



**DENDROBIUM AREA 3B
LONGWALL 14 END OF PANEL
LANDSCAPE REPORT
APRIL 2019**



EXECUTIVE SUMMARY

This report summarises the observed and measured subsidence effects on landscape features resulting from the extraction of Dendrobium Area 3B (DA3B) Longwall 14.

Longwall 14 is the sixth panel extracted from DA3B. Extraction began on 22 May 2018 and was completed on 26 February 2019.

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

- Dendrobium Area 3B Subsidence Management Plan (SMP);
- Dendrobium Area 3B Watercourse Impact, Monitoring, Management and Contingency Plan (WIMMCP) (October 2015 and October 2017);
- Dendrobium Area 3B Swamp Impact, Monitoring, Management and Contingency Plan (SIMMCP) (October 2015 and 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.

25 surface impacts were identified by ICEFT. Eleven of these surface impacts were observed on natural features with fourteen occurring on fire roads and access tracks. This report also includes three additional Longwall 13 impacts and an update on three existing Longwall 13 impacts.

Swamp groundwater and water quality triggers were also recorded during Longwall 14 and will be addressed in detail in the specialist Surface Water and Shallow Groundwater Assessment.

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Abbreviations

CMA – Corrective Management Action

DPE - Department of Planning and Environment

EoP – End of Panel

ICEFT – Illawarra Coal Environmental Field Team

OEH - Office of Environment and Heritage

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 workings of an active longwall.

1 OVERVIEW OF MONITORING PROGRAM

Landscape monitoring was conducted within the Longwall 14 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.

Surface Monitoring for Longwall 14

ICEFT 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 approvals, 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 (examples shown in Photo 1 and Photo 2). A total of 16 landscape sites (SLMMP photo points) were monitored before, during and after the Longwall 14 extraction period (Table 1). Longwall 14 post-mining inspections was carried out with one impact site observed. This impact is addressed in the impacts to other landscape features section.



Photo 1: A3b-SS8 baseline inspection. Taken 13/04/2017.



Photo 2: A3b-SS8 post-mining inspection. Taken 4/04/2019.

Table 1: Summary table of SLMMP sites relevant to Longwall 14.

Site Name	Easting	Northing	Impact Description
A3b-SS11	288686	6191850	No impacts observed
A3b-SS12	289098	6191676	No impacts observed
A3b-SS13	290056	6191749	No impacts observed
A3b-SS14	290060	6191587	No impacts observed
A3b-SS6-Pt1	289635	6192622	No impacts observed
A3b-SS7	288131	6192361	No impacts observed
A3b-SS8	288329	6192167	No impacts observed
A3b-SS9-Pt1	290162	6192078	No impacts observed
A3b-SS9-Pt2	290133	6191978	Rock fracturing, rockfall and soil cracking
AT1-slmmp	289463	6192132	No impacts observed
AT2-slmmp	289938	6192033	No impacts observed
AT3-slmmp	290566	6191598	No impacts observed
FR6A-Pt3	289017	6192596	No impacts observed
FR6A-Pt4	288947	6192408	No impacts observed
FR6A-Pt5	289065	6192149	No impacts observed
FR6N-slmmp	288243	6192395	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 22/02/2018



Photo 4: Reference site S24_S01. Photo taken 01/02/2019

3 TARP OVERVIEW

In accordance with the Dendrobium Area 3B SMP approvals, the SIMMCP and WIMMCP (and Environmental Management Plan) were revised during the extraction of Longwalls 9 and 10. Key government agencies including the DPI, DRE, DPE, WaterNSW and OEH were consulted during this process. This revision included the TARPs, which address Performance Measures, specified in the approval conditions. Impacts to surface features observed during the extraction of Longwall 14 were reported under the 2015 TARPs. 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 14 will be reported under the 2017 TARPs.

Table 2: Summary of the date range of Dendrobium Area 3B TARPs used in this report

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 - 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 - 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

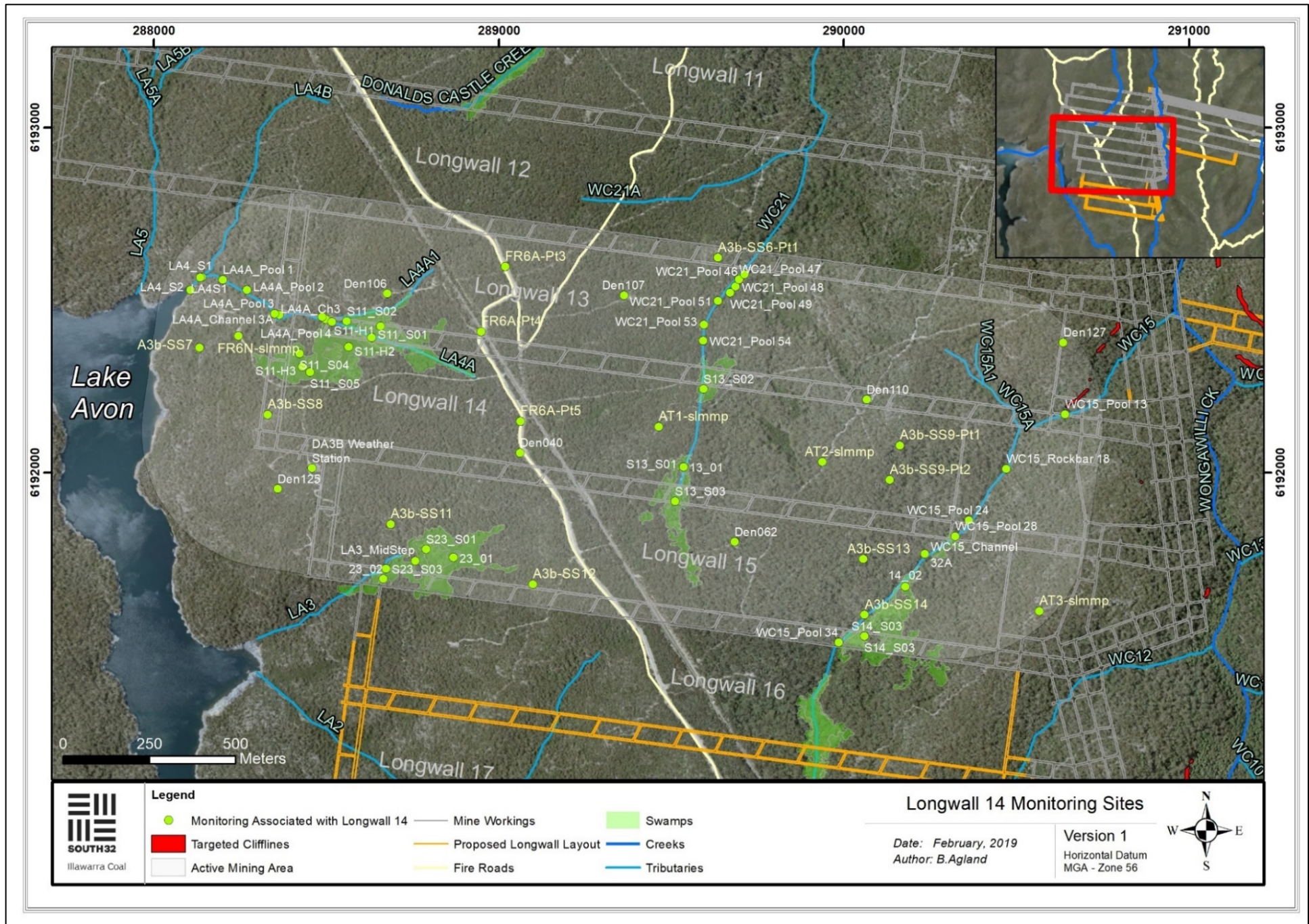


Figure 1: Map showing monitoring sites for the Longwall 14 active mining area.

4 SUMMARY OF IMPACTS

During the extraction of Longwall 14, 25 new surface impacts were identified (Table 3, Figure 2). These impacts are labelled as *DA3B_LW14_001* to *DA3B_LW14_025*. Three additional Longwall 13 impacts were identified; these impacts are labelled as *DA3B_LW13_044* to *DA3B_LW14_046*. Updates are provided for three existing Longwall 13 impacts; these impacts are labelled as *DA3B_LW13_035 (Update)*, *DA3B_LW13_042 (Update)* and *DA3B_LW14_043 (Update)*. An additional three water quality triggers, four soil moisture triggers and two shallow groundwater triggers were identified. These triggers will be addressed in the Longwall 14 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 rock falls. 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 14 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 the Longwall 14 EoP Report).

Landscape features

Fractures and cracking observed during the extraction of Longwall 14 were assessed against the relevant TARP (for landscape, swamp or watercourse) and assigned a trigger value (Level 1, Level 2, Level 3 or Exceeding Prediction, where applicable). Trigger values for fractures and cracks were determined based on characteristics such as:

- Width and length of the fracture;
- 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.

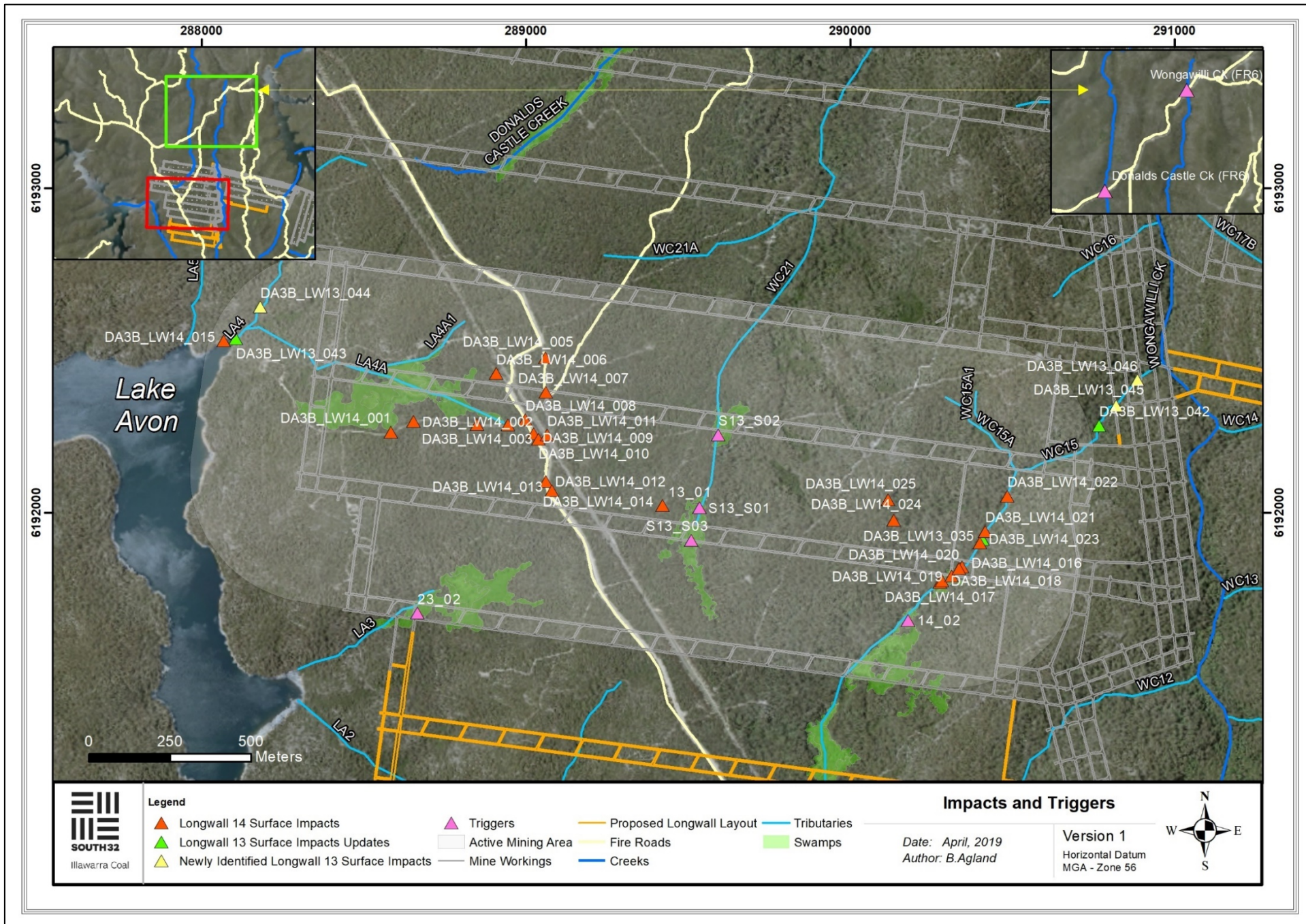
Table 3: Summary of impacts and triggers relevant to Longwall 14

Site ID	Easting	Northing	Impact Type	Feature Affected	Identification Date	Trigger Level	Description	Refer to Impact Report/s Dated
DA3B_LW14_001	288548	6192249	Surface Cracking	Fire Trail 6N	3/07/2018	1	Soil cracking on access track, approximately 5m length, 0.02m width, 0.1m depth.	4/07/2018
DA3B_LW14_002	288653	6192281	Surface Cracking	Fire Trail 6N	7/07/2018	1	Five soil cracks along a 30m section of Fire Trail 6N. The largest crack is approximately 3m long, 0.01m wide and 0.01m at deepest measurable point	8/08/2018
DA3B_LW14_003	288849	6192272	Surface Cracking	Fire Trail 6N	7/07/2018	1	Four soil cracks along a 70m section of Fire Trail 6N. The largest crack is approximately 4.5m long, 0.03m wide and 0.23m at deepest measurable point	8/08/2018
DA3B_LW14_004	288944	6192270	Surface Cracking	Fire Trail 6N	13/08/2018	1	Five soil cracks along a 40m section of Fire Trail 6N. The largest crack is approximately 5 m long, 0.025m wide and 0.122m at the deepest measurable point	29/08/2018
DA3B_LW14_005	289060	6192478	Surface Cracking	Fire Road 6AA	13/08/2018	1	Two soil cracks along a 10m section of Fire Road 6AA. The largest crack is approximately 3.3m long, 0.007m wide and 0.066m at the deepest measurable point.	29/08/2018
DA3B_LW14_006	288908	6192429	Surface Cracking	Access Track	19/08/2018	1	Two soil cracks along a 10m on an access track. The largest crack is approximately 2.1m long and 0.01m wide.	29/08/2018
DA3B_LW14_007	289061	6192371	Surface Cracking	Fire Road 6AA	28/08/2018	1	Singular soil crack on Fire Road 6AA. The soil crack is approximately 3m long, 0.01m wide and 0.07m at the deepest measurable point.	29/08/2018
DA3B_LW14_008	288998	6192286	Surface Cracking	Fire Road 6A	28/08/2018	1	Two soil cracks along a 20m section of Fire Road 6A. The largest soil crack is approximately 4.5m long, 0.02m wide and 0.15m at the deepest measurable point.	29/08/2018
DA3B_LW14_009	289022	6192242	Surface Cracking	Fire Road 6A	3/09/2018	1	Three soil cracks along 20 m of Fire Road 6A. The largest continuous crack is 5m long, 0.02m wide and 0.4m deep.	3/09/2018
DA3B_LW14_010	289038	6192227	Surface Cracking and Uplift	Fire Road 6A	10/09/2018	2	Continuous soil crack and uplift along Fire Trail 6A. The crack is approximately 12m long, 0.05m wide with a maximum uplift of 0.03m and 0.26m at the deepest measurable point.	20/09/2018

DA3B_LW14_011	289065	6192240	Soil Cracking, Rock Fracture and Uplift	Rail Corridor	16/9/2018	1	Soil crack, rock fracture and uplift on rail corridor adjacent to Fire Road 6A.	20/09/2018
DA3B_LW14_012	289062	6192097	Surface Cracking	Fire Road 6A	16/9/2018	1	Multiple surface cracks within a 20m section. Longest crack measuring approximately 9m long, 0.01m wide and 0.03m deep.	20/09/2018
DA3B_LW14_013	289080	6192069	Surface Cracking	Access Track	26/09/2018	2	Surface cracking on access track adjacent to Fire Road 6A. The crack is approximately 14m long, 0.01m wide and 0.05m deep at the deepest measurable point.	27/09/2018
DA3B_LW14_014	289432	6192021	Surface Cracking	Access Track	13/11/2018	1	Surface cracking on access track adjacent to Swamp 13. The crack is 1.1m long, 0.06m wide and 0.15m deep.	16/11/2018
DA3B_LW14_015	288070	6192528	Rock Fracturing and Rockfall	Step/ledge of Lake Avon	5/12/2018	1	Rockfall and rock fracturing on Lake Avon rock ledge. The rock fracturing has a maximum length of 1.8m, a maximum width of 0.01m and a maximum depth of 0.29m. The rock fall is approximately 4m x 1.5m x 0.5m.	18/12/2018
DA3B_LW14_016	290345	6191835	Rock Fracturing, Uplift and Rock Displacement	WC15	21/01/2019	2	Multiple fractures, uplift and dislodged sections of rock on WC15. The longest fracture is up to 4.0m long and 0.03m wide.	24/01/2019
DA3B_LW14_017	290276	6191786	Rock Fracturing	WC15	20/02/2019	2	Rock fracturing to WC15. The rock fracturing has a maximum measurable length of 0.8m, a maximum width of 0.025m and a maximum measurable depth of 0.17m.	21/02/2019
DA3B_LW14_018	290282	6191791	Rock Fracturing	WC15	20/02/2019	2	Rock fracturing to WC15. The rock fracture has a maximum measurable length of 0.7m, a maximum width of 0.015m and a maximum measurable depth of 0.10m.	21/02/2019
DA3B_LW14_019	290312	6191805	Rock Fracturing and Uplift	WC15	20/02/2019	1	Rock fracturing to WC15. The rock fracture has a maximum measurable length of 4.5m, a maximum width of 0.05m, a maximum measurable depth of 0.7m.	21/02/19
DA3B_LW14_020	290334	6191828	Rock Fracturing	WC15	20/02/2019	2	Rock fracturing to WC15. The rock fracture has a maximum measurable length of 1.3m, a maximum width of 0.05m and a maximum measurable depth of 1.13m.	21/02/19
DA3B_LW14_021	290416	6191943	Rock Fracturing	WC15	20/02/2019	2	Rock fracturing to WC15. The rock fractures have a maximum measurable length of 1.1m and a maximum width of 0.01m.	21/02/19
DA3B_LW14_022	290283	6192052	Rock Fracturing	WC15	20/02/2019	2	Rock fracturing to WC15. The rock fracture has a maximum measurable length of 2.9m, and a maximum width of 0.05m.	21/02/19

DA3B_LW14_023	290398	6191907	Rock Fracturing	WC15	1/04/2019	1	Rock fracturing to WC15_Pool 22. The rock fracture has a maximum measurable length of 0.35m, and a maximum width of 0.001m.	3/04/19
DA3B_LW14_024	290133	6191	Rock Fracturing & Rock Fall & Soil Cracking	A3b-SS9-Pt2 (Steep Slope)	9/04/2019	1	Rock fracturing, rockfall and soil cracking at SLMMP site 'A3b-SS9-Pt2'.	10/04/2019
DA3B_LW14_025	290115	6192041	Rock Fracturing	Steep Slope/Step	9/04/2019	1	Rock fracturing and displacement at a steep slope/ step between WC15 and Fire road 6P.	10/04/2019
DA3B_LW13_035 (Update)	290406	6191915	Rock Fracturing	WC15	23/04/2018	2	Additional fracturing with flow diversion was observed on WC15. The largest fracture is up to 3.7m long, with the widest fracture up to 0.02m wide.	27/04/2018 24/01/2019
DA3B_LW13_042 (Update)	290772	6192286	Rock Fracturing	WC15	16/05/2018	2	Additional fracturing and rock fragmentation was observed at WC15_Pool 22. The new rock fracturing has a maximum measurable length of 0.2m and a maximum width of 0.002m.	17/05/2018 3/04/2019
DA3B_LW13_043 (Update)	288106	6192537	Rock Fracturing & Rock Fall & Iron Staining	LA4	16/05/2018	2	Rock fracturing to LA4_ Step 0. The additional fracturing has a maximum length of 1.5m and a maximum width of 0.01m. An increase of iron staining was also identified evident.	17/05/2018 06/08/2018
DA3B_LW13_044	288180	6192634	Rock Fracturing	LA4B	26/07/2018	2	Rock fracturing to the base of a step on tributary LA4B. Maximum length of 1.7m, horizontal depth of 1.05m and a width of 0.1m.	08/08/2018
DA3B_LW13_045	290819	6192330	Rock Fracturing	WC15	8/07/2018	2	Rock fracture across a rock bar on tributary WC15. The fracture is approximately 0.3m long, 0.03m wide and 0.03m at the deepest measurable point.	08/08/2018
DA3B_LW13_046	290887	6192408	Rock Fracturing	WC15	1/04/2019	1	Rock fracturing to the base of a step on tributary WC15. Maximum length of 1.2m, and a width of 0.02m.	3/04/2018
Donalds Castle Ck (FR6)	289395	6195367	Water Quality	Donalds Castle Creek	25/03/2019	3	Electrical conductivity trigger.	28/03/2019
Wongawilli Creek (FR6)	290960	6197376	Water Quality	Wongawilli Creek	3/10/2018	3	Dissolved oxygen trigger.	16/10/2018
Wongawilli Creek (FR6)	290960	6197376	Water Quality	Wongawilli Creek	3/10/2018	3	Electrical conductivity trigger.	16/10/2018
S13_01	289535	6192016	Soil Moisture	Swamp 13	12/10/2018	3	Soil moisture level below baseline.	15/10/2018 16/10/2018

S13_02	289593	6192241	Soil Moisture	Swamp 13	12/10/2018	3	Soil moisture level below baseline.	15/10/2018 16/10/2018
S13_03	289510	6191916	Soil Moisture	Swamp 13	12/10/2018	3	Soil moisture level below baseline.	15/10/2018 16/10/2018
23_02	288665	6191691	Soil Moisture	Swamp 23	23/09/2018	1	Soil moisture level below baseline.	21/09/2018
14_02	290178	6191669	Groundwater	Swamp 14	12/02/2019	2	Shallow groundwater rate of recession.	13/02/2019
13_01	289535	6192016	Groundwater	Swamp 13	5/12/2018	3	Shallow groundwater level below baseline.	06/12/2018



5 IMPACTS TO FIRST AND SECOND ORDER STREAMS

Nine first and second order streams were monitored as part of the Longwall 14 monitoring program; *LA3*, *LA4*, *LA4B*, *LA4A*, *LA4A1*, *WC21*, *WC15*, *WC15A* and *WC15A1*. Impacts observed at these streams during Longwall 14 are described below.

5.1 LA4B

DA3B_LW13_044

Impact *DA3B_LW13_044* was identified on 26 July 2018 and consists of rock fracturing to the base of a step on tributary *LA4B* (Photo 5 and Photo 6). The fracturing likely occurred during the extraction of Longwall 13 but wasn't identified during this time due to thick vegetation and safety concerns accessing this step during active subsidence. The fracturing has a maximum length of approximately 1.7m, with a horizontal depth of 1.05m at its deepest measurable point. The width of the fracturing is approximately 0.1m.

Level 2: Crack or fracture between 100mm and 300mm width



Photo 5: *DA3b_LW13_044*, looking at a section of rock fracturing. Taken 26/07/18.



Photo 6: *DA3b_LW13_044*, looking at a section of rock fracturing. Taken 26/07/18.

5.2 LA4

DA3B_LW13_043 (Update)

Impact *DA3B_LW13_043* is located on *LA4*, a tributary to *Lake Avon*, 300 m from the commencing end of Longwall 13 and 300 m from the southern edge of Longwall 12. The impact is comprised of rock fracturing at *LA4_Step 0* (Photo 7), which is the most downstream feature before entering *Lake Avon*. The impact was originally identified on 18 May 2018 however lowering lake water levels has enabled recent access to areas that were previously underwater. During an inspection on 6 December 2018, additional rock fracturing was observed. The additional fracturing has a maximum length of 1.5m and a maximum width of 0.01m. An increase in iron staining was also identified during this inspection (Photo 8).

Level 2: Crack or fracture that results in observable loss of surface water and observable increase in iron staining within the mining area continues to outside the mining area



Photo 7: DA3B_LW13_043, looking at a section of rock fracturing and uplift. Taken 6/12/2018



Photo 8: DA3B_LW13_043, looking at iron staining. Taken 6/12/2018.

5.3 WC15

DA3B_LW13_045

Impact DA3B_LW13_045 was identified on 8 August 2018 and consists of a rock fracture across a rock bar on tributary WC15. The fracturing likely occurred during the extraction of Longwall 13 but wasn't identified during this time due to access difficulties during active subsidence. The fracture is approximately 0.3m long, 0.03m wide and 0.03m at the deepest measurable point (Photo 9 and Photo 10). No flow diversion could be observed at the site however the fracture is across the main flow path and flow diversion is possible during higher flow conditions at the site.

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



Photo 9: DA3b_LW13_045, site overview. Taken 8/07/18.



Photo 10: DA3b_LW13_045, Looking at the rock fracturing. Taken 8/07/18.

DA3B_LW13_046

DA3B_LW13_046 is located on WC15, a tributary to Wongawilli Creek. The impacted feature is the base of WC15_Step 2 which is situated approximately 245m east of Longwall 13 and 590m north-east of Longwall 14. It is likely that this impact occurred during the extraction of Longwall 13 however has only now become visible due to heavy rainfall events (187.5mm between 15 March and 20 March 2019) which has dislodged vegetation and rock fragments (Photo 11 and 12). The impact is comprised of a rock fracture and minor rock displacement. The rock fracture has a maximum measurable length of 1.2m and a maximum width of 0.02m. No flow diversion was evident due to location of the fracture on the step.

Level 1: Crack or fracture up to 10m Length



Photo 11: DA3B_LW13_046, looking at the extent of the rock fracturing. Taken 01/04/2019.



Photo 12: DA3B_LW13_046, looking at the section of rock displacement. Taken 01/04/2019.

Impact DA3B_LW14_016

Impact DA3B_LW14_016 was identified on the 21st of January 2019 and is located on *Wongawilli Creek* tributary WC15. The impact consists of multiple fractures, uplift and dislodged sections of rock (Photo 13 and Photo 14). The longest fracture is up to 4.0m long and 0.03m wide. Surface flow diversion was recorded at the site during baseline mapping on WC15. While there was no active flow diversion observed through fractures, it is likely diversion would occur during higher flow conditions.

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



Photo 13: DA3B_LW14_016, looking at fracturing and dislodged rock segments. Taken on 21/01/2019.



Photo 14: DA3B_LW14_016, looking at fracturing and dislodged sections of rock. Taken on 21/01/2019.

Impact DA3B_LW14_017

DA3B_LW14_017 is located on WC15, a tributary to Wongawilli Creek. The impacted feature is WC15_Channel 30 which is situated approximately 79m south of Longwall 14 at its closest point. The impact is comprised of two rock fractures (Photo 15 and 16). The rock fracturing has a maximum measurable length of 0.8m, a maximum width of 0.025m and a maximum measurable depth of 0.17m. While there was no active flow diversion observed through fractures, it is likely diversion would occur during higher flow conditions.

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



Photo 15: DA3B_LW14_017, looking at a section of rock fracturing. Taken 20/02/2019.



Photo 16: DA3B_LW14_017, looking at a section of rock fracturing. Taken 20/02/2019.

Impact DA3B_LW14_018

DA3B_LW14_018 is located on WC15, a tributary to Wongawilli Creek. The impacted feature is WC15_Pool 30 which is situated approximately 73m south of Longwall 14 at its closest point (Figure 1). The impact is comprised of a rock fracture (Photo 17 and 18). The rock fracture has a maximum measurable length of 0.7m, a maximum width of 0.015m and a maximum measurable depth of 0.10m. While there was no active flow diversion observed through fractures, it is likely diversion would occur during higher flow conditions.

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



Photo 17: DA3B_LW14_018, looking at the extent of the rock fracturing. Taken 20/02/2019.



Photo 18: DA3B_LW14_018, looking at the width of the fracturing. Taken 20/02/2019.

Impact DA3B_LW14_019

DA3B_LW14_019 is located on WC15, a tributary to Wongawilli Creek. The impacted feature is WC15_Rockbar 28 which is situated approximately 55m south of Longwall 14 at its closest point. The impact is comprised of rock fracturing and uplift (Photo 19 and 20). The rock fracture has a maximum measurable length of 4.5m, a maximum width of 0.05m, a maximum measurable depth of 0.7m.

Level 1: Crack or fracture up to 10m Length



Photo 19: DA3B_LW14_019, looking at a section of uplift. Taken 20/02/2019.



Photo 20: DA3B_LW14_019, looking at a section of rock fracturing. Taken 20/02/2019.

Impact DA3B_LW14_020

DA3B_LW14_020 is located on WC15, a tributary to Wongawilli Creek. The impacted feature is WC15_Rockbar 26 which is situated approximately 40m south east of Longwall 14 at its closest point. The impact is comprised of a rock fracture (Photo 21). The rock fracture has a maximum measurable length of 1.3m, a maximum width of 0.05m and a maximum measurable depth of 1.13m (Photo 22). While there was no active flow diversion observed through fractures, it is likely diversion would occur during higher flow conditions.

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



Photo 21: DA3B_LW14_020, looking at the extent of the rock fracturing. Taken 20/02/2019.



Photo 22: DA3B_LW14_020, looking at the depth of the fracturing. Taken 20/02/2019.

Impact DA3B_LW14_021

DA3B_LW14_021 is located on WC15, a tributary to Wongawilli Creek. The impacted features are WC15_Rockbar 21 and WC15_step 21 which are situated approximately 100m east of Longwall 14 at its closest point. The impact is comprised of two rock fractures (Photo 23 and 24). The rock fractures have a maximum measurable length of 1.1m and a maximum width of 0.01m. While there was no active flow diversion observed through fractures, it is likely diversion would occur during higher flow conditions.

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



Photo 23: DA3B_LW14_021, looking at the section of rock fracturing. Taken 20/02/2019.



Photo 24: DA3B_LW14_021, looking at the section of rock fracturing. Taken 20/02/2019.

Impact DA3B_LW14_022

DA3B_LW14_022 is located on WC15, a tributary to Wongawilli Creek. The impacted feature is WC15_Rockbar 18 which is situated approximately 150m east of Longwall 14 at its closest point. The impact is comprised of a rock fracture (Photo 25 and 26). The rock fracture has a maximum measurable length of 2.9m, and a maximum width of 0.05m. While there was no active flow diversion observed through fractures, it is likely diversion would occur during higher flow conditions.

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



Photo 25: DA3B_LW14_022, looking at the section of rock fracturing. Taken 20/02/2019.



Photo 26: DA3B_LW14_022, looking at the section of rock fracturing. Taken 20/02/2019.

DA3B_LW14_023

DA3B_LW14_023 is located on WC15, a tributary to Wongawilli Creek. The impacted feature is WC15_Pool 22 which is situated approximately 75m east of Longwall 14 at its closest point. The impact is comprised of three rock fractures (Photo 27 and 28). The rock fracturing has a maximum measurable length of 0.35m and a maximum width of 0.001m. No flow diversion was evident.

Level 1: Crack or fracture up to 10m Length



Photo 27: DA3B_LW14_023, looking at a section of rock fracturing. Taken 01/04/2019.



Photo 28: DA3B_LW14_023, looking at a section of rock fracturing. Taken 01/04/2019.

DA3B_LW13_035 (Update)

DA3B_LW13_035 was first identified on 23 April 2018 during Longwall 13 and is located on tributary WC15. Additional fracturing with flow diversion was observed on 21 of January 2019 when Longwall 14 was approximately 240m from the site. Previously the impact was comprised of multiple small fractures and minor uplift. The largest fracture was 1.6m in length and 0.002m in width. The impact was classified as a level 1 impact as there was no evidence of flow diversion at the site.

Additional fracturing with flow diversion was observed during a Longwall 14 inspection (Photo 29 and 30). The largest fracture is now 3.7m long, with the widest fracture up to 0.02m wide. Uplifted sections of rock and flow diversion are associated with the fracturing.

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



Photo 29: DA3B_LW13_035, fracturing with flow diversion across small step on rockbar. Taken on 21/01/2019.



Photo 30: DA3B_LW13_035, fracturing and uplift on rockbar. Taken on 21/01/2019.

DA3B_LW13_042 Update

DA3B_LW13_042 is located on tributary WC15. The impact site is situated approximately 150m east of Longwall 13. The impact was first identified on 16 May 2018 during the extraction of Longwall 13. The impact was originally comprised of multiple rock fractures, with associated rock fragmentation and iron staining to WC15_Rockbar 7, an incised rockbar. Additional fracturing and rock fragmentation was observed during the most recent inspection. The new rock fracturing has a maximum measurable length of 0.2m and a maximum width of 0.002m (Photo 32). The largest rock fragment has a length of 0.8m, width of 0.65m and height of 0.1m (Photo 31). Recent heavy rainfall events (187.5mm between 15 March and 20 March 2019) have cleared vegetation and debris which allowed the new fractures to be identified. Additionally, the rainfall events have likely caused dislodgement of the new rock fragments and transport downstream.

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



Photo 31: DA3B_LW13_042, looking at largest section of rock fragmentation. Taken 01/04/2019.



Photo 32: DA3B_LW13_042, looking at a section of new rock fracturing. Taken 01/04/2019.

6 IMPACTS TO OTHER LANDSCAPE FEATURES

DA3B_LW14_015

Impact *DA3B_LW14_015* is located on a ledge of *Lake Avon*, approximately 350 m from the commencing end of Longwall 13 and Longwall 14, and 330 m from the southern edge of Longwall 12. The impact is comprised of two distinct rock fractures and a rockfall (Photo 33 and 34). The rock fracturing has a maximum length of 1.8m, a maximum width of 0.01m and a maximum measurable depth of 0.29m. The rock fall is approximately 4m x 1.5m x 0.5m. It is probable that the impact occurred during the extraction of Longwall 13. Previously, the site has been inundated by lake water, which prevented observation of the impact.

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



Photo 33: *DA3B_LW14_015*, looking at a section of rock fracturing. Taken 6/12/2018.



Photo 34 : *DA3B_LW14_015*, looking at the rockfall. Taken 6/12/2018.

7 TARP TRIGGERS

7.1 Shallow Groundwater

13_01 (Swamp 13)

During analysis of shallow groundwater levels for borehole 13_01, changes to the typical rainfall response were observed. A piezometer and logger were installed at the site in June 2012. The site was passed by Longwall 13 on 21 September 2017 and mined beneath by Longwall 14 on 4 November 2018 (Figure 3). The lowest recorded baseline water level was RL 400.95 m, which corresponds to water levels below the piezometer, however groundwater levels typically increased following rainfall events during the baseline period. Following Longwall 14 passing beneath the site, groundwater levels had not responded to rainfall events (Figure 3).

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) *Note- there is one shallow groundwater site in Swamp 13, hence the >80% trigger.

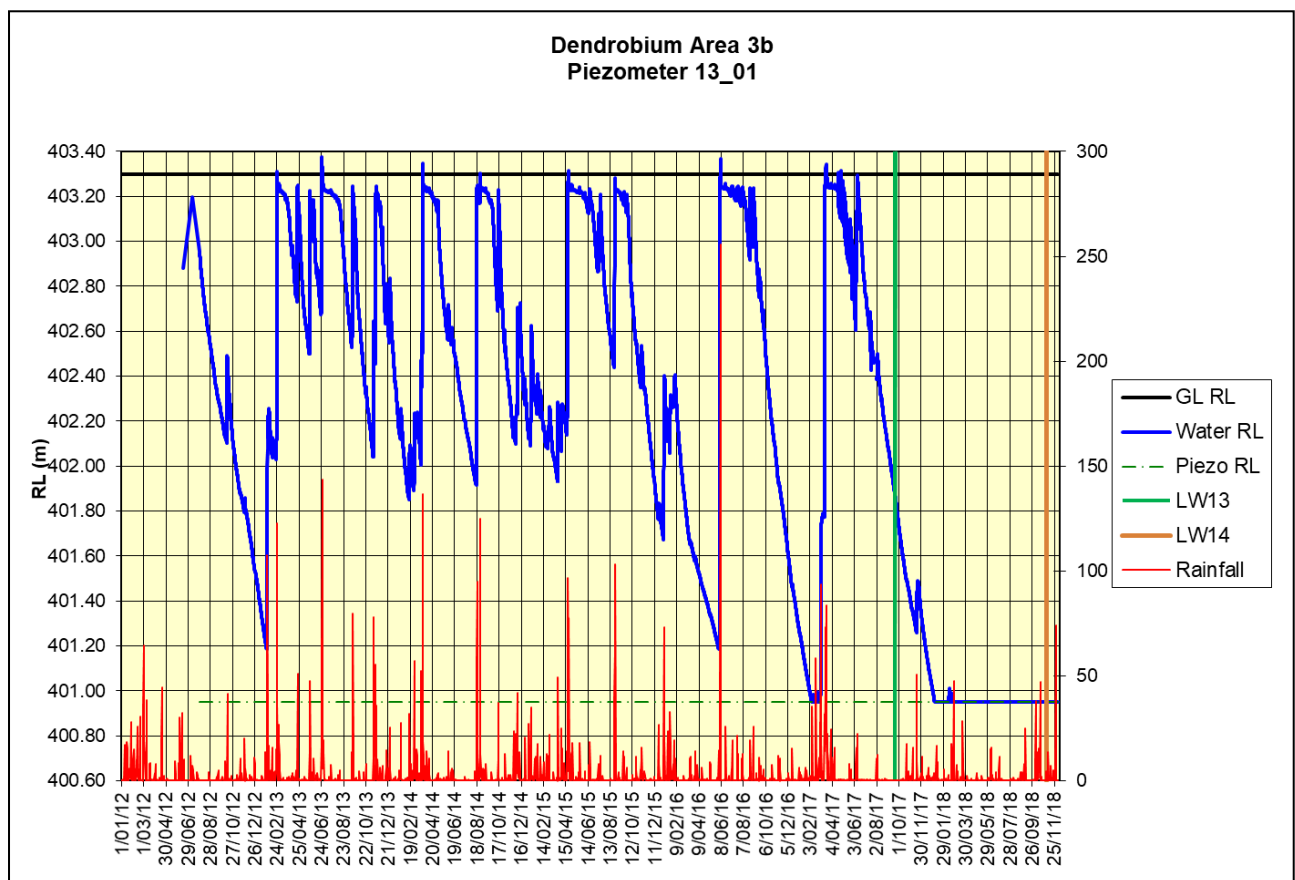


Figure 3: Shallow groundwater levels at 13_01, logged hourly interval.

14_02 (Swamp 14)

A shallow groundwater trigger was recorded at borehole 14_02 during analysis of piezometer data for Swamp 14. A piezometer and logger were installed in a hand-augured borehole at 14_02 in July 2015. This site is situated approximately 205m south of Longwall 14 at its closest point. The post-mining rate of water level recession (0.89 mm/hour calculated between 29/01/2019 11:00 and 7/02/2019 14:00) 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 4).

Level 2: 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.

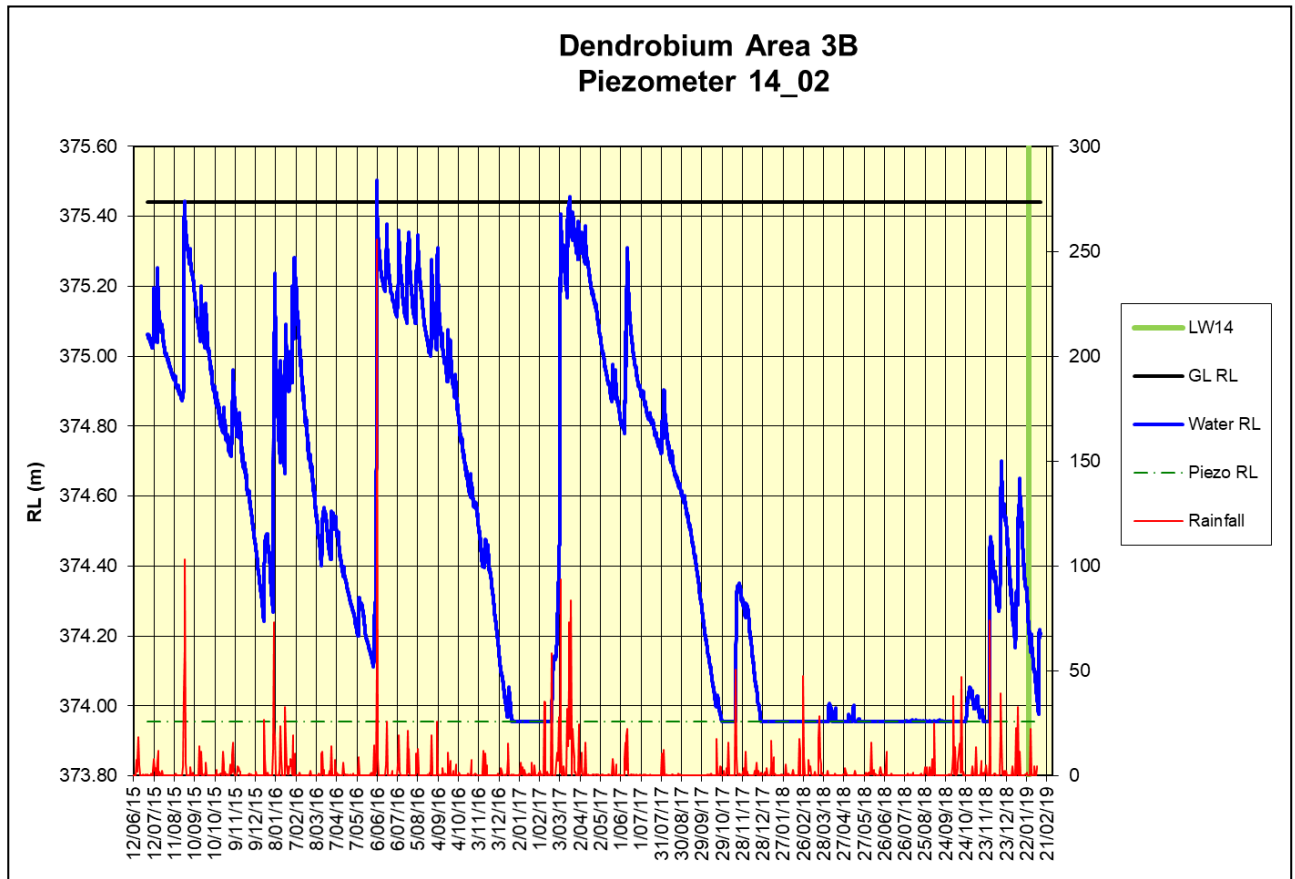


Figure 4: Shallow groundwater levels at 14_02, logged hourly.

7.2 Soil Moisture

S23_02 (Swamp 23)

A soil moisture trigger was measured at site S23_02 during analysis of Swamp 23 soil moisture data. The site was established in July 2015, in a hand-augured hole. The site was passed by Longwall 14 on 8 July 2018. Data indicates that soil moisture levels at this site have dropped below baseline levels (Figure 5).

Level 1: Soil moisture level lower than baseline level at any monitoring sites (within 400m of mining) within a swamp

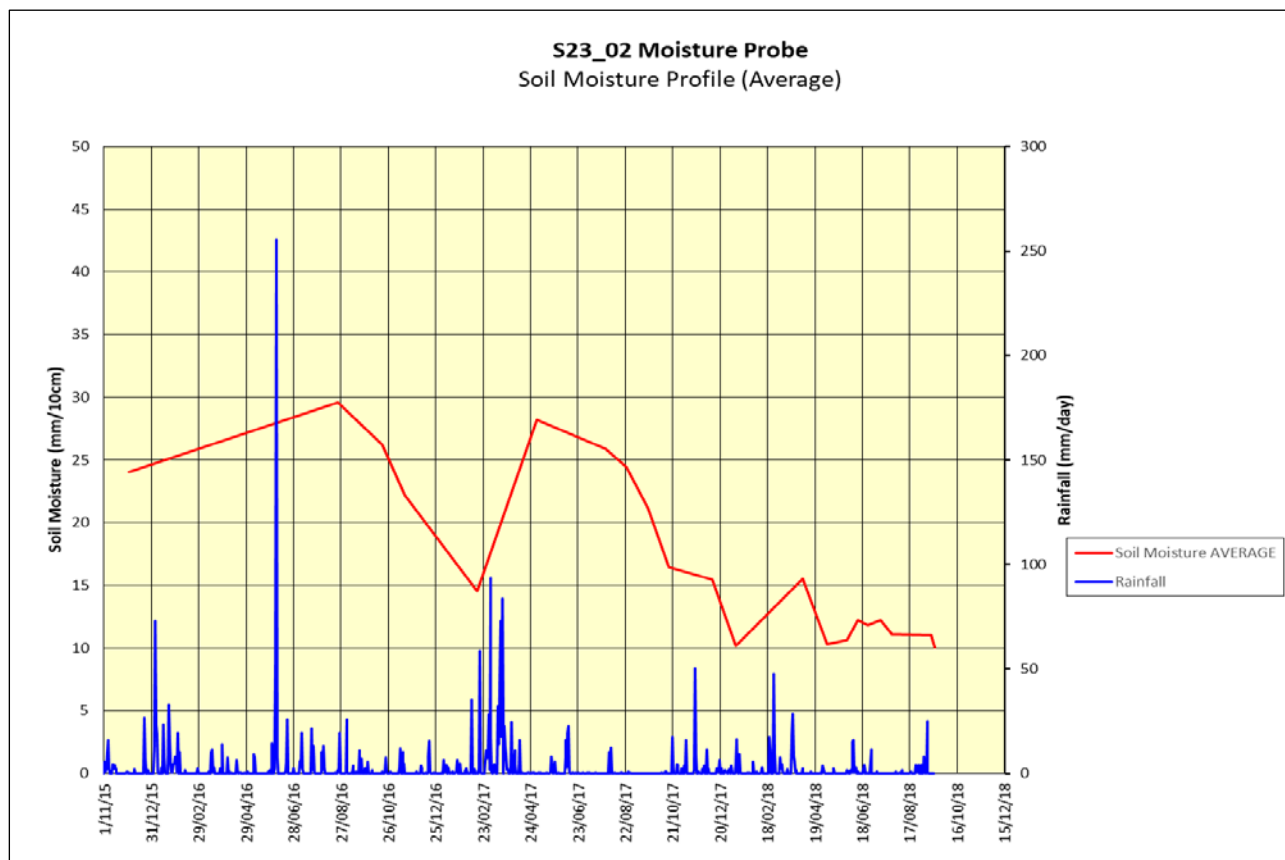


Figure 5: Soil moisture levels at S23_02.

S13_01

A soil moisture trigger was measured at S13_01 during analysis of Swamp 13 data. The site was established in 2014, in a hand-augured hole. The site entered the Longwall 14 active mining area on the 8th of September 2018. Data indicates that soil moisture levels dropped below baseline levels (Figure 6).

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

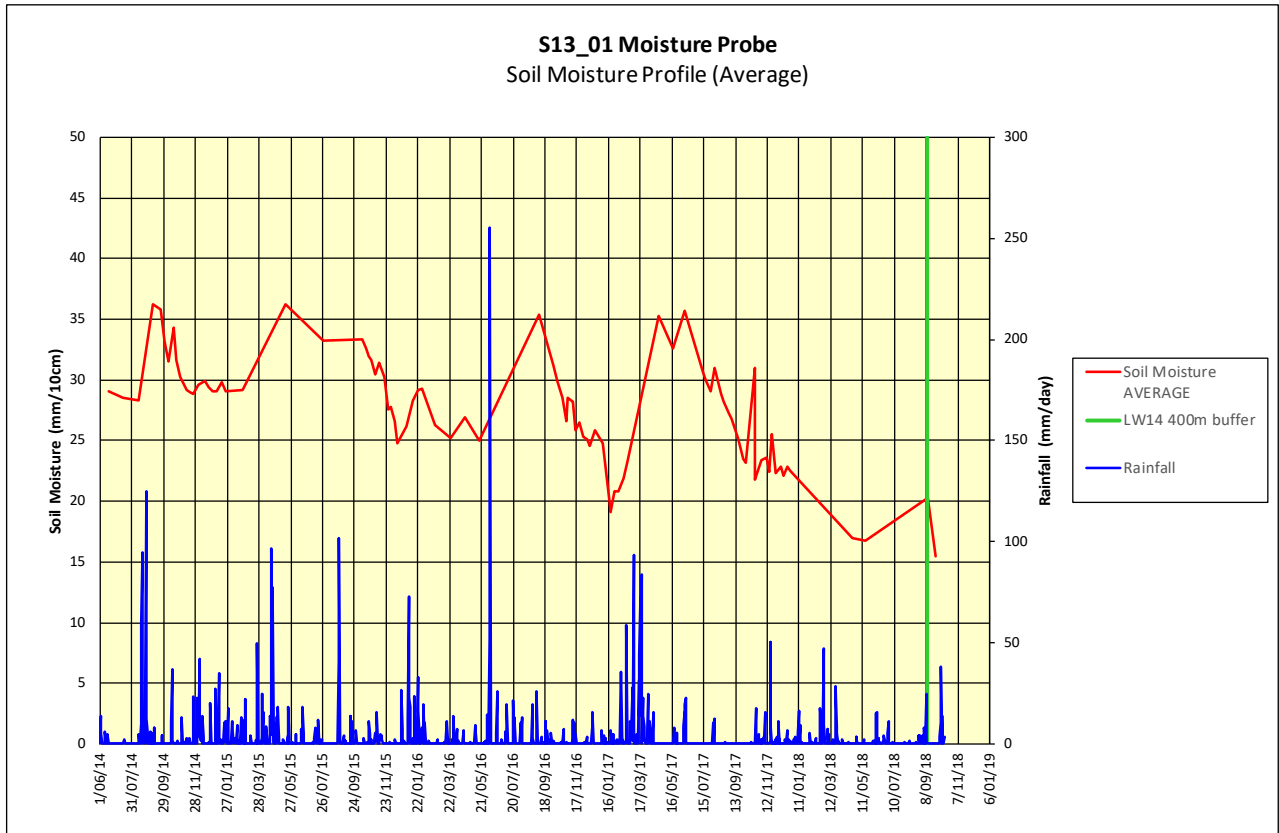


Figure 6: Soil moisture levels at site S13_01.

S13_02

A soil moisture trigger was measured at S13_02 during analysis of Swamp 13 data. The site was established in 2014, in a hand-augured hole. The site entered the Longwall 14 active mining area on 11 of September 2018. Data indicates that soil moisture levels dropped below baseline levels (Figure 7).

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

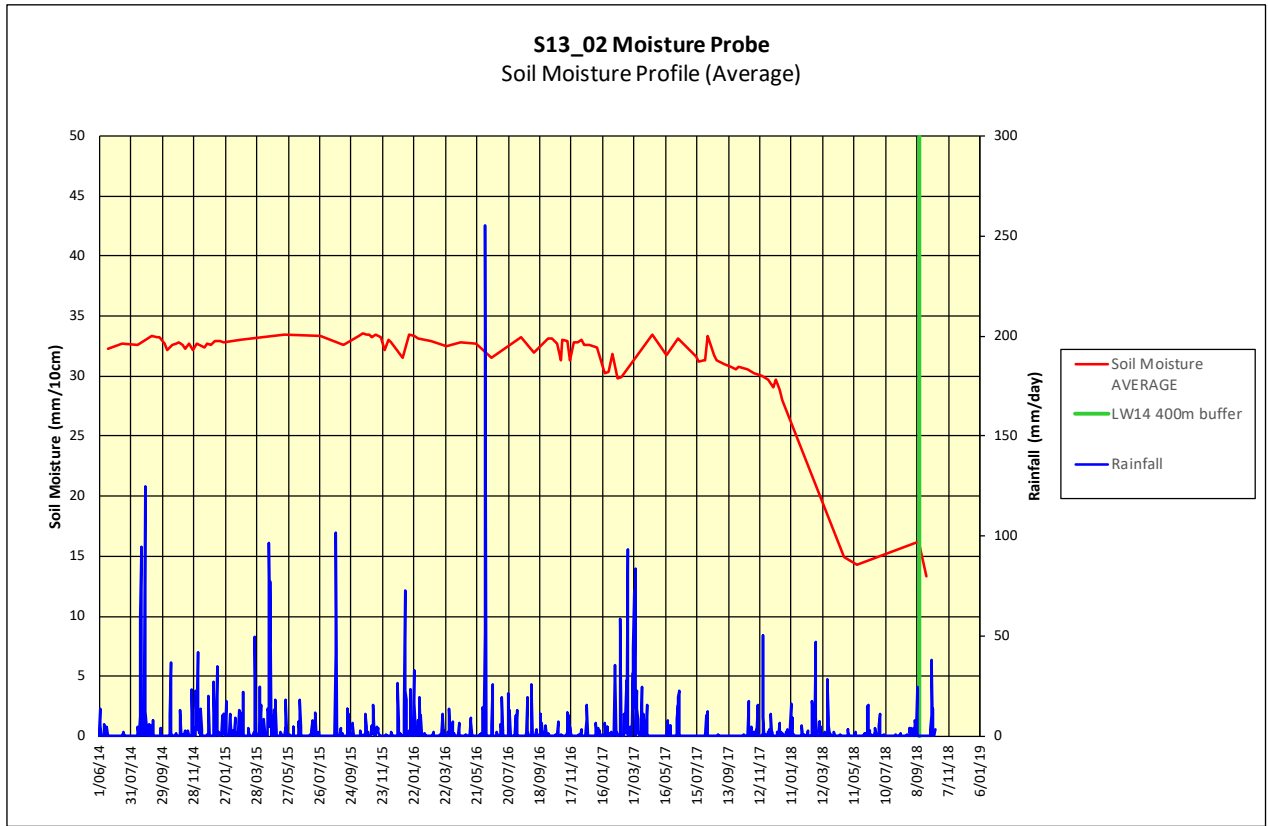


Figure 7: Soil moisture levels at site S13_02.

S13_03

A soil moisture trigger was measured at S13_03 during analysis of Swamp 13 data. The site was established in 2014, in a hand-augured hole. The site entered the Longwall 14 active mining area on 8 September 2018. Data indicates that soil moisture levels dropped below baseline levels (Figure 8).

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

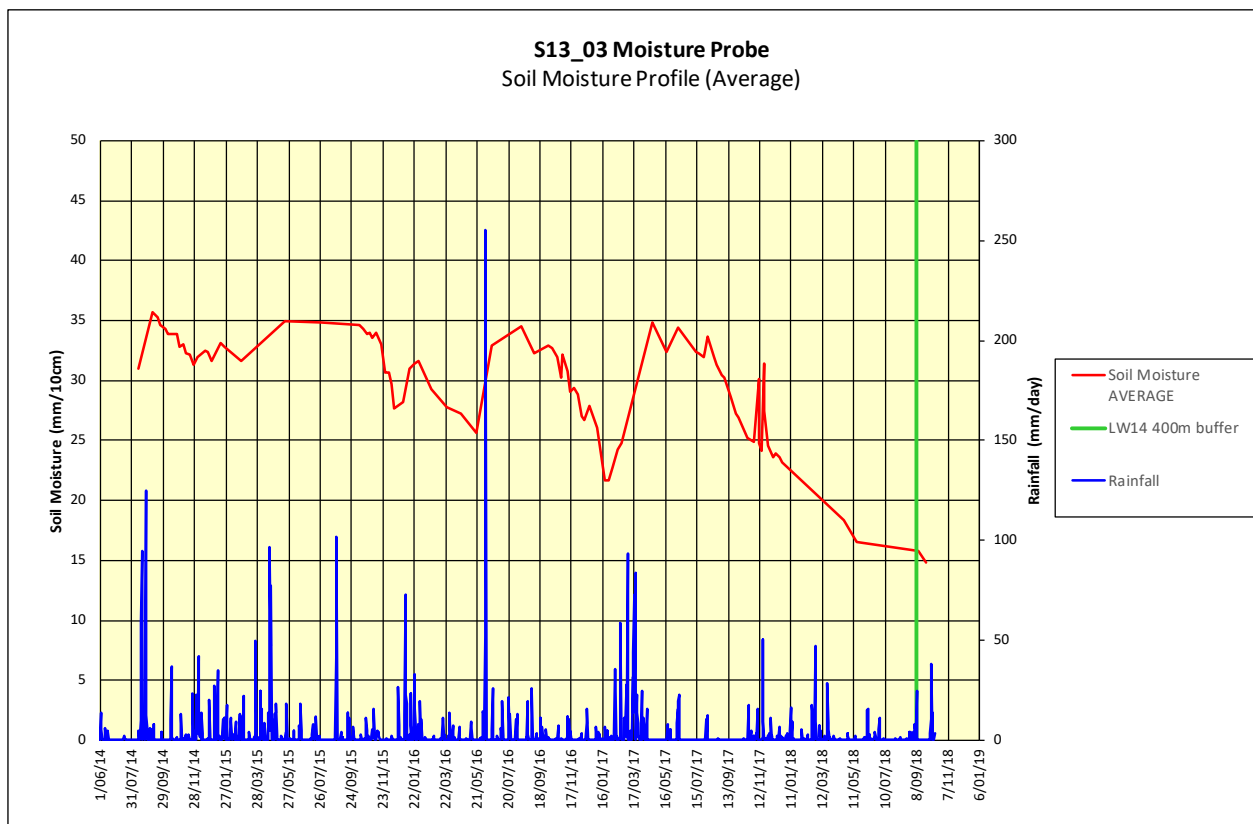


Figure 8: Soil moisture levels at site S13_03.

7.3 Water Quality

Wongawilli Creek (FR6)

Wongawilli Ck (FR6) is a water quality monitoring site approximately 3.5km downstream from DA3B. During an inspection of Wongawilli Ck (FR6), on 3 October 2018, water quality triggers for Dissolved Oxygen (DO) and Electrical Conductivity (EC) were identified. During the inspection, a DO of 45.5 % saturation and an EC of 169 $\mu\text{S}/\text{cm}$ were recorded (Figure 9 and Figure 10). DO and EC triggers have previously been recorded during the baseline and mining periods. No surface flow was present at Wongawilli Ck (FR6) leading up to and including this inspection.

These water quality observations contribute to Level 3 Triggers according to the Dendrobium Area 3B WIMMCP:

- 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 $\mu\text{S}/\text{cm}$**
 - **DO 50.5%**

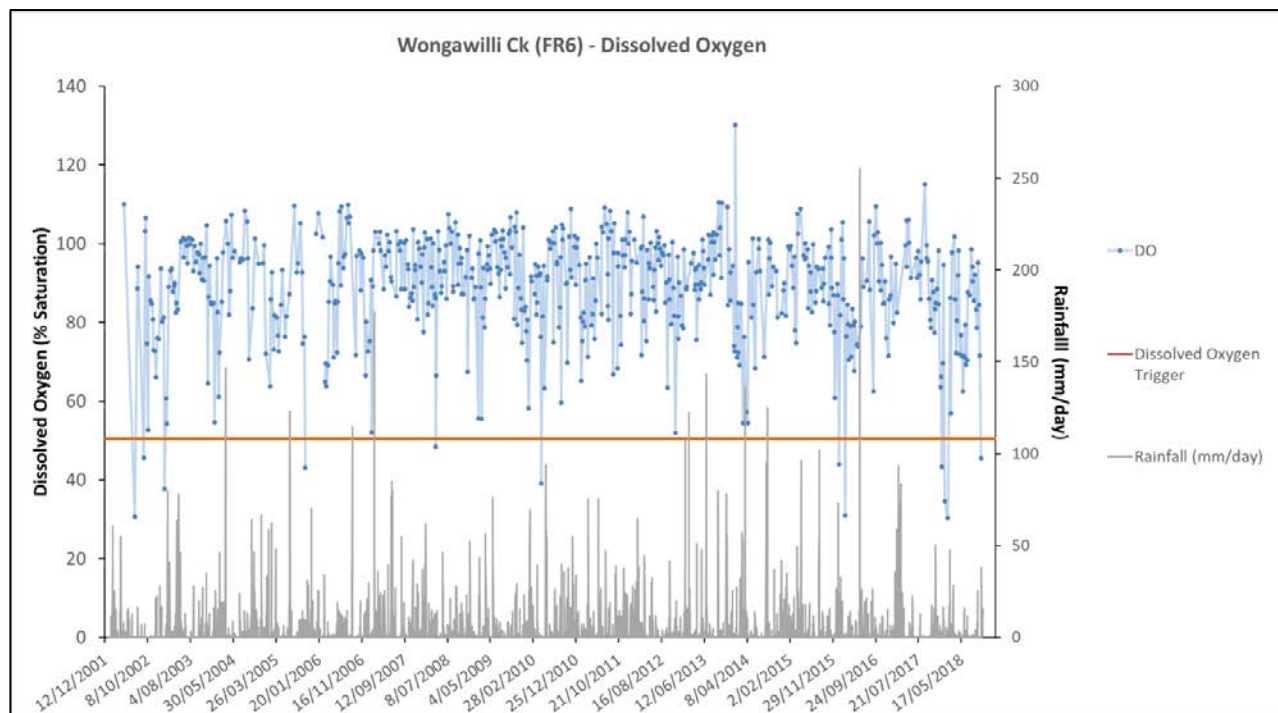


Figure 9: Dissolved Oxygen recorded at site Wongawilli Ck (FR6), downstream from DA3B operations.

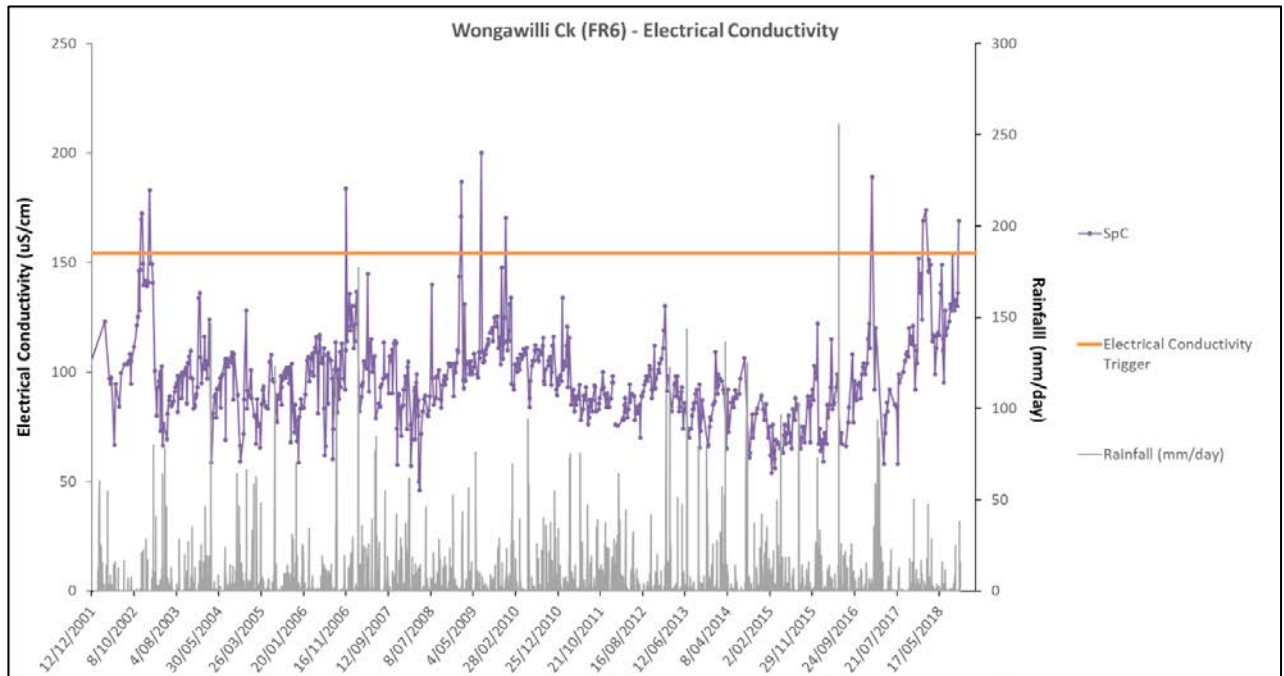


Figure 10: Electrical Conductivity recorded at site *Wongawilli Ck (FR6)*, downstream from DA3B operations.

Donalds Castle Creek (FR6)

Donalds Castle Ck (FR6) is a water quality monitoring site approximately 1.4km downstream from DA3B. Water quality triggers for Electrical Conductivity (EC) were identified during inspections of the site. EC values on 6 December 2018, 10 December 2018, 23 January 2019 and 25 March 2019 exceeded the 185.8 $\mu\text{S/cm}$ trigger level for EC (Figure 11). EC values exceeding the trigger level have been recorded during the baseline monitoring period (Figure 11).

No surface flow was present at *Donalds Castle Ck (FR6)* during three of the inspections where EC triggers were recorded. An absence in surface flow can result in an increase in EC due to evaporation and resultant increase in salt concentration in the pool. The latest inspection where EC was above the trigger level was associated with surface flow present at the site, following heavy rainfall in the preceding week.

This water quality observation contributes to a Level 3 Trigger according to the Dendrobium Area 3B Watercourse Impacts, Triggers and Response Plan (Appendix A, Table 2), specifically:

- 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 $\mu\text{S/cm}$**
 - DO <40.1%

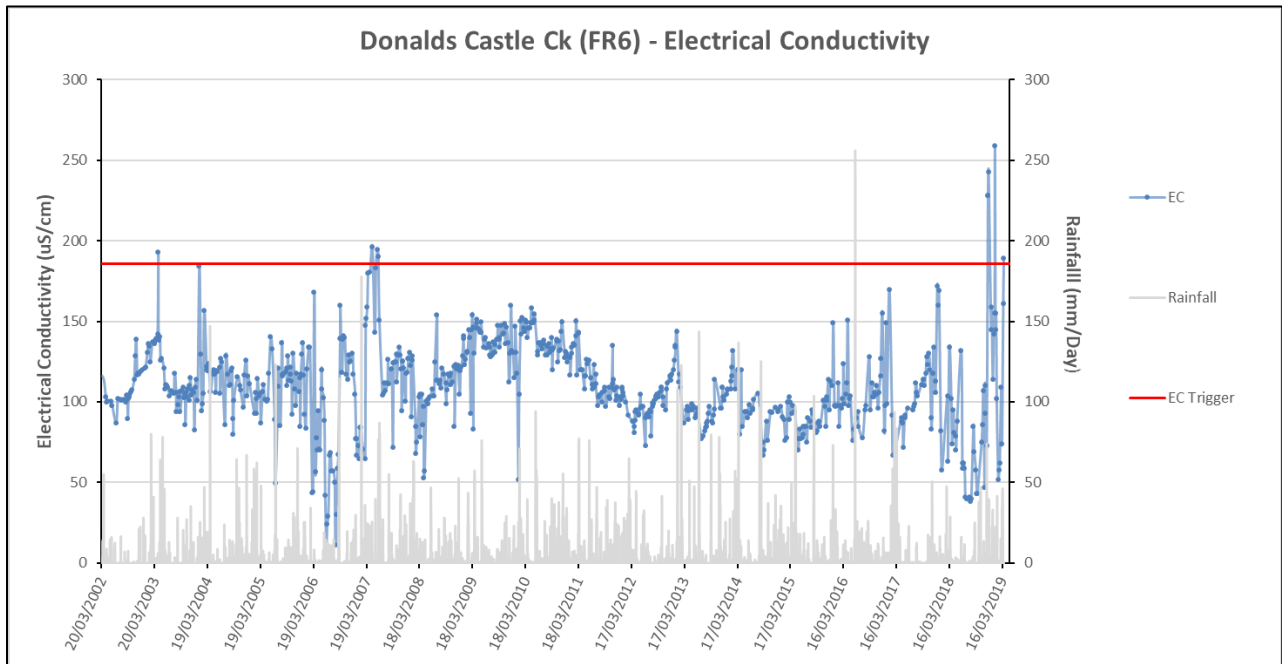


Figure 11: Electrical Conductivity recorded at site *Donalds Castle Ck (FR6)*, downstream from DA3B operations.

8 IMPACTS TO BUILT FEATURES

Fourteen surface impacts associated with built features were identified during the extraction of Longwall 14 (Figure 2). These features include FR6A (Fire Road 6A), AT6AA (Access Track 6AA, also known as Access Track 6000) and some smaller unnamed access tracks.

8.1 Level 1 Surface Cracking

Twelve impacts (Table 3) to built features were reported as Level 1 in accordance with the Dendrobium Area 3B SMP (Table 10); 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 35: DA3b_LW14_003. Taken 7/07/18.



Photo 36: DA3B_LW14_009. Taken 03/09/18.



Photo 37: DA3B_LW14_012. Taken 16/09/18.



Photo 38: DA3B_LW14_014. Taken 13/11/2018.

8.2 Level 2 Surface Cracking

Two impacts (Table 3) to built features were reported as Level 2 in accordance with the Dendrobium Area 3B SMP (Table 10); specifically:

Level 2: 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 39: DA3B_LW14_010. Taken 10/09/18.



Photo 40: DA3B_LW14_013. Taken 26/09/18.

8.3 Remediation

Following approval from WaterNSW, surface cracking across *Fire Road 6A* and *Fire Road 6AA* was remediated. Minor soil cracks in other areas are expected to infill through natural processes.

9 ADDITIONAL OBSERVATIONS

9.1 DC13 Water Quality

DC13_Pool 2b is a water quality monitoring site on Donald's Castle Creek tributary DC13 which is approximately 680m downstream from DA3B. During analyses of DC13 water quality data, an increase in electrical conductivity (EC) was observed at Pool 2b (Figure 12). A decrease in pH was also observed (Figure 13). The site is approximately 2.4km away from Longwall 14. The changes in field parameters don't appear to be reflected at other nearby sites. These changes will be addressed in the Surface Water and Shallow Groundwater Assessment.

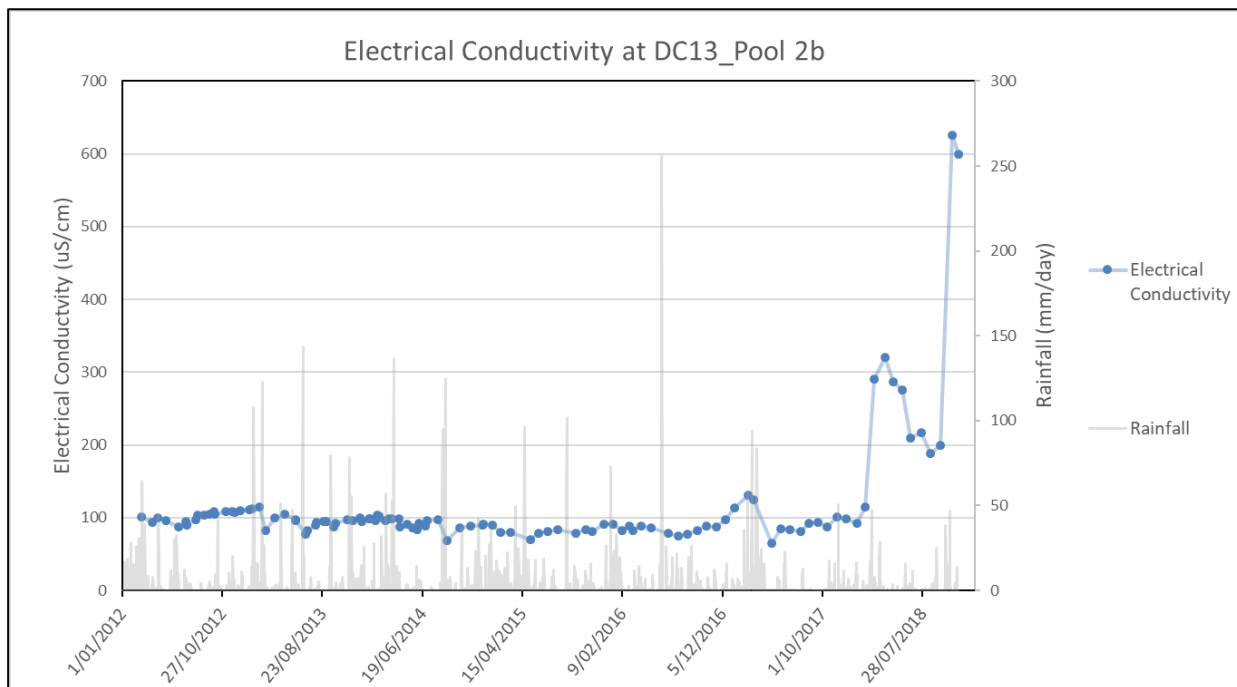


Figure 12: Electrical conductivity recorded at site DC13_Pool 2b, downstream from DA3B operations.

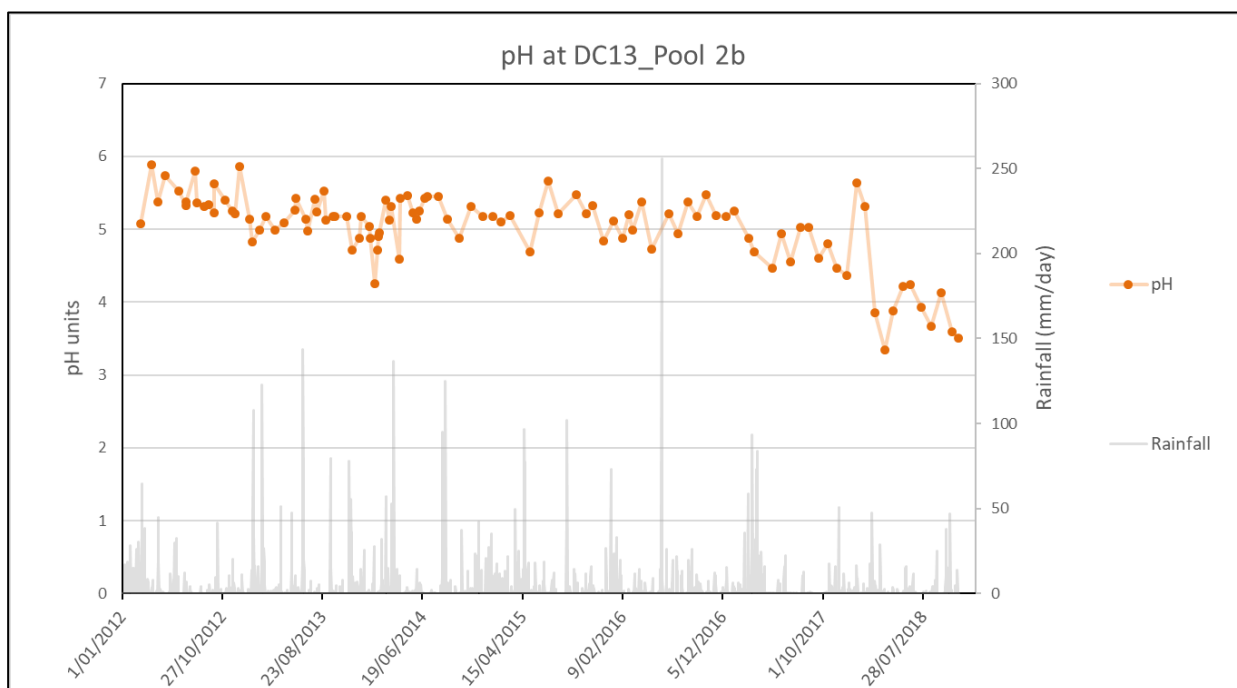


Figure 13: pH recorded at site DC13_Pool 2b, downstream from DA3B operations.

9.2 WC15_Pool 28

WC15_Pool 28 is located on WC15, a tributary to Wongawilli Creek. The pool is situated approximately 47m south east of Longwall 14. Recent data and observations show water levels have decreased despite rainfall events (Photo 41 to Photo 44, Figure 14). No fractures have been identified in the pool however three surface impacts to WC15 have been recorded upstream.



Photo 41: WC15_Pool 28, looking downstream. Taken 5/02/2019.



Photo 42: WC15_Pool 28, looking downstream. Taken 11/02/2019.



Photo 43: WC15_Pool 28, looking upstream. Taken 5/02/2019.



Photo 44: WC15_Pool 28, looking upstream. Water level logger housing also shown. Taken 11/02/2019.

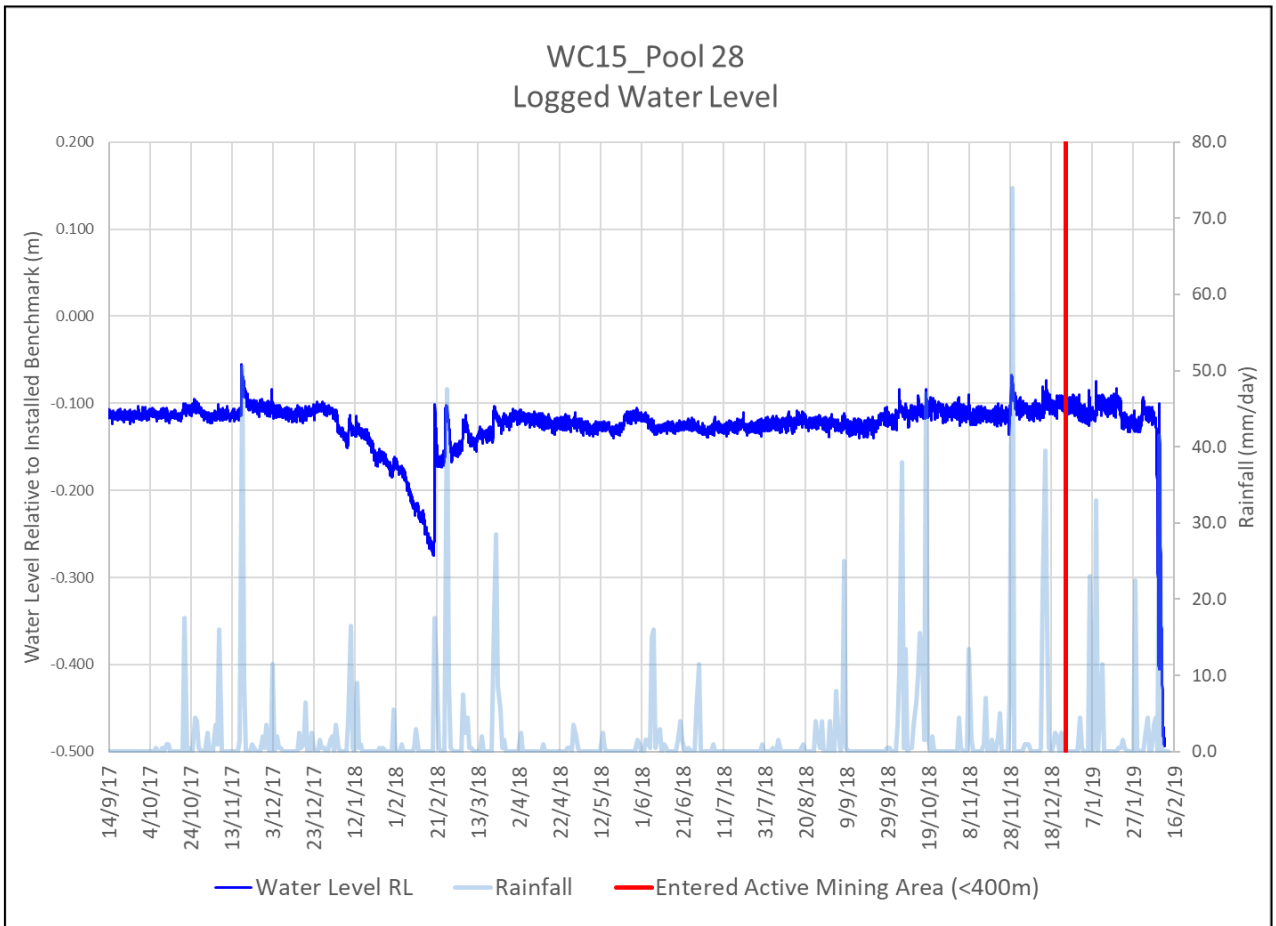


Figure 14: Pool water level results from logger installed at WC15_Pool 28.

9.3 WC15 Crack Monitoring

Crack monitoring devices were installed 9 November 2018 on pre-existing rock fractures resulting from Longwall 13. These devices were installed to measure the movement of fractures resulting from Longwall 14. Figure 15 outlines the movement of each fracture. Devices dislodged by subsidence movements are represented with a dotted line.

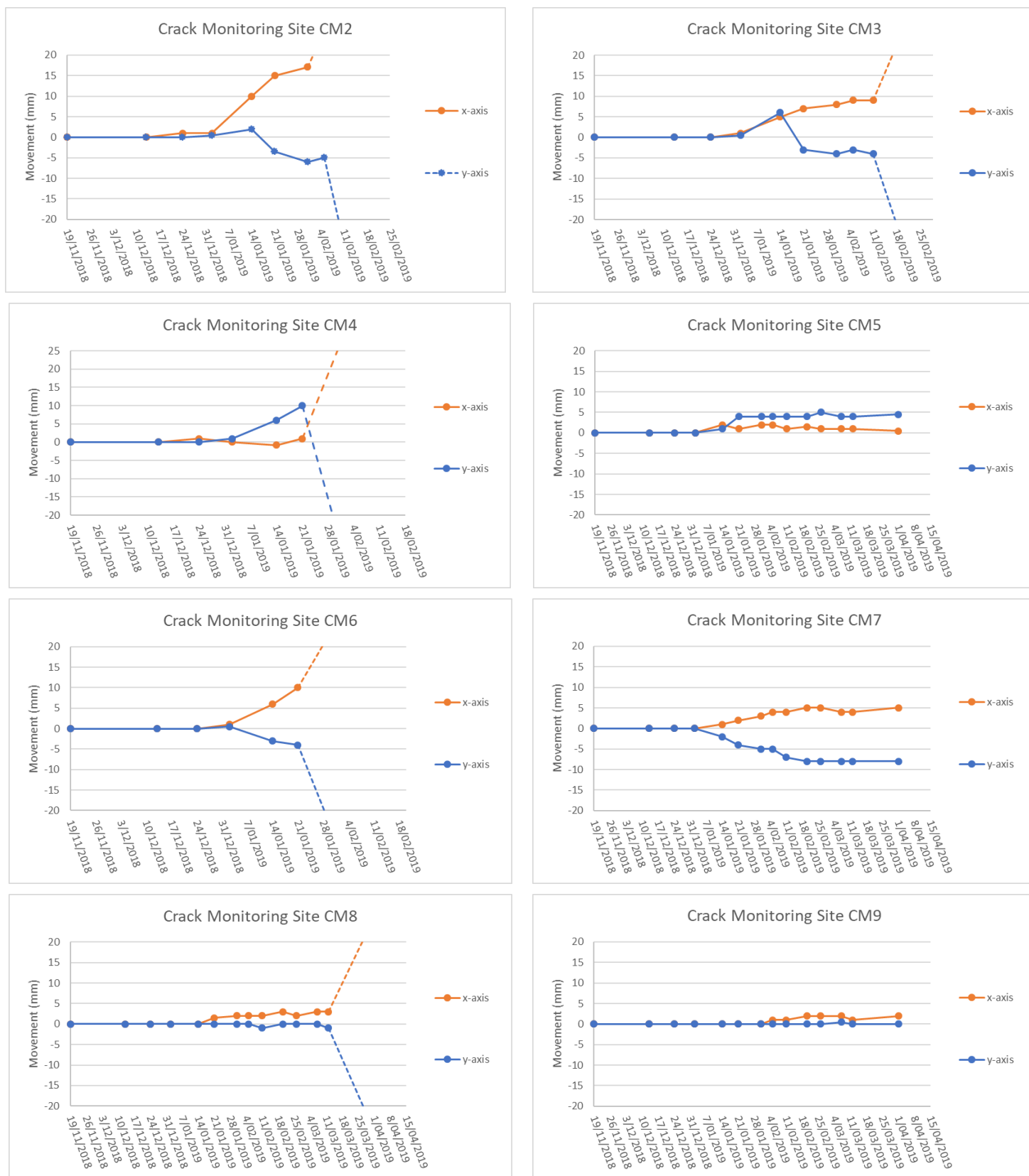


Figure 15: WC15 crack monitoring - crack movements due to Longwall 14. Dotted lines indicate movement past the measurable range.

10 RECOMMENDATIONS FOR FUTURE MONITORING

Recommendations for future monitoring in Dendrobium Area 3B, particularly concerning Longwall 15, 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.

Table 4: Monitoring associated with Longwall 14 and recommendations for monitoring during the extraction of Longwall 15.

ASPECT	MONITORING SITES ASSOCIATED WITH LONGWALL 14	MONITORING REQUENCY	RECOMMENDED FUTURE MONITORING FOR LONGWALL 15
Watercourses	Observational, Photo Point and Water Monitoring		
	<ul style="list-style-type: none"> • Donald's Castle Creek • LA3 • LA4, LA4A, LA4B • Swamp 23 • Swamps 4, 5, 8, 10, 11,13 and 14 • WC15 • WC21, WC16 and WC18 • Wongawilli Creek 	<p>Monthly 2 years pre and post mining, weekly when longwall is within 400m of monitoring site</p> <p>SLMMP Sites: pre and post mining, monthly when longwall is within 400m of monitoring site</p>	<ul style="list-style-type: none"> • Donald's Castle Creek – Continue as required. • Lake Avon • LA2 • LA3 – Continue as required • LA4, LA4A, LA4B - Continue as required • Swamp 23 – Continue as required • Swamps 4, 5,10,11,13 and 14 – Continue as required • WC12 • WC15, WC16 and WC21 – Continue as required • Wongawilli Creek – Continue as required • WC6, WC7, WC8, WC9, ND1; and Swamps 35a and 35b - <i>pre-mining monitoring</i>
	Water Quality		
	<ul style="list-style-type: none"> • Wongawilli Creek • WWU1 (Wongawilli Creek headwaters) • WWU4 (Wongawilli Creek upstream) • WC_Pool 49 (Wongawilli Creek adjacent to LW15) • WC_Pool 46 [<i>Previously named WWM1</i>] (Wongawilli Creek adjacent to LW12) • WWM2 (Wongawilli Creek adjacent to LW11) • WC_Pool 43b [<i>Previously named WWM3</i>] (Wongawilli Creek downstream of LW9) • Wongawilli Ck (FR6) [<i>Previously named WWL2</i>] (Wongawilli Creek downstream) • WC21_Pool 5 [<i>Previously named WC21S1</i>] (Wongawilli Creek tributary downstream of mining) • WC21_Pool 30 (Wongawilli Creek tributaries over mining) • WC21_Pool 53 (Wongawilli Creek tributaries over mining) • WC12_Pool 1 (Wongawilli Creek tributaries downstream of mining) • WC15_Pool 9 [<i>Previously named WC15S1</i>] (Wongawilli Creek tributary downstream of mining) <p>Lake Avon</p> <ul style="list-style-type: none"> • LA4_S1, LA4_S2, LA5_S1, LA5_S2, LA_1, LA1, LA2_Pool 5, LA3_Pool 4 	<p>Monthly monitoring during and post mining for two years until required</p>	<p>Continue water quality sample sites as required by the SMP</p>

	<p>Donalds Castle Creek:</p> <ul style="list-style-type: none"> • Donalds Castle Ck (FR6) [Previously named DCU3] (Donalds Castle Creek lower) • DCL3 (Donalds Castle Creek @ Cordeaux River) • DC_Pool 22 [Previously named DCS2] (Donalds Castle Creek downstream of mining) • DC13_Pool 2b [Previously named DC13S1] (Donalds Castle Creek tributary downstream of mining) 		
Swamps	Observational, Photo Point and Water Monitoring		
	<ul style="list-style-type: none"> • Swamps 4, 5, 8, 10, 11, 13, 14 and 23 	Pre and post mining for two years, monthly when longwall is within 400m of monitoring site	<ul style="list-style-type: none"> • Swamps 3, 4, 5, 10, 11 13, 14 and 23 - continue as required by the SMP
	Shallow Groundwater Level		
	<ul style="list-style-type: none"> • Swamp 05: 05_01, 05_02, 05_03, 05_03i, 05_03ii, 05_03iii, 05_04, 05_05, 05_06 • Swamp 08: 08_01, 08_02, 08_03, 08_04, 08_05, 08_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 <p>Reference Sites:</p> <ul style="list-style-type: none"> • 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 	<p>For open hole sites:</p> <ul style="list-style-type: none"> • Monthly monitoring pre, during and post mining for two years to be removed annually • Reference sites 6 monthly <p>For instrumented sites:</p> <ul style="list-style-type: none"> • Automatic groundwater level monitoring, during and post mining (4 hour interval or similar) • Monitoring post mining for five years to be reviewed annually 	<ul style="list-style-type: none"> • 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 <p>Reference Sites:</p> <ul style="list-style-type: none"> • 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		
	<ul style="list-style-type: none"> • Swamp 05: S05_S01, S05_S02, S05_S03, S05_S03i, S05_S03ii, S05_S03iii, S05_S04, S05_S05, S05_S08 • Swamp 08: S08_S01, S08_S02, S08_S03, S08_S04, S08_S05, S08_S06 • 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 <p>Reference Sites:</p> <ul style="list-style-type: none"> • 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 	<ul style="list-style-type: none"> • 6 monthly baseline and reference site monitoring • Weekly monitoring when longwall is within 400m of swamp • 6 monthly monitoring for 2 years post mining 	<ul style="list-style-type: none"> • 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 <p>Reference Sites:</p> <ul style="list-style-type: none"> • 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		

	<p>Cliffs</p> <ul style="list-style-type: none"> • DA3-CF19 • DA3-CF20 • DA3-CF21 • DA3-CF22 • DA3-CF23 <p>Fire Trails</p> <p>Fire Road 6A (across LWs 10-18) - Continue as required by the SMP</p> <p>Fire Road 6N</p>	<ul style="list-style-type: none"> • Baseline monitoring campaign prior to monitoring • Monthly monitoring during any subsidence period • Monitoring to continue 6 monthly for 2 years following the completion of mining 	<p>Cliffs</p> <p>No targeted cliff lines associated with Longwall 15</p> <p>Fire Trails</p> <p>Fire Road 6A (across LWs 10-18) - Continue as required by the SMP</p> <p>Fire Road 6N</p> <p>Fire Road 6P</p>
Inspection of Active Mining Area – Landscape Features, Vegetation, Watercourses			
	<p>All mapped cliff, steep slopes, watercourse, swamp and fire trail sites in subsidence area</p> <p>General observation of active mining areas</p>	<ul style="list-style-type: none"> • Weekly monitoring when longwall extraction is within 400m of feature 	<p>Continue monitoring of all mapped cliffs, steep slopes, watercourse, swamp and fire trail sites in subsidence area</p> <p>Continue general observation of active mining areas</p>

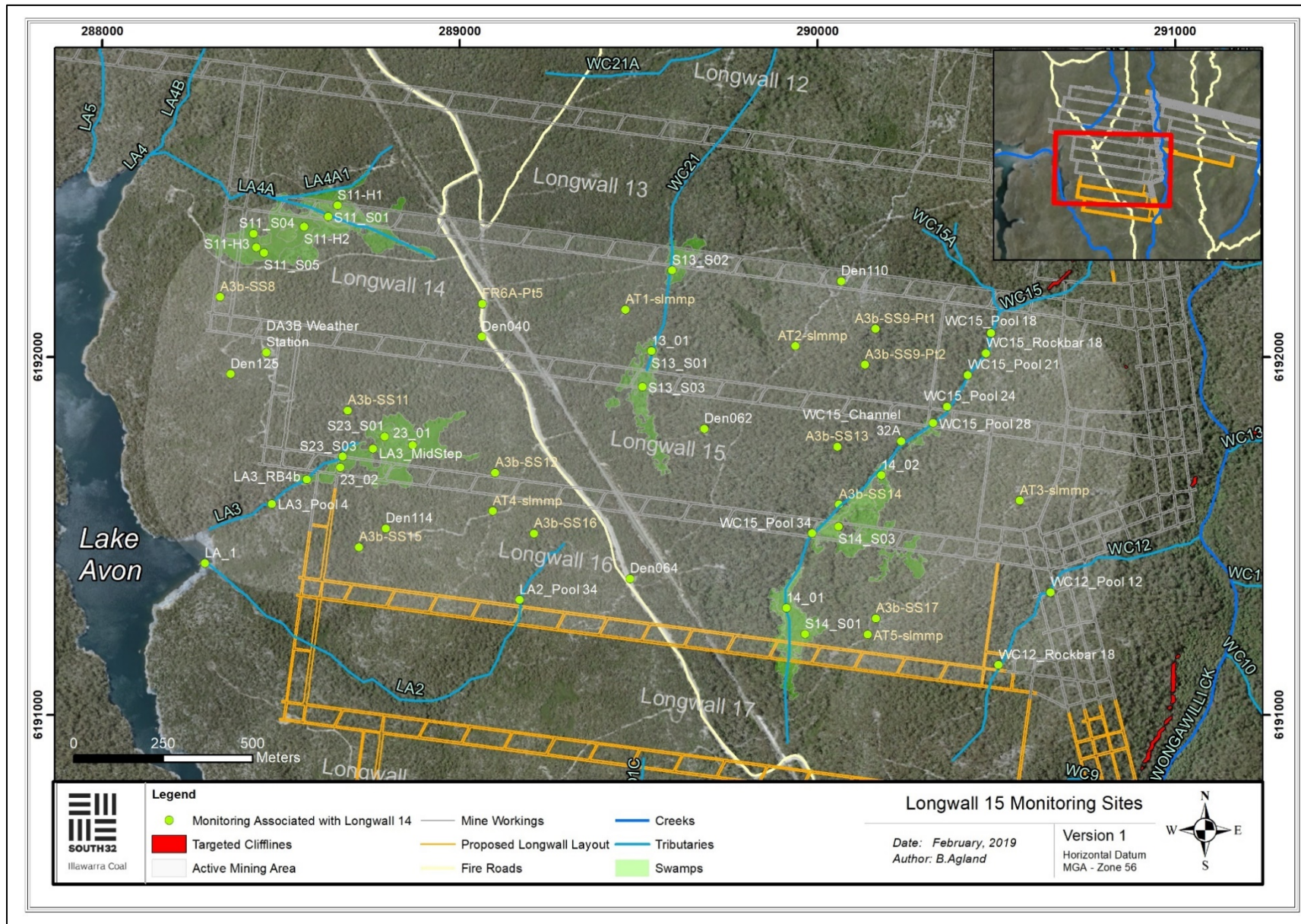


Figure 16: Monitoring sites relevant to Longwall 15.

11 APPENDIX A – LONGWALL 14 MONITORING PROGRAM

Table 5: Overview of surface monitoring for Longwall 14

ASPECT	MONITORING SITE	MONITORING FREQUENCY	MONITORED SITES ASSOCIATED WITH LONGWALL 14
Watercourse	Observational, Photo Point and Water Monitoring		
	<p>Impact Sites:</p> <ul style="list-style-type: none"> • Native Dog, Wongawilli and Donalds Castle Creeks, WC21, WC15, LA4, DC13, LA5, LA6, ND1, WC6, WC7, WC8, WC9, WC12, WC16 and WC18 • Swamps 5, 10, 11, 13, 14, 23, 35a, 35b, 1a, 1b, 8, 3 and 4 <p>Reference Sites:</p> <ul style="list-style-type: none"> • Wongawilli Creek, Sandy Creek, LC5, WC11, SC9A, SC10A, NDC1, DC10 and D10 • Swamps 2, 7, 15a, 22, 24, 25, 33, 84, 85, 86, 87 and 88 	<ul style="list-style-type: none"> • Monthly 2 years pre and post mining, weekly when longwall is within 400m of monitoring site • Reference sites 6 monthly • SLMMP Sites: Pre and post mining, monthly when longwall is within 400m of monitoring site 	<ul style="list-style-type: none"> • Wongawilli Creek • Donalds Castle Creek • WC21, WC15, WC16 • LA3, LA4, LA4A, LA4B • Swamps 4, 5, 10, 11,13, 14 and 23
	Water Quality		
	<p>Wongawilli Creek</p> <ul style="list-style-type: none"> • WWU1 (Wongawilli Creek headwaters) • WWU4 (Wongawilli Creek upstream) • WC_S1 • 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) • WC_Rockbar 39 • WC7_Pool 1 • WC12_Pool 1 • Wongawilli Ck (FR6) (Wongawilli Creek downstream) • WC12_Pool 1 (FR6) (Wongawilli Creek downstream) • WC21_Pool 5 (Wongawilli Creek tributary downstream of mining) • WC21 Pools 30 and 53 (Wongawilli Creek tributaries over mining) • WC15_Pool 28 (Wongawilli Creek tributary downstream of mining) • WC15_Pool 9 (Wongawilli Creek tributary downstream of mining) 	<ul style="list-style-type: none"> • Monthly monitoring pre, during and post mining for two years 	<p>Wongawilli Creek</p> <ul style="list-style-type: none"> • WWU1 • WWU4 • WC_Pool 49 • WC_Pool 46 • WWM2 • WC_Pool 43b • Wongawilli Ck (FR6) • WC_S1 • WC21_Pool 5, Pool 30 and Pool 53 • WC15_Pool 28 • WC15_Pool 9 • WC15_Pool 2 • WC12_Pool 1

	<ul style="list-style-type: none"> • WC15_Pool 2 (Wongawilli Creek tributary downstream of mining) <p>Lake Avon</p> <ul style="list-style-type: none"> • LA4_S1, LA4_S2, LA5_S1, LA5_S2, LA3 Pool 4, LA2 Pool 5, LA_1, and LA1 (Lake Avon tributaries downstream of mining) • NDC4 (Native Dog Creek downstream of mining) • NDC1 (Native Dog Creek upstream of Area 3B) <p>Donalds Castle Creek</p> <ul style="list-style-type: none"> • Donalds Castle Ck (FR6) (Donalds Castle Creek lower) • DCL3 (Donalds Castle Creek @ Cordeaux River) • DC_Pool 22 (Donalds Castle Creek downstream of mining) • DC13_Pool 2b (Donalds Castle Creek tributary downstream of mining) 	<p>Lake Avon</p> <ul style="list-style-type: none"> • LA4_S1, LA4_S2, LA3 Pool 4, LA2 Pool 5, LA_1 and LA1 • NDC4 • NDC1 <p>Donalds Castle Creek</p> <ul style="list-style-type: none"> • Donalds Castle Ck (FR6) • DCL3 • DC_Pool 22 • DC13_Pool 2b
Swamps	Observational, Photo Point and Water Monitoring	
	<p>Impact Sites:</p> <ul style="list-style-type: none"> • Swamps 1a, 1b, 3, 4, 5, 8, 10, 11, 13, 14, 23, 35a and 35b <p>Reference Sites:</p> <ul style="list-style-type: none"> • Swamps 2, 7, 15a, 22, 24, 25, 33, 84, 85, 86, 87 and 88 	<ul style="list-style-type: none"> • Pre and post mining for 2 years, monthly when longwall is within 400m of monitoring site • Weekly inspection and pool water levels when longwall is within 400m of monitoring site • Reference sites 6 monthly
	Erosion Monitoring	
	<p>Impact Sites:</p> <ul style="list-style-type: none"> • Swamps 1a, 1b, 3, 4, 5, 8, 10, 11, 13, 14, 23, 35A and 35B <p>Reference Sites:</p> <ul style="list-style-type: none"> • Swamps 2, 7, 15A, 22, 24, 25, 33, 84, 85, 86, 87 and 88 	<p>ALS base surveys were completed in December 2005, with a verification base survey performed in 2013, immediately prior to the commencement of Longwall 9 extraction Ground based surveys to be completed for each longwall after each longwall or to define any new erosions identified by ALS survey</p> <ul style="list-style-type: none"> • Swamps 4, 5,10, 11, 13, 14 and 23
	Shallow Groundwater Level	
	<p>Impact Sites:</p> <ul style="list-style-type: none"> • Swamp 01A: 01a_01, 01a_02, 01a_03, 01a_04, 01a_04i, 01a_04ii, 01a_04iii, 01a_04iv, 01a_04v • Swamp 01B: 01b_01, 01b_02, 01b_02i, 01b_02ii, 01b_02iii, 01b_02iv, 01b_03 • Swamp 03: 03_01 • Swamp 04: (thin soil profile) • Swamp 05: 05_01, 05_02, 05_03, 05_03i, 05_03ii, 05_03iii, 05_04, 05_05, 05_06 	<p>For open hole sites:</p> <ul style="list-style-type: none"> • Monthly monitoring pre, during and post mining for two years to be reviewed annually • Reference sites 6 monthly <p>For instrumented sites:</p> <ul style="list-style-type: none"> • Automatic groundwater level monitoring pre,

<ul style="list-style-type: none"> • Swamp 08: 08_01, 08_02, 08_03, 08_04, 08_05, 08_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 • Swamp 35A: 35A_01 • Swamp 35B: 35B_01 <p>Note: Swamp 4 is too shallow for a piezometer to be installed. Piezometers to be installed in Swamps 14, 23, 35A and 35B prior to mining</p> <p>Reference Sites:</p> <ul style="list-style-type: none"> • Swamp 2: 02_01 • Swamp 7: 07_05, 07_06 • Swamp 15A: 15a_02, 15a_03, 15a_04, 15a_06, 15a_07, 15a_08, 15a_09, 15a_11, 15a_12, 15a_15 • Swamp 22: 22_01, 22_02 • Swamp 24: 24_01 • Swamp 25: 25_01 • Swamp 33: 33_01, 33_03 • Swamp 84: 84_02 • Swamp 85: 85_01, 85_02 • Swamp 86: 86_01, 86_02 • Swamp 87: 87_01, 87_02 • Swamp 88: 88_01, 88_02 	<p>during and post mining (4-hour interval or similar)</p> <ul style="list-style-type: none"> • Monitoring post mining for five years to be reviewed annually
Soil Moisture	
<p>Impact Sites:</p> <ul style="list-style-type: none"> • Swamp 03: (thin soil profile) • Swamp 04: (thin soil profile) • Swamp 05: S05_S01, S05_S02, S05_S05, S05_S08 • Swamp 08: S08_S05 • Swamp 11: S11_S01, S11_S02, S11_S05 • Swamp 13: S13_S01, S13_S02, S13_S03 • Swamp 14: 14_01, 14_02 	<p>For manually measured sites:</p> <ul style="list-style-type: none"> • Monthly monitoring for 2 years baseline and post mining and 6 monthly reference site • Weekly monitoring when longwall is within 400m of monitoring site <p>For instrumented sites:</p> <ul style="list-style-type: none"> • Automatic soil moisture monitoring pre, during and post <p style="text-align: right;">•Swamps 4, 5, 10, 11, 13, 14 and 23</p>

	<ul style="list-style-type: none"> • Swamp 23: 23_01, 23_02 • Swamp 35A: 35a_01 • Swamp 35B: 35b_01 <p>Reference Sites:</p> <ul style="list-style-type: none"> • 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 	<ul style="list-style-type: none"> • Monitoring post mining for five years to be reviewed annually
Landscape	Targeted sites	
	<p>Cliffs</p> <ul style="list-style-type: none"> • DA3-CF19 (E LW13) • DA3-CF20 (E LW13) • DA3-CF21 (E LW13) • DA3-CF22 (E LW13) • DA3-CF23 (E LW13) • DA3-CF25 (E LW17) • DA3-CF26 (E LW17) • DA3-CF41 (E LW18) • DA3-CF42 (E LW18) • DA3-CF43 (E LW18) <p>Watercourses/Swamps</p> <p>Refer to DA3B Watercourses/Swamps Impact Monitoring Management Contingency Plan/s</p> <p>Fire Trails</p> <ul style="list-style-type: none"> • Fire Road No.6A (across LWs 10-18) • Fire Road No.6N (across LW14) • Fire Road No.6Q (across LW 15, 16 and 17) 	<ul style="list-style-type: none"> • Baseline monitoring prior to mining • monthly monitoring during any subsidence period • Monitoring to continue 6 monthly for 2 years following the completion of mining <p>Cliffs</p> <ul style="list-style-type: none"> • DA3-CF19 • DA3-CF20 • DA3-CF21 • DA3-CF22 • DA3-CF23 <p>Fire Trails</p> <ul style="list-style-type: none"> • Fire Road No.6A (across LWs 10-18) • Fire Road No.6N (across LW14)

Inspection of Active Mining Area - Landscape Features, Vegetation, Watercourses

- All mapped cliff, steep slopes, watercourse, swamp and fire trail sites in subsidence area

- General observation of active mining areas

- Weekly monitoring when longwall extraction is within 400m of feature

- All mapped cliff, steep slopes, watercourse, swamp and fire trail sites in subsidence area

- General observation of active mining areas

Table 6: Dendrobium Area 3B Impacts, TARPs & Performance Measures – Longwall 14 End of Panel Report

Performance Measure	Potential Impacts	Exceeding Prediction	TARP Trigger Level	Observed Impacts	Additional Comments
Watercourses					
<p>Wongawilli Creek & Donalds Castle Creek</p> <p><i>Dendrobium Area 3B SMP Approval:</i></p> <p>Minor environmental consequences including:</p> <ul style="list-style-type: none"> • <i>minor</i> fracturing, gas release and iron staining; and • <i>minor</i> impacts on water flows, water levels and water quality. <p><i>Dendrobium Modified Development Consent:</i></p> <ul style="list-style-type: none"> • Operations shall not cause subsidence impacts at Wongawilli Creek other than “minor 	<p>Minor environmental consequences including: minor fracturing, gas release and iron staining; and minor impacts on water flows, water levels and water quality</p>	<p><u>Observational</u></p> <ul style="list-style-type: none"> • 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 	<p><u>Observational</u></p> <p>Level 1</p> <ul style="list-style-type: none"> • 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 	<p>No level 1 impacts observed</p>	

Performance Measure	Potential Impacts	Exceeding Prediction	TARP Trigger Level	Observed Impacts	Additional Comments
<p>impacts” (such as minor fracturing, gas release, iron staining and minor impacts on water flows, water levels and water quality);</p> <ul style="list-style-type: none"> • 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. 		<p>attributed to natural variation</p> <ul style="list-style-type: none"> • 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) 	<p>Level 2</p> <ul style="list-style-type: none"> • 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 	No Level 2 impacts observed	
			<p>Level 3</p> <ul style="list-style-type: none"> • 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, 	<p>Wongawilli Ck (FR6)- exceedance of the +3 standard deviation level from the baseline mean for Electrical Conductivity and dissolved oxygen. (<i>Further discussed in Surface and Shallow Groundwater Assessment</i>)</p> <p>Donalds Castle Ck (FR6)- exceedance of the +3 standard deviation level from the baseline mean for Electrical Conductivity and dissolved oxygen. (<i>Further discussed in Surface and Shallow Groundwater Assessment</i>)</p>	<p>See impact report dated: - 3/10/2018</p> <p>See impact report dated: - 28/3/2019</p>

Performance Measure	Potential Impacts	Exceeding Prediction	TARP Trigger Level	Observed Impacts	Additional Comments
			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 Level 2 • Fracturing resulting in diversion of flow Level 3 • Fracturing resulting in diversion of flow such that <10% of the pools have water levels lower than baseline period	No Level 1 impacts observed No Level 2 impacts observed No Level 3 impacts observed	

Performance Measure	Potential Impacts	Exceeding Prediction	TARP Trigger Level	Observed Impacts	Additional Comments
	<p><u>Drainage lines</u></p> <ul style="list-style-type: none"> • 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 <p><i>N.B. Not linked specifically to a performance measure</i></p>	<ul style="list-style-type: none"> • 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) 	<p>Level 1</p> <ul style="list-style-type: none"> • 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 	<ul style="list-style-type: none"> • Impact DA3B_LW13_046 – Rock fracturing to WC15_Step 2. • Impact DA3B_LW14_019 – Rock fracturing to WC15_Rockbar 28 • Impact DA3B_LW14_023 – Rock fracturing to WC15_Rockbar 28 	<p>See impact report dated: - 01/04/2019</p> <p>See impact report dated: - 21/02/2019</p> <p>See impact report dated: - 01/04/2019</p>

Performance Measure	Potential Impacts	Exceeding Prediction	TARP Trigger Level	Observed Impacts	Additional Comments
		<ul style="list-style-type: none"> • 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) 	<p>Level 2</p> <ul style="list-style-type: none"> • 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 	<ul style="list-style-type: none"> • Impact DA3B_LW13_035 (Update) – Rock fracturing to WC15_Rockbar 21. • Impact DA3B_LW13_042 (Update) – Rock fracturing and dislodgement to WC15_Rockbar 7. • Impact DA3B_LW13_043 (Update) – Rock fracturing, rockfall and iron staining evident at LA4_Step 0 • Impact DA3B_LW13_044 – Rock fracturing, rockfall and iron staining evident at LA4_Step 0 • Impact DA3B_LW13_045 – Rock fracturing, rockfall and iron staining evident at LA4_Step 0 • Impact DA3B_LW14_016 – Rock fracturing to WC15_Rockbar 25 and Step 25 • Impact DA3B_LW14_017 – Rock fracturing to WC15_Channel 30 • Impact DA3B_LW14_018 – Rock fracturing to WC15_Pool 30 • Impact DA3B_LW14_020 – Rock fracturing to WC15_Rockbar 26 • Impact DA3B_LW14_021 – Rock fracturing to 	<ul style="list-style-type: none"> See impact report dated: - 27/04/2018 (Original) - 24/01/2019 (Update) See impact report dated: - 17/05/2018 (Original) - 01/04/2019 (Update) See impact report dated: - 18/05/2018 - 06/12/2018 See impact report dated: - 08/08/2018 See impact report dated: - 08/08/2018 See impact report dated: - 24/01/2019 See impact report dated: - 24/01/2019 See impact report dated: - 21/02/2019 See impact report dated: - 21/02/2019 See impact report dated: - 21/02/2019

Performance Measure	Potential Impacts	<i>Exceeding</i> Prediction	TARP Trigger Level	Observed Impacts	Additional Comments
				WC15_Rockbar 21 and WC15_Step 21 <ul style="list-style-type: none"> • Impact DA3B_LW14_022 – Rock fracturing to WC15_Rockbar 18 	See impact report dated: - 21/02/2019

Performance Measure	Potential Impacts	<i>Exceeding Prediction</i>	TARP Trigger Level	Observed Impacts	Additional Comments
			<p>Level 3</p> <ul style="list-style-type: none"> • 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	Additional Comments
SWAMPS					
	<p>Falls in surface or near-surface groundwater levels in swamps.</p> <p><i>N.B. not linked specifically to a performance measure and would not be considered a breach if predictions were exceeded.</i></p>		<p>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).</p>	<p>No new Level 1 impacts observed.</p>	
			<p>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.</p>	<p>• 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.</p>	<p>See impact report dated: - 13/02/2019</p>

Performance Measure	Potential Impacts	Exceeding Prediction	TARP Trigger Level	Observed Impacts	Additional Comments
			<p>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.</p>	<ul style="list-style-type: none"> • Swamp 13 (13_01): Groundwater level lower than baseline level at >80% (within 400m of mining) of monitoring sites. 	See impact report dated: - 06/12/2018
	<p>Falls in soil moisture levels in swamps.</p> <p><i>N.B. Not linked specifically to a performance measure and would not be considered a breach if predictions were exceeded.</i></p>		<p>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).</p>	<ul style="list-style-type: none"> • Swamp 23 (S23_02): Soil moisture level below baseline 	See impact report dated: - 16/10/2018
			<p>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)</p>	No new Level 2 impacts observed.	
			<p>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).</p>	<ul style="list-style-type: none"> • Swamp 13 (S13_01): Soil moisture level lower than baseline level at >80% of monitoring sites (within 400m of mining) within a swamp. • Swamp 13 (S13_02): 	See impact report dated: - 16/10/2018 See impact report dated: - 16/10/2018

Performance Measure	Potential Impacts	Exceeding Prediction	TARP Trigger Level	Observed Impacts	Additional Comments
				<p>Soil moisture level lower than baseline level at >80% of monitoring sites (within 400m of mining) within a swamp.</p> <ul style="list-style-type: none"> • Swamp 13 (S13_03): Soil moisture level lower than baseline level at >80% of monitoring sites (within 400m of mining) within a swamp 	See impact report dated: - 16/10/2018
LANDSCAPE					
	<p>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 some small isolated rock falls could occur along the cliffs as a result of the extraction of the proposed longwalls. It is not expected however, that,</p>		<p>Level 1</p> <ul style="list-style-type: none"> • Rock fall from a cliff which is left mostly intact (<10% length), resulting in insignificant ground disturbance • Surface movement or rock displacement with negligible soil surface exposed • Crack at the surface, which should not result in any significant erosion or further ground movement • Crack in a fire trail which should not result in erosion or impede access • Crack or fracture up to 100mm width 	<ul style="list-style-type: none"> • Impact DA3B_LW14_001 – Surface cracking on FR6N • Impact DA3B_LW14_002 – Surface cracking on FR6N • Impact DA3B_LW14_003 – Surface cracking on FR6N • Impact DA3B_LW14_004 – Surface cracking on FR6N • Impact DA3B_LW14_005 – Surface cracking on FR6AA • Impact DA3B_LW14_006 – Surface cracking on Access Track 	<p>See impact report dated: - 4/7/2019</p> <p>See impact report dated: - 48/8/2018</p> <p>See impact report dated: - 8/8/2018</p> <p>See impact report dated: - 29/8/2018</p> <p>See impact report dated: - 29/8/2018</p> <p>See impact report dated: - 29/8/2018</p>

Performance Measure	Potential Impacts	Exceeding Prediction	TARP Trigger Level	Observed Impacts	Additional Comments
	<p>any large scale cliff instabilities would occur based on previous experience.</p> <p>Impacts to steep slopes due to mining induced subsidence are most likely to occur in the form of surface cracks.</p> <p>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.</p> <p>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.</p>		<ul style="list-style-type: none"> • 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 	<ul style="list-style-type: none"> • Impact DA3B_LW14_007 – Surface cracking on FR6AA • Impact DA3B_LW14_008 – Surface cracking on FR6A • Impact DA3B_LW14_009 – Surface cracking on FR6A • Impact DA3B_LW14_011 – Surface cracking and uplift on rail corridor • Impact DA3B_LW14_012 – Surface cracking on FR6A • Impact DA3B_LW14_014 – Surface cracking on Access Track • Impact DA3B_LW14_015 – Rock fracturing and rockfall to Lake Avon cliff edge • Impact DA3B_LW14_024 – Rock fracturing, rockfall and soil cracking at SLMMP site <i>A3b-SS9-Pt2</i> Impact DA3B_LW14_025 – Rock fracturing and displacement at a steep slope 	<p>See impact report dated: - 29/8/2018</p> <p>See impact report dated: - 29/8/2018</p> <p>See impact report dated: - 3/9/2018</p> <p>See impact report dated: - 20/9/2018</p> <p>See impact report dated: - 20/9/2018</p> <p>See impact report dated: - 16/11/2018</p> <p>See impact report dated: - 18/12/2018</p> <p>See impact report dated: - 10/04/19</p> <p>See impact report dated: - 10/04/19</p>
			<p>Level 2</p> <ul style="list-style-type: none"> • Rock fall or overhang collapse at a cliff site, where characteristics of the cliff have changed, and there has been significant ground Disturbance 	<ul style="list-style-type: none"> • Impact DA3B_LW14_010 – Surface cracking on FR6A. • Impact DA3B_LW14_013 – Surface cracking on Access Track 	<p>See impact report dated: - 20/9/2018</p> <p>See impact report dated: - 27/9/2018</p>

Performance Measure	Potential Impacts	<i>Exceeding Prediction</i>	TARP Trigger Level	Observed Impacts	Additional Comments
			<ul style="list-style-type: none"> • 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 		

Performance Measure	Potential Impacts	Exceeding Prediction	TARP Trigger Level	Observed Impacts	Additional Comments
			<p>Level 3</p> <ul style="list-style-type: none"> • 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 	No Level 3 Landscape Impacts observed.	

12 APPENDIX B – IMPACTS, TRIGGERS AND RESPONSE

Table 7: Dendrobium Swamp Impacts, Triggers and Response

<i>Performance Measures</i>	<i>Potential Impacts</i>	<i>Performance Triggers</i>	<i>Management Strategies</i>	<i>Offsets</i>	<i>Other Actions</i>
Negligible erosion of the surface of the swamp	Gully erosion or similar	<p><u>Level 1:</u> The increase in length of erosion within a swamp (compared to its pre-mining length) is 2% of the swamp length or area; and/or</p> <p>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.</p> <p><u>Level 2:</u> The increase in length of erosion within a swamp (compared to its pre-mining length) is 3% of the swamp length or area; and/or</p> <p>Soil surface crack that causes erosion that is likely to stabilise within the monitoring period without intervention; and/or</p> <p>Gully knickpoint forms or an existing gully knickpoint becomes active.</p> <p><u>Level 3:</u> The increase in length of erosion within a swamp (compared to its pre-mining length) is 4% of the swamp length or area; and/or</p> <p>Soil surface crack that causes erosion that is unlikely to stabilise within the monitoring period without intervention.</p> <p><u>Exceeding Prediction</u></p> <p>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</p>	<p>a) upfront mine planning</p> <p>b) erosion monitoring (i.e. ALS, observation)</p> <p>c) coir logs</p> <p>d) knickpoint control</p> <p>e) water spreading</p> <p>f) weeding</p> <p>g) fire management</p> <p>h) reporting</p> <p>i) investigation and review</p> <p>j) update future predictions</p>	<p>Offset required immediately, if no remediation considered practicable.</p> <p>Offset required 2 years following remediation, if it is ineffective.</p> <p>This period can be extended to 5 years, with the agreement of the Secretary.</p>	

		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%).			
<p>Minor changes in the size of the swamps</p> <p>Minor changes in the ecosystem functionality of the swamps</p> <p>No significant change to the composition or distribution of species within the swamps</p>	<p>Swamp vegetation changes:</p> <ul style="list-style-type: none"> - Swamp size - Species richness, distribution, composition and diversity - Vegetation sub-communities 	<p>Swamp Size</p> <p><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.</p> <p><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.</p> <p><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.</p> <p><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.</p> <p>Ecosystem Functionality</p> <p><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.</p>	<ul style="list-style-type: none"> 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 rockbars and bedrock base and/or use of other remediation techniques i) reporting j) investigation and review k) update future predictions 	<p>Offset required immediately, if no remediation considered practicable.</p> <p>Offset required 5 years following remediation, if it is ineffective.</p> <p>This period can be extended to 10 years, with the agreement of the Secretary.</p>	<p>Monitoring period for swamp size is related to capture of Lidar data at the end of each longwall ~ 1 year</p> <p>Triggers for groundwater decline result in increased intensity and frequency of vegetation monitoring</p>

		<p><u>Level 2:</u> 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.</p> <p><u>Level 3:</u> 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.</p> <p><u>Exceeding Prediction:</u> 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.</p> <p>Species Composition and Distribution</p> <p><u>Level 1:</u> 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</p> <p><u>Level 2:</u> 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.</p> <p><u>Level 3:</u> 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.</p> <p><u>Exceeding Prediction:</u></p>			
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		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	<p><u>Level 1:</u> 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).</p> <p><u>Level 2:</u> 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).</p> <p><u>Level 3:</u> 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).</p> <p><u>Exceeding Prediction</u> 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.</p>	<ul style="list-style-type: none"> 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 	<p>Offset required immediately, if no remediation considered practicable.</p> <p>Offset required 2 years following remediation, if it is ineffective.</p> <p>This period can be extended to 5 years, with the agreement of the Secretary.</p>	
Minor changes in the ecosystem	Falls in surface or near-surface groundwater	<u>Level 1:</u> Groundwater level lower than baseline level at any monitoring site within a swamp (in comparison to reference swamps); and/or	<ul style="list-style-type: none"> a) upfront mine planning b) groundwater monitoring 		Triggers for groundwater decline result in increased

functionality of the swamps	<p>levels in swamps</p> <p><i>N.B. Not linked specifically to a PM and would not be considered a breach if predictions were exceeded.</i></p>	<p>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).</p> <p><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</p> <p>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.</p> <p><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</p> <p>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.</p>	<p>c) implementation of swamp research program</p> <p>d) weeding</p> <p>e) fire management</p> <p>f) reporting</p> <p>g) update future predictions</p>		<p>intensity and frequency of vegetation monitoring and/or further investigations of subsidence impacts on bedrock base and rockbars</p>
<p>Minor changes in the ecosystem functionality of the swamps</p>	<p>Falls in soil moisture levels in swamps</p> <p><i>N.B. Not linked specifically to a PM and would not be considered a breach if predictions were exceeded.</i></p>	<p><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).</p> <p><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).</p> <p><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).</p>	<p>a) upfront mine planning</p> <p>b) soil moisture monitoring</p> <p>c) water spreading</p> <p>d) weeding</p> <p>e) fire management</p> <p>f) reporting</p> <p>g) update future predictions</p>		<p>Triggers of soil moisture decline result in increased intensity and frequency of vegetation monitoring and/or further investigations of subsidence impacts on</p>

					bedrock base and rockbars
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Table 8: Dendrobium Watercourse Impacts, Triggers and Response

Monitoring	Trigger	Action
OBSERVATIONAL, PHOTO POINT AND WATER MONITORING		
<p>Native Dog, Wongawilli and Donalds Castle Creeks, WC21, WC15, LA4, DC13, LA5, ND1, WC6, WC7, WC8, WC9, WC12, WC16 and WC18</p> <p>General observation of streams in active mining areas when longwall is within 400m</p>	<p>Level 1 *</p> <ul style="list-style-type: none"> 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 	<ul style="list-style-type: none"> 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
<p>Relevant Performance Measure(s):</p> <ul style="list-style-type: none"> Wongawilli Creek - minor environmental consequences Donalds Castle Creek - minor environmental consequences Waterfall WC-WF54 – negligible environmental consequences 	<p>Level 2 *</p> <ul style="list-style-type: none"> 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 	<ul style="list-style-type: none"> <i>Actions as stated for Level 1</i> Review monitoring frequency Notify relevant technical specialists and seek advice on any CMA required Implement agreed CMAs as approved (subject to stakeholder feedback)
	<p>Level 3 *</p> <ul style="list-style-type: none"> 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 	<ul style="list-style-type: none"> <i>Actions as stated for Level 2</i> Site visit with OEH, DoPE, T&I, Water NSW and other resource manager/s (if requested) Implement additional monitoring or increase frequency if required Develop site CMA (subject to stakeholder feedback). This may include: grouting of rockbar and bedrock base of any significant pool where it is appropriate to do so in consultation with OEH, DoPE, T&I, Water NSW and other stakeholders Completion of works following approvals and at a time agreed between BHPBIC, DoPE, T&I and Water NSW (i.e. may be after

Monitoring	Trigger	Action
	<ul style="list-style-type: none"> 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 	<p>mining induced movements and impacts are complete), including monitoring and reporting on success</p> <ul style="list-style-type: none"> Review relevant TARP and Management Plan in consultation with key stakeholders
	<p>Exceeding Prediction</p> <ul style="list-style-type: none"> Structural integrity of the bedrock base of any significant pool or controlling rockbar cannot be restored i.e. pool water level within the pool after CMAs continues to be lower than baseline period Gas release results in vegetation dieback that does not revegetate Gas release results in mortality of threatened species or ongoing loss of aquatic habitat Iron staining and associated increases in dissolved iron resulting from the mining is observed in water at Wongawilli Creek downstream monitoring site WONGAWILLI CK (FR6) Iron staining and associated increases in dissolved iron resulting from the mining is observed in water at the Donalds Castle Creek downstream monitoring site Donalds Castle Ck (FR6) Rock fall at WC-WF54 or its overhang Impacts on the structural integrity of WC-WF54, its overhang or its pool 	<ul style="list-style-type: none"> 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		
<p>Wongawilli Creek</p> <p>Wongawilli Ck (FR6)</p> <p>Baseline means:</p> <ul style="list-style-type: none"> pH 5.98 EC 98.8 uS/cm DO 89.5% <p>Relevant Performance Measure(s):</p> <ul style="list-style-type: none"> Wongawilli Creek - minor environmental consequences 	<p>Level 1 *</p> <ul style="list-style-type: none"> One exceedance of the ± 3 standard deviation level (positive for EC, negative for pH and DO) from the baseline mean during the monitoring period: <ul style="list-style-type: none"> pH 4.45 EC 154.1 uS/cm DO 50.5% <p>Level 2 *</p> <ul style="list-style-type: none"> Two exceedances of the ± 3 standard deviation level (positive for EC, negative for pH and DO) from the baseline mean during the monitoring period: <ul style="list-style-type: none"> pH 4.45 	<ul style="list-style-type: none"> Continue monitoring program Submit an Impact Report to OEHL, DoPE, T&I, Water NSW and other relevant resource managers Report in the End of Panel Report Summarise actions and monitoring in AEMR <p><i>Actions as stated for Level 1</i></p> <ul style="list-style-type: none"> Review monitoring frequency Notify relevant technical specialists and seek advice on any CMA required

Monitoring	Trigger	Action
	<ul style="list-style-type: none"> - EC 154.1 uS/cm - DO 50.5% 	<ul style="list-style-type: none"> • Implement agreed CMAs as approved (subject to stakeholder feedback)
	<p>Level 3 *</p> <ul style="list-style-type: none"> • Three exceedances of the ± 3 standard deviation level (positive for EC, negative for pH and DO) from the baseline mean during the monitoring period: <ul style="list-style-type: none"> - pH 4.45 - EC 154.1 uS/cm - DO 50.5% 	<ul style="list-style-type: none"> • <i>Actions as stated for Level 2</i> • 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: <ul style="list-style-type: none"> - 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
	<p>Exceeding Prediction</p> <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> - pH 4.45 - EC 154.1 uS/cm - DO 50.5% 	<ul style="list-style-type: none"> • <i>Actions as stated for Level 3</i> • 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
<p>Donalds Castle Creek</p> <p>Donalds Castle Ck (FR6)</p> <p>Baseline means:</p> <ul style="list-style-type: none"> • pH 5.41 • EC 116.0 uS/cm • DO 85.6% 	<p>Level 1 *</p> <ul style="list-style-type: none"> • One exceedance of the ± 3 standard deviation level (positive for EC, negative for pH and DO) from the baseline mean during the monitoring period: <ul style="list-style-type: none"> - pH 3.60 - EC 185.8 uS/cm - DO 40.1% 	<ul style="list-style-type: none"> • 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
	<p>Level 2 *</p>	<ul style="list-style-type: none"> • <i>Actions as stated for Level 1</i> • Review monitoring frequency

Monitoring	Trigger	Action
Relevant Performance Measure(s): <ul style="list-style-type: none"> • Donalds Castle Creek - minor environmental consequences 	<ul style="list-style-type: none"> • Two exceedances of the ± 3 standard deviation level (positive for EC, negative for pH and DO) from the baseline mean during the monitoring period: <ul style="list-style-type: none"> - pH 3.60 - EC 185.8 uS/cm - DO 40.1% 	<ul style="list-style-type: none"> • Notify relevant technical specialists and seek advice on any CMA required • Implement agreed CMAs as approved (subject to stakeholder feedback)
	<p>Level 3 *</p> <ul style="list-style-type: none"> • Three exceedances of the ± 3 standard deviation level (positive for EC, negative for pH and DO) from the baseline mean during the monitoring period: <ul style="list-style-type: none"> - pH 3.60 - EC 185.8 uS/cm - DO 40.1% 	<ul style="list-style-type: none"> • <i>Actions as stated for Level 2</i> • Site visit with OEHL, 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: <ul style="list-style-type: none"> - pH, EC, major cations, major anions, Total Fe, Mn & Al - Filterable suite of metals • Develop site CMA (subject to stakeholder feedback). This may include: <ul style="list-style-type: none"> - 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
	<p>Exceeding Prediction</p> <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> - pH 3.60 - EC 185.8 uS/cm - DO 40.1% 	<ul style="list-style-type: none"> • <i>Actions as stated for Level 3</i> • 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
<p>Lake Avon</p> <p>Lake Avon tributary (LA4_S1)</p> <p>Baseline means:</p> <ul style="list-style-type: none"> • pH 5.38 • EC 90.8 uS/cm • DO 89.9% <p>(24 months of baseline data available - to be updated with additional baseline data)</p> <p>Relevant Performance Measure(s):</p> <ul style="list-style-type: none"> • Lake Avon - negligible reduction in the quality of surface water inflows to Lake Avon 	<p>Level 1 *</p> <ul style="list-style-type: none"> • One exceedance of the ± 3 standard deviation level (positive for EC, negative for pH and DO) from the baseline mean during the monitoring period: <ul style="list-style-type: none"> - pH 4.90 - EC 129.8 uS/cm - DO 69.5% 	<ul style="list-style-type: none"> • 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
	<p>Level 2 *</p> <ul style="list-style-type: none"> • Two exceedances of the ± 3 standard deviation level (positive for EC, negative for pH and DO) from the baseline mean during the monitoring period: <ul style="list-style-type: none"> - pH 4.90 - EC 129.8 uS/cm - DO 69.5% 	<ul style="list-style-type: none"> • <i>Actions as stated for Level 1</i> • Review monitoring frequency • Notify relevant technical specialists and seek advice on any CMA required • Implement agreed CMAs as approved (subject to stakeholder feedback)
	<p>Level 3 *</p> <ul style="list-style-type: none"> • Three exceedances of the ± 3 standard deviation level (positive for EC, negative for pH and DO) from the baseline mean during the monitoring period: <ul style="list-style-type: none"> - pH 4.90 - EC 129.8 uS/cm - DO 69.5% 	<ul style="list-style-type: none"> • <i>Actions as stated for Level 2</i> • 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: <ul style="list-style-type: none"> - pH, EC, major cations, major anions, Total Fe, Mn & Al - Filterable suite of metals • Develop site CMA (subject to stakeholder feedback). This may include: <ul style="list-style-type: none"> - 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
	<p>Exceeding Prediction</p>	<ul style="list-style-type: none"> • <i>Actions as stated for Level 3</i> • Investigate reasons for the exceedance

Monitoring	Trigger	Action
	<ul style="list-style-type: none"> 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: <ul style="list-style-type: none"> pH 4.90 EC 129.8 uS/cm DO 69.5% 	<ul style="list-style-type: none"> 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		
<p>Mapped pools in the mining area:</p> <ul style="list-style-type: none"> Wongawilli Creek Donalds Castle Creek <p>Relevant Performance Measure(s):</p> <ul style="list-style-type: none"> Wongawilli Creek - minor environmental consequences Donalds Castle Creek - minor environmental consequences 	<p>Level 1 *</p> <ul style="list-style-type: none"> Fracturing not resulting in diversion of flow 	<ul style="list-style-type: none"> 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
	<p>Level 2 *</p> <ul style="list-style-type: none"> Fracturing resulting in diversion of flow 	<ul style="list-style-type: none"> <i>Actions as stated for Level 1</i> Review monitoring frequency Notify relevant technical specialists and seek advice on any CMA required Implement agreed CMAs as approved (subject to stakeholder feedback)
	<p>Level 3 *</p> <ul style="list-style-type: none"> Fracturing resulting in diversion of flow such that <10% of the pools have water levels lower than baseline period 	<ul style="list-style-type: none"> <i>Actions as stated for Level 2</i> 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
	<p>Exceeding Prediction</p> <ul style="list-style-type: none"> Fracturing resulting in diversion of flow such that >10% of the pools have water levels lower than baseline period 	<ul style="list-style-type: none"> <i>Actions as stated for Level 3</i> Investigate reasons for the exceedance Update future predictions based on the outcomes of the investigation

Monitoring	Trigger	Action
		<ul style="list-style-type: none"> • Provide residual environmental offset for any mining impact where CMAs are unsuccessful as required by Condition 14 Schedule 3 of the Development Consent
<p>Waterfall WC-WF54</p> <p>Relevant Performance Measure(s):</p> <ul style="list-style-type: none"> • Waterfall WC-WF54 – negligible environmental consequences 	<p>Exceeding Prediction</p> <ul style="list-style-type: none"> • 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 	<ul style="list-style-type: none"> • <i>Actions as stated for Level 3</i> • 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
MODELLED PERIODS OF RECESSIONAL, BASEFLOW AND SMALL STORM UNIT HYDROGRAPH PERIODS		
<p>Subcatchments of Wongawilli and Donalds Castle Creeks and Lake Avon tributaries **</p>	<p>Level 1 *</p> <ul style="list-style-type: none"> • Change 6-12% less than average annual precipitation *** 	<ul style="list-style-type: none"> • 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
	<p>Level 2 *</p> <ul style="list-style-type: none"> • Change 12-18% less than average annual precipitation *** 	<ul style="list-style-type: none"> • <i>Actions as stated for Level 1</i> • Review monitoring frequency • Notify relevant technical specialists and seek advice on any CMA required • Implement agreed CMAs as approved (subject to stakeholder feedback)
	<p>Level 3 *</p> <ul style="list-style-type: none"> • Change >18% less than average annual precipitation *** 	<ul style="list-style-type: none"> • <i>Actions as stated for Level 2</i> • Site visit with OEH, DoPE, T&I, Water NSW and other resource manager/s (if requested) • Implement additional monitoring or increase frequency if required • Develop site CMA (subject to stakeholder feedback). This may include: grouting of rockbar and bedrock base of any significant pool where it is appropriate to do so in consultation with OEH, DoPE, T&I, Water NSW and other stakeholders • Completion of works following approvals and at a time agreed between BHPBIC, DoPE, T&I and Water NSW (i.e. may be after mining induced movements and impacts are complete), including monitoring and reporting on success • Review relevant TARP and Management Plan in consultation with key stakeholders
<p>Inflows to Lake Avon and Cordeaux River **</p>	<p>Exceeding Prediction</p>	<ul style="list-style-type: none"> • <i>Actions as stated for Level 3</i> • Investigate reasons for the exceedance

Monitoring	Trigger	Action
Relevant Performance Measure(s): <ul style="list-style-type: none"> • Lake Avon - negligible reduction in the quantity of surface water inflows to Lake Avon • Cordeaux River - negligible reduction in the quantity of surface water flows from Wongawilli Creek to Cordeaux River 	<ul style="list-style-type: none"> • Measured surface water flow reduction in Wongawilli 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 attributed to natural variation • Surface water flow reduction into Lake Avon is greater than predicted by the groundwater model (to the satisfaction of the Director General - Condition 13 of the SMP) that cannot be attributed to natural variation 	<ul style="list-style-type: none"> • 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

* These may be revised in consultation with DoPE and T&I 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.

** Water budgets during recessionary, baseflow and small storm unit hydrograph periods would be determined by hydrologic modelling of pre- and post-mining hydrographic data using the Free University of Amsterdam RUNOFF2005 model and validation of model-determined ETs against those estimated by the independent CSIRO Land and Water Division (Zhang et al.) method. These TARPs would apply only to the whole of catchment water delivered to Lake Cordeaux, Lake Avon and Cordeaux River. Model reliability is maintained only for catchments in excess of 1 km² in area. Average annual precipitation is modelled using the most recent 5 years of local record.

*** Hydrologic modelling conducted in the manner described above for the baseline period routinely produces mean estimated water budgets lying within about ±6% of average annual precipitation at the one standard deviation level and within about ±12% at the two standard deviation level.

Table 9: Dendrobium Landscape Impacts, Triggers and Response

Monitoring	Trigger	Action
LANDSCAPE FEATURES		
<p><u>DENDROBIUM AREA 3B</u> Cliffs All mapped cliff sites in subsidence area Refer to <i>Dendrobium Area 3B SMP</i> Figures 18.1 for location of sites</p>	<p>Level 1 *</p> <ul style="list-style-type: none"> • Rock fall from a cliff which is left mostly intact (<10% length), resulting in insignificant ground disturbance • Surface movement or rock displacement with negligible soil surface exposed • Crack at the surface, which should not result in any significant erosion or further ground movement • Crack in a fire trail which should not result in erosion or impede access • Crack or fracture up to 100mm width • Crack or fracture up to 10m length • Erosion in a localised area which would be expected to naturally stabilise without CMA and within the period of monitoring 	<ul style="list-style-type: none"> • Continue monitoring program • Report impacts to key stakeholders • Summarise impacts and Report in the End of Panel Report and AEMR
	<p>Level 2 *</p> <ul style="list-style-type: none"> • Rock fall or overhang collapse at a cliff site, where characteristics of the cliff have changed, and there has been significant ground disturbance • Surface movement or rock displacement that has exposed significant areas of soil • A crack at the surface, which could result in significant erosion or movement at the surface • A crack at the surface with potential risk to safety and/or fauna entrapment • A crack in the fire trail, which could result in significant erosion or impede vehicle access • Crack or fracture between 100 and 300mm width • Crack or fracture between 10 and 50m length • Significant erosion at any location, which is not likely to naturally stabilise within the period of monitoring, or is located in a sensitive area e.g. swamps, creek, lake shore, 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 	<ul style="list-style-type: none"> • <i>Actions as stated for Level 1</i> • 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 <p><i>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</i></p>

Monitoring	Trigger	Action
	<p>Level 3 *</p> <ul style="list-style-type: none"> 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 	<ul style="list-style-type: none"> 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 <p><i>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</i></p>
Sandy Creek Waterfall	<p>Exceeding Prediction</p> <ul style="list-style-type: none"> Rock fall at Sandy Creek Waterfall or from its overhang Structural integrity of the waterfall, its overhang and its pool are impacted More than negligible cracking within 30m of the waterfall More than negligible diversion of water from the lip of the waterfall 	<ul style="list-style-type: none"> 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		
<p>A number of sites located across and around Areas 2, 3A and 3B Refer <i>Dendrobium</i> Area 3A SMP Figure 21.1, 21.2 and 21.3 and <i>Dendrobium</i> Area 3B Figure 20.1 for location of sites</p>	<p>Level 1 *</p> <ul style="list-style-type: none"> Vegetation impacted by mining (by rockfalls, soil slippage, gas emissions) that is likely to naturally regenerate within the monitoring period 	<ul style="list-style-type: none"> Continue monitoring program Report impacts to key stakeholders Summarise impacts and Report in the End of Panel Report and AEMR
<p>General observation of active mining areas</p>	<p>Level 2 *</p> <ul style="list-style-type: none"> Vegetation impacted by mining (by rockfalls, soil slippage, gas emissions) that is unlikely to naturally regenerate within the monitoring period 	<ul style="list-style-type: none"> 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
	<ul style="list-style-type: none"> • Statistically significant difference between Before After Control Impact sites as a result of mining <p>Level 3 *</p> <ul style="list-style-type: none"> • Vegetation impacted by mining that is not responding to CMAs 	<ul style="list-style-type: none"> • 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.