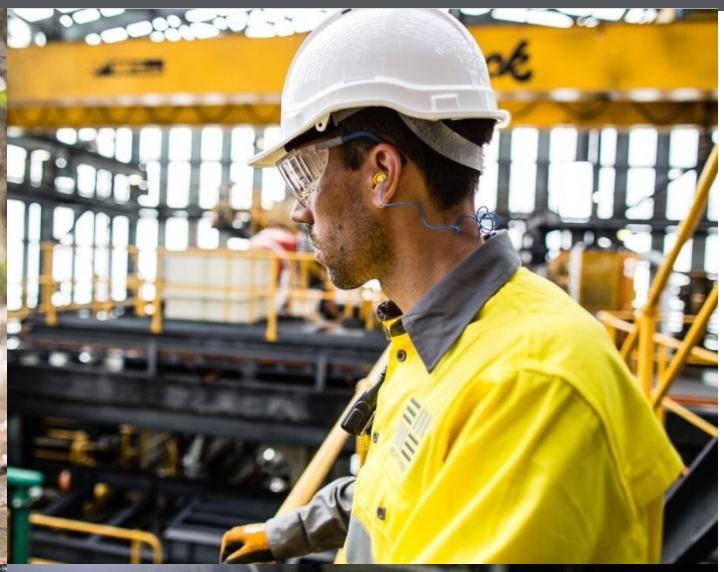
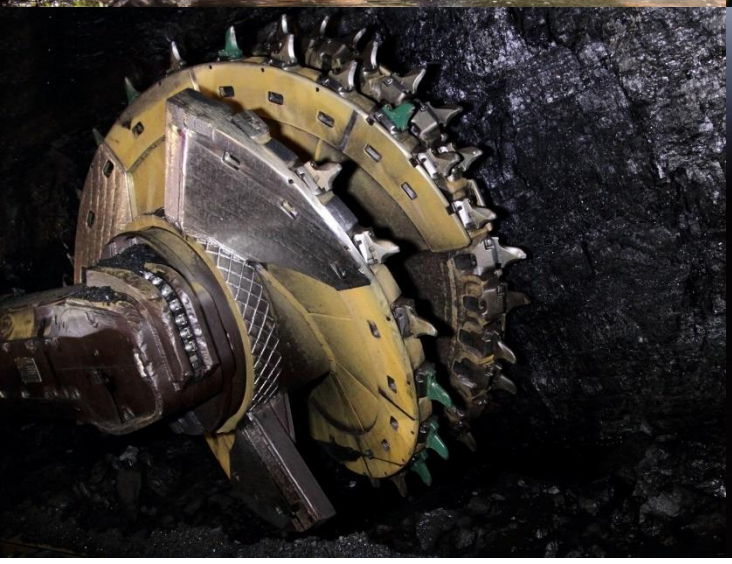
SOUTH32

END OF PANEL
LANDSCAPE REPORT
DENDROBIUM AREA 3B


DENDROBIUM AREA 3B LONGWALL 15 END OF PANEL LANDSCAPE REPORT

MARCH 2020

EXECUTIVE SUMMARY

This report summarises the observed and measured subsidence effects on landscape features resulting from the extraction of Dendrobium Area 3B (DA3B) Longwall 15.

Longwall 15 is the seventh panel extracted from DA3B. Extraction began on 4 April 2019 and was completed on 22 January 2020.

The Illawarra Metallurgical Coal Environmental Field Team (IMCEFT) conducts detailed monitoring and inspections of landscape features including swamps, watercourses, rock outcrops and the general area within Dendrobium Area 3B. This monitoring was conducted in accordance with:

- Dendrobium Area 3B Subsidence Management Plan (SMP);
- Dendrobium Area 3B Watercourse Impact, Monitoring, Management and Contingency Plan (WIMMCP) (October 2017);
- Dendrobium Area 3B Swamp Impact, Monitoring, Management and Contingency Plan (SIMMCP) (October 2017); and
- Dendrobium Subsidence, Landscape Monitoring and Management Plan (SLMMP) (November 2012).

The Watercourse, Swamp and Landscape Trigger Action Response Plans (TARPs) form the basis of the impact assessments in this report.

28 surface impacts were identified by IMCEFT. 22 of these surface impacts were observed on natural features with six occurring on fire roads and access tracks. This report also includes an update on three existing Longwall 13 impacts and an update on two existing Longwall 14 Impacts.

Swamp groundwater and water quality triggers were also recorded during Longwall 15 and will be addressed in detail in the specialist Surface Water and Shallow Groundwater Assessment.

Contents

Figures

Tables

Abbreviations

CMA – Corrective Management Action

DPIE - Department of Planning, Industry and Environment

EoP – End of Panel

IMCEFT – Illawarra Metallurgical Coal Environmental Field Team

OEH - Office of Environment and Heritage (former agency)

SIMMCP – Swamp Impact, Monitoring, Management and Contingency Plan

SLMMP – Subsidence Landscape Monitoring and Management Plan

SMP – Subsidence Management Plan

TARP – Trigger Action Response Plan

WaterNSW – previously Sydney Catchment Authority

WIMMCP – Watercourse Impact, Monitoring, Management and Contingency Plan

Definitions

Active Mining Area – Within 400m of the active longwall.

1 OVERVIEW OF MONITORING PROGRAM

Landscape monitoring was conducted within the Longwall 15 mining area during baseline, active mining and post-mining periods. Baseline inspections were conducted up until the longwall was within 400m of each feature. When active mining occurred within 400m of each feature, inspections increased to weekly until the longwall was at least 400m past the feature. Post-mining inspections continue as outlined in the relevant Management Plans.

Hazardous fire danger conditions towards the end of 2019 and beginning of 2020 forced closure of the Metropolitan Special Area, in which the Dendrobium mining area is located. This has resulted in some inspections not being undertaken over this period and resultant gaps in some datasets.

Surface Monitoring for Longwall 15

IMCEFT and external consultants conducted observations and measurements of surface and shallow groundwater levels, swamp soil moisture, surface water flows, surface water quality and inspections of key landscape features. This monitoring included targeted sites within swamps and watercourses as well as steep slopes, clifflines and other landscape features.

Landscape Monitoring Summary (SLMMP)

In accordance with the Dendrobium Area 3B SMP approval, landscape monitoring sites (SLMMP photo points) within the active mining area were monitored at monthly intervals. Monitoring photos from SLMMP sites are compared to baseline photos at each site (Photo 1 and Photo 2). A total of 16 landscape sites (SLMMP photo points) were monitored before, during and after the Longwall 15 extraction period (Table 1). Longwall 15 post-mining inspections were undertaken, and two impacted sites were observed. These impacts are addressed in the Impacts to Other Landscape Features section.

Photo 1: *A3b-SS13* baseline inspection. Taken on 25/01/18.

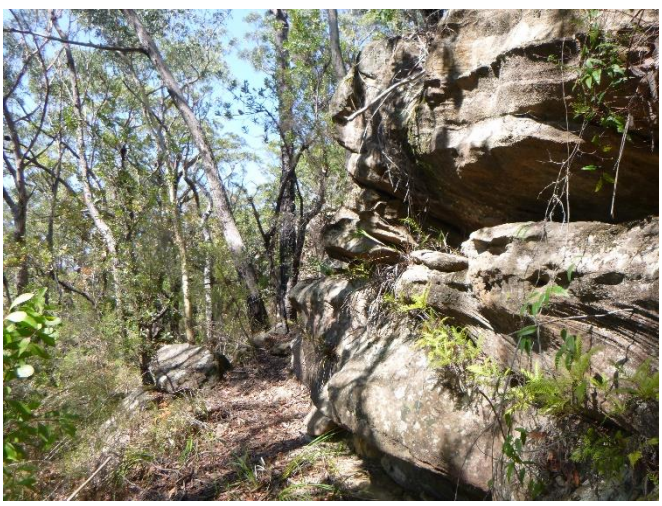


Photo 2: *A3b-SS13* post-mining inspection. Taken on 21/01/20.

Table 1: Summary table of SLMMP sites relevant to Longwall 15.

Site Name	Easting	Northing	Impact Description
A3b-SS8	288329	6192167	No impacts observed
A3b-SS9-Pt1	290162	6192078	Rockfall
A3b-SS9-Pt2	290133	6191978	No impacts observed
A3b-SS11	288686	6191850	No impacts observed
A3b-SS12	289098	6191676	No impacts observed
A3b-SS13	290056	6191749	Soil cracking & displacement
A3b-SS14	290060	6191587	No impacts observed
A3b-SS15	288717	6191468	No impacts observed
A3b-SS16	289207	6191506	No impacts observed
A3b-SS17	290163	6191269	No impacts observed
AT1-slmmp	289463	6192132	No impacts observed
AT2-slmmp	289938	6192033	No impacts observed
AT3-slmmp	290566	6191598	No impacts observed
AT4-slmmp	289092	6191569	No impacts observed
AT5-slmmp	290140	6191224	No impacts observed
FR6A-Pt5	289065	6192149	No impacts observed

2 REFERENCE SITE MONITORING

Swamp reference sites are monitored in accordance with the SIMMCP (example reference swamps- Photo 3 and Photo 4). Data recorded from reference swamps is compared with data from impact monitoring sites relevant to previously mined and active longwalls.

Photo 3**:** Reference site *S88_S01*. Photo taken 19/10/2019.

Photo 4**:** Reference site *S24_S01*. Photo taken 26/07/2019.

3 TARP OVERVIEW

In accordance with the Dendrobium Area 3B SMP approval, the SIMMCP and WIMMCP (and Environmental Management Plan) were revised during the extraction of Longwalls 9 and 10. Key government agencies including DPIE, WaterNSW and OEH were consulted during this process. This revision included updates to the TARPs, which address Performance Measures, specified in the approval conditions. Table 2 shows the TARPs used to date. In accordance with the Dendrobium Area 3B SMP approvals, the SIMMCP and WIMMCP (and Environmental Management Strategy) were revised prior to the extraction of Longwall 14. Impacts to surface features observed during the extraction of Longwall 15 will be reported under the 2017 TARPs.

Table 2: History of management plan updates for DA3B. Highlighted Plans show those used for reporting during Longwall 15.

Aspect	Management Plan	TARP Date Range
Swamps	Swamp Impact, Monitoring, Management and Contingency Plan (October 2013)	10/10/2013 – 03/06/2014
	Swamp Impact, Monitoring, Management and Contingency Plan (June 2014)	04/06/2014 – 11/10/2015
	Swamp Impact, Monitoring, Management and Contingency Plan (October 2015)	12/10/2015 – 30/10/2017
	Swamp Impact, Monitoring, Management and Contingency Plan (October 2017)	31/10/2017 – 6/02/2020
	Swamp Impact, Monitoring, Management and Contingency Plan (February 2020)	07/02/2020 - present
Watercourse	Watercourse Impact, Monitoring, Management and Contingency Plan (December 2013)	19/12/2013 – 03/06/2014
	Watercourse Impact, Monitoring, Management and Contingency Plan (June 2014)	04/06/2014 – 11/10/2015
	Watercourse Impact, Monitoring, Management and Contingency Plan (October 2015)	12/10/2015 – 30/10/2017
	Watercourse Impact, Monitoring, Management and Contingency Plan (October 2017)	31/10/2017 – 13/02/2020
	Watercourse Impact Monitoring, Management and Contingency Plan (October 2020)	14/02/2020 - present
Landscape	Dendrobium Area 3B Subsidence Management Plant (SMP), Volume 2 – Table 1.2 Dendrobium Landscape Impacts, Triggers and Response (November 2012)	12/11/2012 – Present

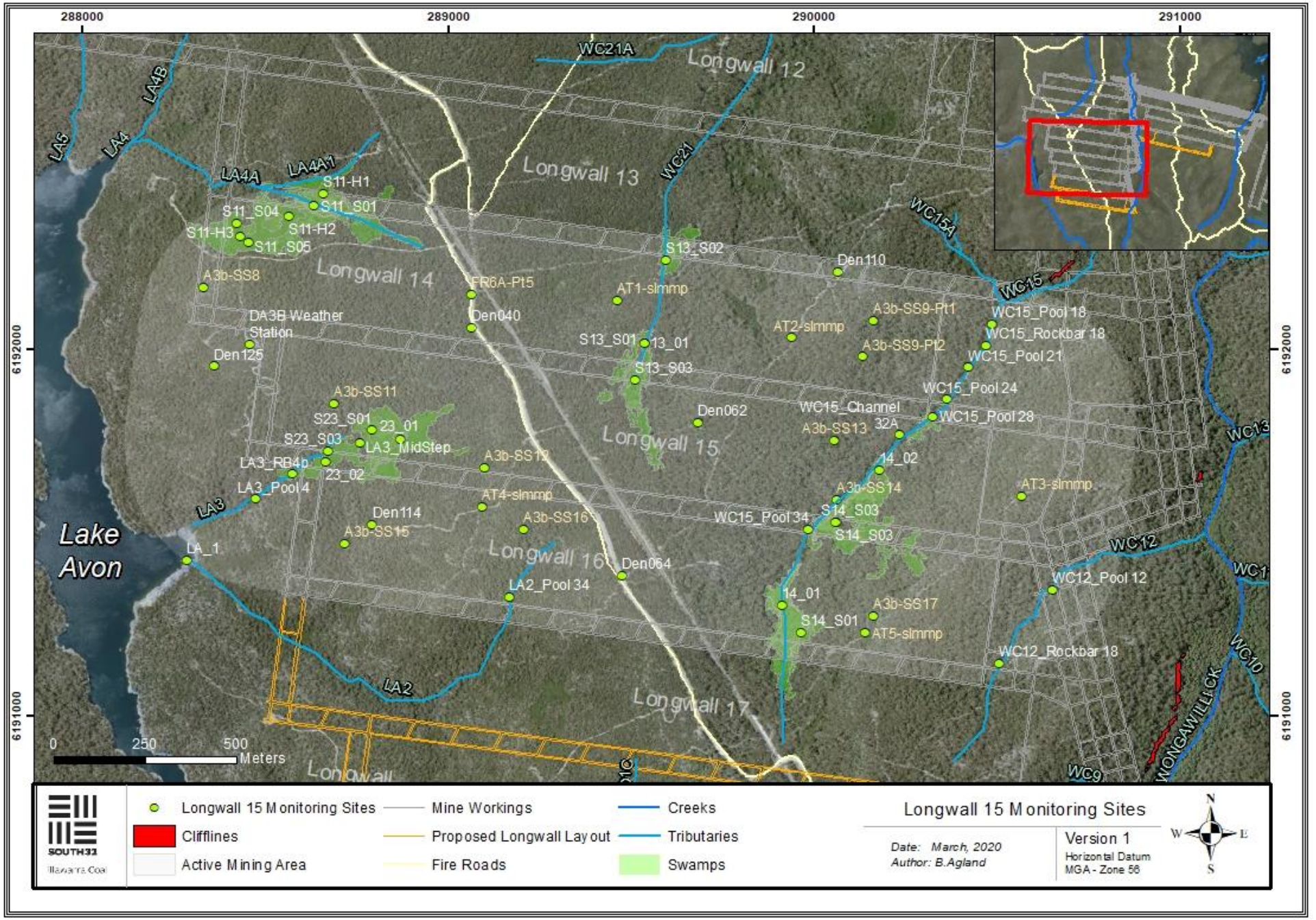


Figure 1: Map showing monitoring sites for the Longwall 15 active mining area.

4 SUMMARY OF IMPACTS

During the extraction of Longwall 15, 28 new surface impacts were identified (Table 3: **Summary of impacts and triggers relevant to Longwall 15.** Figure 2). These impacts are labelled as *DA3B_LW15_001* to *DA3B_LW15_028*. Updates are provided for three existing Longwall 13 impacts; these impacts are labelled as *DA3B_LW13_010 (Update), DA3B_LW13_035 (Update)* and *DA3B_LW13_046 (Update).* Updates are provided for two existing Longwall 14 impacts; these impacts are labelled as *DA3B_LW14_015 (Update)* and *DA3B_LW14_016 (Update)*. An additional three water quality triggers, three shallow groundwater triggers and two soil moisture triggers were identified. These triggers will be addressed in the Longwall 15 Surface Water and Shallow Groundwater Assessment.

Impacts to Natural 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 Dendrobium Area 3B are discussed in the Dendrobium Area 3B SMP, WIMMCP and SIMMCP.

An overview of impacts observed during the extraction of Longwall 15 is provided in the following sections. For specific details on the impacts listed in Table 3, refer to the relevant impact reports (attached separately to this report).

Landscape features

Fractures and cracking observed during the extraction of Longwall 15 were assessed against the relevant TARP (for landscape, swamp or watercourse) and assigned a trigger value (Level 1, Level 2 or Level 3 where applicable). Trigger values for fractures and cracks were determined based on characteristics such as:

- Width and length;
- Whether the fracture contributed to any observable loss of surface water or water diversion; and
- Any erosion or potential for erosion caused by a fracture or crack.

Table 3: Summary of impacts and triggers relevant to Longwall 15.

Site ID	Easting	Northing	Impact Type	Feature Affected	Identification Date	Trigger Level	Description	Refer to Impact Report/s Dated
DA3B_LW15_001	288679	6191767	Rock Fracturing and Rockfall	*Sandstone Outcrop*	29/05/2019	1	Rock fracturing and rockfall at a step adjacent to *Swamp 23*.	31/05/2019
DA3B_LW15_002	288651	6191771	Rockfall	*Sandstone Outcrop*	29/05/2019	1	Rockfall at a step adjacent to *Swamp 23*.	31/05/2019
DA3B_LW15_003	288351	6192457	Rock Fracturing	*LA4A*	17/06/2019	1	Rock fracturing and associated rock fragmentation at *LA4A_Step 3A*.	19/06/2019
DA3B_LW15_004	289196	6191848	Soil Cracking	*Fire Road 6A*	09/07/2019	2	Soil cracking along *Fire Road 6A*.	11/07/2019
DA3B_LW15_005	289151	6191960	Soil Cracking	*Fire Road 6A*	09/07/219	1	Soil cracking and uplift across *Fire Road 6A*.	11/07/2019
DA3B_LW15_006	288876	6191945	Soil Cracking and Rock Fracturing	*Access Track & Sandstone Outcrop*	09/07/219	1	Soil cracking to a closed access track and fracturing to adjacent rock outcrop.	11/07/2019
DA3B_LW15_007	288696	6191767	Rock Fracturing	*Sandstone Outcrop*	09/07/219	1	Fracturing to sandstone step, north of *Swamp 23*.	11/07/2019
DA3B_LW15_008	289221	6191783	Soil Cracking and Uplift	*Fire Road 6A*	29/07/2019	1	Soil cracking and uplift across *Fire Road 6A.*	30/07/2019
DA3B_LW15_009	288744	6191771	Rockfall	*Steep Slope/ Step*	29/07/2019	1	Small rockfall to ledge adjacent to *Swamp 23*.	30/07/2019
DA3B_LW15_010	289323	6191824	Soil Cracking and Uplift	*Closed Access Track*	13/08/2019	1	Soil cracking and uplift to a closed access track adjacent to *Swamp 23*.	23/08/2019
DA3B_LW15_011	289399	6191703	Soil Cracking	*Fire Road 6P and Ballast*	28/08/2019	2	Soil cracking to railway corridor ballast and entrance to *Fire Road 6P*.	30/08/2019
DA3B_LW15_012	289249	6191777	Soil Cracking	*Access Track*	28/08/219	1	Soil cracking to access track connecting *Fire Road 6A* and *Ballast*, near *Swamp 23*.	30/08/2019
DA3B_LW15_013	288673	6191855	Rock Fracturing and Fragmentation	*Steep Slope/ Step*	05/09/2019	1	Rock fracturing and fragmentation near SLMMP site *A3b-SS11*.	06/09/2019

Site ID	Easting	Northing	Impact Type	Feature Affected	Identification Date	Trigger Level	Description	Refer to Impact Report/s Dated
DA3B_LW15_014	288376	6192452	Rockfall, Rock Fracturing and Fragmentation	*LA4A*	11/10/2019	2	Rockfall, rock fracturing and fragmentation to *LA4A_Step 3B* and *LA4A_Channel 3A*.	15/10/2019
DA3B_LW15_015	288344	6192464	Rock Fracturing	*LA4A*	11/10/2019	2	Rock fracturing to *LA4A_Rockbar 2*.	15/10/2019
DA3B_LW15_016	290011	6191602	Rock Displacement	*Steep Slope*	25/10/2019	1	Rock displacement at a steep slope between *Fire Road 6P* and *Swamp 14*.	28/10/2019
DA3B_LW15_017	289939	6191673	Rockfall	*Steep Slope*	25/10/2019	1	Small rockfall at a steep slope between *Fire Road 6P* and *Swamp 14*.	28/10/2019
DA3B_LW15_018	290090	6191892	Rock Fracturing	*Steep Slope*	25/10/2019	1	Rock fracturing at a steep slope between *Fire Road 6P* and *WC15.*	28/10/2019
DA3B_LW15_019	290125	6191990	Rock Fracturing	*Steep Slope*	25/10/2019	1	Rock fracturing at a steep slope between *Fire Road 6P* and *WC15.*	28/10/2019
DA3B_LW15_020	290140	6192074	Rockfall	*Steep Slope*	25/10/2019	1	Small rockfall at a steep slope between *Fire Road 6P* and *WC15.*	28/10/2019
DA3B_LW15_021	290151	6192085	Rockfall	*Steep Slope*	25/10/2019	1	Small rockfall at SLMMP site *A3b-SS9-Pt1.*	28/10/2019
DA3B_LW15_022	290172	6192102	Rock Fracturing	*Steep Slope*	25/10/2019	1	Rock fracturing at a steep slope between *Fire Road 6P* and *WC15.*	28/10/2019
DA3B_LW15_023	290174	6192128	Rock Fracturing	*Steep Slope*	25/10/2019	2	Rock fracturing at a steep slope between *Fire Road 6P* and *WC15.*	28/10/2019
DA3B_LW15_024	290033	6191605	Rock Fracturing and Soil Uplift	*Steep Slope*	21/01/2020	1	Rock fracturing and soil uplift at a steep slope between *Swamp 14* and *WC15.*	23/01/2020
DA3B_LW15_025	290057	6191622	Rockfall	*Steep Slope*	21/01/2020	1	Rockfall at a steep slope between *Swamp 14* and *WC15*.	23/01/2020
DA3B_LW15_026	290056	6191749	Soil Cracking and Displacement	*A3B-SS13 (Steep Slope)*	21/01/2020	1	Soil cracking and displacement at SLMMP site *A3B-SS13*.	23/01/2020
DA3B_LW15_027	290467	6192043	Rock Fracturing	*WC15*	21/01/2020	1	Rock fracturing to *WC15_Rockbar 18*	23/01/2020

Site ID	Easting	Northing	Impact Type	Feature Affected	Identification Date	Trigger Level	Description	Refer to Impact Report/s Dated
DA3B_LW15_028	290142	6192091	Rock Fracturing	*Rock Outcrop*	30/01/2020	1	Rock fracturing to sandstone outcrop between *Fire road 6P* and *WC15.*	07/02/2020
DA3B_LW13_010 (Update)	289591	6192424	Rockfall	*WC21*	21/08/2019	2	Rockfall to a step at *WC21_Pool 53*.	23/08/2019
DA3B_LW13_035 (Update)	290408	6191915	Rock Fracturing	*WC15*	21/01/2020	2	Additional rock fracturing to *WC15_Rockbar 21*.	23/01/2020
DA3B_LW13_046 (Update)	290887	6192408	Rock Fracturing and Displacement	*WC15*	1/04/2020	1	Additional rock fracturing and displacement to *WC15_Pool 2*.	3/04/2019
DA3B_LW14_015 (Update)	288070	6192528	Rockfall	*Cliff line*	5/12/2019 and 11/06/2019	2	Rockfall on Avon Reservoir cliff edge.	06/12/2018 and 12/06/2019
DA3B_LW14_016 (Update)	290345	6191835	Rock Fracturing	*WC15*	21/01/2020	2	Additional rock fracturing to *WC15_Rockbar 25.*	23/01/2020
DA3A_LW7_001	291245	6193313	Rock Fracturing	*Rock Outcrop*	20/08/2019	2	Fracturing to a rock outcrop over DA3A.	23/08/2019
DA3A_LW8_001	291336	6192291	Rock Fracturing and Uplift	*WC14*	28/01/2020	2	Rock fracturing and uplift to *rockbar.*	7/02/2020
DA3A_LW8_002	291345	6192304	Rock Fracturing and Uplift	*WC14*	28/01/2020	2	Rock fracturing and uplift to *rockbar.*	7/02/2020
DA3A_LW8_003	291345	6192335	Rock Fracturing and Uplift	*WC14*	28/01/2020	1	Rock fracturing and uplift to *step.*	7/02/2020
DA3A_LW8_004	291550	6192337	Rock Fracturing and Uplift	*WC14*	28/01/2020	1	Rock fracturing and uplift to *step.*	7/02/2020
23_01	288868	6191753	Shallow Groundwater Trigger	*Swamp 23*	01/05/2019	2	Rate of recession greater than baseline.	03/05/2019
14_02	290178	6191669	Shallow Groundwater Trigger	*Swamp 14*	01/11/2019	2	Rate of recession greater than baseline.	08/11/2019
S14_02	290178	6191669	Soil Moisture Trigger	*Swamp 14*	13/12/2019	3	Soil moisture level lower than baseline.	17/12/2019

Site ID	Easting	Northing	Impact Type	Feature Affected	Identification Date	Trigger Level	Description	Refer to Impact Report/s Dated
14_01	289913	6191298	Shallow Groundwater Trigger	*Swamp 14*	15/01/2020	2	Groundwater level lower than baseline.	16/01/2020
S14_01	289913	6191298	Soil Moisture Trigger	*Swamp 14*	15/01/2020	3	Soil Moisture level lower than baseline.	16/01/2020
Wongawilli Creek (FR6)	290960	6197376	Water Quality	*Wongawilli Creek*	29/01/2020	2	Dissolved oxygen trigger	7/02/2020
Wongawilli Creek (FR6)	290960	6197376	Water Quality	*Wongawilli Creek*	29/01/2020	2	Electrical conductivity trigger	7/02/2020
Donalds Castle Creek (FR6)	289395	6195367	Water Quality	*Donalds Castle Creek*	25/03/2019	3	Electrical conductivity trigger	28/3/2019 & 31/05/2019

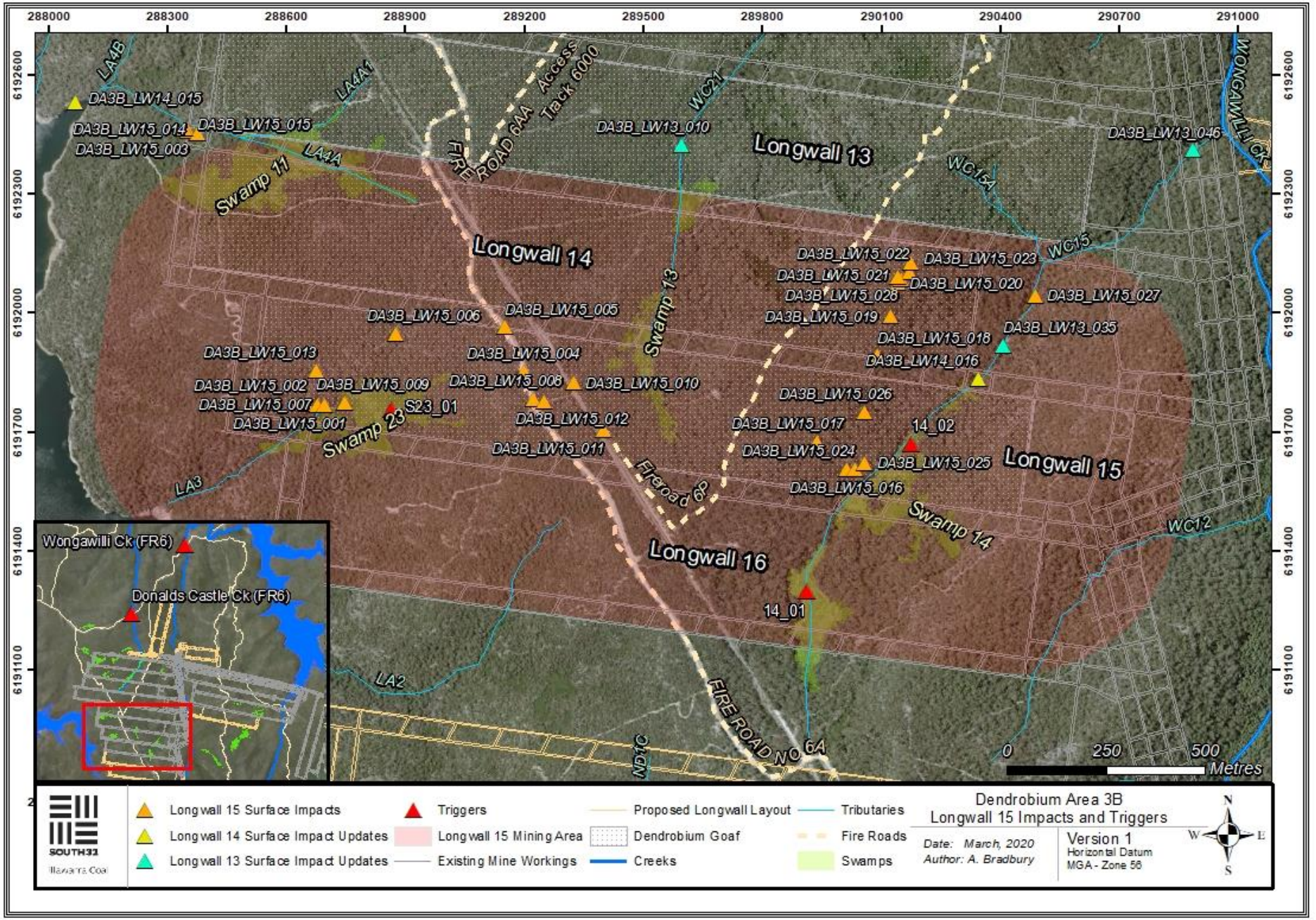


Figure 2: Map showing surface impacts and triggers recorded during Longwall 15.

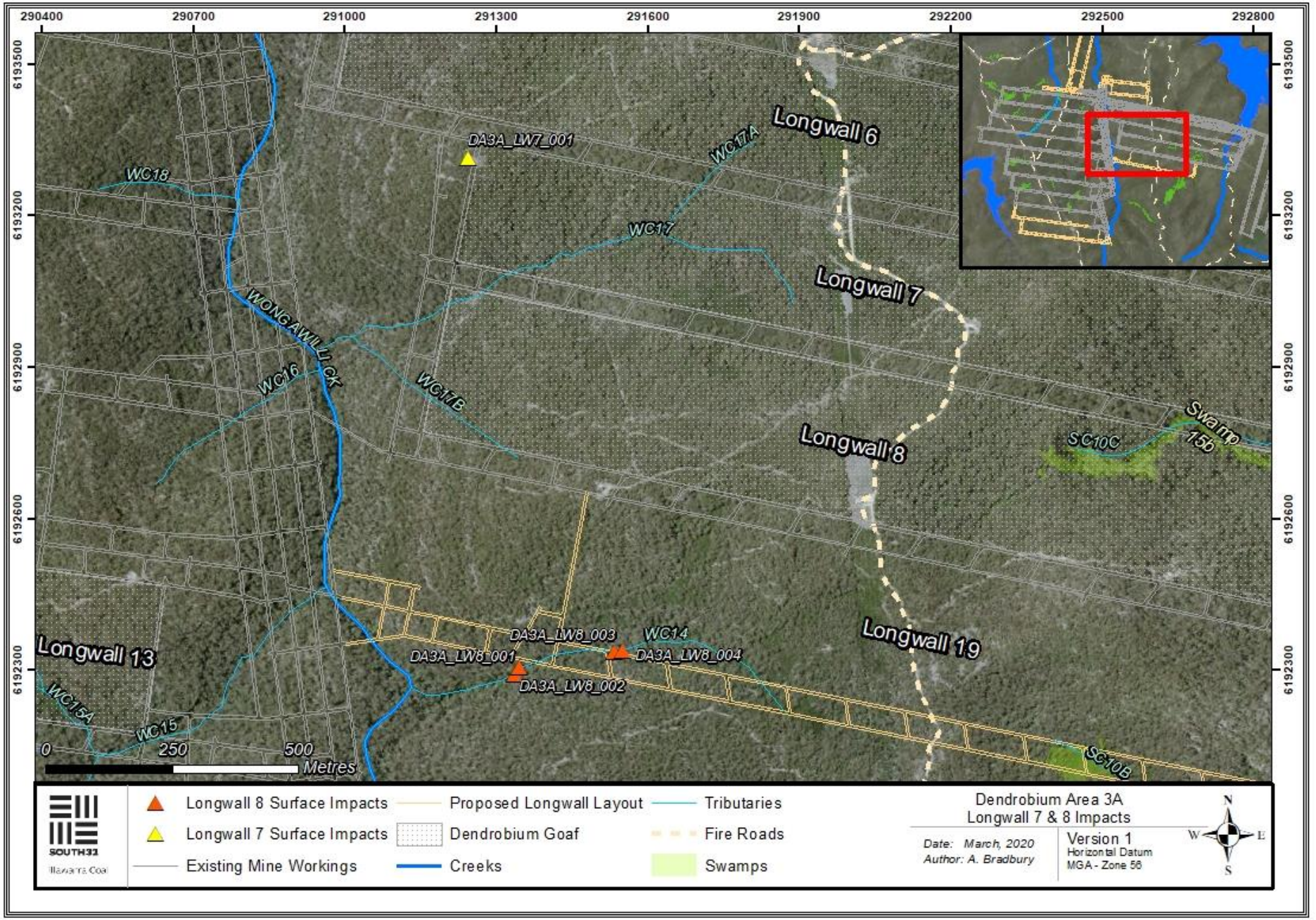


Figure 3: Map showing surface impacts and triggers over Longwall 7 and 8, recorded during Longwall 15.

5 IMPACTS TO FIRST AND SECOND ORDER STREAMS

Five first and second order streams were monitored as part of the Longwall 15 monitoring program- *LA2, LA3, LA4A, WC15, WC12*. Impacts observed at these streams during Longwall 15 are described below.

5.1 LA4A

DA3B_LW15_003

DA3B_LW15_003 is located on *LA4A*, a tributary to Lake Avon. The impacted feature, *LA4A_Step 3A*, is situated 80m north-west of the commencing end of Longwall 14 (Figure 2). It is likely this impact occurred during the extraction of Longwall 14, however, only later become visible due to rainfall events which dislodged vegetation and rock fragments. The impact includes rock fracturing and associated rock fragmentation (Photo 5 to Photo 7). The rock fracturing has a maximum measurable length of 0.5m and a maximum width of 0.02m. The largest rock fragment has a length of 0.30m, a width of 0.03m and a height of 0.19m. No flow diversion was evident due to the location of the fracture on the step. *DA3B_LW15_003* was inspected on 27 February 2020 and remains unchanged from original identification (Photo 8).

<u>Level 1:</u> Crack or fracture up to 100 mm width at its widest point with no observable loss of surface water or erosion, and/ or, crack or fracture up to 10 m width at its widest point with no observable loss of surface water or erosion.

Photo 5: *DA3B_LW15_003,* looking at largest rock fragment. Taken on 17/06/2019.

Photo 6: *DA3B_LW15_003,* looking at a section of rock fracturing. Taken on 17/06/2019.

Photo 7: *DA3B_LW15_003,* overview of impacted area. Taken on 17/06/2019.

Photo 8: *DA3B_LW15_003,* overview of impacted area. Taken on 27/02/2020.

DA3B_LW15_014

DA3B_LW15_014 is located on *LA4A*, a tributary to Lake Avon. The impacted features, *LA4A_Step 3B* and *LA4A_Channel 3A*, are situated approximately 454m north-west of the commencing end of Longwall 15 and 52m north-west of the commencing end of Longwall 14 (Figure 2). It is likely this impact occurred during the extraction of Longwall 14, however has only become visible due to rainfall events which dislodged rock fragments. The impact is comprised of rock fracturing, a rockfall and associated rock fragmentation (Photo 9 and Photo 10). Approximately 10 rock fragments were dislodged from the step. The largest rock fragment has a length of 1.3m, width of 0.8m and height of 0.4m. The rock fracturing has a maximum measurable length of 4.3m, a maximum measurable width of 0.015m and a maximum measurable depth of 0.25m. While not evident during the latest inspection, flow diversion would occur if surface flow was present. *DA3B_LW15_014* was inspected on 27 February 2020 and remains unchanged from original identification (Photo 11).

Level 2: Crack or fracture that results in observable loss of surface water or erosion.

Photo 9: *DA3B_LW15_014,* an overview of the rockfall. Taken on 11/10/2019.

Photo 10: *DA3B_LW15_014,* looking at widest rock fracture. Taken on 11/10/2019.

Photo 11: *DA3B_LW15_014,* an overview of the rockfall. Taken on 27/02/2020.

DA3B_LW15_015

DA3B_LW15_015 is located on *LA4A*, a tributary to Lake Avon. The impacted feature, *LA4A_Rockbar 2*, is situated approximately 480m north-west of the commencing end of Longwall 15 and 80m north-west of the commencing end Longwall 14 (Figure 2). It is likely this impact occurred during the extraction of Longwall 14, however has only become visible due to rainfall events which dislodged vegetation and rock fragments. The impact is comprised of two rock fractures (Photo 12 and Photo 13). The rock fracturing has a maximum length of 1m and a maximum width of 0.002m. While not evident during the latest inspection, flow diversion would occur if surface flow was present. *DA3B_LW15_015* was inspected on 27 February 2020 and remains unchanged from original identification (Photo 14).

Level 2: Crack or fracture that results in observable loss of surface water or erosion.

Photo 12: *DA3B_LW15_015,* looking at a section of rock fracturing. Taken on 11/10/2019.

Photo 13: *DA3B_LW15_015,* looking at a section of rock fracturing. Taken on 11/10/2019.

Photo 14: *DA3B_LW15_015,* looking at a section of rock fracturing. Taken on 02/27/2020.

5.2 WC21

DA3B_LW13_010 *Update*

DA3B_LW13_010 was identified on 27 October 2017 consisting of lateral fracturing to the step at the upstream extent of *WC21_ Pool 53* (Photo 15). This site was mined beneath by Longwall 13 on 24 September 2017 (Figure 2). On 21 August 2019, a rockfall was identified at the site (Photo 16). On 21 August 2019, a further five rock fragments were observed dislodged from the step. The largest fragment was approximately 0.4m^2. Survey results from the site indicated the changes are not subsidence related. On 26 February 2020, additional rock fragmentation was identified. It is likely these rock fragments dislodged from the step during recent rainfall events (455.5mm between 8 February 2020 to 10 February 2020) (Photo 17 and Photo 18).

<u>Level 2:</u> 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.

Photo 15: *DA3B_LW13_010,* step at *WC21_Pool 53*. Taken on 27/10/2017.

Photo 16: *DA3B_LW13_010,* showing rockfall at step. Taken on 21/08/2019.

Photo 17: *DA3B_LW13_010,* step at *WC21_Pool 53*. Taken on 26/02/2020.

Photo 18: *DA3B_LW13_010,* showing rockfall at step. Taken on 26/02/2020.

5.3 WC15

DA3B_LW15_027

DA3B_LW15_027 is located on *WC15*, a tributary of *Wongawilli Creek*. The impacted feature, *WC15_Rockbar 18,* is situated approximately 260m north of Longwall 15 at its closest point (Figure 2). The impact is comprised of rock fracturing and uplift (Photo 19 and Photo 20). The rock fracture has a maximum measurable length of 6m, a maximum width of 0.04m and a depth of approximately 2.5m. The fracture is not located in the direct surface flow path. *DA3B_LW15_027* was inspected on 28 February 2020 and remains unchanged from original identification (Photo 21).

Level 1: Crack or fracture up to 10m length, and/or, crack or fracture up to 100m width.

Photo 19: *DA3B_LW15_027,* looking at rock fracture. Taken on 21/01/2020.

Photo 20: *DA3B_LW15_027,* looking at an area of uplift. Taken on 21/01/2020.

Photo 21: *DA3B_LW15_027,* looking at the rock fracture. Taken on 28/02/2020.

DA3B_LW13_035 Update

DA3B_LW13_035 is located on *WC15_Rockbar 21* and was originally identified during the extraction of Longwall 13 on 23 April 2018 (Figure 2). The impact site is situated approximately 123m north of Longwall 15 at its closest point. Additional fracturing with flow diversion was identified and reported during the extraction of Longwall 14. On 21 January 2020, further fracturing and uplift was observed (Photo 24). The rock fracture has a length of 1m and a width of 0.02m. Uplifted sections are associated with the fracturing. On 26 February 2020, due to recent rainfall events, further rock fragmentation and displacement was evident. Previous rock fragmentation and uplift has been displaced downstream with the largest fragment having a maximum length of 2m, width of 1m and height of 0.4m (Photo 25 to Photo 26).

Level 2: Crack or fracture that results in observable loss of surface water.

Photo 24*: DA3B_LW13_035*, looking at the rock fracture and uplift. Taken on 21/01/2020.

Photo 25: *DA3B_LW13_035*, looking at the area of displaced rock. Taken on 28/02/2020.

Photo 22: *DA3B_LW13_035*, looking at the rock fragmentation.
Taken on 28/02/2020.

Photo 23: *DA3B_LW13_035*, overview of rock fragmentation and displacement. Taken on 28/02/2020.

Photo 26: *DA3B_LW13_035*, looking at largest displaced rock fragment. Taken on 28/02/2020.

DA3B_LW13_046 Update

DA3B_LW13_046 is located on *WC15*, a tributary to *Wongawilli Creek*. The impacted feature, *WC15_Step 2*, is situated approximately 245m east of Longwall 13 and 590m north-east of Longwall 14 (Figure 2). It is likely that this impact occurred during the extraction of Longwall 13 however only become visible on 1 April 2019, due to heavy rainfall events (187.5mm between 15 March and 20 March 2019) which dislodged vegetation and rock fragments. The impact is comprised of a rock fracture and minor rock displacement (Photo 27 and Photo 28). The rock fracture has a maximum measurable length of 1.2m and a maximum width of 0.02m. On 10 March 2020, additional rock fracturing and displacement was evident at *WC15_Pool 2*, following a heavy rainfall event. A section of sandstone bedrock with a length of 1.42m, width of 1.05m and depth of 0.21m, had been displaced 3.2m downstream (Photo 29 and Photo 30). No flow diversion was observed during inspection.

Level 1: Crack or fracture up to 10m length with no observable loss of surface water or erosion.

Photo 27: *DA3B_LW13_046*, looking at the extent of rock fracturing. Taken on 01/04/2019.

Photo 28: *DA3B_LW13_046*, looking at the section of rock displacement. Taken on 01/04/2019.

Photo 29: *DA3B_LW13_046*, looking at the section of rock displaced. Taken on 10/03/2020.

Photo 30: *DA3B_LW13_046*, an overview of the rock displacement. Taken on 10/03/2020.

DA3B_LW14_016 Update

DA3B_LW14_016 is located on *WC15_Rockbar 25* and *Step 25* and was originally identified during the extraction of Longwall 14. The impact site is situated approximately 30m north of Longwall 15 at its closest point (Figure 2). On 21 January 2020, additional fracturing and associated displacement were identified on *WC21_Rockbar 25*, an undercut rockbar (Photo 31 and Photo 32). The fracturing has resulted in the 4m by 2m by 0.15m area of overhanging rock to be displaced approximately 0.1m onto underlying bedrock. On 28 February 2020, further rock fracturing and displacement was evident, likely due to heavy rainfall events. The section of rockbar previously displaced has been further fractured into approximately 6 large pieces, with the largest fragment having a length of 1.5m, width of 1.5m and depth of 0.2m (Photo 33 and Photo 34). A small rock fracture was also present 6m downstream, with a maximum length of 1m and width of 0.01m (Photo 35).

<u>Level 2:</u> Crack or fracture that results in observable loss of surface water.

Photo 31: *DA3B_LW14_016,* looking at the rock fracture and displacement. Taken on 21/01/2020.

Photo 32: *DA3B_LW14_016,* looking at the rock fracture and displacement. Taken on 21/01/2020.

Photo 33: *DA3B_LW14_016,* looking at the rock fracture and displacement. Taken on 28/02/2020.

Photo 34: *DA3B_LW14_016,* looking at the rock fracture and displacement. Taken on 28/02/2020.

Photo 35: *DA3B_LW14_016,* looking at the rock fracture**.** Taken on 28/02/2020.

5.4 WC14

DA3B_LW8_001

DA3A_LW8_001 is located within Dendrobium Area 3A on *WC14*, a tributary to *Wongawilli Creek* and was identified during some mapping of the watercourse The rock fracturing and uplift is situated approximately 433m south of Longwall 8 at its closest point (Figure 3) and has a maximum length of 7m, and a maximum width of 0.005m (Photo 36). Iron staining was observed downstream (Photo 37).

Level 2: *Crack or fracture that results in observable loss of surface water or erosion, and/or, observable increase in iron staining.*

Photo 36: DA3A_LW8_001, looking at the rock fracturing and uplift. Taken on 28/01/2020.

Photo 37: DA3A_LW8_001, iron stained pool located approximately 7m downstream from the impact site. Taken on 28/01/2020.

DA3B_LW8_002

DA3A_LW8_002 is located within Dendrobium Area 3A on *WC14*, a tributary to *Wongawilli Creek*. The fracturing is situated approximately 420m south of Longwall 8 at its closest point (Figure 3). The fracturing has a maximum length of 2m and a maximum width of 0.01m (Photo 38 and Photo 39).

Level 2: Crack or fracture that results in observable loss of surface water or erosion.

Photo 38: DA3A_LW8_002, looking at the rock fracturing and uplift. Taken on 28/01/2020.

Photo 39: *DA3A_LW8_002*, looking at the rock fracturing and uplift. Taken on 28/01/2020.

DA3B_LW8_003

DA3A_LW8_003 is located within Dendrobium Area 3A on *WC14*, a tributary to *Wongawilli Creek*. The rock fracturing is situated approximately 353m south of Longwall 8 at its closest point (Figure 3). The fracturing has a maximum length of 1.8m and a maximum width of 0.005m (Photo 40 and Photo 41). Iron staining was observed downstream (Photo 42).

Level 1: Crack or fracture up to 10m length, and/or, crack or fracture up to 100mm width, and/or, observable increase in iron staining within the mining area.

Photo 40: DA3A_LW8_003, looking at the rock fracturing and uplift. Taken o**n** 28/01/2020.

Photo 41: *DA3A_LW8_003*, looking at the rock fracturing and uplift. Taken o**n** 28/01/2020.

Photo 42: *DA3A_LW8_003*, looking at iron staining on step. Taken on 28/01/2020.

DA3A_LW8_004

DA3A_LW8_004 is located within Dendrobium Area 3A on *WC14*, a tributary to *Wongawilli Creek*. The fracture is situated approximately 348m south of Longwall 8 at its closest point (Figure 3). The fracture has a maximum length of 4.4m, a maximum width of 0.03m and a maximum measurable depth of 0.15m (Photo 43 and Photo 44). The fracture is not located in the direct surface flow path.

Level 1: Crack or fracture up to 10m length, and/or, crack or fracture up to 100mm width.

Photo 43: DA3A_LW8_004, looking at the rock fracturing. Taken on 28/01/2020.

Photo 44: *DA3A_LW8_004*, looking at the rock fracturing and uplift. Taken on 28/01/2020.

6 IMPACTS TO OTHER LANDSCAPE FEATURES

DA3B_LW15_001

DA3B_LW15_001 is located on a 4m step adjacent to *Swamp 23* (Figure 2). The site was mined beneath by Longwall 15 on 28 April 2019. The impact is comprised of rock fracturing and a small rockfall (Photo 45 and Photo 46). The rock fracturing has a maximum measurable length of 1m and a maximum width of 0.01m. The largest rock fragment resulting from the rockfall has a length of 0.40m, width of 0.15m and height of 0.15m. *DA3B_LW15_001* was inspected on 26 February 2020 and remains unchanged from original identification (Photo 47).

Level 1: Crack or fracture up to 100m width, and/or, crack or fracture up to 10m length, and/or, rockfall from a cliff (step) which is left mostly intact (<10% length) resulting in insignificant ground disturbance.

Photo 45: *DA3B_LW15_001,* looking at a section of rockfall. Taken on 29/05/2019.

Photo 46: *DA3B_LW15_001,* looking at a section of rock fracturing. Taken on 29/05/2019.

Photo 47: *DA3B_LW15_001,* looking at a section of rock fracturing. Taken on 26/02/2020.

DA3B_LW15_002

DA3B_LW15_002 is located on a 4m step adjacent to *Swamp 23* (Figure 2). The site was mined beneath by Longwall 15 on 25 April 2019. The impact is comprised of a rockfall with a length of 3m, width of 2m and height of 1m (Photo 48 and Photo 49). *DA3B_LW15_002* was inspected on 26 February 2020 and remains unchanged from original identification (Photo 50).

<u>Level 1:</u> Rockfall from a cliff (step) which is left mostly intact (<10% length) resulting in insignificant ground disturbance.

Photo 48: *DA3B_LW15_002*, looking at the rockfall. Taken on 29/05/2019.

Photo 49: *DA3B_LW15_002*, looking at the rockfall. Taken on 29/05/2019.

Photo 50: *DA3B_LW15_002*, looking at the rockfall. Taken on 26/02/2020.

DA3B_LW15_006

DA3B_LW15_006 consists of soil cracking and rock fracturing to access track and sandstone outcrop, north of *Swamp 23* (Figure 2). The soil cracking has a length of 2.9m, width of 0.01m and maximum measurable depth of 0.3m (Photo 51). The rock fracturing has a maximum measurable length of 0.7m, width of 0.01m wide and depth of 0.3m (Photo 52). The soil cracking appears stable and should self-remediate over time through natural processes.

<u>Level 1:</u> Crack or fracture less than 10m in length, and/or, crack or fracture up to 100mm width.

Photo 51: *DA3B_LW15_006*, looking at soil cracking. Taken on 09/07/2019.

Photo 52: *DA3B_LW15_007*, looking at rock fracture. Taken on 09/07/2019.

Photo 53: *DA3B_LW15_006*, looking at soil cracking. Taken on 09/07/2019.

DA3B_LW15_007

DA3B_LW15_007 is located on a step to the north of *Swamp 23* (Figure 2). The site was mined beneath by Longwall 15 on 30 April 2019. The impact consists of rock fracturing with a length of 2.3m and width of 0.05m (Photo 54 and Photo 55). *DA3B_LW15_007* was inspected on 26 February 2020 and remains unchanged from original identification (Photo 56).

Level 1: Rockfall from a cliff (step) which is left mostly intact (<10% length) resulting in insignificant ground disturbance.

Photo 54: *DA3B_LW15_007*, looking at fracturing on step. Taken on 09/07/2019.

Photo 55: *DA3B_LW15_007*, looking at width of fracturing. Taken on 09/07/2019.

Photo 56: *DA3B_LW15_007*, looking at fracturing on step. Taken on 26/02/2020.

DA3B_LW15_009

DA3B_LW15_009 consists of a small rockfall to an overhanging ledge, north of *Swamp 23* (Figure 2). The site was mined beneath by Longwall 15 on 4 April 2019. The fragment of rock fallen from the ledge is approximately 0.2m^3 (Photo 57 and Photo 58). *DA3B_LW15_009* was inspected on 26 February 2020 and remains unchanged from original identification (Photo 59).

<u>Level 1:</u> Rockfall from a cliff (step) which is left mostly intact (<10% length) resulting in insignificant ground disturbance.

Photo 57: *DA3B_LW15_009,* looking at a section of rockfall. Taken on 29/07/2019.

Photo 58: *DA3B_LW15_009*, looking at rock fragment on ground. Taken on 29/07/2019.

Photo 59: *DA3B_LW15_009,* looking at a section of rockfall. Taken on 26/02/2020.

DA3B_LW15_013

DA3B_LW15_013 is located approximately 10m from SLMMP site '*A3b-SS11'* which is a 7m high sandstone face (Figure 2). The site was mined beneath by Longwall 15 on 26 April 2019. The impact includes rock fracturing and fragmentation (Photo 60 and Photo 61). The rock fracturing has a length of 4m, a maximum width of 0.06m and a maximum measurable depth of 1.7m. The largest rock fragment resulting from the rock fracturing has an approximate volume of 0.2m^3. *DA3B_LW15_013* was inspected on 26 February 2020 and remains unchanged from original identification (Photo 62).

<u>Level 1:</u> Crack or fracture up to 100mm width, and/or, crack or fracture up to 10m length and/or rockfall from a cliff (step) which is left mostly intact (<10% length) resulting in insignificant ground disturbance.

Photo 60: *DA3B_LW15_013*, looking at a section of rock fracturing. Taken on 05/09/2019.

Photo 61: *DA3B_LW15_013*, looking at a section of rock fragmentation. Taken on 05/09/2019.

Photo 62: *DA3B_LW15_013*, looking at a section of rock fracturing. Taken on 26/02/2020.

DA3B_LW15_016

DA3B_LW15_016 is located at the base of a steep slope/step between *Swamp 14* and *Fire Road 6P* (Figure 2). The site was mined beneath by Longwall 15 on 22 October 2019. The impact includes displacement of rock from adjacent soil (Photo 63 and Photo 64). The displacement has a maximum measurable length of 2.5m, a maximum width of 0.02m and a depth of 0.6m. *DA3B_LW15_016* was inspected on 28 February 2020. The displacement has naturally infilled with sediment and debris (Photo 65).

Level 1: Crack or fracture up to 100mm width, and/or, crack or fracture up to 10m length.

Photo 63: *DA3B_LW15_016,* looking at a section of displacement. Taken on 25/10/2019.

Photo 64: *DA3B_LW15_016,* looking at the width of displacement. Taken on 25/10/2019.

Photo 65: *DA3B_LW15_016,* looking at area of previous displacement. Taken on 28/2/2020.

DA3B_LW15_017

DA3B_LW15_017 is located at the base of a steep slope/step between *Swamp 14* and *Fire Road 6P* (Figure 2). The site was mined beneath by Longwall 15 on 11 October 2019. The impact is comprised of a small rockfall (Photo 66). The rock fragment resulting from the rockfall has a length of 0.5m, a width of 0.17m and a height of 0.1m. *DA3B_LW15_017* was inspected on 27 February 2020 and remains unchanged from original identification (Photo 67).

<u>Level 1:</u> Rockfall from a cliff (step) which is left mostly intact (<10% length) resulting in insignificant ground disturbance.

Photo 66: *DA3B_LW15_017,* looking at the area of rockfall. Taken on 25/10/2019.

Photo 67: *DA3B_LW15_017,* looking at the area of rockfall. Taken on 27/02/2020.

DA3B_LW15_018

DA3B_LW15_018 is located at a steep slope between tributary *WC15* and *Fire Road 6P* (Figure 2). The site was mined beneath by Longwall 14 on 12 January 2019. The impact is comprised of a rock fracture with a maximum length of 0.9m, width of 0.03m and horizontal depth of 0.25m (Photo 68). *DA3B_LW15_018* was inspected on 27 February 2020 and remains unchanged from original identification (Photo 69).

Level 1: Crack or fracture up to 100mm width, and/or, crack or fracture up to 10m length.

Photo 68: *DA3B_LW15_018,* looking at the rock fracture. Taken on 25/10/2019.

Photo 69: *DA3B_LW15_018,* looking at the rock fracture. Taken on 27/02/2020.

DA3B_LW15_019

DA3B_LW15_019 is located at a steep slope between tributary *WC15* and *Fire Road 6P* (Figure 2). The site was mined beneath by Longwall 14 on 15 January 2019. The impact is comprised of a rock fracture with a maximum measurable length of 1m, a width of 0.02m and a horizontal depth of 0.22m (Photo 70 and Photo 71). *DA3B_LW15_019* was inspected on 27 February 2020 and remains unchanged from original identification (Photo 72).

Level 1: Crack or fracture up to 100mm width, and/or, crack or fracture up to 10m length.

Photo 70: *DA3B_LW15_019,* looking at width of rock fracture. Taken on 25/10/2019.

Photo 71: *DA3B_LW15_019,* looking at horizontal depth of rock fracture. Taken on 25/10/2019.

Photo 72: *DA3B_LW15_019,* looking at width of rock fracture. Taken on 27/02/2020.

DA3B_LW15_020

DA3B_LW15_020 is located at the base of a steep slope between tributary *WC15* and *Fire Road 6P* (Figure 2). The site was mined beneath by Longwall 14 on 15 January 2019. The impact is comprised of a small rockfall (Photo 73). The rock fragment resulting from the rockfall has a length of 0.4m, a width of 0.2m and a height of 0.09m. *DA3B_LW15_020* was revisited on 27 February 2020 and remains unchanged from original identification (Photo 74).

Level 1: Rockfall from a cliff (step) which is left mostly intact (<10% length) resulting in insignificant ground disturbance.

Photo 73: *DA3B_LW15_020,* looking at area of rockfall. Taken on 25/10/2019.

Photo 74: *DA3B_LW15_020,* looking at area of rockfall. Taken on 27/02/2020.

DA3B_LW15_021

DA3B_LW15_021 is located at SLMMP site *A3b-SS9-Pt1* which is a steep slope/step located between tributary *WC15* and *Fire Road 6P* (Figure 2). The site was mined beneath by Longwall 14 on 16 January 2019. The impact is comprised of a small rockfall (Photo 75). The area of exposed rock has a length of 0.4m, width of 0.12m and height of 0.2m. On 27 February 2020, the width of exposed rock was identified to have increased to 0.27m (Photo 76).

<u>Level 1:</u> Rockfall from a cliff (step) which is left mostly intact (<10% length) resulting in insignificant ground disturbance.

Photo 75: *DA3B_LW15_021,* looking at the area of rockfall. Taken on 25/10/2019.

Photo 76: *DA3B_LW15_021,* looking at the area of rockfall. Taken on 27/02/2020.

DA3B_LW15_022

DA3B_LW15_022 is located at a steep slope/step between tributary *WC15* and *Fire Road 6P* (Figure 2). The site was mined beneath by Longwall 14 on 18 January 2019. The impact is comprised of a rock fracture and associated rock displacement (Photo 77 and Photo 78). The rock fracture has a length of 4m and a width of 0.01m. The rock fragment resulting from the displacement has a length of 0.2m and a height of 0.08m. *DA3B_LW15_022* was revisited on 27 February 2020 and remains unchanged from original identification (Photo 79).

Level 1: Crack or fracture up to 100mm width, and/or, crack or fracture up to 10m length.

Photo 77: *DA3B_LW15_022*, looking at rock fracture. Taken on 25/10/2019.

Photo 78: *DA3B_LW15_022*, looking at area of rock displacement. Taken on 25/10/2019.

Photo 79: *DA3B_LW15_022*, looking at rock fracture. Taken on 27/02/2020.

DA3B_LW15_023

DA3B_LW15_023 is located at a steep slope/step between tributary *WC15* and *Fire Road 6P* (Figure 2). The site was mined beneath by Longwall 14 on 18 January 2019. The impact is comprised of two rock fractures with a maximum length of 25m, a maximum width of 0.08m and a depth greater than 5m (Photo 80 and Photo 81). *DA3B_LW15_023* was revisited on 27 February 2020 and remains unchanged from original identification.

Level 2: Crack or fracture between 10m to 50m in length.

Photo 80: *DA3B_LW15_023,* looking at section of rock fracture. Taken on 25/10/2019.

Photo 81: *DA3B_LW15_023,* looking at width of rock fracture. Taken on 25/10/2019.

DA3B_LW15_024 Update

DA3B_LW15_024 is located at a steep slope/step between *Swamp 14* and *Fire Road 6P* (Figure 2). The site was mined beneath by Longwall 15 on 25 October 2019. The impact was first reported on 23 January 2020. The impact was comprised of a rock fracture and soil uplift (Photo 82 and Photo 83). The rock fracture has a length of 1.8m, a width of 0.005m and a depth of approximately 0.02m. A 1m² area of soil uplift was evident at the base of the steep slope. On 28 February 2020, additional rock uplift was observed approximately 5m from the rock fracturing. The rock fragment had a length of 2m, width of 1.8m, depth 0.7m and uplift of 0.25m.

Level 1: Crack or fracture up to 100mm width, and/or, crack or fracture up to 10m length, and/or, surface movement or rock displacement with negligible soil surface exposed.

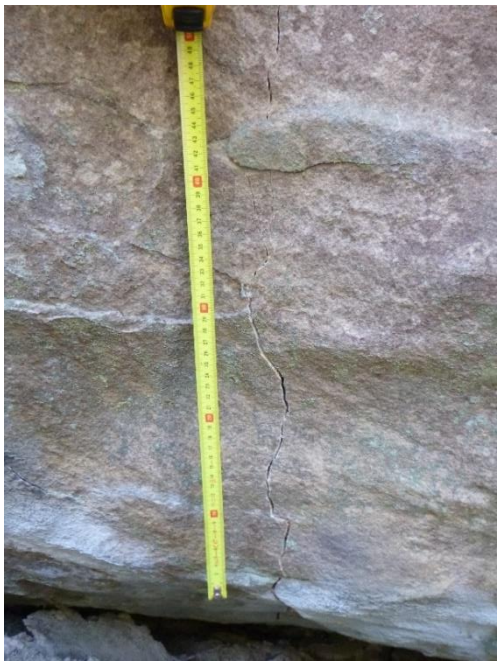


Photo 82: *DA3B_LW15_024,* looking at the rock fracturing. Taken on 21/01/2020.

Photo 83: *DA3B_LW15_024,* looking at area of soil uplift. Taken on 21/01/2020.

Photo 84: *DA3B_LW15_024,* looking at rock uplift. Taken on 28/02/2020.

Photo 85: *DA3B_LW15_024,* looking at rock uplift. Taken on 28/02/2020.

DA3B_LW15_025

DA3B_LW15_025 is located at a steep slope/step between *Swamp 14* and *Fire Road 6P* (Figure 2). The site was mined beneath by Longwall 15 on 29 October 2019. The impact is comprised of a rockfall with associated displacement and fragmentation (Photo 86 and Photo 88). The largest rock fragment resulting from the rockfall has a length of 1.7m, width of 0.5m and height of 1.7m. *DA3B_LW15_025* was inspected on 28 February 2020 and remains unchanged from original identification (Photo 89).

Level 1: Rockfall from a cliff (step) which is left mostly intact (<10% length) resulting in insignificant ground disturbance.

Photo 86: *DA3B_LW15_025,* looking at the rockfall. Taken on 21/01/2020.

Photo 87**:** *DA3B_LW15_025,* looking at the rockfall. Taken on 21/01/2020.

Photo 88: *DA3B_LW15_025,* overview of the rockfall. Taken on 21/01/2020.

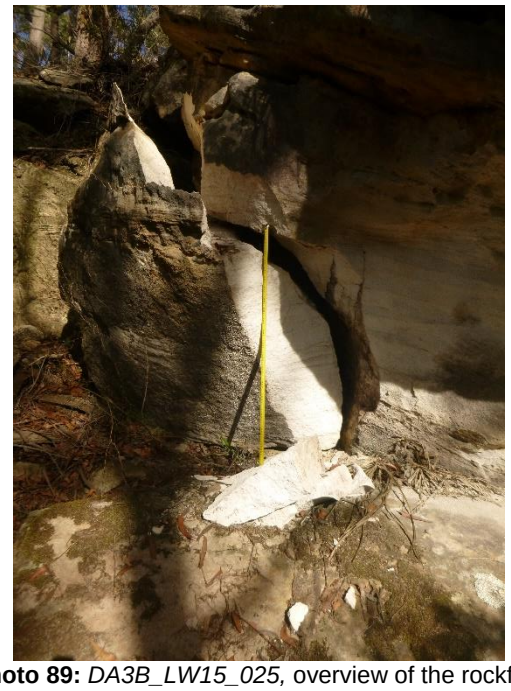


Photo 89: *DA3B_LW15_025,* overview of the rockfall. Taken on 28/02/2020.

DA3B_LW15_026

DA3B_LW15_026 is located at SLMMP site *A3b-SS13* which is a steep slope/step between *Swamp 14* and *Fire Road 6P* (Figure 2). The site was mined beneath by Longwall 15 on 26 October 2019. The impact includes displacement of rock from adjacent soil and associated soil cracking (Photo 90 and Photo 91). The displacement has a maximum measurable length of 1.05m, a maximum width of 0.03m and a depth of approximately 0.2m. *DA3B_LW15_025* was revisited on 27 February 2020 and remains unchanged from original identification (Photo 92).

Level 1: Crack or fracture up to 100mm width, and/or, crack or fracture up to 10m length.

Photo 90: *DA3B_LW15_026,* looking at soil cracking. Taken on 21/01/2020.

Photo 91: *DA3B_LW15_026,* looking at width of soil displacement. Taken on 21/01/2020.

Photo 92: *DA3B_LW15_026,* looking at soil cracking. Taken on 27/02/2020.

DA3B_LW15_028

DA3B_LW15_028 is located at a sandstone outcrop between tributary *WC15* and *Fire Road 6P* (Figure 2). The site was mined beneath by Longwall 14 on 16 January 2019. The impact is comprised of two rock fractures (Photo 93 and Photo 94). The rock fracturing has a maximum length of 5.2m, maximum width of 0.07m and maximum measurable depth of 2.9m. *DA3B_LW15_025* was revisited on 26 February 2020. The depth of the fracture is now 1.3m, likely infilled by debris during the recent rainfall event (Photo 95).

Level 1: Crack or fracture up to 100mm width, and/or, crack or fracture up to 10m length.

Photo 93: *DA3B_LW15_028,* overview of the impact site. Taken on 30/01/2020.

Photo 94: *DA3B_LW15_028,* looking at rock fracturing. Taken on 30/01/2020.

Photo 95: *DA3B_LW15_028,* overview of the impact site. Taken on 26/02/2020.

DA3B_LW14_015 *Update*

DA3B_LW14_015 is located on the cliffline/step edge of Avon Reservoir, approximately 330m from the southern edge of Longwall 12, 350m from the commencing end of Longwall 13 and Longwall 14, and 700m north-west of Longwall 15 (Figure 2). The impact was first reported on 6 December 2018 and was comprised of two distinct rock fractures and a rockfall (Photo **96**). The original rockfall had an approximate length of 4m, width of 1.5m and height of 0.5m. On 11 June 2019, additional rockfalls were observed (Photo **97** and Photo **98**). The impacted length of the cliff line increased to approximately 20m, with eight large boulders, multiple smaller boulders and a tree observed at the base of the cliff. The largest boulder has an approximate length of 5m, width of 3m and height of 1.5m. The site experienced a 42mm rainfall event on 6 June 2019, prior to the changes being identified. *DA3B_LW14_015* was revisited on 26 February 2020 and remains unchanged from previous update (Photo **99**).

<u>Level 2:</u> Rockfall or overhang collapse at a cliff site where characteristics of the cliff have changed, and there has been significant ground disturbance.

Photo 96**:** *DA3B_LW14_015,* looking at the original rockfall. Taken on 5/12/2018.

Photo 97**:** *DA3B_LW14_015,* an overview of the impact site. Taken on 11/6/2019.

Photo 98**:** *DA3B_LW14_015*, looking at the rockfall and associated
debris. Taken on 11/6/2019.

Photo 99**:** *DA3B_LW14_015,* an overview of the impact site. Taken on 26/02/2020.

DA3A_LW7_001

DA3A_LW7_001 is located within Dendrobium Area 3A (DA3A), approximately 20m from the eastern end of Longwall 7 (Figure 3). The impact consists of two fractures to a rock outcrop (Photo 100 and Photo 101). The rock fracture was identified on 20 August 2019, with a maximum length of 21m, width of 0.04m and depth greater than 5m. The fracturing likely occurred during DA3A operations but was only recently identified.

<u>Level 2:</u> Crack or fracture betweeen 10 and 50m length.

Photo 100: *DA3A_LW7_001*, looking at section of cracking. Taken on 20/08/2019.

Photo 101: *DA3A_LW7_001*, looking at width of cracking. Taken on 20/08/2019.

7 TARP TRIGGERS

7.1 Shallow Groundwater

23_01 (Swamp 23)

A swamp groundwater trigger was recorded at borehole *23_01* during analysis of piezometer data for *Swamp 23* (Figure 2). The borehole is located 350 m from the commencing end of Longwall 15. The rate of water level recession (2.79 mm/hour calculated between 24/03/2019 3:00 and 29/03/2019 10:00) has exceeded the rate recorded before mining (0.94 mm/hour calculated between 11/06/17 3:00 and 26/06/17 19:00) (Figure 4).

Level 2: Rate of groundwater level reduction exceeds rate of groundwater level reduction during baseline period at 50% of monitoring sites (within 400 m of mining) within the swamp.

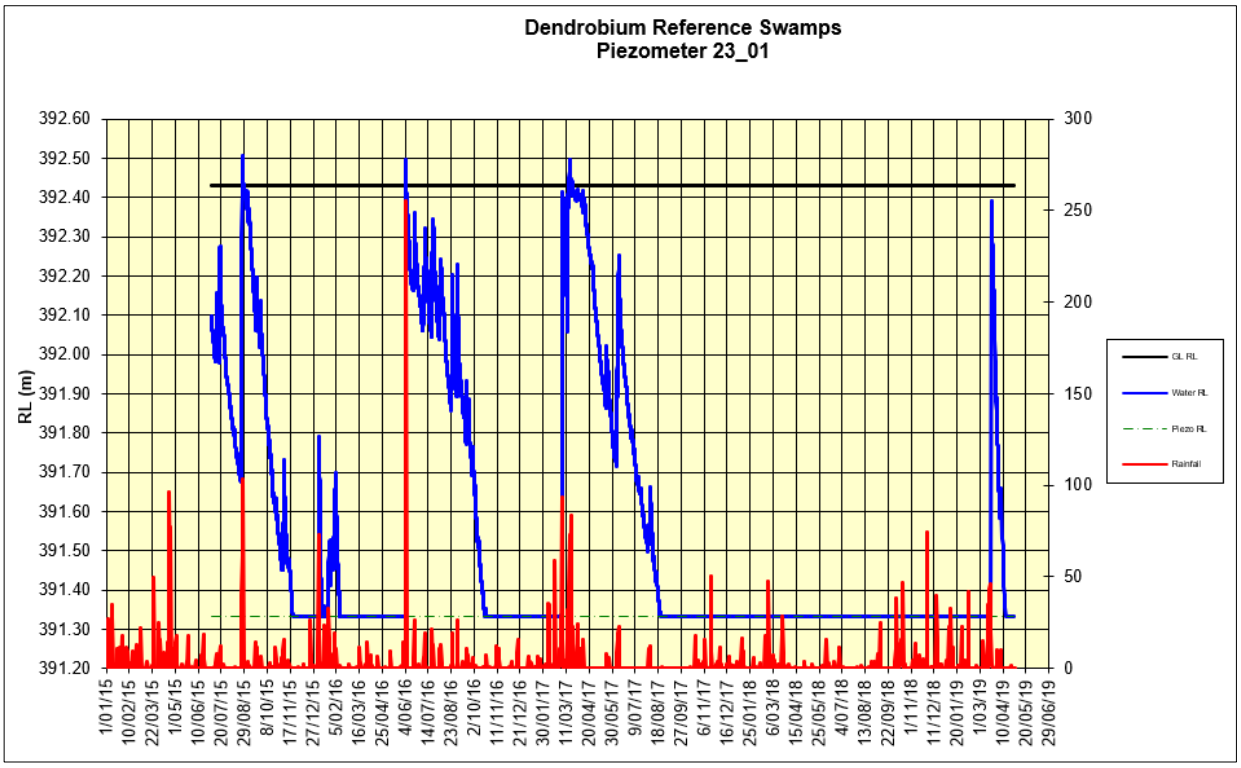


Figure 4: Shallow groundwater level at 23_01, logged hourly. Date range: 02/07/2015 to 28/04/2019.

14_01 (Swamp 14)

A swamp groundwater trigger was recorded at borehole *14_01* during analysis of piezometer data for *Swamp 14* (Figure 2). A piezometer and datalogger were installed at site *14_01* in July 2015. This site is situated over the proposed Longwall 16 and, at its closest point, is approximately 260m south of Longwall 15. Analysis of records at piezometer *14_01* (Figure 5) show water level being lower than the lowest level recorded during the baseline period.

<u>Level 2:</u> Groundwater level lower than baseline level at 50% of monitoring sites (within 400 m of mining) within a swamp.

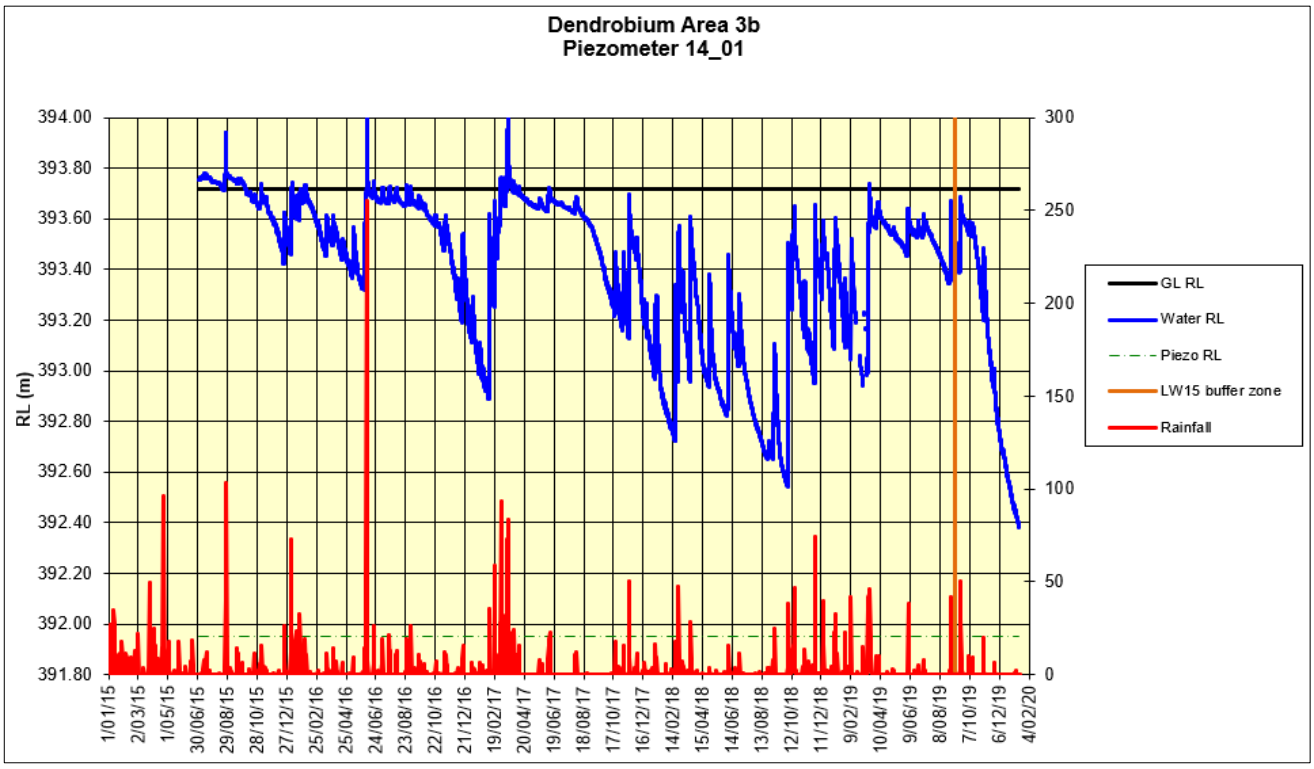


Figure 5: Shallow groundwater levels at *14_01*, logged hourly. Date range: 02/07/2015 to 15/01/2020.

14_02 (Swamp 14)

During analysis of shallow groundwater levels for borehole *14_02*, changes to the rate of water level recession were observed (Figure 2). A piezometer and logger were installed in a hand-augured borehole at site *14_02* in July 2015. A rate of recession trigger was initially reported on 13 February 2019. Specialist assessment undertaken as part of the Longwall 14 End of Panel Report concluded that this trigger was not mining related as a similar effect was observed at reference swamp sites, away from the mining area (HGEO, 2019). Analysis of latest swamp groundwater levels at *14_02* show the recently recorded rate of water level recession (1.35 mm/hour calculated between 20/10/19 19:53 and 28/10/19 15:53) has exceeded the rate recorded before mining (0.64 mm/hour calculated between 9/12/2017 15:00 and 22/12/2017 14:00) (Figure 6). This rate is also greater than the recession rate reported during Longwall 14 (0.89 mm/hour calculated between 29/01/2019 11:00 and 7/02/2019 14:00).

<u>Level 2:</u> Rate of groundwater level reduction exceeds rate of groundwater level reduction during baseline period at 50% of monitoring sites (within 400m of mining) within the swamp.

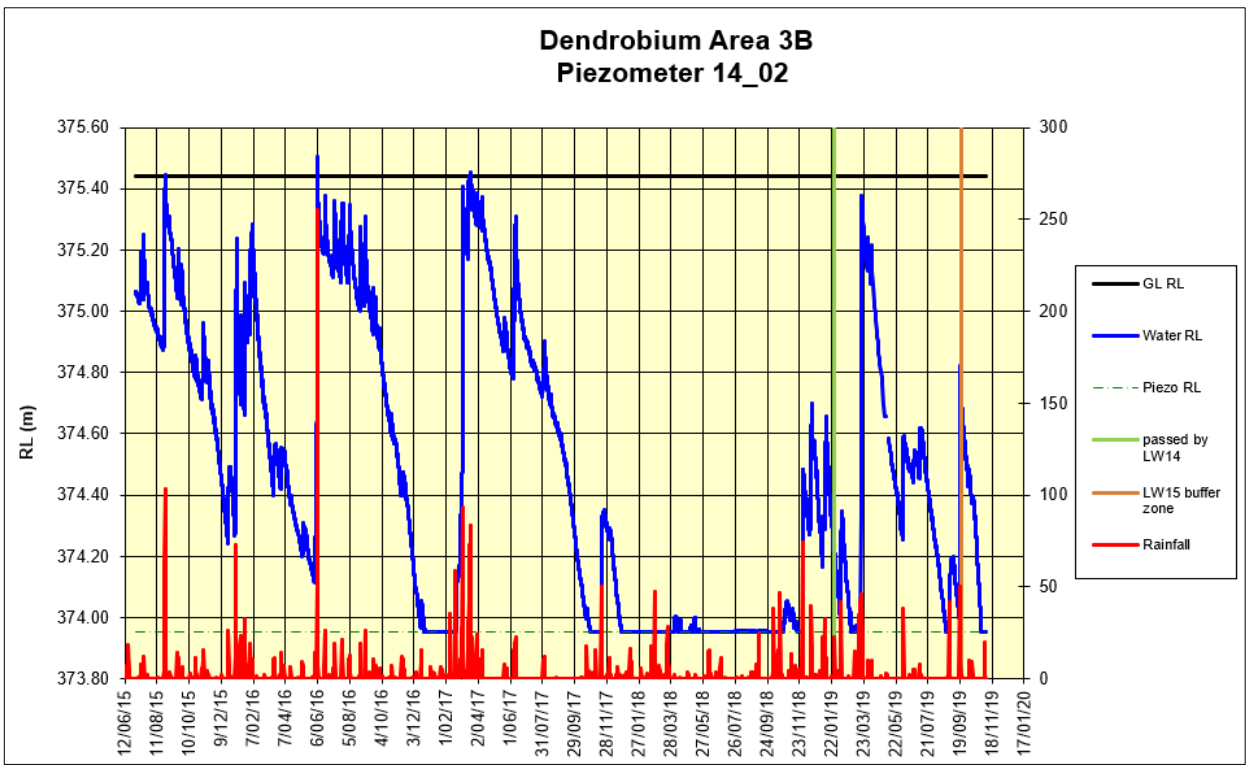


Figure 6: Shallow groundwater levels at *14_02*, logged hourly. Date range: 02/07/2015 to 31/10/2019.

7.2 Soil Moisture

S14_01 (Swamp 14)

A soil moisture trigger was measured at site *S14_01* during analysis of *Swamp 14* soil moisture data (Figure 2). A soil moisture probe and datalogger were installed in January 2016. This site is situated over the proposed Longwall 16 and, at its closest point, is approximately 260m south of Longwall 15. Analysis of records show the average soil moisture level being lower than the lowest baseline record (Figure 7).

<u>Level 3:</u> Soil moisture level lower than baseline level at >80% of monitoring sites (within 400m of mining) within a swamp.

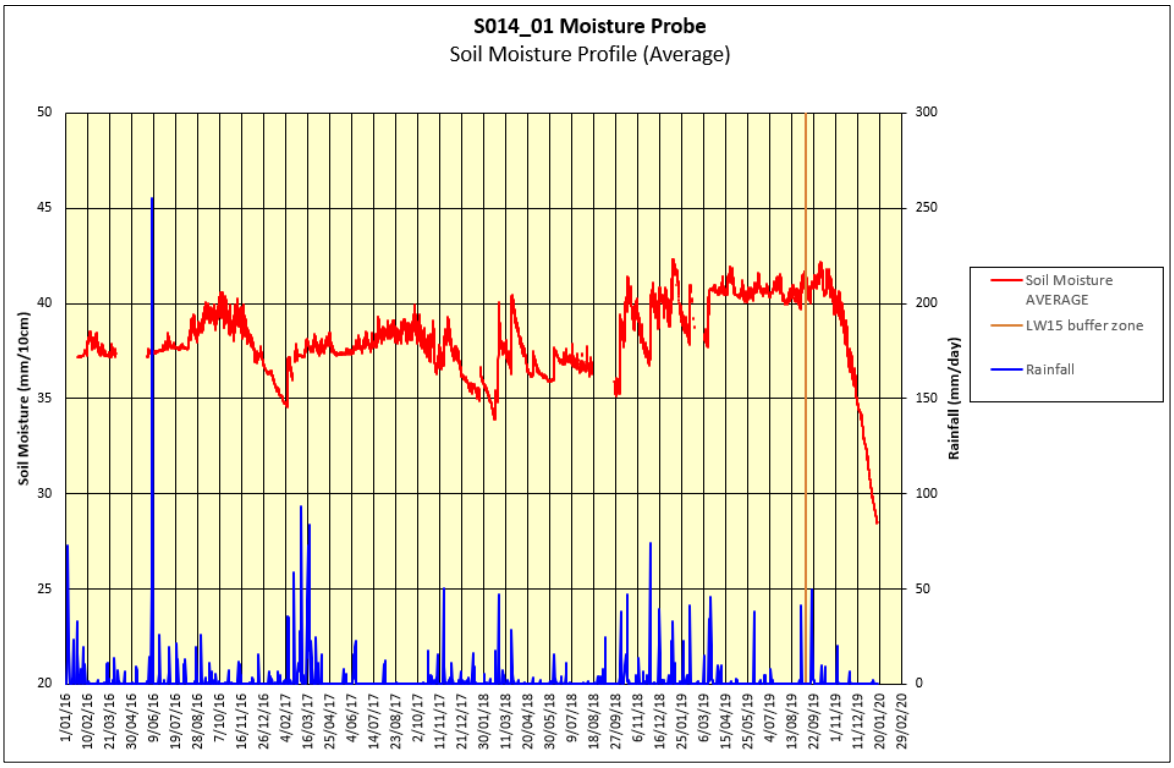


Figure 7: Average soil moisture records at *S14_01*, logged hourly. Date range: 22/01/2016 to 15/01/2020.

S14_02 (Swamp 14)

A soil moisture trigger was measured at site *S14_02* during analysis of *Swamp 14* soil moisture data (Figure 2)**.** A soil moisture probe and datalogger were installed at site *S14_02* in May 2018. Site *S14_02* was mined beneath by Longwall 15 on 23 November 2019. Analysis of records at *S14_02* show the average soil moisture level being lower than the lowest level recorded during the baseline period (Figure 8). Site *S14_02* was originally reported as a Level 2 trigger according to the DA3B Swamp TARP, however has been increased to a Level 3 due to the identified trigger at *S14_01*.

Level 3: Soil moisture level lower than baseline level at >80% of monitoring sites (within 400m of mining) within a swamp.

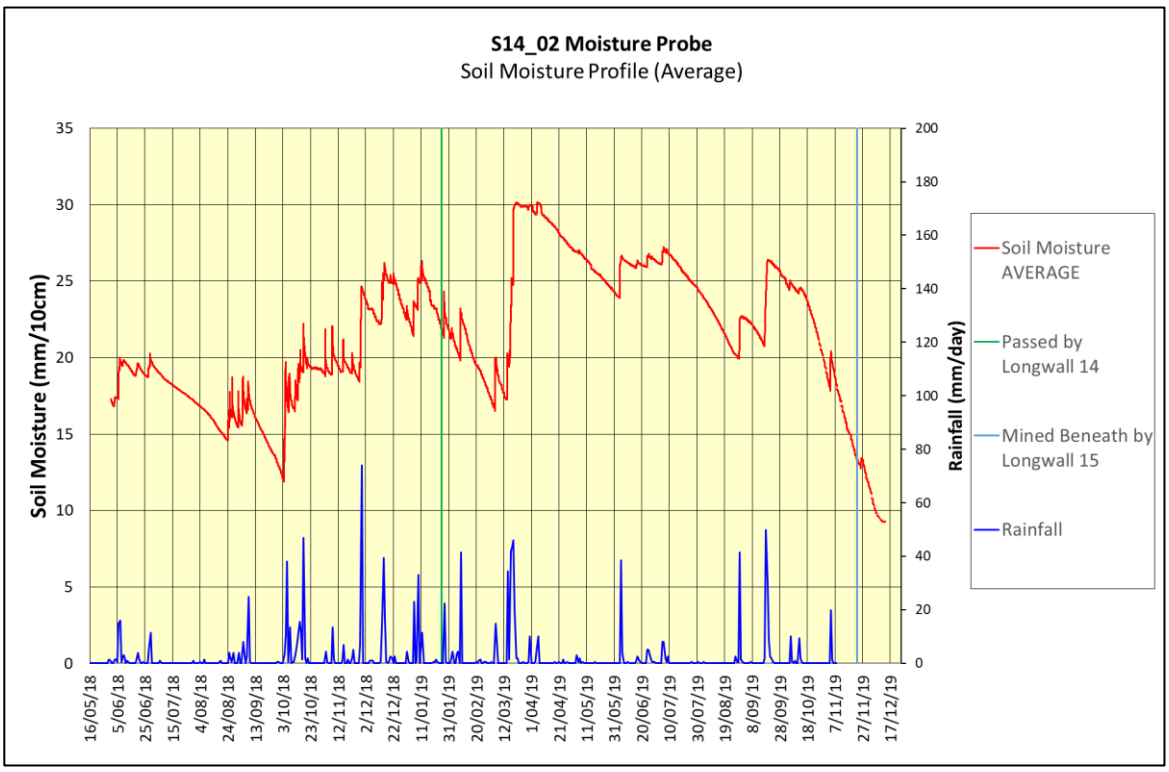


Figure 8: Average soil moisture records at *S14_02*, logged hourly. Date range: 31/05/2018 to 13/12/2019.

7.3 Water Quality

Donalds Castle Creek (FR6)

Donalds Castle Ck (FR6) is a water quality monitoring site approximately 1.4km downstream from DA3B (Figure 2). Water quality triggers for electrical conductivity (EC) were identified during inspections of the site. EC values from 25 March 2019 to 28 October 2019 exceeded the 185.8µS/cm trigger level for EC. The maximum EC value recorded was 344µS/cm on 16 August 2019 (Figure 9). EC values exceeding the trigger level have previously been recorded during the baseline monitoring period. Analysis of mining effect will be included in the specialist Surface and Shallow Groundwater Assessment.

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 µS/cm*
- *DO <40.1%*

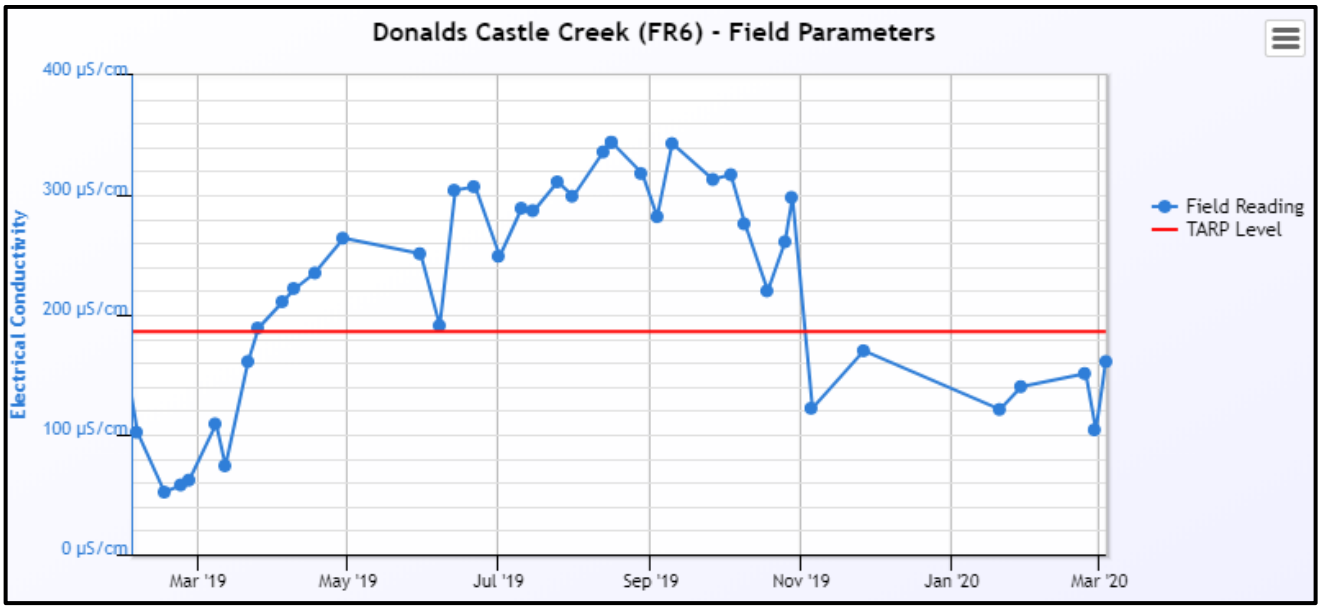


Figure 9: Electrical conductivity recorded at Donalds Castle Creek (FR6) during Longwall 15 extraction.

Wongawilli Creek (FR6)

Wongawilli Ck (FR6) is a water quality monitoring site approximately 3.5km downstream from DA3B (Figure 2). During inspections, water quality triggers for dissolved oxygen (DO) and electrical conductivity (EC) were identified. Two DO readings have been recorded below the 50.5% trigger level (19.1% on 26 November 2019 and 49.4% on 29 January 2020) (Figure 10). Two EC readings have been recorded above the 154.1µS/cm trigger level (162µS/cm on 15 July 2019 and 221µS/cm on 26 November 2019) (Figure 11). DO and EC values outside the trigger level have previously been recorded during the baseline and mining period**.**

No surface flow was present at *Wongawilli Ck (FR6)* during two of the inspections. An absence of surface flow can result in an increase in EC due to evaporation and a decrease in DO due to reduced aeration in the water column.

<u>Level 2:</u> 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 154.1µS/cm

- DO 50.5%

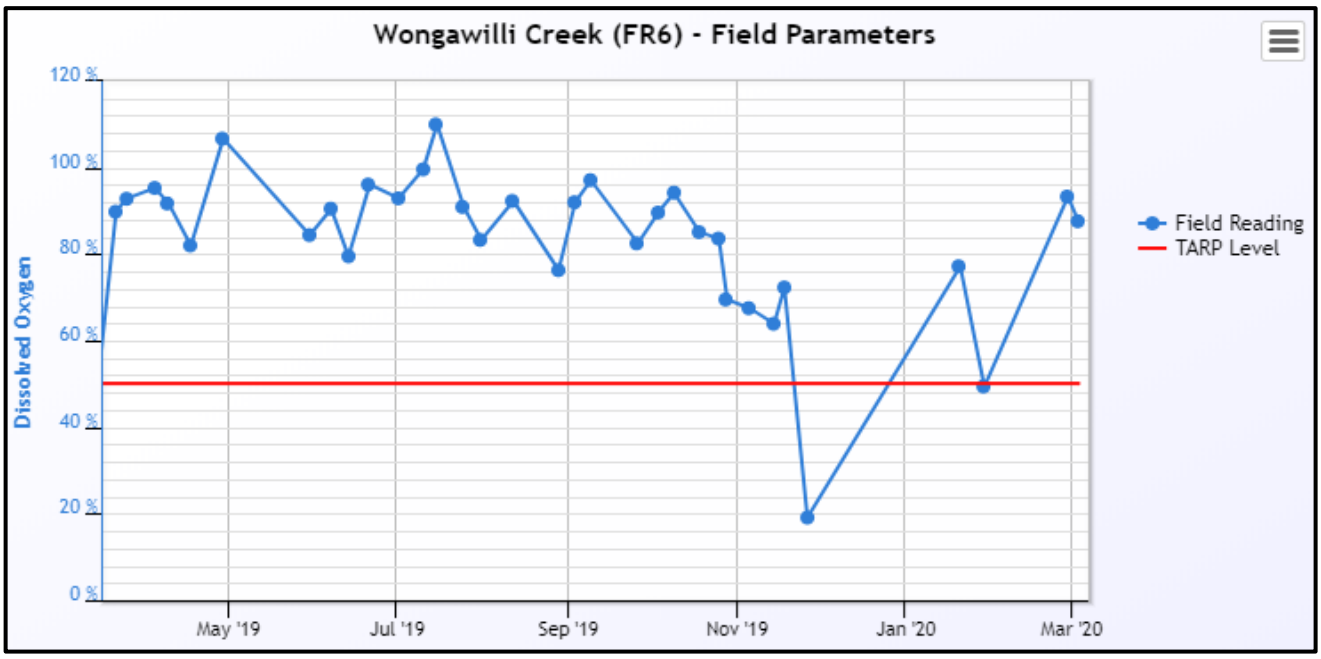


Figure 10: Dissolved oxygen recorded at Wongawilli Creek (FR6) during :Longwall 15 extraction.

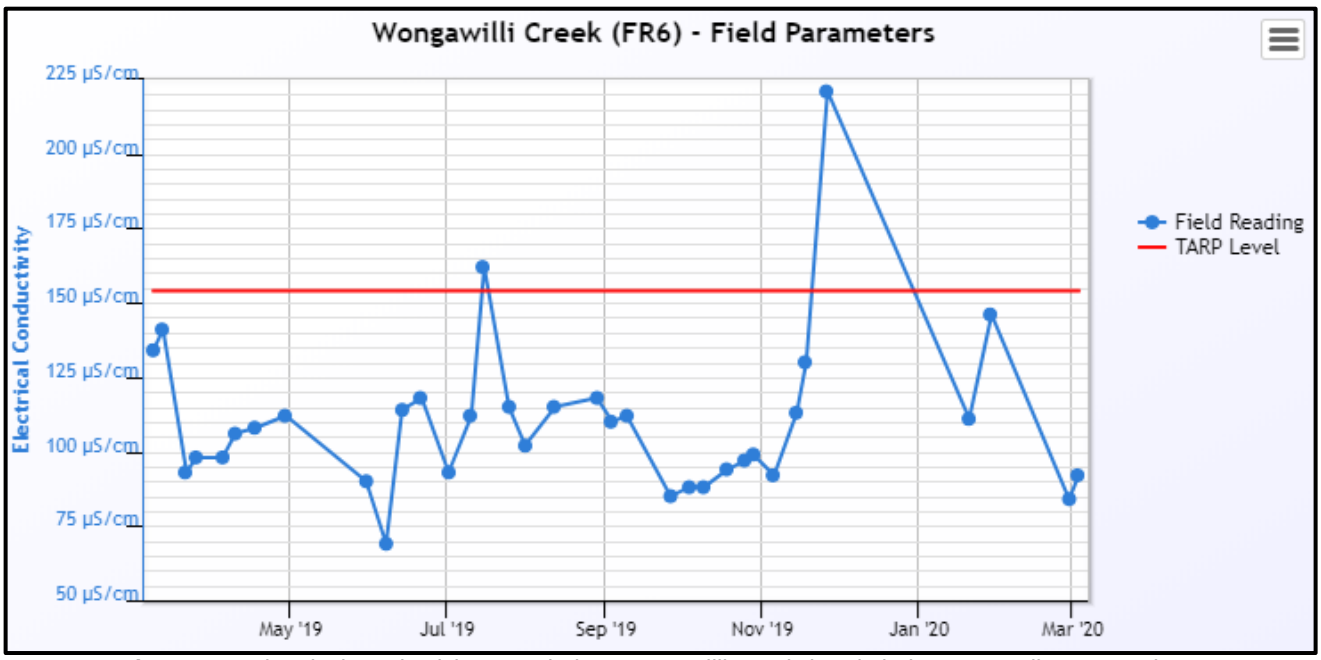


Figure 11: Electrical conductivity recorded at Wongawilli Creek (FR6) during Longwall 15 extraction.

8 IMPACTS TO BUILT FEATURES

Six surface impacts associated with built features were identified during the extraction of Longwall 15 (Table 3). These features include *Fire Road 6A (FR6A), Fire Road 6P (FR6P), railway corridor ballast* and some smaller unnamed access tracks.

8.1 Level 1 Surface Cracking

Four impacts (Table 3) to built features were reported as Level 1 in accordance with the Dendrobium Area 3B SMP (Table 8); specifically:

Level 1: 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.

Photo 102: *DA3B_LW15_005*. Taken on 09/07/2019.

Photo 103: *DA3B_LW15_005*. Taken on 26/02/2020.

Photo 104**:** *DA3B_LW15_010*. Taken on 12/08/2019.

Photo 105: *DA3B_LW15_010*. Taken on 26/02/2020.

Photo 106: *DA3B_LW15_012*. Taken on 28/08/2019.

Photo 107: *DA3B_LW15_012*. Taken on 26/02/2020.

Photo 108: *DA3B_LW15_008.* Taken on 29/07/2019.

Photo 109: *DA3B_LW15_008.* Taken on 26/02/2020.

8.2 Level 2 Surface Cracking

Two impacts (Table 3) to built features were reported as Level 2 in accordance with the DA3B SMP (Table 8); specifically:

<u>Level 2:</u> Crack or fracture between 100mm and 300mm width.
Crack in the fire trail, which could result in significant erosion or impede vehicle access.
Crack or fracture between 10m and 50m length.

Photo 110: *DA3B_LW15_004*. Taken on 09/07/2019.

Photo 111: *DA3B_LW15_004*. Taken on 26/02/2020.

Photo 112: *DA3B_LW15_011*. Taken on 28/08/2019.

Photo 113: *DA3B_LW15_011.* Taken on 28/08/2019.

Photo 114: *DA3B_LW15_011.* Taken on 26/02/2020.

8.3 Remediation

Following approval from WaterNSW, surface cracking across railway corridor ballast and *FR6P* was remediated. Some additional remediation was required following a large rainfall event. The latest inspection showed no further change (Photo 114). Minor soil cracks in other areas are expected to continue to infill through natural processes.

9 ADDITIONAL OBSERVATIONS

9.1 WC15_Pool 34

WC15_Pool 34 experienced low pool water levels during the extraction of Longwall 15 (Figure 12). Water level receded below the installed water level logger, however similar patterns have been observed during the baseline period (Photo 115 to Photo 116). Water level has since risen due to a recent rainfall event (Photo 117). No surface impacts have been observed to date. Monitoring will continue at site.

Photo 115: *WC15_Pool 34*, looking downstream at pool. Taken 29/08/2018.

Photo 116: *WC15_Pool 34*, looking downstream at pool. Taken 13/12/2019.

Photo 117: *WC15_Pool 34*, looking downstream at pool. Taken 24/02/2020.

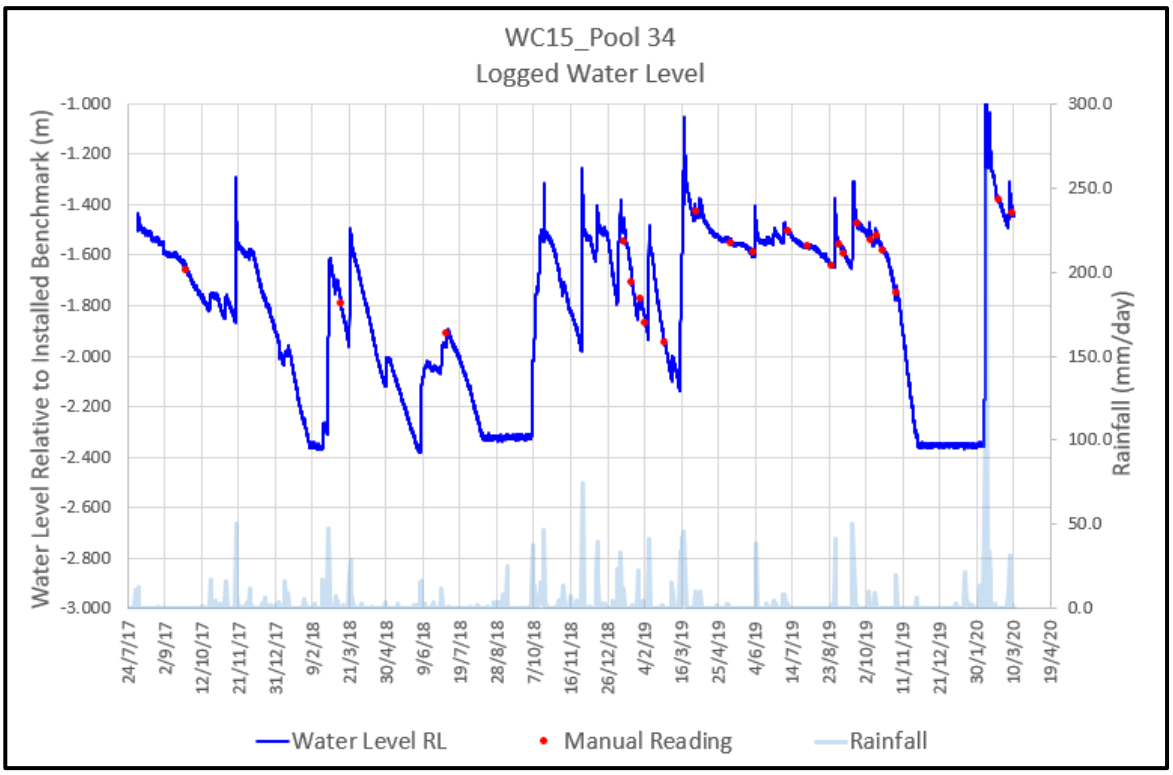


Figure 12: Water levels recorded in *WC15_Pool 34*, logged hourly. 'Flat line' levels indicate water level is below the installed level logger.

9.2 WC15

Increased rock fragmentation and displacement has been observed at *WC15*, following a heavy rainfall event (455.5mm between 8 February 2020 to 10 February 2020). Existing rock fracturing and uplift has been dislodged and displaced downstream from original site (Photo 118 and Photo 119). Monitoring will continue along *WC15* with any further changes reported.

Photo 118: *WC15_Rockbar 21*, looking downstream at rock debris. Taken on 10/03/2020.

Photo 119: *WC15_Pool 21,* looking upstream at rock debris. Taken on 10/03/2020.

9.3 Donalds Castle Creek

Quarterly longitudinal surveys have been conducted in pools along *Donalds Castle Creek* to identify the source of increased electrical conductivity (EC) recorded at *Donalds Castle Creek (FR6)*. The EC trigger level for *Donalds Castle Creek (FR6)* is 185.8µS/cm. Longitudinal surveys were completed on 31 October 2019 and 24 February 2020, including pools that are not routinely monitored. On 31 October 2019, the highest recorded EC value was in *DC_Pool 7* (398µS/cm), located approximately 190m upstream of *Donalds Castle Creek (FR6)* (Electrical conductivity recorded along Donalds Castle Creek on 31/10/2019.. On 24 February 2020, the highest recorded EC value was in *DC_Pool 10* (152µS/cm), located approximately 410m upstream of *Donalds Castle Creek (FR6)* (Figure 14). Results will be further discussed in the specialist Surface Water and Shallow Groundwater Assessment.

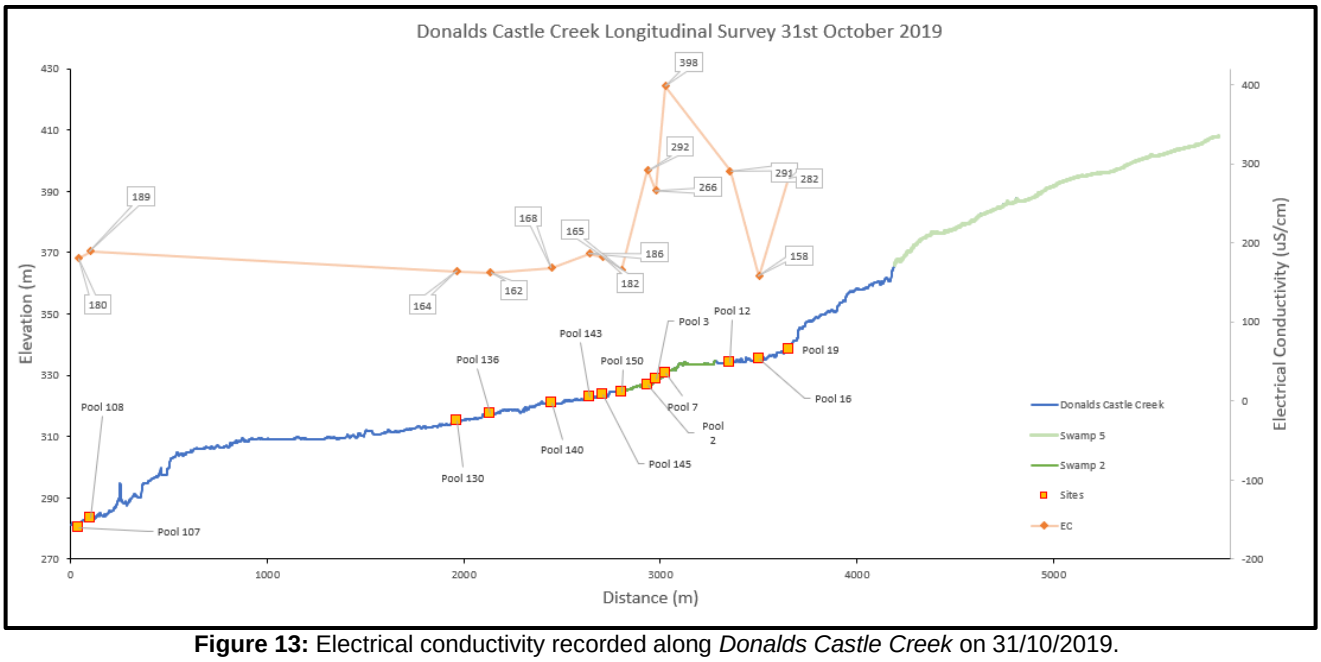


Figure 13: Electrical conductivity recorded along *Donalds Castle Creek* on 31/10/2019.

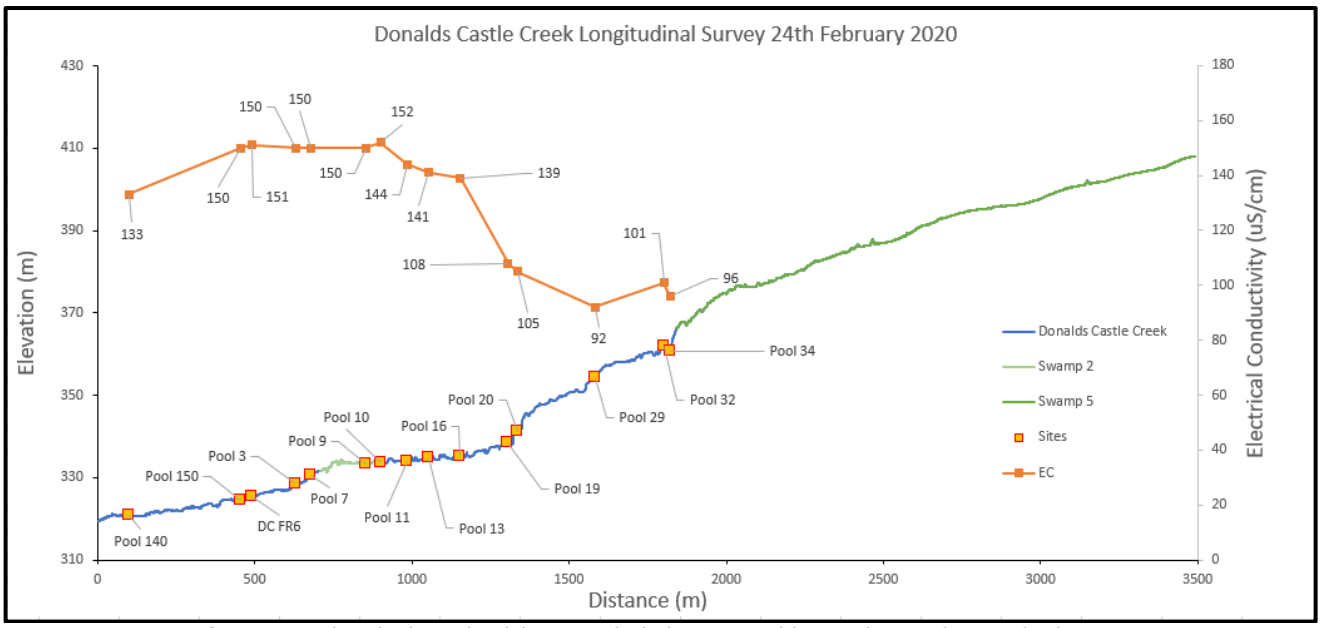


Figure 14: Electrical conductivity recorded along *Donalds Castle Creek* on 24/02/2020.

10 CURRENT AND FUTURE MONITORING

Monitoring undertaken during Longwall 15 and recommendations for future monitoring in Dendrobium Area 3B, particularly concerning Longwall 16, are outlined in Table 4. These recommendations are based on monitoring commitments in the Dendrobium Area 3B SMP, WIMMCP and SIMMCP and the proximity of sites to future longwalls.

The monthly post mining period of 2 years has lapsed for the below features:

- Tributaries DC13, LA4B, LA5, WC18; and
- Swamps 1a/b, 3 and 4.

They will continue to be monitored however at a reduced frequency.

Table 4: Monitoring associated with Longwall 15 and recommendations for monitoring during extraction of Longwall 16.

ASPECT	MONITORING SITES ASSOCIATED WITH LONGWALL 15	MONITORING REQUENCY	RECOMMENDED FUTURE MONITORING FOR LONGWALL 16
Watercourses	**Observational, Photo Point and Water Monitoring**		
	• Donalds Castle Creek • Lake Avon • LA2 • LA3 • LA4, LA4A, LA4B, LA5 • Swamp 23 • Swamps 3, 4, 5, 10, 11, 13 and 14 • WC12, WC15, WC16, WC18 and WC21 • Wongawilli Creek • WC6, WC7, WC8, WC9, • ND1 • Swamps 35a and 35b	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 • Lake Avon • LA2 • LA3 • LA4A • Swamp 23 • Swamps 5, 10, 11, 13 and 14 • WC12 • WC15, WC16 and WC21 • Wongawilli Creek • WC6, WC7, WC8, WC9, ND1 • Swamp 35a/b • Native Dog Creek
	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)	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)

	Lake Avon • LA4_S1, LA4_S2, LA5_S1, LA5_S2, LA_1, LA1, LA2_Pool 5, LA3_Pool 4 **Donalds Castle Creek:** • Donalds Castle Ck (FR6) (Donalds Castle Creek lower) • DC13_Pool 2b (downstream from mining) • DC_Pool 22 (Donalds Castle Creek downstream of mining) • DCL3 (Donalds Castle Creek further downstream site)		**Lake Avon** • LA_1, LA1, LA2_Pool 5, LA3_Pool 4 **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
Swamps	**Observational, Photo Point and Water Monitoring**		
	• Swamps 3, 4, 5, 10, 11 13, 14 and 23	Pre and post mining for two years, monthly when longwall is within 400m of monitoring site	• Swamps 5, 10, 11, 13, 14 and 23, 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_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
	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: 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	• 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 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: 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 15 **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** No targeted cliff lines associated with Longwall 16 **Fire Trails** Fire Road 6A (across active mining area) Fire Road 6N Fire Road 6P
	All mapped cliff, steep slopes, watercourse, swamps 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, swamps and fire trail sites in subsidence area Continue general observation of active mining areas

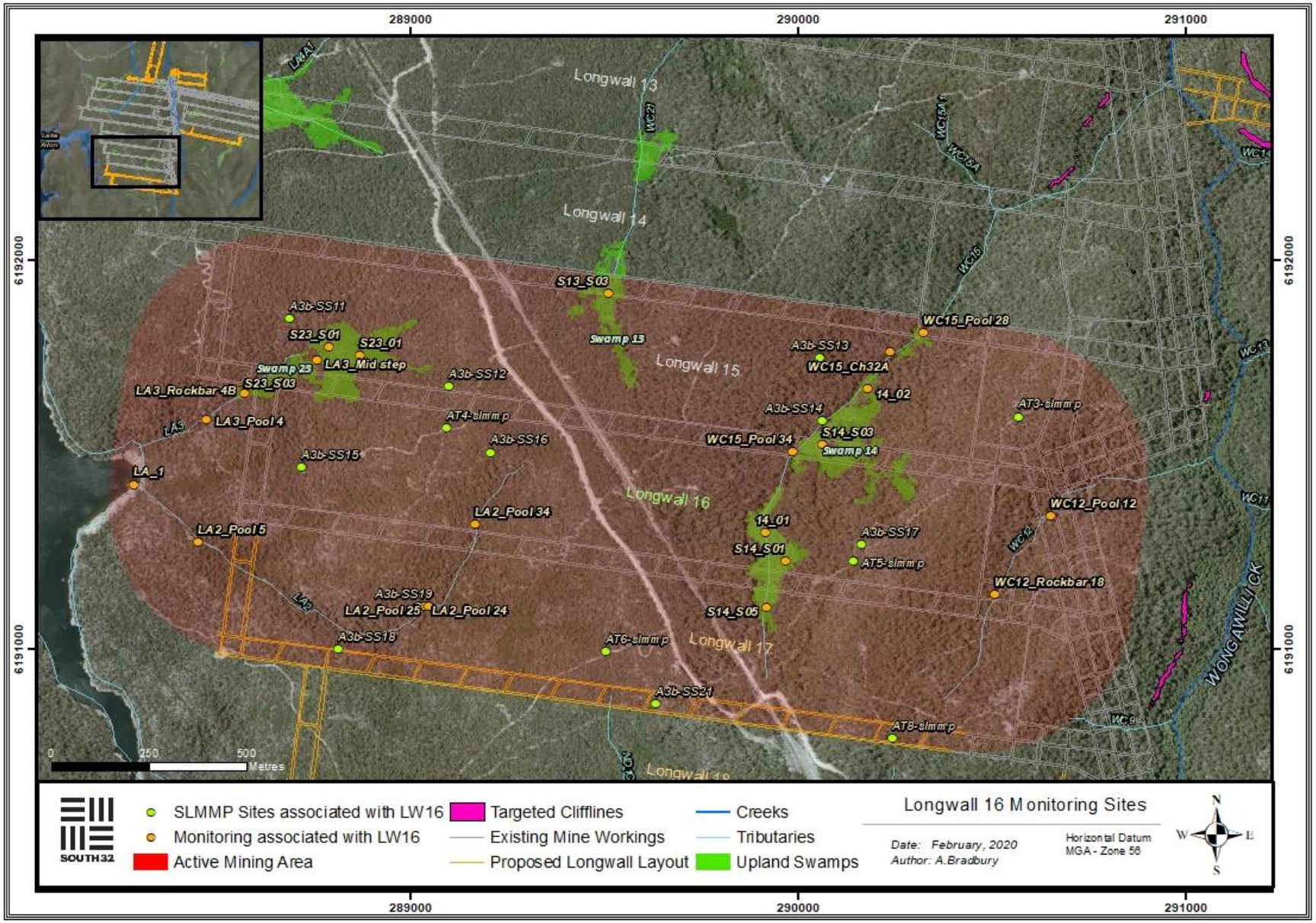


Figure 15: Monitoring sites relevant to Longwall 16.

11 PREDICTED AND OBSERVED IMPACTS

The below table provides a summary of the predicted and observed impacts for Longwall 15 (Table 5).

Table 5: Dendrobium Area 3B Impacts, TARPs & Performance Measures – Longwall 15 End of Panel Report.

Performance Measure	Potential Impacts	*Exceeding* Prediction	TARP Trigger Level	Observed Impacts/Triggers	Additional Comments
Watercourses					
Wongawilli Creek & Donalds Castle Creek *Dendrobium Area 3B SMP Approval:* Minor environmental consequences including: • *minor* fracturing, gas release and iron staining; and • *minor* impacts on water flows, water levels and water quality. *Dendrobium Modified Development Consent:* • Operations shall not cause subsidence impacts at Wongawilli Creek other than "minor	Minor environmental consequences including: minor fracturing, gas release and iron staining; and minor impacts on water flows, water levels and water quality	Observational • Fracturing within Wongawilli Creek and/or Donalds Castle Creek resulting in diversion of flow such that >10% of the pools (in Wongawilli Creek or Donalds Castle Creek) have water levels lower than baseline period • Measured surface water flow reduction in Wongawilli Creek and/or Donalds Castle Creek at its confluence with Cordeaux River that is greater than predicted by the groundwater model (to the satisfaction of the Director General - Condition 13 of the SMP) that cannot be	Observational ***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	No Level 1 impacts observed	

Performance Measure	Potential Impacts	*Exceeding* Prediction	TARP Trigger Level	Observed Impacts/Triggers	Additional Comments
impacts" (such as minor fracturing, gas release, iron staining and minor impacts on water flows, water levels and water quality); • Operations will not result in reduction (other than negligible reduction) in the quality or quantity of surface water or groundwater inflows to Lake Cordeaux or Lake Avon or surface water inflow to the Cordeaux River at its confluence with Wongawilli Creek.		attributed to natural variation • 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)	***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	**Wongawilli Ck (FR6)-** Two exceedances of the +3 standard deviation level from the baseline mean for electrical conductivity and dissolved oxygen. (*Further discussed in Surface and Shallow Groundwater Assessment*)	See impact report dated: - 7/02/2020
			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	**Donalds Castle Creek (FR6)-** Three exceedances of the +3 standard deviation level from the baseline mean for electrical conductivity. (*Further discussed in Surface and Shallow Groundwater Assessment*)	See impact report dated: - 28/3/2019 - 31/05/2019

Performance Measure	Potential Impacts	*Exceeding* Prediction	TARP Trigger Level	Observed Impacts/Triggers	Additional Comments
			• 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		
		<u>Pool Water Level</u> Fracturing resulting in diversion of flow such that >10% of the pools have water levels lower than baseline period	<u>Pool Water Level</u> ***Level 1*** • Fracturing not resulting in diversion of flow	No Level 1 impacts observed	
			Level 2 • Fracturing resulting in diversion of flow	No Level 2 impacts observed	
			Level 3 • Fracturing resulting in diversion of flow such that <10% of the pools have water levels lower than baseline period	No Level 3 impacts observed	

Performance Measure	Potential Impacts	*Exceeding* Prediction	TARP Trigger Level	Observed Impacts/Triggers	Additional Comments
	<u>Drainage lines</u> • Changes in the natural gradient and stream alignment • Changes in the levels of ponding, flooding and scouring of the banks • Surface fracturing • Surface water diversion • Induction of ferruginous springs *N.B. Not linked specifically to a performance measure*	• 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)	***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	• Impact **DA3B_LW15_027** – Rock fracturing to *WC15_Rockbar 18.* • Impact **DA3B_LW15_003** – Rock fracturing and fragmentation to *LA4A_Step 3A*. • Impact **DA3A_LW8_001** – Rock fracturing and uplift to *rockbar*. • Impact **DA3A_LW8_002** – Rock fracturing and uplift to *rockbar*.	See impact report dated: - 23/01/2020 See impact report dated: - 19/06/2019 See impact report dated: - 7/02/2020 See impact report dated: - 7/02/2020

Performance Measure	Potential Impacts	*Exceeding* Prediction	TARP Trigger Level	Observed Impacts/Triggers	Additional Comments
		• 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)	***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	• Impact **DA3B_LW13_010 (Update)** – Rock fracturing to *WC21_Pool 53*. • Impact **DA3B_LW13_035 (Update)** – Rock fracturing to *WC15_Rockbar 21*. • Impact **DA3B_LW13_046 (Update)** – Rock fracturing to *WC15_Pool 2*. • Impact **DA3B_LW14_015 (Update)** – Rockfall on Avon Reservoir cliff edge. • Impact **DA3B_LW14_016 (Update)** – Rock fracturing to *WC15_Rockbar 25*. • Impact **DA3B_LW15_014** – Rockfall, rock fracturing and fragmentation to LA4A_Step 3B and *LA4A_Channel 3A*. • Impact **DA3B_LW15_015** – Rock fracturing to *LA4A_Rockbar 2.* • Impact **DA3B_LW8_003** – Rock fracturing and uplift to *step.* • Impact **DA3B_LW8_004** – Rock fracturing and uplift to *rockbar*.	See impact report dated: - 23/08/2019 See impact report dated: - 23/01/2020 See impact report dated: - 3/04/2019 See impact report dated: - 12/06/2019 See impact report dated: - 23/01/2020 See impact report dated: - 15/10/2019 See impact report dated: - 15/10/2019 See impact report dated: - 15/10/2019 See impact report dated: - 15/10/2019

Performance Measure	Potential Impacts	*Exceeding* Prediction	TARP Trigger Level	Observed Impacts/Triggers	Additional Comments
			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	No Level 3 impacts observed	

Performance Measure	Potential Impacts	*Exceeding* Prediction	TARP Trigger Level	Observed Impacts/Triggers	Additional Comments
SWAMPS					
	Falls in surface or near-surface groundwater levels in swamps. *N.B. not linked specifically to a performance measure 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).	No Level 1 impacts observed	
			Level 2 Groundwater level lower than baseline level at 50% 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 a 50% of monitoring sites (within 400m of mining) within the swamp.	• **Swamp 23 (23_01):** Rate of groundwater level reduction exceeds rate of groundwater level reduction during baseline period at 50% of monitoring sites (within 400m of mining) within the swamp. • **Swamp 14 (14_01)**: Groundwater level lower than baseline level at 50% of monitoring sites (within 400m of mining) within a swamp.	See impact report dated: - 03/05/2019 See impact report dated: - 16/01/2020

Performance Measure	Potential Impacts	*Exceeding* Prediction	TARP Trigger Level	Observed Impacts/Triggers	Additional Comments
			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 400m of mining) within the swamp.	• **Swamp 14 (14_02)**: Rate of groundwater level reduction exceeds rate of groundwater level reduction during baseline period at 50% of monitoring sites (within 400m of mining) within the swamp.	See impact report dated: - 08/11/2019
	Falls in soil moisture levels in swamps. *N.B. Not linked specifically to a performance measure 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 400m of mining) within a swamp (in comparison to reference swamps).	No Level 1 impacts observed.	
			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)	No Level 2 impacts observed.	

Performance Measure	Potential Impacts	*Exceeding* Prediction	TARP Trigger Level	Observed Impacts/Triggers	Additional Comments
			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).	• **Swamp 14 (S14_01)**: Soil moisture level lower than baseline level at >80% of monitoring sites (within 400m of mining) within a swamp. • **Swamp 14 (S14_02)**: Soil moisture level lower than baseline level at >80% of monitoring sites (within 400m of mining) within a swamp.	See impact report dated: - 16/01/2020 See impact report dated: - 17/12/2019
LANDSCAPE					
	The cliffs located in the SMP Area are all located outside the extents of the proposed longwalls, at minimum distances of 30m to 460m at the closest points. It is possible therefore that		***Level 1*** • Rockfall 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	• Impact **DA3B_LW15_001** – Rock fracturing and rockfall to a sandstone outcrop. • Impact **DA3B_LW15_002** – Rockfall at a step. • Impact **DA3B_LW15_005** – Soil cracking and uplift to FR6A. • Impact **DA3B_LW15_006** –	See impact report dated: - 31/05/2019 See impact report dated: - 31/05/2019 See impact report dated: - 11/07/2019 See impact report dated: - 11/07/2019

Performance Measure	Potential Impacts	*Exceeding* Prediction	TARP Trigger Level	Observed Impacts/Triggers	Additional Comments
	some small isolated rockfalls could occur along the cliffs as a result of the extraction of the proposed longwalls. It is not expected however, that, any large scale cliff instabilities would occur based on previous experience. Impacts to steep slopes due to mining induced subsidence are most likely to occur in the form of surface cracks. Experience indicates that the likelihood of large-scale down-slope movements is extremely low due to the high depth of cover within the SMP Area. If tension cracks do develop it is possible that soil erosion may occur if the cracks are left untreated. Some remediation may therefore be required.		• 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	Soil cracking and rock fracturing to access track. • Impact **DA3B_LW15_007** – Rock fracturing to step. • Impact **DA3B_LW15_008** – Soil cracking and uplift to FR6A. • Impact **DA3B_LW15_009** – Rockfall to steep slope/step. • Impact **DA3B_LW15_010** – Soil cracking and uplift to closed access track. • Impact **DA3B_LW15_012** – Soil cracking to access track. • Impact **DA3B_LW15_013** – Rock fracturing and fragmentation to steep slope/step. • Impact **DA3B_LW15_016** – Rock displacement at a steep slope. • Impact **DA3B_LW15_017** – Rockfall at a steep slope. • Impact **DA3B_LW15_018** – Rock fracturing at a steep slope. • Impact **DA3B_LW15_019** – Rock fracturing at a steep slope. • Impact **DA3B_LW15_020** – Rockfall at a steep slope.	See impact report dated: - 11/07/2019 See impact report dated: - 30/07/2019 See impact report dated: - 30/07/2019 See impact report dated: - 23/08/2019 See impact report dated: - 30/08/2019 See impact report dated: - 06/09/2019 See impact report dated: - 28/10/2019 See impact report dated: - 28/10/2019 See impact report dated: - 28/10/2019 See impact report dated: - 28/10/2019 See impact report dated: - 28/10/2019

Performance Measure	Potential Impacts	*Exceeding* Prediction	TARP Trigger Level	Observed Impacts/Triggers	Additional Comments
				• Impact **DA3B_LW15_021** – Rockfall at a SLMMP site *A3b-SS9-Pt1.*	See impact report dated: - 28/10/2019
				• Impact **DA3B_LW15_022** – Rock fracturing at a steep slope.	See impact report dated: - 28/10/2019
				• Impact **DA3B_LW15_024** – Rock fracturing at a steep slope.	See impact report dated: - 23/01/2020
				• Impact **DA3B_LW15_025** – Rockfall at a steep slope.	See impact report dated: - 23/01/2020
				• Impact **DA3B_LW15_026** – Soil cracking and displacement at SLMMP site A3B-SS13.	See impact report dated: - 23/01/2020
				• Impact **DA3B_LW15_028** – Rock fracturing to a sandstone outcrop.	See impact report dated: - 07/02/2020
			Level 2 • Rockfall 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	• Impact **DA3B_LW15_004** – Soil Cracking to FR6A.	See impact report dated: - 11/07/2019
				• Impact **DA3B_LW15_011** – Soil Cracking to Ballast and FR6P.	See impact report dated: - 30/08/2019
				• Impact **DA3B_LW15_023** – Rock fracturing at a steep slope.	See impact report dated: - 28/10/2019
				• Impact **DA3B_LW7_001** – Rock fracturing to a rock outcrop over DA3A.	See impact report dated: - 23/08/2019

Performance Measure	Potential Impacts	*Exceeding* Prediction	TARP Trigger Level	Observed Impacts/Triggers	Additional Comments
			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, 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	No Level 3 impacts observed.	

Performance Measure	Potential Impacts	*Exceeding* Prediction	TARP Trigger Level	Observed Impacts/Triggers	Additional Comments
			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		

12 APPENDIX A – TRIGGER ACTION RESPONSE PLANS

Table 6: Dendrobium Swamp Impacts, Triggers and Response.

Performance Measures	***Potential Impacts***	***Performance Triggers***	***Management Strategies***	***Offsets***	***Other Actions***
Negligible erosion of the surface of the swamp	Gully erosion or similar	*Level 1:* 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. *Level 2*: 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. *Level 3:* 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. *Exceeding Prediction* 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	a) upfront mine planning b) erosion monitoring (i.e. 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.	

		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%**).			
Minor changes in the size of the swamps **Minor changes** in the ecosystem functionality of the swamps **No significant change** to the composition or distribution of species within the swamps	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. <u>*Level 3:*</u> 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. <u>*Exceeding Prediction:*</u> 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** <u>*Level 1:*</u> 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.	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 bedrock base and/or use of other remediation techniques i) reporting j) investigation and review k) update future predictions	Offset required **immediately**, if no remediation considered practicable. Offset required **5 years** following remediation, if it is ineffective. This period can be extended to **10 years**, with the agreement of the Secretary.	Monitoring period for swamp size is related to capture of Lidar data at the end of each longwall ~ 1 year Triggers for groundwater decline result in increased intensity and frequency of vegetation monitoring

		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. *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 (i.e. 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, i.e. 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	Falls in surface or near-surface groundwater levels in swamps	*Level 1:* Groundwater level lower than baseline level at any monitoring site within a swamp (in comparison to reference swamps); and/or	a) upfront mine planning b) groundwater monitoring		Triggers for groundwater decline result in increased intensity and

functionality of the swamps	*N.B. Not linked specifically to a PM and would not be considered a breach if predictions were exceeded.*	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). <u>*Level 2:*</u> Groundwater level lower than baseline level at **50%** 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 a **50%** of monitoring sites (within 400m of mining) within the swamp. <u>*Level 3:*</u> 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 400m of mining) within the swamp.	c) implementation of swamp research program d) weeding e) fire management f) reporting g) update future predictions		frequency of vegetation monitoring and/or further investigations of subsidence impacts on bedrock base and rockbars
Minor changes in the ecosystem functionality of the swamps	Falls in soil moisture levels in swamps *N.B. Not linked specifically to a PM and would not be considered a breach if predictions were exceeded.*	<u>*Level 1:*</u> Soil moisture level lower than baseline level at **any** monitoring sites (within 400m of mining) within a swamp (in comparison to reference swamps). <u>*Level 2:*</u> Soil moisture level lower than baseline level at **50%** of monitoring sites (within 400m of mining) within a swamp (in comparison to reference swamps). <u>*Level 3:*</u> 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 7: Dendrobium Watercourse Impacts, Triggers and Response.

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	***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
Relevant Performance Measure(s): • Wongawilli Creek - minor environmental consequences • Donalds Castle Creek - minor environmental consequences • Waterfall WC-WF54 – negligible environmental consequences	***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	• *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

Monitoring	Trigger	Action
	• 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	• 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 • 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) • Rockfall 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):	***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:	• *Actions as stated for Level 1* • Review monitoring frequency • Notify relevant technical specialists and seek advice on any CMA required

Monitoring	Trigger	Action
• Wongawilli Creek - minor environmental consequences	– pH 4.45 – EC 154.1 uS/cm – DO 50.5%	• 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 4.45 – 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 consecutive 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*

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%	• 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 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 consecutive 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
Lake Avon Lake Avon 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): • Lake Avon - negligible reduction in the quality of surface water inflows to Lake Avon	***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* • Investigate reasons for the exceedance

Monitoring	Trigger	Action
	• Mining results in two consecutive exceedances of the ±3 standard deviation level (positive for EC, negative for pH and DO) from the baseline mean of the Lake Avon inflows during the monitoring period: – pH 4.90 – EC 129.8 uS/cm – DO 69.5%	• 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 • Fracturing resulting in diversion of flow such that >10% of the pools have water levels lower than baseline period	• *Actions as stated for Level 3* • Investigate reasons for the exceedance • Update future predictions based on the outcomes of the investigation

Monitoring	Trigger	Action
		• 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 envinmental 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 **Lake Avon and Cordeaux River** **Relevant Performance Measure(s):** • Wongawilli Creek - minor environmental consequences • Donalds Castle Creek - minor environmental consequences • Lake Avon - negligible reduction in the quantity of surface water inflows to Lake Avon[1] • Cordeaux River - negligible reduction in the quantity of surface water inflow to the Cordeaux River at its confluence with Wongawilli Creek[2] **Surface water flow Reference sites** (as in Table 1.1)**:** • Wongawilli Creek - WWU (Wongawilli Creek upstream); • O'Hares Creek at Wedderburn (213200);	***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).
	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.

• (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.

[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].
[1] Flow reduction as determined from measured at flow gauging station WWL_A.

Table 8: Dendrobium Landscape Impacts, Triggers and Response.

Monitoring	Trigger	Action
LANDSCAPE FEATURES		
<u>DENDROBIUM AREA 3B</u> **Cliffs** All mapped cliff sites in subsidence area *Refer to Dendrobium Area 3B SMP Figures 18.1 for location of sites*	***Level 1 **** • Rockfall 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 * • Rockfall 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, 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	• *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
	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*** • Rockfall 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 30m 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
TERRESTRIAL FLORA AND FAUNA		
A number of sites located across and around Areas 2, 3A and 3B *Refer Dendrobium Area 3A SMP Figure 21.1, 21.2 and 21.3 and Dendrobium Area 3B Figure 20.1 for location of sites* General observation of active mining areas	***Level 1** * • Vegetation impacted by mining (by rockfalls, soil slippage, gas emissions) that is likely to naturally regenerate within the monitoring period	• Continue monitoring program • Report impacts to key stakeholders • Summarise impacts and Report in the End of Panel Report and AEMR
	Level 2 * • Vegetation impacted by mining (by rockfalls, soil slippage, gas emissions) that is unlikely to naturally regenerate within the monitoring 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

Monitoring	Trigger	Action
	• Statistically significant difference between Before After Control Impact sites as a result of mining	
	Level 3 * • Vegetation impacted by mining that is not responding to CMAs	• Actions as stated for Level 2 • Immediately notify OEH, DoPI, DPI, SCA, other 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

* These may be revised in consultation with DoPI and DPI and other key stakeholders following analysis of natural variability within the pre-mining baseline data. These TARPs relate to Dendrobium Area 3B and impacts resulting from mining in Areas 1, 2 and 3A were managed under previous TARPs.