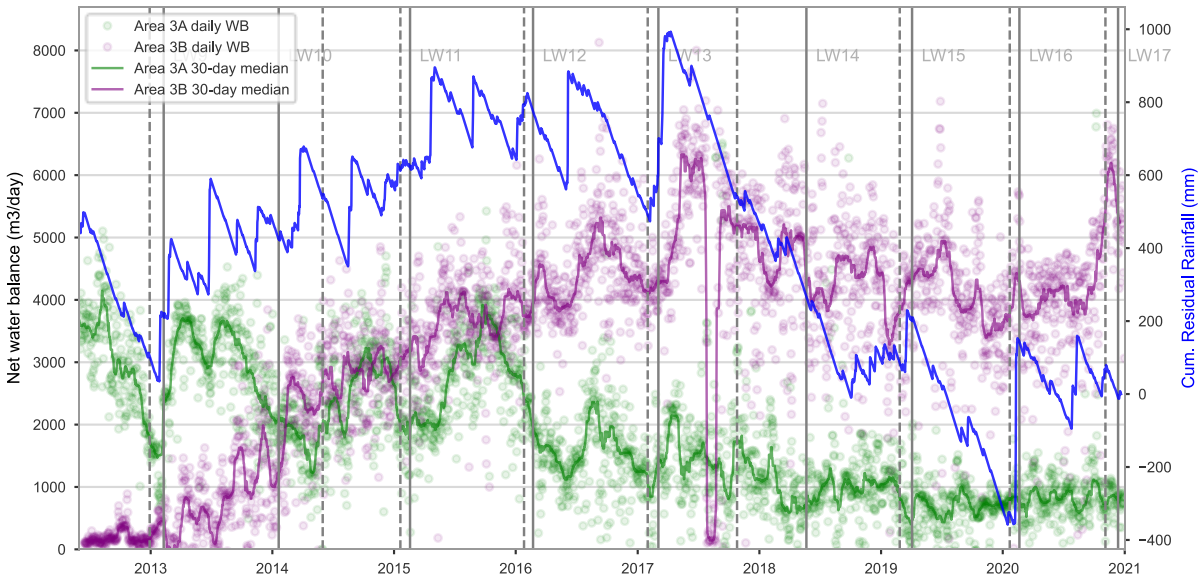

Figure 16: Groundwater inflow to the mine for DA3A and DA3B (kL/d).

3.4.2 Deep Groundwater Levels

Mining of Longwall 16 resulted in continued depressurisation of the target coal seam and overlying strata. The observed changes in groundwater levels are in line with, or less than numerical model predictions that support mining approvals. As expected, the greatest depressurisation is within the Wongawilli Coal Seam, and decreases with height above the seam.

Since 2018, IMC has carried out investigation drilling above extracted longwalls (Longwalls 6, 7, 12, 13, 14, 15 and 16) to characterise the height of fracturing and assess groundwater conditions in strata above the longwall goaf. Investigations to date have found that mining-induced fracturing, including high-angle fracturing is highly variable but appears to extend to the surface in both Dendrobium Area 3A and 3B. Piezometers installed after longwall extraction indicate significant depressurisation throughout all strata, with complete depressurisation

throughout the Hawkesbury Sandstone (HBSS) in most holes. Holes in both areas show positive pressure heads in some sensors in the upper Colo Vale Sandstone (CVSS) and Bald Hill Claystone (BACS) and evidence for localised perching and groundwater recovery above the goaf. However shallow groundwater levels remain below pre-mining levels. Drawdown in the HBSS reduces with distance and is typically negligible at distances greater than 1.2km from the goaf footprint.

Piezometers located to the north and west, and within 1km of the longwall footprint show a gradual decline in groundwater pressures in most strata with the rate of decline increasing with depth and proximity to the longwall. Those observations are consistent with the gradual expansion of a drawdown cone away from the mine and are in line with numerical modelling predictions. The most strongly affected strata are within 500m of extracted longwalls. Piezometers located to the south of the active longwalls in DA3B show more pronounced depressurisation in the mid to deep stratigraphic levels with some strata pressures dropping to zero well in advance of the longwall. It is likely that those piezometers are affected by depressurisation from the Elouera mine to the south, as well as drawdown from Dendrobium, an effect that is predicted from numerical groundwater modelling.

3.4.3 Avon Dam Baseflow Loss

Piezometers installed along the barrier zone between Avon Dam and extracted longwalls in Area 3B show declines in piezometric heads to levels below contemporaneous water levels in Avon Dam. The observed levels imply hydraulic gradients away from the lake and towards the mine adjacent to extracted longwalls. Testing of strata permeability before and after mining of adjacent longwalls indicates that permeability increases by at least an order of magnitude at some locations as a result of strata movement, with minor changes in strata permeability at other locations.

Seepage losses from Avon Dam have been estimated by regional and local scale numerical models to be in the range 0.09 to 0.51 ML/day following the extraction of Longwall 16. The estimates are within the tolerable loss limit of 1 ML/day prescribed by Dams Safety NSW and supported by the declining mine inflow rates to Area 3B during the extraction of Longwall 12-16, adjacent to Avon Dam.

3.4.4 Groundwater Chemistry

Previous reviews have shown that there is no clear spatial pattern in the distribution of groundwater quality in HBSS and Bulgo Sandstone bores. Groundwater salinity (EC) for samples collected from monitoring bores in DA3A and DA3B tends to increase with depth. Not all bores were accessed for sampling during Longwall 16. However, of the samples collected, none recorded EC that was >20% lower than the previous year.

Samples collected from bore *S2377* at depth 113 m reported lower EC during Longwall 15 than the previous longwall. The bore is located adjacent to the Avon Reservoir and follow-up sampling was recommended in the Longwall 15 End of Panel assessment. Sampling during Longwall 16 returned an EC value slightly higher than during Longwall 15.

3.5 Impacts to Upland Swamps

3.5.1 Shallow Groundwater and Soil Moisture

Trigger levels for changes to groundwater and soil moisture levels at surface and near-surface monitoring sites at DA3B swamps have been established within the SIMMCP for Area 3B (South32, 2020a). Shallow groundwater level and soil moisture characteristics have been identified as an indicator of potential changes in ecosystem functionality of Upland Swamps.

Changes to groundwater are reported when measurements of water level drop below baseline levels or when rates of recession exceed those recorded during baseline monitoring. Groundwater level hydrographs for each shallow piezometer are presented in **Attachment D**. Each hydrograph is plotted with ground elevation and the elevation of the piezometer base, longwall timing, groundwater level recession rate (in mm/day), and the dates that longwalls pass under (if relevant) a piezometer. Assessment of mining effects is based on these hydrographs.

The soil moisture TARP has been assessed by comparing the moisture content of the soil profile during the longwall assessment period against that of the baseline period. If the average soil moisture level drops below the minimum level recorded during the baseline period, a TARP is triggered.

Both shallow groundwater levels and soil moisture levels in reference swamps recovered in 2020 following the 2017-2019 drought period.

Longwall 16 mined under and/or passed within 400m of shallow groundwater and soil moisture sites within three swamps: Swamps 13, 14 and 23. It was predicted that these swamps would be affected by mine subsidence due to mining in DA3B (South32 2020c). Soil moisture and shallow groundwater assessments for these swamps are summarised in Table 8 and Table 9.

Trigger levels are assessed differently by the IMCEFT and HGEO. The IMCEFT report triggers when groundwater or moisture decrease below the baseline level during the mining period whilst the HGEO assessment is conducted following the completion of Longwall 16 and considers other factors such as longer-term climatic conditions and reference swamp comparisons.

Further details are presented in **Attachment D.**

Table 8: Summary of soil moisture level TARP status at Longwall 16 impact sites.

Swamp	Sensors and TARP triggers			HGEO Comment	IMCEFT TARP Level	HGEO TARP Level
	Not Triggered	Triggered	Not within mine influence			
13	13_S03	13_S01 13_S02		Revised in 2020 to Tarp level 2 (Previously 3): Soil moisture at all sensors dropped to lowest levels during 2017-2019. Apparent recovery in 2020 at 13_S03. Other sensors record lower moisture levels than baseline.	Level 3 (LW14)	Level 2 (Previously Level 3)
14	14_S02	14_S01		Soil moisture at 14_01 dropped below baseline (except for drought) in 2020 in contrast to recovery at reference swamps. 14_02 shows recovery from drought in 2020. Mining effect at 14_02 possible but not yet clear.	Level 3 (LW15)	Level 2 (Previously Level 3)
23	23_S01 23_S02			Revised in 2020: No TARP trigger (previously Level 2). Both sensors show recovery in 2020 after effects of 2017-2019 drought. Moisture levels in 2020 similar to baseline.	Level 1 (LW14)	No Trigger

Table 9: Summary of shallow groundwater level TARP status at Longwall 16 impact sites and update of Swamp 11 TARP status.

SWAMP	PIEZOMETERS WITH AN OBSERVED RESPONSE			HGEO COMMENT	IMCEFT TARP LEVEL	HGEO TARP LEVEL
	YES	UNCLEAR	NO			
11	11_H1 11_H2 11_H3			All three piezometers show mostly desaturated conditions following the passage of Longwall 14 with only brief periods of saturation following rainfall events.	Level 2	Level 3 (LW14)
14	14_01 14_02			Evidence for impact to swamp groundwater levels at *14_01* and *14_02* following Longwall 16 and Longwall 15 respectively.	Level 3	Level 3
23	23_01	23_02		Evidence for impact to swamp groundwater levels and duration at *23_01* following Longwall 15; Possible effects at *23_02* but unclear as of Longwall 16 end date.	Level 3	Level 2 (LW15)

3.5.2 Erosion in Upland Swamps

The SIMMCP describes the monitoring and assessment to determine any areas of erosion in swamps resulting from mining. Mining induced tilting, cracking, desiccation and/or changes in vegetation health that could result in increased runoff and erosion, which intern could alter water distribution in the swamp. TARPs have been established within the SIMMCP (See Appendix A: Table 19).

Impact assessment of Upland Swamp erosion includes analyses of ALS/LiDAR results, combined with infield observations. ALS results detected no erosion in swamps. Other apparent localised movements were inspected infield with no erosion or subsidence related impacts identified. These apparent localised movements are likely to be due to the effects of the horizontal movements and sloping terrain on the ALS surveys.

3.6 Terrestrial Ecology

The terrestrial ecology assessment for Longwall 16 will be provided at a later date, as approved by DPIE.

3.7 Aquatic Ecology

Cardno was commissioned by South32 to undertake a review of aquatic flora and fauna in relation to the extraction of Longwall 16. Cardno has been undertaking ongoing monitoring of watercourses within the DA3B mining area including Wongawilli Creek, Donalds Castle Creek and several associated tributaries. The overall objective of the monitoring is to determine whether the extent and nature of observed impacts, primarily subsidence-induced fracturing of bedrock, diversion and loss of aquatic habitat, are consistent with the predictions made in the Aquatic Flora and Fauna Assessment (AFFA) (Cardno Ecology Lab 2012) and DA3B SMP (BHPBIC 2012).

The monitoring requirements recommended in the AFFA and included in the SMP incorporates a Before, After, Control, Impact (BACI) sampling design to monitor mine subsidence impacts on the aquatic environment with collection of at least two years of baseline data followed by monitoring during extraction, and at least two years of post-extraction monitoring. The following indicators were monitored at impact and control sites within and outside the SMP area as a measure of aquatic health:

- Aquatic habitat condition - using a modified version of the Riparian, Channel and Environmental Inventory method (Chessman *et al.* 1997);
- Macroinvertebrates, including threatened species of dragonfly (Adams emerald dragonfly and Sydney hawk dragonfly), using AUSRIVAS and standardised artificial collectors;
- Limited in-situ water quality – using a portable probe; and
- Fish abundance using backpack electrofishing and bait traps.

Table 10 compares the predicted impacts against the observed impacts and Table 11 summarises the aquatic ecology assessment against the TARPS.

Further details of the Aquatic Ecology Assessment methodology can be found in **Attachment F.**

Table 10: Summary of predicted and observed impacts to aquatic ecology associated with Longwall 16.

Attribute	Predicted Physical Impacts	Predicted Impacts on Aquatic Ecology	Observed Impacts to Aquatic Ecology
Wongawilli Creek			
Ponding, flooding and scouring of stream banks due to tilt	No significant change predicted.	No measurable effects due to tilt.	None identified by IMCEFT during extraction of Longwall 16.
Fracturing of bedrock and diversion of surface flows	No significant fracturing resulting in surface water flow diversions. Minor, isolated fractures of the streambed may occur within 400m from the proposed Longwalls. Minor fracturing of the creek bed and subsequent diversion of flows would not have significant geochemical effects. Formation of ferruginous springs is unlikely but could occur at the margins or upslope of swamps (Ecoengineers 2011).	No significant changes in the quantity or quality of permanent aquatic habitat due to fracturing of bedrock and diversion of surface flows.	No reductions in pool water levels and flow or changes in water quality observed by South32 during extraction of Longwall 16, and, thus no suggestion of impacts occurring to aquatic habitat and biota.

Attribute	Predicted Physical Impacts	Predicted Impacts on Aquatic Ecology	Observed Impacts to Aquatic Ecology
Donalds Castle Creek and drainage lines (WC15, LA2 and LA4)			
Ponding, flooding and scouring of stream banks due to tilt	Reversals in grade may occur along Tributary WC21, adjacent to the tailgates of Longwalls 10 and 11. These could result in small increases in the levels of ponding, flooding and scouring of stream banks in highly localised areas along the tributaries. The impacts resulting from such changes are expected to be small relative to those that occur naturally during floods.	Localised changes in habitat availability and connectivity may occur along the tributaries due to tilt but will be difficult to detect because of the large variability in natural flows within these ephemeral systems.	No impacts observed due to tilt.
Fracturing of bedrock and diversion of surface flows	Fracturing of the bedrock is likely to occur. In ephemeral creeks with alluvial deposits, fractures are likely to be in-filled by deposits during flow events. In areas with exposed bedrock, some diversion of surface flows into underlying strata and drainage of pools may occur, particularly during low flows. It is unlikely, that this would result in a significant impact on the overall quantity or quality of water flowing from the catchment.	There is unlikely to be any significant long-term changes in the quantity, quality or connectivity of aquatic habitats. Any losses of habitat and connectivity that do occur would be minor, localised and transient.	None observed in Donalds Castle Creek during extraction of Longwall 16. Fracturing of bedrock and diversion of flows in WC15 (a drainage line of Wongawilli Creek) would have resulted in further reduction in quantity and connectivity of ephemeral aquatic habitat in this drainage line. Given the area of affected habitat (10 m x 7 m) and abundance of comparable first and second order stream habitat in the upper Avon and Cordeaux Catchments, associated impacts to aquatic biota would also be expected to be minor. The relatively minor changes in water quality that have been observed in Donalds Castle Creek and LA4 and the appearance of localised iron straining in LA2 are not expected to have significant impacts on aquatic biota.

Table 11: Summary of Aquatic Ecology TARP sites and their respective trigger levels.

TARP	Wongawilli Creek	Donalds Castle Creek
Level 1 – Reduction in aquatic habitat for 1 year	Not triggered	Triggered September 2014
Level 2 – Reduction in aquatic habitat for 2 years following the active subsidence period (i.e. when a longwall within 400m of a feature, such as a creek, is completed)	Not triggered	Triggered 24 October 2015
Level 3 – Reduction in aquatic habitat for >2 years or complete loss of habitat following the active subsidence period	Not triggered	Triggered During 2017 Aquatic Ecology Surveys (Cardno 2018)

3.8 Cultural Heritage

Following the extraction of Longwall 16, an inspection of Aboriginal cultural heritage sites within the Longwall 16 study area (as defined in Niche 2021; **Attachment G**) was conducted on 20 January 2021 (Figure 17). Three out of the six Aboriginal cultural heritage sites located within the Subject Area were visited, with *Dendrobium 7* and *Dendrobium 8* not able to be visited safely due to ongoing Longwall 17 extraction. *Dendrobium 6* consists of an Isolated Artefact and would not be able to be relocated for this assessment. *DM 21* experienced observable impacts from previous subsidence movements related to extraction of Longwall 15 (Niche 2020), however no further impacts to *DM 21* were observed as a result of the extraction of Longwall 16. No impacts were observed at *Browns Road Site 8* or *Upper Avon 35*. Site Inspection assessments for these sites are summarised in Table 12.

In the Aboriginal Heritage Impact Permit (AHIP # 1132005) granted to harm Aboriginal objects located within Dendrobium Underground Mine Area 3B, *DM 21* is identified in Schedule C as a site that can be harmed by extraction related activities, under Section 90 of *The National Parks and Wildlife Act 1974.*

Further details of the methodology and TARPS used by Niche for the Aboriginal Cultural Heritage Assessment can be found in **Attachment G**.

Table 12: Aboriginal cultural heritage sites status following the extraction of Longwall 16.

AHIMS Number	Site Name	Observed Subsidence Related Changes
52-2-1623	Browns Road Site 8	None
52-2-1771	Upper Avon 35	None
52-2-2246	Dendrobium 6	This Isolated Artefact is a surface find that has a negligible chance of impact from subsidence related effects (Biosis 2012). This site was not relocated during this survey and is not expected to be impacted by the extraction of Longwall 16.
52-2-2248	Dendrobium 7	This Shelter with Art was unable to be safely visited for the Longwall 16 EoP monitoring, due to the current extraction of Longwall 17.
52-2-3068	Dendrobium 8	This Shelter with Art was unable to be safely visited for the Longwall 16 EoP monitoring, due to the current extraction of Longwall 17.
52-2-3645	DM21	This Shelter with Art and Deposit site was previously recorded as part of the Longwall 15 End of Panel monitoring program (Niche 2020). During the previous recording, the interior cavern of the shelter had not experienced any direct impacts from subsidence; however, the northern exterior of the shelter was noted to have experienced fracturing as result of subsidence from the extraction of Longwall 15. Four main instances of vertical and diagonal cracking were observed, with the largest crack at the base of the ridgeline measuring 3.7 cm in width (Niche 2020). During the recent monitoring program no observable changes were recorded, and the monitoring point of natural fissuring did not have any further separation in comparison to previous monitoring. The Art Panels had not noticeably faded since the previous monitoring.

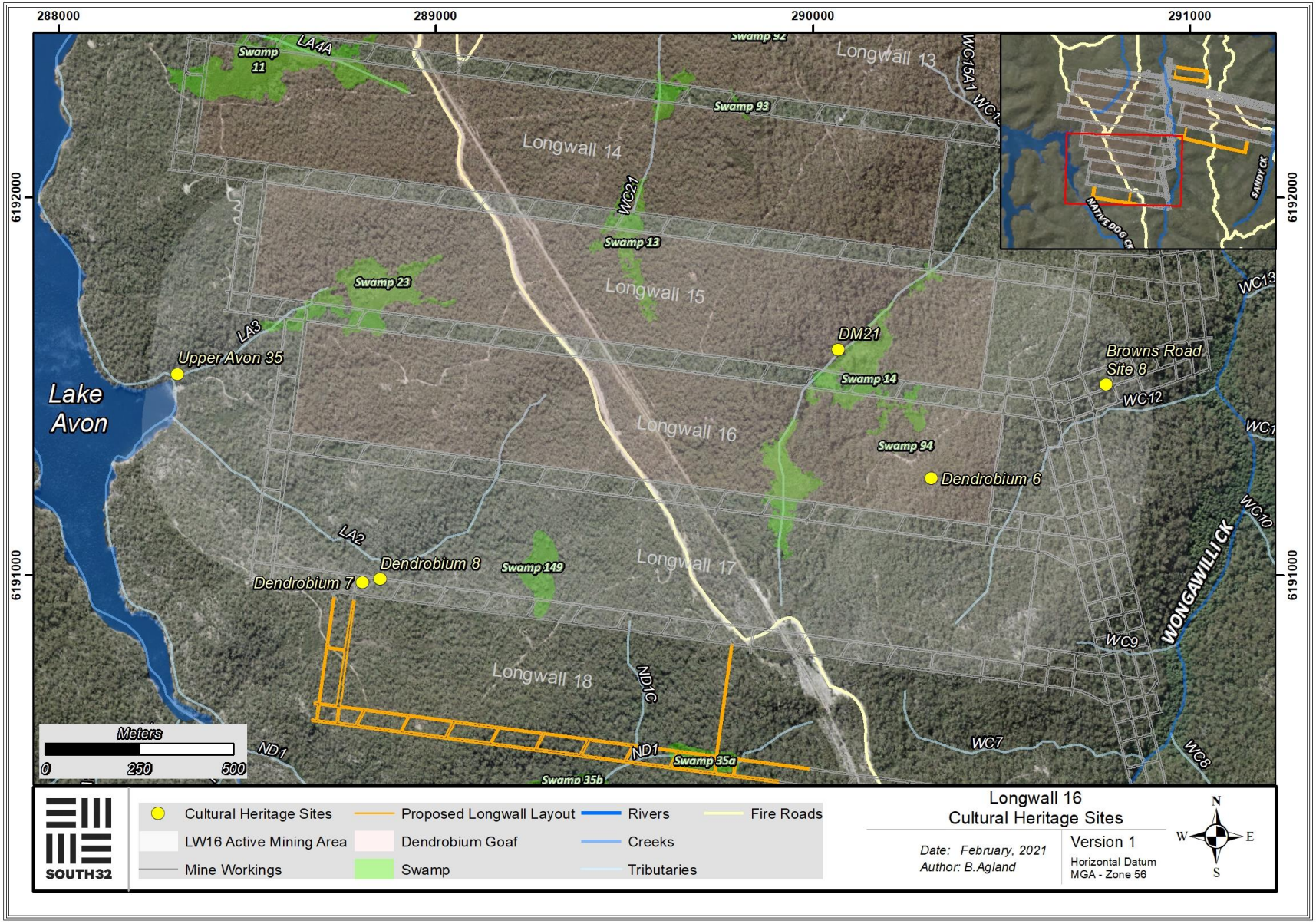

Figure 17: Aboriginal Cultural Heritage sites within the Longwall 16 study area.

4 IMPACTS TO BUILT FEATURES

The built features in proximity to Longwall 16 are shown in **Attachment B**; and include:

- Fire trails and other access tracks;
- Disused Maldon-Dombarton Railway Corridor;
- Survey control marks; and
- Avon Dam.

Cordeaux Dam Wall is located more than 5 km north of Longwall 16, at its closest point. The Upper Cordeaux No.2 Dam Wall is located more than 6 km south-east of Longwall 16, at its closest point. It is unlikely these dam walls would experience any measurable far-field horizontal movements resulting from Longwall 16 and, therefore, they have not been assessed further.

Twenty-four impacts associated with built features were identified during the extraction of Longwall 16 (Table 14 and Table 15). These impacts consist of soil cracks and uplift on seismic trails, Fire Road 6A (FR6A), Fire Road 6P (FR6P) and the disused Maldon Dombarton Railway Corridor. All impacts were either remediated (by means of in-filling) or were observed as self-remediating.

It has been considered that the observed impacts on the surface infrastructure, due to the mining of LW16, are similar to or less than the predicted.

Table 13: Summary of predicted impacts in comparison to observed impacts relevant to Longwall 16.

Built feature	MSEC assessed impacts	Reported impacts
Fire trails and four-wheel drive tracks	Cracking of unsealed road surfaces	Soil / surface cracking observed on or near the fire trails, seismic tracks and railway corridor, with widths ranging between approximately 8mm and 250mm.
Disused Maldon-Dombarton Railway	Possible fracturing of rock cuttings, spalling, and/or mobilisation of rock joints	Surface cracking and rock fracturing along the alignment of the railway corridor above Longwall 16
Avon Dam	Adverse impacts not anticipated	No reported impacts to the dam walls. Refer to associated groundwater report for further details.
Survey control marks	Vertical and horizontal movements which could require re-establishment	No reported damage to the survey control marks. The marks to be re-established after completion of mining, as required.

4.1 Level 1 Surface Cracking

Twenty-one impacts (Photo 34 to Photo 36) to built features were reported as Level 1 impacts in accordance with the DA3B SMP; specifically:

- crack at the surface, which should not result in any significant erosion or further ground movement;
- crack in a fire trail, which should not result in erosion or impede access;
- crack or fracture up to 100mm width;
- crack or fracture up to 10m length; and
- erosion in a localised area, which would be expected to naturally stabilise without CMA and within the period of monitoring.

Table 14: Summary of Level 1 impacts to built features.

Site ID	Easting	Northing	Impact Type	Feature Affected	Identification Date	Trigger Level	Description	Refer to Impact Report/s Dated
DA3B_LW16_001	288780	6191589	Soil Cracking	*Access Track*	16/04/2020	1	Soil cracking on access track between *Lake Avon* and *Fire Road 6A.*	17/04/2020
DA3B_LW16_002	288798	6191599	Soil Cracking	*Access Track*	16/04/2020	1	Soil cracking on access track between *Lake Avon* and *Fire Road 6A.*	17/04/2020
DA3B_LW16_003 (Update) Photo 34	288849	6191590	Soil Cracking & Rock Fracturing	*Access Track*	16/04/2020	1	Soil cracking and rock fracturing on access track between *Lake Avon* and *Fire Road 6A.*	17/04/2020 & 22/04/2020
DA3B_LW16_004	288959	6191517	Rock Fracturing & Soil Cracking	*Access Track*	16/04/2020	1	Rock fracturing and soil cracking on access track between *Lake Avon* and *Fire Road 6A.*	17/04/2020
DA3B_LW16_006	288975	6191508	Soil Cracking	*Access Track*	21/04/2020	1	Soil cracking on access track between *Lake Avon* and *Fire Road 6A.*	22/04/2020
DA3B_LW16_007	288997	6191509	Soil Cracking	*Access Track*	21/04/2020	1	Soil cracking on access track between *Lake Avon* and *Fire Road 6A.*	22/04/2020
DA3B_LW16_008	289034	6191551	Soil Cracking	*Access Track*	27/04/2020	1	Soil cracking on access track between *Lake Avon* and *Fire Road 6A*.	30/04/2020
DA3B_LW16_009	289061	6191483	Soil Cracking	*Closed Access Track*	27/04/2020	1	Soil cracking on rehabilitated seismic track between *Lake Avon* and *Fire Road 6A*.	30/04/2020
DA3B_LW16_014	289141	6191604	Soil Cracking	*Access Track*	12/05/2020	1	Soil cracking on access track between *Lake Avon* and *Fire Road 6A*.	18/05/2020
DA3B_LW16_020	289469	6191376	Soil Cracking	*Fire Road 6A*	30/06/2020	1	Soil cracking across *Fire Road 6A.*	2/07/2020
DA3B_LW16_023	289499	6191327	Soil Cracking	*Fire Road 6A*	7/07/2020	1	Soil cracking across *Fire Road 6A.*	10/07/2020
DA3B_LW16_024	289620	6191348	Rock Fracturing & Soil Cracking	*Access Track*	6/08/2020	1	Rock fracturing and soil cracking to rehabilitated access track between *Swamp 14* and *Fire Road 6A.*	10/08/2020

Site ID	Easting	Northing	Impact Type	Feature Affected	Identification Date	Trigger Level	Description	Refer to Impact Report/s Dated
DA3B_LW16_027 Photo 35	289641	6919508	Soil Cracking	*Fire Road 6P*	21/08/2020	1	Soil cracking to *Fire Road 6P.*	27/08/2020
DA3B_LW16_033	290194	6191325	Soil Cracking	*Access Track*	28/09/2020	1	Soil cracking on an access track parallel to *WC15.*	30/09/2020
DA3B_LW16_034 Photo 36	290144	6191257	Soil Cracking	*Access Track*	28/09/2020	1	Soil cracking on an access track parallel to *WC15.*	30/09/2020
DA3B_LW16_037	290137	6191224	Soil Cracking	*Access Track*	28/09/2020	1	Soil cracking on an access track parallel to *WC15.*	30/09/2020
DA3B_LW16_039	290335	6191371	Soil Cracking	*Access Track*	7/10/2020	1	Soil cracking to access track, east of *Swamp 14.*	12/10/2020
DA3B_LW16_040	290300	6191345	Soil Cracking	*Access Track*	7/10/2020	1	Soil cracking to access track, east of *Swamp 14.*	12/10/2020
DA3B_LW16_041	290275	6191318	Soil Cracking and Displacement	*Access Track*	7/10/2020	1	Soil cracking to access track, east of *Swamp 14.*	12/10/2020
DA3B_LW16_042	290245	6191310	Soil Cracking	*Access Track*	7/10/2020	1	Soil cracking to access track, east of *Swamp 14.*	12/10/2020
DA3B_LW16_043	290443	6191240	Soil Cracking	*Access Track*	7/10/2020	1	Soil cracking to access track, east of *Swamp 14.*	12/10/2020
DA3B_LW15_008 Update	2893221	6191783	Soil Cracking and Uplift	*Fire Road 6A*	12/05/2020	1	Soil cracking and uplift across *Fire Road 6A.*	18/05/2020

Photo 34: *DA3B_LW16_003,* soil cracking and rock fracturing on access track between *Lake Avon* and *FR6A*. Taken on 22/04/2020.

Photo 35: *DA3B_LW16_027*, soil cracking across Fire Road 6P. Taken on 21/08/2020.

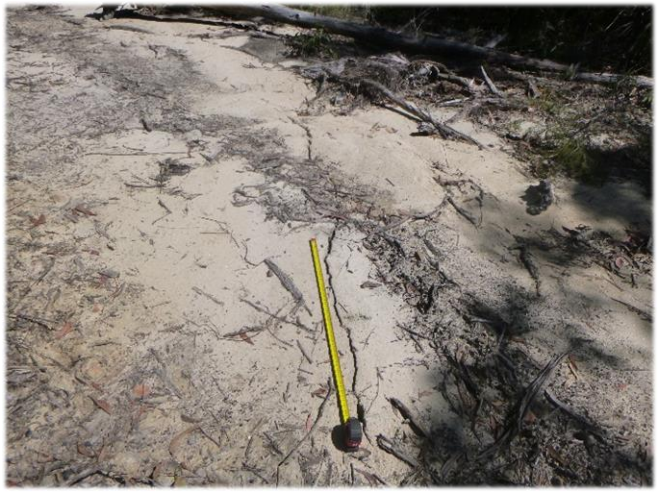

Photo 36: *DA3B_LW16_034*, looking at the length of soil cracking on access track parallel to *WC15*. Taken on 28/09/2020.

4.2 Level 2 Surface Cracking

Three impacts (Photo 37 to Photo 39) to built features were reported as Level 2 impacts in accordance with the DA3B SMP; specifically:

- Crack or fracture between 100mm and 300mm width;
- Crack in the fire trail, which could result in significant erosion or impede vehicle access; and
- Crack or fracture between 10m and 50m length.

Table 15: Summary of Level 2 impacts to built features.

Site ID	Easting	Northing	Impact Type	Feature Affected	Identification Date	Trigger Level	Description	Refer to Impact Report/s Dated
DA3B_LW16_005	288863	6191503	Soil Cracking	*Access Track*	21/04/2020	2	Soil cracking on access track between *Lake Avon* and *Fire Road 6A.*	22/04/2020
DA3B_LW16_013 (Update)	289119	6191571	Soil Cracking	*Access Track*	12/05/2020 & 28/05/2020 & 11/06/2020	2	Soil cracking on access track between *Lake Avon* and *Fire Road 6A*.	18/05/2020 & 29/05/2020 & 19/06/2020
DA3B_LW16_019 (Update)	289436	6191478	Soil Cracking	*Fire Road 6A*	19/06/2020 & 25/06/2020	2	Soil cracking across *Fire Road 6A* (now remediated).	24/06/2020 & 30/06/2020

Photo 37: *DA3B_LW16_005*, soil cracking to access track between *Lake Avon* and *FR6A*. Taken on 22/04/2020.

Photo 38: *DA3B_LW16_013*, soil cracking to access track between *Lake Avon* and *FR6A*. Taken on 12/05/2020.

Photo 39: *DA3B_LW16_019*, looking at length of soil cracking on *FR6A*. Taken on 23/06/2020.

5 SUMMARY OF TARP TRIGGERS

A summary of TARP triggers during the extraction of Longwall 16 is presented below in Table 16; additionally, an overview of Longwall 16 surface impacts and triggers is presented in Figure 18.

Table 16: Summary of TARP Triggers during the extraction of Longwall 16.

Site ID	Impact Type	Feature Affected	Identification Date	Trigger Level	Description	Refer to Impact Report/s Dated
DA3B_LW16_001	Soil Cracking	*Access Track*	16/04/2020	1	Soil cracking on access track between *Lake Avon* and *Fire Road 6A.*	17/04/2020
DA3B_LW16_002	Soil Cracking	*Access Track*	16/04/2020	1	Soil cracking on access track between *Lake Avon* and *Fire Road 6A.*	17/04/2020
DA3B_LW16_003 (Update)	Soil Cracking & Rock Fracturing	*Access Track*	16/04/2020	1	Soil cracking and rock fracturing on access track between *Lake Avon* and *Fire Road 6A.*	17/04/2020 & 22/04/2020
DA3B_LW16_004	Rock Fracturing & Soil Cracking	*Access Track*	16/04/2020	1	Rock fracturing and soil cracking on access track between *Lake Avon* and *Fire Road 6A.*	17/04/2020
DA3B_LW16_005	Soil Cracking	*Access Track*	21/04/2020	2	Soil cracking on access track between *Lake Avon* and *Fire Road 6A.*	22/04/2020
DA3B_LW16_006	Soil Cracking	*Access Track*	21/04/2020	1	Soil cracking on access track between *Lake Avon* and *Fire Road 6A.*	22/04/2020
DA3B_LW16_007	Soil Cracking	*Access Track*	21/04/2020	1	Soil cracking on access track between *Lake Avon* and *Fire Road 6A.*	22/04/2020
DA3B_LW16_008	Soil Cracking	*Access Track*	27/04/2020	1	Soil cracking on access track between *Lake Avon* and *Fire Road 6A*.	30/04/2020
DA3B_LW16_009	Soil Cracking	*Closed Access Track*	27/04/2020	1	Soil cracking on rehabilitated seismic track between *Lake Avon* and *Fire Road 6A*.	30/04/2020
DA3B_LW16_010	Rock Fracturing	*Rock Outcrop*	27/04/2020	2	Rock fracturing to rock outcrop between *Lake Avon* and *Fire Road 6A*.	30/04/2020

Site ID	Impact Type	Feature Affected	Identification Date	Trigger Level	Description	Refer to Impact Report/s Dated
DA3B_LW16_011	Rockfall	*Steep Slope/ Step*	27/04/2020	1	Small rock fall at steep slope/step between *Lake Avon* and *Fire Road 6A*.	30/04/2020
DA3B_LW16_012	Rock Fracturing	*Steep Slope/ Step*	28/04/2020	1	Rock fracturing at a steep slope/step between *Fire Road 6P* and *Swamp 14.*	30/04/2020
DA3B_LW16_013 (Update)	Soil Cracking	*Access Track*	12/05/2020 & 28/05/2020 & 11/06/2020	2	Soil cracking on access track between *Lake Avon* and *Fire Road 6A*.	18/05/2020 & 29/05/2020 & 19/06/2020
DA3B_LW16_014	Soil Cracking	*Access Track*	12/05/2020	1	Soil cracking on access track between *Lake Avon* and *Fire Road 6A*.	18/05/2020
DA3B_LW16_015 (Update)	Rock Fracturing	*Steep Slope/ Step*	15/05/2020	1	Rock fracturing at a steep slope/step between *Lake Avon* and *Fire Road 6A*.	18/05/2020
DA3B_LW16_016	Rock Fracturing and Rockfall	*Steep Slope/ Step*	15/05/2020	1	Rock fracturing and rockfall at a steep slope/step between *Lake Avon* and *Fire Road 6A*.	18/05/2020
DA3B_LW16_017	Rock Fracturing	*Rock Outcrop*	16/06/2020	1	Rock fracturing to outcrop between *Swamp 23* and *LA2.*	19/06/2020
DA3B_LW16_018	Rock Fracturing	*A3B-SS16*	16/06/2020	1	Rock fracturing to SLMMP site *A3B-SS16*.	19/06/2020
DA3B_LW16_019 (Update)	Soil Cracking	*Fire Road 6A*	19/06/2020 & 25/06/2020	2	Soil cracking across *Fire Road 6A* (now remediated).	24/06/2020 & 30/06/2020
DA3B_LW16_020	Soil Cracking	*Fire Road 6A*	30/06/2020	1	Soil cracking across *Fire Road 6A.*	2/07/2020
DA3B_LW16_021	Rock Fracturing	*Steep Slope/ Step*	30/06/2020	2	Rock fracturing to step with small rockfall.	2/07/2020
DA3B_LW16_022 (Update)	Rock Fracturing	*Railway Corridor*	7/07/2020 & 6/08/2020	3	Rock fracturing to cut-through of railway corridor.	10/07/2020 & 10/08/2020
DA3B_LW16_023	Soil Cracking	*Fire Road 6A*	7/07/2020	1	Soil cracking across *Fire Road 6A.*	10/07/2020

Site ID	Impact Type	Feature Affected	Identification Date	Trigger Level	Description	Refer to Impact Report/s Dated
DA3B_LW16_024	Rock Fracturing & Soil Cracking	*Access Track*	6/08/2020	1	Rock fracturing and soil cracking to rehabilitated access track between *Swamp 14* and *Fire Road 6A.*	10/08/2020
DA3B_LW16_025	Rock Fracturing	*Steep Slope/ Step*	6/08/2020	1	Rock fracturing to steep slope between *Swamp 14* and *Fire Road 6A.*	10/08/2020
DA3B_LW16_026 (Update)	Rock Fracturing	*Steep Slope/ Step*	6/08/2020 & 24/08/2020	1	Rock fracturing to steep slope between *Swamp 14* and *Fire Road 6P.*	10/08/2020 & 27/08/2020
DA3B_LW16_027	Soil Cracking	*Fire Road 6P*	21/08/2020	1	Soil cracking to *Fire Road 6P.*	27/08/2020
DA3B_LW16_028	Rock Fracturing	*WC15*	31/08/2020	2	Rock fracture to rockbar/step above *WC15_Pool 34.*	1/09/2020
DA3B_LW16_029	Rockfall	*Steep Slope/ Step*	31/08/2020	1	Rockfall to step on western slope of *WC15* valley.	1/09/2020
DA3B_LW16_030 (Update)	Erosion	*WC15*	31/08/2020 & 9/9/2020	1	Localised erosion on tributary *WC15.*	1/09/2020 & 14/09/2020
DA3B_LW16_031	Rock Fracturing and Rockfall	*Cliffline*	14/09/2020	1	Rock fracturing on cliff line to the north-west of *WC15.*	30/09/2020
DA3B_LW16_032	Soil Cracking	*Bushland*	28/09/2020	1	Soil cracking to the north-west of *WC15.*	30/09/2020
DA3B_LW16_033	Soil Cracking	*Access Track*	28/09/2020	1	Soil cracking on an access track parallel to *WC15.*	30/09/2020
DA3B_LW16_034	Soil Cracking	*Access Track*	28/09/2020	1	Soil cracking on an access track parallel to *WC15.*	30/09/2020
DA3B_LW16_035	Soil Cracking and Displacement	*Steep Slope/ Step*	28/09/2020	1	Soil cracking and displacement near SLMMP site *A3B-SS17.*	30/09/2020
DA3B_LW16_036	Rock Fracturing	*A3B-SS17*	28/09/2020	1	Rock fracturing to a cliff line at SLMMP site *A3B-SS17*.	30/09/2020

Site ID	Impact Type	Feature Affected	Identification Date	Trigger Level	Description	Refer to Impact Report/s Dated
DA3B_LW16_037	Soil Cracking	*Access Track*	28/09/2020	1	Soil cracking on an access track parallel to *WC15.*	30/09/2020
DA3B_LW16_038	Iron Staining	*LA2*	14/09/2020	1	Ironing staining present at *LA2_Pool34.*	30/09/2020
DA3B_LW16_039	Soil Cracking	*Access Track*	7/10/2020	1	Soil cracking to access track, east of *Swamp 14.*	12/10/2020
DA3B_LW16_040	Soil Cracking	*Access Track*	7/10/2020	1	Soil cracking to access track, east of *Swamp 14.*	12/10/2020
DA3B_LW16_041	Soil Cracking and Displacement	*Access Track*	7/10/2020	1	Soil cracking to access track, east of *Swamp 14.*	12/10/2020
DA3B_LW16_042	Soil Cracking	*Access Track*	7/10/2020	1	Soil cracking to access track, east of *Swamp 14.*	12/10/2020
DA3B_LW16_043	Soil Cracking	*Access Track*	7/10/2020	1	Soil cracking to access track, east of *Swamp 14.*	12/10/2020
DA3B_LW16_044	Soil Cracking, Rock Fracturing & Displacement	*Steep Slope*	10/11/2020	2	Soil cracking, rock fracturing and displacement on steep slope east of *Swamp 14.*	16/11/2020
DA3B_LW16_045	Rock Fracturing	*Steep Slope*	10/11/2020	1	Rock fracturing to a steep slope east of *Swamp 14*.	16/11/2020
DA3B_LW16_046	Rock Fracturing	*Steep Slope/ Step*	25/11/2020	1	Rock fracture to a steep slope/step east of *Swamp 14.*	27/11/2020
DA3B_LW16_047	Rock Fracturing	*Steep Slope/ Step*	30/11/2020	1	Rock fracturing to steep slope east of *Swamp 14*.	2/12/2020
DA3B_LW16_048	Rock Fracturing	*Rock Outcrop*	30/11/2020	1	Rock fracture to rock outcrop west of *Swamp 14*.	2/12/2020
DA3B_LW16_049	Rock Fracturing & Fragmentation	*Steep Slope/ Step*	30/11/2020	2	Rock fracturing and fragmentation to steep slope west of *Swamp 14*.	2/12/2020

Site ID	Impact Type	Feature Affected	Identification Date	Trigger Level	Description	Refer to Impact Report/s Dated
DA3B_LW16_050	Rock Fracturing	*Steep Slope/ Step*	30/11/2020	1	Rock fracture to steep slope west of *Swamp 14*.	2/12/2020
DA3B_LW16_051	Rock Fracturing and Soil Cracking	*Rock Outcrop & Bushland*	30/11/2020	2	Rock fracturing and soil cracking to rock outcrop and bushland west of *Swamp 14*.	2/12/2020
DA3B_LW16_052	Soil Cracking	*Bushland*	1/12/2020	1	Soil cracking in bushland to the west of *Swamp 14.*	2/12/2020
DA3B_LW14_017 (Update)	Rock Fracturing & Displacement	*WC15*	9/09/2020	2	Additional rock fracturing and displacement on tributary *WC15.*	14/09/2020
DA3B_LW14_019 (Update)	Rock Fracturing, Uplift & Displacement	*WC15*	9/09/2020	2	Additional rock fracturing, uplift and displacement near tributary *WC15*.	14/09/2020
DA3B_LW15_002 (Update)	Rock Fracturing and Rockfall	*Steep Slope/ Step*	05/05/2020	1	Rock fracturing and rockfall at step adjacent to *Swamp 23.*	18/05/2020
DA3B_LW15_008 Update	Soil Cracking and Uplift	*Fire Road 6A*	12/05/2020	1	Soil cracking and uplift across *Fire Road 6A.*	18/05/2020
DA3B_LW15_026 Update	Rock Fracturing	*Steep Slope/ Step*	24/08/2020	1	Rock fracturing to steep slope between *Swamp 14* and *Fire Road 6P.*	27/08/2020
DA3_LW8_158 (Update)	Iron Staining	*Sandy Creek*	14/10/2020	2	Increase in iron staining for >2 consecutive months in *Sandy Creek.*	19/10/2020
14_01	Shallow Groundwater Trigger	*Swamp 14*	9/09/2020	3	Rate of recession groundwater trigger in *Swamp 14.*	14/09/2020 & 16/11/2020
23_02	Groundwater trigger	*Swamp 23*	27/04/2020	3	Near-surface groundwater trigger in *Swamp 23* (recession rate).	30/04/2020
11_H2	Groundwater Trigger	*Swamp 11*	13/05/2020	2	Near-surface groundwater trigger in *Swamp 11.*	18/05/2020

Site ID	Impact Type	Feature Affected	Identification Date	Trigger Level	Description	Refer to Impact Report/s Dated
Swamp 14 (HGEO)	Shallow Groundwater	Swamp 14	N/A	3	Evidence for impact to swamp groundwater levels at *14_01* and *14_02*.	HGEO (February 2021)
LA4_S1	Water Quality Trigger	*LA4*	3/08/2020	1	Trigger for dissolved oxygen at *LA4_S1.*	5/08/2020
LA4_S1	Water Quality Trigger	*LA4*	3/08/2020 & 1/09/2020	2	Trigger for electrical conductivity at *LA4_S1.*	5/08/20//20 & 14/09/2020
LA4_S1	Water Quality Trigger	*LA4*	3/08/2020 & 1/09/2020	2	Trigger for pH at *LA4_S1.*	5/08/2020 & 14/09/2020
Donalds Castle Creek (FR6) (Update)	Water Quality Trigger	*Donalds Castle Creek*	20/05/2020 & 1/06/2020 & 30/06/2020	3	Trigger for electrical conductivity.	26/05/2020 & 4/06/2020 & 2/07/2020
DCU	Surface Water Hydrology	Donalds Castle Creek	N/A	1	Frequency and duration of ecologically-significant cease-to-flow events.	HGEO (February 2021)
DCS2	Surface Water Hydrology	Donalds Castle Creek	N/A	3	General hydrological behaviour.	HGEO (February 2021)
				3	Frequency and duration of ecologically-significant cease-to-flow events.	
				3	Changes to median flow.	
DC13S1	Surface Water Hydrology	DC13	N/A	3	General hydrological behaviour.	HGEO (February 2021)
				2	Frequency and duration of ecologically-significant cease-to-flow events.	
				3	Changes to median flow.	

Site ID	Impact Type	Feature Affected	Identification Date	Trigger Level	Description	Refer to Impact Report/s Dated
WC21S1	Surface Water Hydrology	WC21	N/A	3	General hydrological behaviour.	HGEO (February 2021)
				2	Frequency and duration of ecologically-significant cease-to-flow events.	
				3	Changes to median flow.	
WC15S1	Surface Water Hydrology	WC15	N/A	3	General hydrological behaviour.	HGEO (February 2021)
				3	Changes to median flow.	
LA4S1	Surface Water Hydrology	LA4	N/A	1	General hydrological behaviour.	HGEO (February 2021)
				3	Changes to median flow.	
LA3S1	Surface Water Hydrology	LA3	N/A	3	General hydrological behaviour.	HGEO (February 2021)
				3	Frequency and duration of ecologically-significant cease-to-flow events.	
				3	Changes to median flow.	
LA2S1	Surface Water Hydrology	LA2	N/A	3	Changes to median flow.	HGEO (February 2021)
Wongawilli Creek	Surface Water Hydrology	Wongawilli Creek	February 2020	2	Surface flow observations.	HGEO (February 2021)
Donalds Castle Creek	Aquatic Ecology	Donalds Castle Creek	N/A	3	Reduction in aquatic habitat for >2 years or complete loss of habitat following the active subsidence period.	Cardno (January 2021)

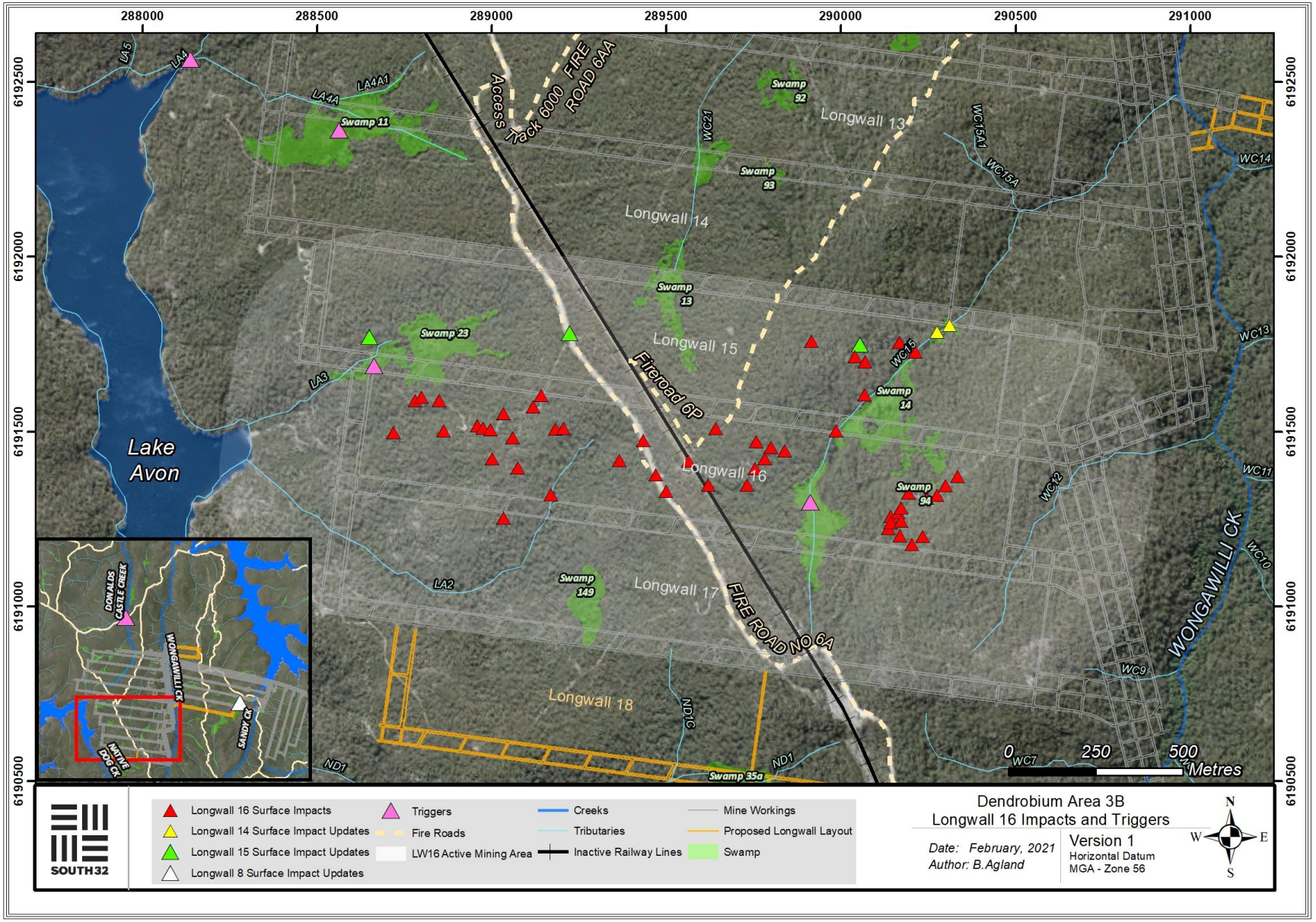

Figure 18: Overview of surface impacts observed during the extraction of Longwall 16.

6 LONGWALL 16 MONITORING PROGRAM

Table 17: Summary of monitoring sites associated with the extraction of Longwall 16. Recommended monitoring sites associated with the extraction of Longwall 17 are also included.

Aspect	Monitoring Sites Associated with Longwall 16	Monitoring Frequency	Recommended Future Monitoring for Longwall 17
Watercourses	**Observational, photo point and water monitoring**		
	• Donalds Castle Creek • Avon Dam • LA2 • LA3 • LA4A • Swamp 23 • Swamps 5, 10, 11, 13 and 14 • WC12, WC15, WC16 and WC21 • Wongawilli Creek • WC6, WC7, WC8, WC9, • ND1 • Swamps 35a and 35b • Native Dog Creek	Monthly 2 years pre and post mining, weekly when longwall is within 400m of monitoring site SLMMP Sites: pre and post mining, monthly when longwall is within 400m of monitoring site	• Donalds Castle Creek • Avon Dam • LA2 • LA3 • LA4A • Swamp 23 • Swamps 10, 11, 13 and 14 • WC12, WC15 and WC21 • Wongawilli Creek • WC6, WC7, WC8, WC9 • Swamp 35a/b • Native Dog Creek • ND1, ND1C
	Water Quality		
	Wongawilli Creek • WWU1 (Wongawilli Creek headwaters) • WWU4 (Wongawilli Creek upstream) • WC_Pool 49 (Wongawilli Creek adjacent to LW15) • WC_Pool 46 (Wongawilli Creek adjacent to LW12) • WWM2 (Wongawilli Creek adjacent to LW11) • WC_Pool 43b (Wongawilli Creek downstream of LW9) • Wongawilli Ck (FR6) (Wongawilli Creek downstream) • WC21_Pool 5 (Wongawilli Creek tributary downstream of mining) • WC21_Pool 30 (Wongawilli Creek tributaries over mining) • WC21_Pool 53 (Wongawilli Creek tributary over mining) • WC12_Pool 1 (Wongawilli Creek tributary downstream of mining) • WC15_Pool 9 (Wongawilli Creek tributary downstream of mining) **Avon Dam** • LA_1, LA1, LA2_Pool 5, LA3_Pool 4	Monthly monitoring during and post mining for two years until required	**Wongawilli Creek** • WWU1 (Wongawilli Creek headwaters) • WWU4 (Wongawilli Creek upstream) • WC_Pool 49 (Wongawilli Creek adjacent to LW15) • WC_Pool 46 (Wongawilli Creek adjacent to LW12) • WWM2 (Wongawilli Creek adjacent to LW11) • WC_Pool 43b (Wongawilli Creek downstream of LW9) • Wongawilli Ck (FR6) (Wongawilli Creek downstream) • WC21_Pool 5 (Wongawilli Creek tributary downstream of mining) • WC21_Pool 30 (Wongawilli Creek tributaries over mining) • WC21_Pool 53 (Wongawilli Creek tributary over mining) • WC12_Pool 1 (Wongawilli Creek tributary downstream of mining) • WC15_Pool 9 (Wongawilli Creek tributary downstream of mining) **Avon Dam** • LA_1, LA1, LA2_Pool 5, LA3_Pool 4

Aspect	Monitoring Sites Associated with Longwall 16	Monitoring Frequency	Recommended Future Monitoring for Longwall 17
	Donalds Castle Creek: • Donalds Castle Ck (FR6) (Donalds Castle Creek lower) • DC_Pool 22 (Donalds Castle Creek downstream of mining) • DCL3 (Donalds Castle Creek further downstream site) **Reference Site** • LC5_S1		**Donalds Castle Creek:** • Donalds Castle Ck (FR6) (Donalds Castle Creek lower) • DC_Pool 22 (Donalds Castle Creek downstream of mining) • DCL3 (Donalds Castle Creek further downstream site) **Native Dog Creek** • NDC_Pool 1 • ND1_Pool 2 • ND2_Pool 3 **Reference Site** • LC5_S1 • NDC1
Swamps	**Observational, Photo Point and Water Monitoring**		
	• Swamps 5, 10, 11 13, 14, 23 and 35a/b	Pre and post mining for two years, monthly when longwall is within 400m of monitoring site.	• Swamps 10, 11, 13, 14, 23 and 35a/b
	Shallow Groundwater Level		
	• Swamp 05: 05_01, 05_02, 05_03, 05_03i, 05_03ii, 05_03iii, 05_04, 05_05, 05_06 • Swamp 10: 10_01 • Swamp 11: S11-H1, S11-H2, S11-H3 • Swamp 13: 13_01 • Swamp 14: 14_01, 14_02 • Swamp 23: 23_01, 23_02 **Reference Sites** • Swamp 2: 02_S01 • Swamp 7: 07_S05, 07_S06 • Swamp 15A: S15a_S01, S15a_Piezo, S15a_S04, S15a_S06 • Swamp 22: 22_01, 22_02 • Swamp 25: S25_S01 • Swamp 33: S33_S01, S33_S03 • Swamp 84: S84_S02 • Swamp 85: S85_S01, S85_S02 • Swamp 86: S86_S01, S86_S02 • Swamp 87: S87_S01, S87_S02 • Swamp 88: S88_S01, S88_S02	For open hole sites: • Monthly monitoring pre, during and post mining for two years to be removed annually • Reference sites 6 monthly For instrumented sites: • Automatic groundwater level monitoring, during and post mining (4 hour interval or similar) • Monitoring post mining for five years to be reviewed annually	• Swamp 05: 05_01, 05_04 • Swamp 10: 10_01 • Swamp 11: S11-H1, S11-H2, S11-H3 • Swamp 13: 13_01 • Swamp 14: 14_01, 14_02 • Swamp 23: 23_01, 23_02 • Swamp 35a: 35a_01 • Swamp 35b: 35b_01 **Reference Sites** • Swamp 2: 02_S01 • Swamp 7: 07_S05, 07_S06 • Swamp 15A: S15a_S01, S15a_Piezo, S15a_S04, S15a_S06 • Swamp 22: 22_01, 22_02 • Swamp 25: S25_S01 • Swamp 33: S33_S01, S33_S03 • Swamp 84: S84_S02 • Swamp 85: S85_S01, S85_S02 • Swamp 86: S86_S01, S86_S02 • Swamp 87: S87_S01, S87_S02 • Swamp 88: S88_S01, S88_S02

Aspect	Monitoring Sites Associated with Longwall 16	Monitoring Frequency	Recommended Future Monitoring for Longwall 17
	Soil Moisture		
	• Swamp 05: S05_S01, S05_S02, S05_S03, S05_S03i, S05_S03ii, S05_S03iii, S05_S04, S05_S05, S05_S08 • Swamp 11: S11_S01, S11_S02, S11_S05 • Swamp 13: S13_S01, S13_S02, S13_S03 • Swamp 14: 14_01, 14_02 • Swamp 23: 23_01, 23_02 **Reference Sites:** • Swamp 2: S02_S01 • Swamp 7: S07_S05, S07_S06 • Swamp 15A: S15a_S01, S15a_Piezo, S15a_S04, S15a_S06 • Swamp 22: 22_01, 22_02 • Swamp 24: S24_S01 • Swamp 25: S25_S01 • Swamp 33: S33_S01, S33_S03 • Swamp 84: S84_S02 • Swamp 85: S85_S01, S85_S02 • Swamp 86: S86_S01, S86_S02 • Swamp 87: S87_S01, S87_S02 • Swamp 88: S88_S01, S88_S02	• 6 monthly baseline and reference site monitoring • Weekly monitoring when longwall is within 400m of swamp • 6 monthly monitoring for 2 years post mining	• Swamp 11: S11_S01, S11_S02, S11_S05 • Swamp 13: S13_S01, S13_S02, S13_S03 • Swamp 14: 14_01, 14_02 • Swamp 23: 23_01, 23_02 • Swamp 35a: 35a_01 • Swamp 35b: 35b_01 **Reference Sites:** • Swamp 2: S02_S01 • Swamp 7: S07_S05, S07_S06 • Swamp 15A: S15a_S01, S15a_Piezo, S15a_S04, S15a_S06 • Swamp 22: 22_01, 22_02 • Swamp 24: S24_S01 • Swamp 25: S25_S01 • Swamp 33: S033_S01, S033_S03 • Swamp 84: S84_S02 • Swamp 85: S85_S01, S85_S02 • Swamp 86: S86_S01, S86_S02 • Swamp 87: S87_S01, S87_S02 • Swamp 88: S88_S01, S88_S02
Landscape	**Targeted Sites**		
	Cliffs No targeted cliff lines associated with Longwall 16 **Fire Trails** Fire Road 6A (across active mining area) Fire Road 6N Fire Road 6P	• Monthly monitoring during any subsidence period • Monitoring to continue 6 monthly for 2 years following the completion of mining	**Cliffs** • DA3-CF25 • DA3-CF26 • DA3-CF41 • DA3-CF42 • DA3-CF43 **Fire Trails** Fire Road 6A (across active mining area) Fire Road 6N Fire Road 6P
	Inspection of Active Mining Area – Landscape Features, Vegetation, Watercourses		
	All mapped cliff, steep slopes, watercourse, swamp and fire trail sites in subsidence area. General observation of active mining areas.	• Weekly monitoring when longwall extraction is within 400m of feature.	Continue monitoring of all mapped cliffs, steep slopes, watercourse, swamp and fire trail sites in subsidence area. Continue general observation of active mining areas.

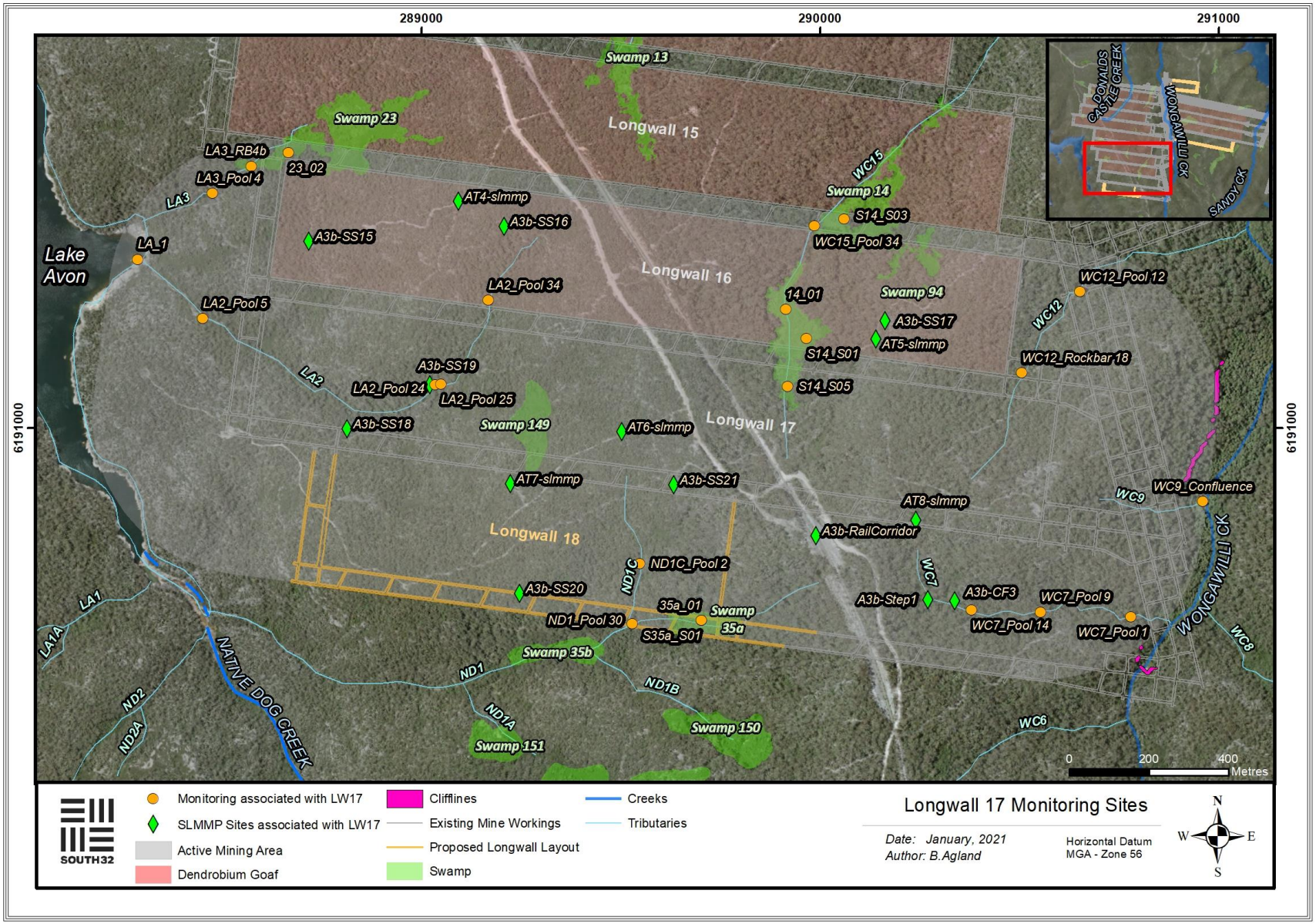

Figure 19: Overview of monitoring sites relevant to Longwall 17 active mining area.

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8 APPENDIX A – IMPACTS, TRIGGERS AND RESPONSE

Table 18: Dendrobium Area 3B Landscape TARPs.

Monitoring	Trigger	Action
LANDSCAPE FEATURES		
AREA 2 **Cliffs** • A2-CL1 (above LW4) **Steep Slopes** • A2-SL1 and A2-SL2 (above LWs 4 & 5) **Watercourses** • A2-WC10 and A2-WC11 (above LW3) • A2-WC13 & A2-WC16 (above LWs 4 & 5) **Swamp** • A2-SW1 (above LWs 4 & 5) **4WD Track** • A2-FT1 (above LWs 4 & 5) **Crinanite Surface Extent** • A2-CN1 & A2-CN2 (above LWs 3 & 4) **AREA 3A**	***Level 1*** * • Rock fall from a cliff which is left mostly intact (<10% length), resulting in insignificant ground disturbance • Surface movement or rock displacement with negligible soil surface exposed • Crack at the surface, which should not result in any significant erosion or further ground movement • Crack in a fire trail which should not result in erosion or impede access • Crack or fracture up to 100mm width • Crack or fracture up to 10m length • Erosion in a localised area which would be expected to naturally stabilise without CMA and within the period of monitoring	• Continue monitoring program • Report impacts to key stakeholders • Summarise impacts and Report in the End of Panel Report and AEMR
	***Level 2 ** • Rock fall or overhang collapse at a cliff site, where characteristics of the cliff have changed, and there has been significant ground disturbance • Surface movement or rock displacement that has exposed significant areas of soil • A crack at the surface, which could result in significant erosion or movement at the surface • A crack at the surface with potential risk to safety and/or fauna entrapment • A crack in the fire trail, which could result in significant erosion or impede vehicle access • Crack or fracture between 100 and 300mm width • Crack or fracture between 10 and 50m length • Significant erosion at any location, which is not likely to naturally stabilise within the period of monitoring, or is located in a sensitive area e.g. swamps, creek, lake shore,	• *Actions as stated for Level 1* • Review monitoring frequency • Notify relevant technical specialists and seek advice on any CMA required • Provide safety signage and barricades as appropriate • Implement approved repairs to ensure safety and serviceability on fire trails • Implement agreed CMAs as approved *Note: CMAs are to be proposed based on appropriate management of environmental and other consequences of impacts i.e. cracking at the surface with insignificant consequences may not require specific CMAs other than ongoing monitoring to confirm there are no ongoing impacts*

Monitoring	Trigger	Action
Cliffs All mapped cliff sites in subsidence area (Refer to Dendrobium Area 3A SMP Figures 19.3 for location of sites) **Steep Slopes** All mapped steep slopes in subsidence area *Refer to Dendrobium Area 3A SMP Figures 19.3 for location of sites* **Watercourses/ Swamps** All mapped watercourse and swamps in subsidence area *Refer to Dendrobium Area 3A SMP Figure 19.3* **Fire Trails** All mapped fire trails in subsidence area *Refer to Dendrobium Area 3A SMP Figure 19.3* **AREA 3B** **Cliffs** All mapped cliff sites in subsidence area *Refer to Dendrobium Area 3B SMP Figures 18.1 for location of sites*	and may result in increased sediment transport to Cordeaux Dam, or has been previously identified as Level 1, but is not likely to naturally stabilise within the monitoring period	
	Level 3 * • Major cliff collapse where the characteristics of the cliff change significantly and there is significant ground disturbance that is unlikely to naturally stabilise within the monitoring period • Crack or fracture over 300mm width • Crack or fracture over 50m length • Mass movement of a slope causing large areas of exposed soil with potential for further movement	• *Actions as stated for Level 2* • Immediately notify DoPI, DPIM, SCA, resource managers and relevant technical specialists and seek advice on any CMA required • Site visits with stakeholders if required • Review monitoring program and modify if necessary within 1 month • Implement increased monitoring if required within 2 weeks • Develop site CMA in consultation with key stakeholders within 1 month, (pending stakeholder availability) and seek approvals • Completion of works following approvals • Issue CMA report within 1 month of works completion • Conduct initial follow up monitoring & reporting within 2 months of CMA completion • Review the relevant TARP and Management Plan in consultation with key stakeholders *Note: CMAs are to be proposed based on appropriate management of environmental and other consequences of impacts i.e. cracking at the surface with insignificant consequences may not require specific CMAs other than ongoing monitoring to confirm there are no ongoing impacts*
Sandy Creek Waterfall	***Exceeding Prediction*** • Rock fall at Sandy Creek Waterfall or from its overhang • Structural integrity of the waterfall, its overhang and its pool are impacted • More than negligible cracking within 30 m of the waterfall • More than negligible diversion of water from the lip of the waterfall	• Actions as stated for Level 3 • Investigate reasons for the exceedance • Update future predictions based on the outcomes of the investigation

Table 19: Dendrobium Area 3B Swamp TARP.

Performance Measures	***Potential Impacts***	***Performance Triggers***	***Management Strategies***	***Offsets***	***Other Actions***
Negligible erosion of the surface of the swamp	Gully erosion or similar	<u>*Level 1:*</u> The increase in length of erosion within a swamp (compared to its pre-mining length) is **2%** of the swamp length or area; and/or Erosion in a localised area (not associated with cracking or fracturing) which would be expected to naturally stabilise without CMA and within the period of monitoring. <u>*Level 2*</u>: The increase in length of erosion within a swamp (compared to its pre-mining length) is **3%** of the swamp length or area; and/or Soil surface crack that causes erosion that is likely to stabilise within the monitoring period without intervention; and/or Gully knickpoint forms or an existing gully knickpoint becomes active. <u>*Level 3:*</u> The increase in length of erosion within a swamp (compared to its pre-mining length) is **4%** of the swamp length or area; and/or Soil surface crack that causes erosion that is unlikely to stabilise within the monitoring period without intervention. <u>*Exceeding Prediction*</u> Mining results in the total length of erosion within a swamp (compared to its pre-mining length) to increase **>5%** of the length or area of the swamp compared to any increase in total erosion length in a reference swamp (ie increase in length or area of erosion in an impact swamp less any increase in length or area in erosion in a reference swamp is **>5%**).	a) upfront mine planning b) erosion monitoring (ie ALS, observation) c) coir logs d) knickpoint control e) water spreading f) weeding g) fire management h) reporting i) investigation and review j) update future predictions	Offset required **immediately**, if no remediation considered practicable. Offset required **2 years** following remediation, if it is ineffective. This period can be extended to **5 years**, with the agreement of the Secretary.	
Minor changes in the size of the swamps **Minor changes** in the ecosystem functionality of the swamps **No significant change** to the composition or	Swamp vegetation changes: - Swamp size - Species richness, distribution, composition and diversity - Vegetation sub-communities	**Swamp Size** <u>*Level 1:*</u> A trending decline in the extent of an upland swamp (combined area of groundwater dependent communities) for two consecutive monitoring periods, greater than observed in the Control Group, and exceeding the standard error (SE) of the Control Group <u>*Level 2:*</u> A trending decline in the extent of an upland swamp (combined area of groundwater dependent communities) for three consecutive monitoring periods, greater than observed in the Control Group, and exceeding the SE of the Control Group.	a) upfront mine planning b) vegetation monitoring c) water spreading d) seeding/planting e) weeding f) fauna monitoring g) fire management h) grouting of controlling of controlling rockbars and	Offset required **immediately**, if no remediation considered practicable. Offset required **5 years** following remediation, if it is ineffective.	Monitoring period for swamp size is related to capture of LiDAR (ALS) data at the end of each longwall ~ 1 year Triggers for groundwater decline result in increased intensity and frequency of

distribution of species within the swamps		*Level 3:* A trending decline in the extent of an upland swamp (combined area of groundwater dependent communities) for four consecutive monitoring periods, greater than observed in the Control Group, and exceeding the SE of the Control Group. *Exceeding Prediction:* Mining results in a trending decline in the extent of an upland swamp (combined area of groundwater dependent communities) for five consecutive monitoring periods, greater than observed in the Control Group, and exceeding the SE of the Control Group. **Ecosystem Functionality** *Level 1:* A trending decline in the extent of any individual groundwater dependent community within a swamp for two consecutive monitoring periods, greater than observed in the Control Group, and exceeding the SE of the Control Group. *Level 2:* A trending decline in the extent of any groundwater dependent community within a swamp for three consecutive monitoring periods, greater than observed in the Control Group, and exceeding the SE of the Control Group. *Level 3:* A trending decline in the extent of any groundwater dependent community within a swamp for four consecutive monitoring periods, greater than observed in the Control Group, and exceeding the SE of the Control Group. *Exceeding Prediction:* Mining results in a trending decline in the extent of a groundwater dependent community within a swamp for five consecutive monitoring periods, greater than observed in the Control Group, and exceeding the SE of the Control Group. **Species Composition and Distribution** *Level 1:* A **2%** (or otherwise statistically significant) decline in species richness or diversity during a period of stability or increase in species richness/diversity in reference swamps for **two** consecutive years; and/or *Level 2:* A **5%** (or otherwise statistically significant) decline in species richness or diversity during a period of stability or increase in species richness/diversity in reference swamps for **three** consecutive years. *Level 3:* An **8%** (or otherwise statistically significant) decline in species richness or diversity during a period of stability or increase in species richness/diversity in reference swamps for **four** consecutive years.	bedrock base and/or use of other remediation techniques i) reporting j) investigation and review k) update future predictions	This period can be extended to **10 years**, with the agreement of the Secretary.	vegetation monitoring

		Exceeding Prediction: Mining results in a **>10%** (or otherwise statistically significant) decline in species richness or diversity during a period of stability or increase in species richness/diversity in reference swamps for **five** consecutive years.			
Maintenance or restoration of the structural integrity of the bedrock base of any significant permanent pool or controlling rockbar within the swamps	Subsidence impacts (ie cracking) on bedrock base or controlling rockbar	*Level 1:* Fracturing observed in the bedrock base of any significant permanent pool which results in observable loss of surface water of **10%** compared to baseline for the pool (in addition to any decrease in reference pools). *Level 2:* Fracturing observed in the bedrock base of any significant permanent pool which results in observable loss of surface water of **20%** compared to baseline for the pool (in addition to any decrease in reference pools). *Level 3:* Fracturing observed in the bedrock base of any significant permanent pool which results in observable loss of surface water of **20%** compared to baseline for the pool for **>20%** of the time over a period of **1** year (in addition to any decrease in reference pools). *Exceeding Prediction* Structural integrity of the bedrock base of any significant permanent pool or controlling rockbar cannot be restored, ie pool water level within the swamp after CMAs continues to be **>20%** lower than baseline for **>20%** of the time over a period of **1** year.	a) upfront mine planning b) subsidence monitoring c) surface water monitoring d) groundwater monitoring e) grouting of controlling of controlling rockbars and bedrock base and/or use of other remediation techniques f) CMAs g) reporting h) investigation and review i) update future predictions	Offset required **immediately**, if no remediation considered practicable. Offset required **2 years** following remediation, if it is ineffective. This period can be extended to **5 years**, with the agreement of the Secretary.	
Minor changes in the ecosystem functionality of the swamps	Falls in surface or near-surface groundwater levels in swamps *NB. Not linked specifically to a PM and would not be considered a breach if predictions were exceeded.*	*Level 1:* Groundwater level lower than baseline level at any monitoring site within a swamp (in comparison to reference swamps); and/or Rate of groundwater level reduction exceeds rate of groundwater level reduction during baseline period at any monitoring site (measured as average mm/day during the recession curve). *Level 2:* Groundwater level lower than baseline level at **50%** of monitoring sites (within 400 m of mining) within a swamp (in comparison to reference swamps); and/or Rate of groundwater level reduction exceeds rate of groundwater level reduction during baseline period at a **50%** of monitoring sites (within 400m of mining) within the swamp.	a) upfront mine planning b) groundwater monitoring c) implementation of swamp research program d) weeding e) fire management f) reporting g) update future predictions		Triggers for groundwater decline result in increased intensity and frequency of vegetation monitoring and/or further investigations of subsidence impacts on bedrock base and rockbars

		Level 3: Groundwater level lower than baseline level at **>80%** of monitoring sites (within 400m of mining) within a swamp (in comparison to reference swamps); and/or Rate of groundwater level reduction exceeds rate of groundwater level reduction during baseline period at **>80%** of monitoring sites (within 400 m of mining) within the swamp.			
Minor changes in the ecosystem functionality of the swamps	Falls in soil moisture levels in swamps *NB. Not linked specifically to a PM and would not be considered a breach if predictions were exceeded.*	*Level 1:* Soil moisture level lower than baseline level at **any** monitoring sites (within 400 m of mining) within a swamp (in comparison to reference swamps). *Level 2:* Soil moisture level lower than baseline level at **50%** of monitoring sites (within 400m of mining) within a swamp (in comparison to reference swamps). *Level 3:* Soil moisture level lower than baseline level at **>80%** of monitoring sites (within 400m of mining) within a swamp (in comparison to reference swamps).	a) upfront mine planning b) soil moisture monitoring c) water spreading d) weeding e) fire management f) reporting g) update future predictions		Triggers of soil moisture decline result in increased intensity and frequency of vegetation monitoring and/or further investigations of subsidence impacts on bedrock base and rockbars

Table 20: Dendrobium Area 3B Watercourse TARP.

Monitoring	Trigger	Action
OBSERVATIONAL, PHOTO POINT AND WATER MONITORING		
Native Dog, Wongawilli and Donalds Castle Creeks, WC21, WC15, LA4, DC13, LA5, ND1, WC6, WC7, WC8, WC9, WC12, WC16 and WC18 General observation of streams in active mining areas when longwall is within 400m •Relevant Performance Measure(s): • Wongawilli Creek - minor environmental consequences • Donalds Castle Creek - minor environmental consequences • Waterfall WC-WF54 – negligible environmental consequences	***Level 1*** * • Crack or fracture up to 100mm width at its widest point with no observable loss of surface water or erosion • Crack or fracture up to 10m length with no observable loss of surface water or erosion • Erosion in a localised area (not associated with cracking or fracturing) which would be expected to naturally stabilise without CMA and within the period of monitoring • Observable release of strata gas at the surface • Observable increase in iron staining within the mining area	• Continue monitoring program • Submit an Impact Report to OEH, DoPE, T&I, Water NSW and other relevant resource managers • Report in the End of Panel Report • Summarise actions and monitoring in AEMR
	***Level 2 ** • Crack or fracture between 100 and 300mm width at its widest point or any fracture which results in observable loss of surface water or erosion • Crack or fracture between 10 and 50m length • Soil surface crack that causes erosion that is likely to stabilise within the monitoring period without intervention • Observable increase in iron staining within the mining area continues to outside the mining area i.e. 400m from the longwall	• *Actions as stated for Level 1* • Review monitoring frequency • Notify relevant technical specialists and seek advice on any CMA required • Implement agreed CMAs as approved (subject to stakeholder feedback)
	***Level 3 ** • Crack or fracture over 300mm width at its widest point • Crack or fracture over 50m length • Fracturing observed in the bedrock base of any significant permanent pool which results in observable loss of surface water • Soil surface crack that causes erosion that is unlikely to stabilise within the monitoring period without intervention • Gas release results in vegetation dieback, mortality or loss of aquatic habitat • Observable increase in iron staining within the mining area continues more than 600m from the longwall	• *Actions as stated for Level 2* • Site visit with OEH, DoPE, T&I, Water NSW and other resource manager/s (if requested) • Implement additional monitoring or increase frequency if required • Develop site CMA (subject to stakeholder feedback). This may include: grouting of rockbar and bedrock base of any significant pool where it is appropriate to do so in consultation with OEH, DoPE, T&I, Water NSW and other stakeholders • Completion of works following approvals and at a time agreed between BHPBIC, DoPE, T&I and Water NSW (i.e. may be after mining induced movements and impacts are complete), including monitoring and reporting on success

Monitoring	Trigger	Action
	•	• Review relevant TARP and Management Plan in consultation with key stakeholders
	Exceeding Prediction • Structural integrity of the bedrock base of any significant pool or controlling rockbar cannot be restored i.e. pool water level within the pool after CMAs continues to be lower than baseline period • Gas release results in vegetation dieback that does not revegetate • Gas release results in mortality of threatened species or ongoing loss of aquatic habitat • Iron staining and associated increases in dissolved iron resulting from the mining is observed in water at Wongawilli Creek downstream monitoring site WONGAWILLI CK (FR6) • Iron staining and associated increases in dissolved iron resulting from the mining is observed in water at the Donalds Castle Creek downstream monitoring site Donalds Castle Ck (FR6) • Rock fall at WC-WF54 or its overhang • Impacts on the structural integrity of WC-WF54, its overhang or its pool	• *Actions as stated for Level 3* • Investigate reasons for the exceedance • Update future predictions based on the outcomes of the investigation • Provide residual environmental offset for any mining impact where CMAs are unsuccessful as required by Condition 14 Schedule 3 of the Development Consent
•WATER QUALITY		
Wongawilli Creek Wongawilli Ck (FR6) Baseline means: • pH 5.98 • EC 98.8 uS/cm • DO 89.5% •Relevant Performance Measure(s): • Wongawilli Creek - minor environmental consequences	***Level 1*** * • One exceedance of the ±3 standard deviation level (positive for EC, negative for pH and DO) from the baseline mean during the monitoring period: – pH 4.45 – EC 154.1 uS/cm – DO 50.5%	• Continue monitoring program • Submit an Impact Report to OEH, DoPE, T&I, Water NSW and other relevant resource managers • Report in the End of Panel Report • Summarise actions and monitoring in AEMR
	Level 2 * • Two exceedances of the ±3 standard deviation level (positive for EC, negative for pH and DO) from the baseline mean during the monitoring period: – pH 4.45 – EC 154.1 uS/cm	• *Actions as stated for Level 1* • Review monitoring frequency • Notify relevant technical specialists and seek advice on any CMA required • Implement agreed CMAs as approved (subject to stakeholder feedback)

Monitoring	Trigger	Action
	– DO 50.5%	
	Level 3 * • Three exceedances of the ±3 standard deviation level (positive for EC, negative for pH and DO) from the baseline mean during the monitoring period: – pH 4.45 – EC 154.1 uS/cm – DO 50.5%	• *Actions as stated for Level 2* • Site visit with OEH, DoPE, T&I, Water NSW and other resource manager/s (if requested) • Implement additional monitoring or increase frequency if required • Review relevant TARP and Management Plan in consultation with key stakeholders • Develop site CMA (subject to stakeholder feedback). This may include: – Limestone emplacement to raise pH where it is appropriate to do so – Grouting of fractures in rockbar and bedrock base of any significant pool where flow diversion results in pool water level lower than baseline period • Completion of works following approvals and at a time agreed between BHPBIC, DoPE, T&I and Water NSW (i.e. may be after mining induced movements and impacts are complete), including monitoring and reporting on success
	Exceeding Prediction • Mining results in two conecutive exceedances of the ±3 standard deviation level (positive for EC, negative for pH and DO) from the baseline mean during the monitoring period: – pH 4.45 – EC 154.1 uS/cm – DO 50.5%	• *Actions as stated for Level 3* • Investigate reasons for the exceedance • Update future predictions based on the outcomes of the investigation • Provide residual environmental offset for any mining impact where CMAs are unsuccessful as required by Condition 14 Schedule 3 of the Development Consent
Donalds Castle Creek Donalds Castle Ck (FR6) Baseline means: • pH 5.41 • EC 116.0 uS/cm • DO 85.6%	***Level 1*** * • One exceedance of the ±3 standard deviation level (positive for EC, negative for pH and DO) from the baseline mean during the monitoring period: – pH 3.60 – EC 185.8 uS/cm – DO 40.1%	• Continue monitoring program • Submit an Impact Report to OEH, DoPE, T&I, Water NSW and other relevant resource managers • Report in the End of Panel Report • Summarise actions and monitoring in AEMR
	Level 2 *	• *Actions as stated for Level 1* • Review monitoring frequency

Monitoring	Trigger	Action
•Relevant Performance Measure(s): • Donalds Castle Creek - minor environmental consequences	• Two exceedances of the ±3 standard deviation level (positive for EC, negative for pH and DO) from the baseline mean during the monitoring period: – pH 3.60 – EC 185.8 uS/cm – DO 40.1%	• Notify relevant technical specialists and seek advice on any CMA required • Implement agreed CMAs as approved (subject to stakeholder feedback)
	Level 3 * • Three exceedances of the ±3 standard deviation level (positive for EC, negative for pH and DO) from the baseline mean during the monitoring period: – pH 3.60 – EC 185.8 uS/cm – DO 40.1%	• *Actions as stated for Level 2* • Site visit with OEH, DoPE, T&I, Water NSW and other resource manager/s (if requested) • Implement additional monitoring or increase frequency if required • Review relevant TARP and Management Plan in consultation with key stakeholders • Collect laboratory samples and analyse for: – pH, EC, major cations, major anions, Total Fe, Mn & Al – Filterable suite of metals • Develop site CMA (subject to stakeholder feedback). This may include: – Limestone emplacement to raise pH where it is appropriate to do so – Grouting of fractures in rockbar and bedrock base of any significant pool where flow diversion results in pool water level lower than baseline period • Completion of works following approvals and at a time agreed between BHPBIC, DoPE, T&I and Water NSW (i.e. may be after mining induced movements and impacts are complete), including monitoring and reporting on success
	Exceeding Prediction • Mining results in two conecutive exceedances of the ±3 standard deviation level (positive for EC, negative for pH and DO) from the baseline mean during the monitoring period: – pH 3.60 – EC 185.8 uS/cm – DO 40.1%	• *Actions as stated for Level 3* • Investigate reasons for the exceedance • Update future predictions based on the outcomes of the investigation • Provide residual environmental offset for any mining impact where CMAs are unsuccessful as required by Condition 14 Schedule 3 of the Development Consent

Monitoring	Trigger	Action
Avon Dam Avon Dam tributary (LA4_S1) Baseline means: • pH 5.38 • EC 90.8 uS/cm • DO 89.9% (24 months of baseline data available - to be updated with additional baseline data) •Relevant Performance Measure(s): • Avon Dam - negligible reduction in the quality of surface water inflows to Avon Dam	***Level 1 **** • One exceedance of the ±3 standard deviation level (positive for EC, negative for pH and DO) from the baseline mean during the monitoring period: – pH 4.90 – EC 129.8 uS/cm – DO 69.5%	• Continue monitoring program • Submit an Impact Report to OEH, DoPE, T&I, Water NSW and other relevant resource managers • Report in the End of Panel Report • Summarise actions and monitoring in AEMR
	Level 2 * • Two exceedances of the ±3 standard deviation level (positive for EC, negative for pH and DO) from the baseline mean during the monitoring period: – pH 4.90 – EC 129.8 uS/cm – DO 69.5%	• *Actions as stated for Level 1* • Review monitoring frequency • Notify relevant technical specialists and seek advice on any CMA required • Implement agreed CMAs as approved (subject to stakeholder feedback)
	Level 3 * • Three exceedances of the ±3 standard deviation level (positive for EC, negative for pH and DO) from the baseline mean during the monitoring period: – pH 4.90 – EC 129.8 uS/cm – DO 69.5%	• *Actions as stated for Level 2* • Site visit with OEH, DoPE, T&I, Water NSW and other resource manager/s (if requested) • Implement additional monitoring or increase frequency if required • Review relevant TARP and Management Plan in consultation with key stakeholders • Collect laboratory samples and analyse for: – pH, EC, major cations, major anions, Total Fe, Mn & Al – Filterable suite of metals • Develop site CMA (subject to stakeholder feedback). This may include: – Limestone emplacement to raise pH where it is appropriate to do so – Grouting of fractures in rockbar and bedrock base of any significant pool where flow diversion results in pool water level lower than baseline period • Completion of works following approvals and at a time agreed between BHPBIC, DoPE, T&I and Water NSW (i.e. may be after mining induced movements and impacts are complete), including monitoring and reporting on success
	Exceeding Prediction	• *Actions as stated for Level 3*

Monitoring	Trigger	Action
	• Mining results in two conecutive exceedances of the ±3 standard deviation level (positive for EC, negative for pH and DO) from the baseline mean of the Avon Dam inflows during the monitoring period: – pH 4.90 – EC 129.8 uS/cm – DO 69.5% –	• Investigate reasons for the exceedance • Update future predictions based on the outcomes of the investigation • Provide residual environmental offset for any mining impact where CMAs are unsuccessful as required by Condition 14 Schedule 3 of the Development Consent
•POOL WATER LEVEL		
Mapped pools in the mining area: • Wongawilli Creek • Donalds Castle Creek •Relevant Performance Measure(s): • Wongawilli Creek - minor environmental consequences • Donalds Castle Creek - minor environmental consequences	***Level 1*** * • Fracturing not resulting in diversion of flow	• Continue monitoring program • Submit an Impact Report to OEH, DoPE, T&I, Water NSW and other relevant resource managers • Report in the End of Panel Report • Summarise actions and monitoring in AEMR
	Level 2 * • Fracturing resulting in diversion of flow	• *Actions as stated for Level 1* • Review monitoring frequency • Notify relevant technical specialists and seek advice on any CMA required • Implement agreed CMAs as approved (subject to stakeholder feedback)
	Level 3 * • Fracturing resulting in diversion of flow such that <10% of the pools have water levels lower than baseline period	• *Actions as stated for Level 2* • Site visit with OEH, DoPE, T&I, Water NSW and other resource manager/s (if requested) • Implement additional monitoring or increase frequency if required • Review relevant TARP and Management Plan in consultation with key stakeholders • Develop site CMA (subject to stakeholder feedback). This may include: grouting of rockbar and bedrock base of any significant pool where it is appropriate to do so in consultation with OEH, DoPE, T&I, Water NSW and other stakeholders • Completion of works following approvals and at a time agreed between BHPBIC, DoPE, T&I and Water NSW (i.e. may be after mining induced movements and impacts are complete), including monitoring and reporting on success
	Exceeding Prediction	• *Actions as stated for Level 3* • Investigate reasons for the exceedance

Monitoring	Trigger	Action
	• Fracturing resulting in diversion of flow such that >10% of the pools have water levels lower than baseline period	• Update future predictions based on the outcomes of the investigation • Provide residual environmental offset for any mining impact where CMAs are unsuccessful as required by Condition 14 Schedule 3 of the Development Consent
•**Waterfall WC-WF54** •Relevant Performance Measure(s): • Waterfall WC-WF54 – negligible environmental consequences	***Exceeding Prediction*** • Fracturing in Wongawilli Creek within 30m of the waterfall which results in observable flow diversion • Fracturing in Wongawilli Creek which results in observable flow diversion from the lip of the waterfall	• *Actions as stated for Level 3* • Investigate reasons for the exceedance • Update future predictions based on the outcomes of the investigation • Provide residual environmental offset for any mining impact where CMAs are unsuccessful as required by Condition 14 Schedule 3 of the Development Consent
SURFACE WATER FLOW		
Wongawilli Creek and Donalds Castle Creek **Avon Dam and Cordeaux River** **Relevant Performance Measure(s):** • Wongawilli Creek - minor environmental consequences • Donalds Castle Creek - minor environmental consequences • Avon Dam - negligible reduction in the quantity of surface water inflows to Avon Dam[1] • Cordeaux River - negligible reduction in the quantity of surface water inflow to the Cordeaux River at its confluence with Wongawilli Creek[2]	***Level 1*** • A) Lower flow than expected (additional 10-15% of days where Q% lower than Reference Q%) • B) 5-10% increase in cease-to-flow frequency beyond natural) • C) Reduction in Q50 (10-15% beyond natural)	• Continue monitoring program. • Submit an Impact Report to BCD, DPIE, DRG, WaterNSW. • Report in the End of Panel Report. • Summarise actions and monitoring in AEMR.
	Level 2 • A) Lower flow than expected (additional 15-20% of days where Q% lower than Reference Q%). • B) 10-20% increase in cease-to-flow frequency (beyond natural) • C) 15-20% reduction in Q50 (beyond natural) • D) Observation that the subject Creek has ceased to flow at spatially consecutive monitoring sites.	• *Actions as stated for Level 1* • Review monitoring frequency. • D) → carry out Water Flow Assessment Method D. • Submit letter report to DPIE, DRG and WaterNSW and seek advice on any CMA required. • Implement agreed CMAs as approved (subject to agency feedback).
Surface water flow Reference sites (as in Table 1.1)**:** • Wongawilli Creek - WWU (Wongawilli Creek upstream); • O'Hares Creek at Wedderburn (213200);	***Level 3*** • A) Lower flow than expected (additional >20% of days where Q% lower than Reference Q%) • B) >20% increase in cease-to-flow frequency (beyond natural) • C) >20% reduction in Q50 (beyond natural)	• *Actions as stated for Level 2* • Offer site visit with BCD, DPIE, DRG, WaterNSW. • Implement additional monitoring or increase frequency if required. • Develop site CMA (subject to agency feedback). This may include: grouting of rockbar and bedrock base of any significant pool where it is appropriate to do so in consultation with BCD, DPIE, DRG, WaterNSW.

[1] Surface water inflows calculation = [Impacts at gauged catchments (LA1 + LA2 + LA3 + LA4 + LA6+ NDT1 + ND2) + estimated impacts at ungauged but undermined catchments (e.g. LA5)] / [total inflow to LA].
[2] Flow reduction as determined from measured at flow gauging station WWL_A.

• (other such sites, if necessary, include Woronora River 2132101 and Bomaderry Creek 215016) NB. This section of the TARP contains four Water Flow Assessment Methods, labelled A, B, C and D, which are specified in detail in Watershed HydroGeo (2019). Hydrological changes are assessed by comparing pre- and post-mining observed flows from impact or assessment sites to flow data from the reference sites. *Natural variability ('NV') will be defined as the 'average' change at the selected reference sites. Triggers may occur when the apparent impact at a site (NV + x% change) could be less than maximum observed variability at one of the reference sites.*		• Completion of works following approvals and at a time agreed between S32, DPIE, DRG and WaterNSW (i.e. may be after mining induced movements and impacts are complete), including monitoring and reporting on success. • Review relevant TARP and Management Plan in consultation with key agencies.
	Exceeding Prediction Measured surface water flow reduction, based on Assessment Methods C, D, to be compared against predictions made in contemporary groundwater modelling conducted to the satisfaction of the Secretary to assess whether effects that cannot be explained by natural variability "exceed prediction".	• *Actions as stated for Level 3* • Investigate reasons for the exceedance. • Update future predictions based on the outcomes of the investigation. • Provide residual environmental offset for any mining impact where CMAs are unsuccessful as required by Condition 14 Schedule 3 of the Development Consent.
Tributaries of Wongawilli Creek and Donalds Castle Creek and other affected watercourses not subject to performance measures **Surface water flow Reference sites** (as in Table 1.1)**:** • Wongawilli Creek - WWU (Wongawilli Creek upstream); • O'Hares Creek and Wedderburn (213200); • (other such sites, if necessary, include Woronora River 2132101 and Bomaderry Creek 215016) NB. This section of the TARP contains four Water Flow Assessment Methods, labelled A, B, C and D, which are specified in detail in Watershed HydroGeo (2019).	***Level 1*** • A) Lower flow than expected (additional 10-20% of days where Q% lower than Reference Q%) • B) 5-10% increase in cease-to-flow frequency (beyond natural) • C) 10-20% reduction in Q50 (beyond natural)	• Continue monitoring program. • Submit an Impact Report to BCD, DPIE, DRG, WaterNSW. • Report in the End of Panel Report. • Summarise actions and monitoring in AEMR.
	Level 2 • A) Lower flow than expected (additional 20-30% of days where Q% lower than Reference Q%) • B) 10-20% increase in cease-to-flow frequency (beyond natural) • C) 20-30% reduction in Q50 (beyond natural)	• *Actions as stated for Level 1* • Review monitoring frequency. • Submit letter report to DPIE, DRG and WaterNSW and seek advice on any CMA required. • Implement agreed CMAs as approved (subject to agency feedback).

Hydrological changes are assessed by comparing pre- and post-mining observed flows from impact or assessment sites to flow data from the reference sites. *Natural variability ('NV') will be defined as the 'average' change at the selected reference sites. Triggers may occur when the apparent impact at a site (NV + x% change) could be less than maximum observed variability at one of the reference sites.*	***Level 3*** • A) Lower flow than expected (additional >30% of days where Q% lower than Reference Q%) • B) >20% increase in cease-to-flow frequency (beyond natural) • C) >30% reduction in Q50 (beyond natural)	• *Actions as stated for Level 2* • Offer site visit with BCD, DPIE, DRG, WaterNSW. • Implement additional monitoring or increase frequency if required • Develop site CMA (subject to agency feedback). This may include: grouting of rockbar and bedrock base of any significant pool where it is appropriate to do so in consultation with BCD, DPIE, DRG, WaterNSW. • Completion of works following approvals and at a time agreed between S32, DPIE, DRG and WaterNSW (i.e. may be after mining induced movements and impacts are complete), including monitoring and reporting on success. • Review relevant TARP and Management Plan in consultation with key agencies.
AQUATIC ECOLOGY		
Pool water level, interconnectivity between pools and loss of connectivity, noticeable alteration of habitat • Wongawilli Creek catchment – 8 sites • Donalds Castle Creek catchment – 1 site	***Level 1 **** • Reduction in aquatic habitat for 1 year •	• Continue monitoring program • Submit an Impact Report to OEH, DoPE, T&I, Water NSW and other relevant resource managers • Report in the End of Panel Report • Summarise actions and monitoring in AEMR
	Level 2 * • Reduction in aquatic habitat for 2 years following the active subsidence period	• *Actions as stated for Level 1* • Review monitoring frequency • Notify relevant technical specialists and seek advice on any CMA required • Implement agreed CMAs as approved (subject to stakeholder feedback)
	Level 3 * • Reduction in aquatic habitat for >2 years or complete loss of habitat following the active subsidence period	• *Actions as stated for Level 2* • Site visit with OEH, DoPE, T&I, Water NSW and other resource manager/s (if requested) • Implement additional monitoring or increase frequency if required • Review relevant TARP and Management Plan in consultation with key stakeholders • Develop site CMA (subject to stakeholder feedback). This may include: grouting of rockbar and bedrock base of any significant pool where it is appropriate to do so in consultation with OEH, DoPE, T&I, Water NSW and other stakeholders

		• Completion of works following approvals and at a time agreed between BHPBIC, DoPE, T&I and Water NSW (i.e. may be after mining induced movements and impacts are complete), including monitoring and reporting on success
TERRESTRIAL FAUNA – THREATENED FROG SPECIES		
Pool water level, interconnectivity between pools and loss of connectivity, noticeable alteration of habitat • Wongawilli Creek catchment – 2 sites • Donalds Castle Creek catchment – 2 sites • Avon Dam tributary – 1 site • Native Dog tributary – 1 site	***Level 1 **** • Reduction in habitat for 1 year	• Continue monitoring program • Submit an Impact Report to OEH, DoPE, T&I, Water NSW and other relevant resource managers • Report in the End of Panel Report • Summarise actions and monitoring in AEMR
	Level 2 * • Reduction in habitat for 2 years following the active subsidence period	• *Actions as stated for Level 1* • Review monitoring frequency • Notify relevant technical specialists and seek advice on any CMA required • Implement agreed CMAs as approved (subject to stakeholder feedback)
	Level 3 * • Reduction in habitat for > 2 years or complete loss of habitat following the active subsidence period	• *Actions as stated for Level 2* • Site visit with OEH, DoPE, T&I, Water NSW and other resource manager/s (if requested) • Implement additional monitoring or increase frequency if required • Review relevant TARP and Management Plan in consultation with key stakeholders • Develop site CMA (subject to stakeholder feedback). This may include: grouting of rockbar and bedrock base of any significant pool where it is appropriate to do so in consultation with OEH, DoPE, T&I, Water NSW and other stakeholders • Completion of works following approvals and at a time agreed between BHPBIC, DoPE, T&I and Water NSW (i.e. may be after mining induced movements and impacts are complete), including monitoring and reporting on success