



**DENDROBIUM LONGWALL 13
END OF PANEL LANDSCAPE
REPORT**

JUNE 2018



EXECUTIVE SUMMARY

This report summarises the observed and measured subsidence effects on landscape features resulting from the extraction of Dendrobium Longwall 13.

Longwall 13 is the fifth panel extracted from Dendrobium Area 3B. Extraction began on the 4th of March 2017 and was completed on the 19th of April 2018.

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.

Forty-three surface impacts were identified by the ICEFT. Nineteen of these surface impacts were observed on natural features with 24 occurring on fire roads and access tracks.

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

The Dendrobium Area 3B mine plan was modified to reduce the potential for impacts to *Wongawilli Creek*. Three level 3 triggers were identified on *Wongawilli Creek* during the extraction of Longwall 13. They are addressed in this report, with a comprehensive assessment to be included in the 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 13 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 13

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 15 landscape sites (SLMMP photo points) were monitored before, during and after the Longwall 13 extraction period (Table 1). A Longwall 13 post-mining inspection was carried out on the 25th of May 2018 and no additional impacts were observed.



Photo 1: A3b-CF2 Baseline photo. Taken 21/04/201

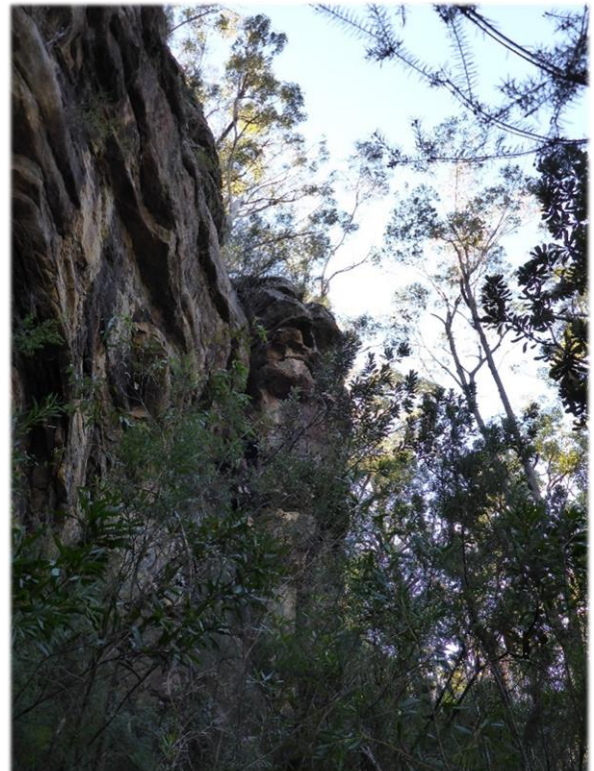


Photo 2: A3b-CF2 Post mining photo. Taken 23/05/2018.

Table 1: Summary table of SLMMP sites relevant to Longwall 13.

Site Name	Easting	Northing	Impact Description
A3b-CF1	290736	6192338	No impacts observed
A3b-CF2	290716	6192196	No impacts observed
A3b-SS10	290790	6192145	No impacts observed
A3b-SS6-Pt1	289635	6192622	No impacts observed
A3b-SS6-Pt2	289634	6192653	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	No impacts observed
AT1-slmmp	289938	6192033	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
AT1-slmmp	289463	6192132	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 06/10/2017

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 OEHL 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 13 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 - 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 - Present
Landscape	Dendrobium Area 3B Subsidence Management Plan (SMP), Volume 2 – Table 1.2 Dendrobium Landscape Impacts, Triggers and Response (November 2012)	12/11/2012 – Present

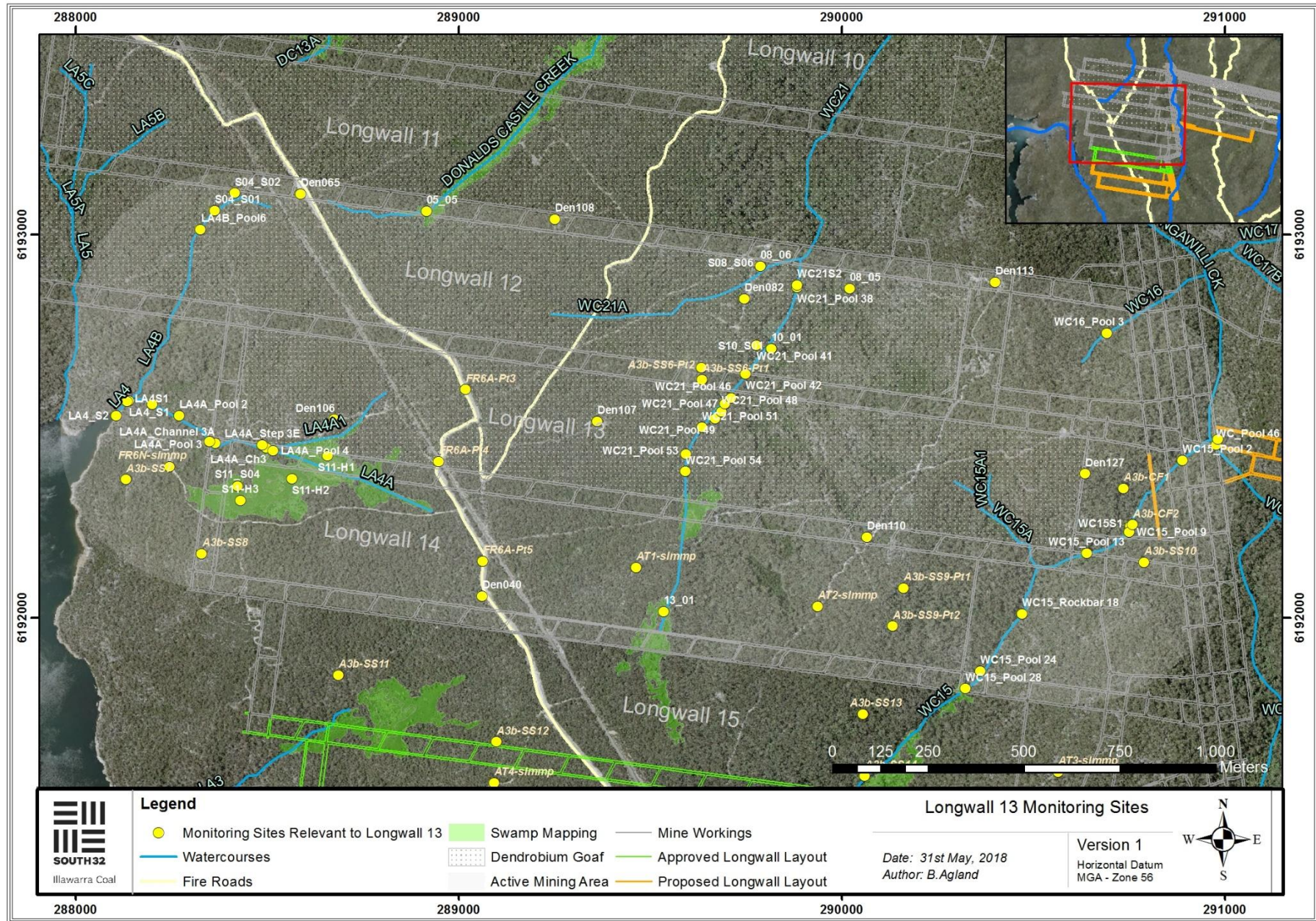


Figure 1: Map showing monitoring sites for the Longwall 13 active mining area.

4 SUMMARY OF IMPACTS

During the extraction of Longwall 13, 43 new surface impacts were identified (Table 3, Figure 2). These impacts are labelled as “DA3B_LW13_001” to “DA3B_LW13_043”. An additional two water quality triggers were recorded at *Wongawilli Ck (FR6)* and two shallow groundwater triggers were recorded in *Swamp 11*. These triggers are further discussed in the Longwall 13 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 13 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 13 EoP Report).

Landscape features

Fractures and cracking observed during the extraction of Longwall 13 were assessed against the relevant TARP (for landscape, swamp or watercourse) and assigned a trigger value (Level 1, Level 2, Level 3 or exceedance of performance measure, 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 13

Site ID	Easting	Northing	Impact Type	Feature Affected	Identification Date	Impact Level	Description	Refer to Impact Report/s Dated
DA3B_LW13_001	288133	6192564	Rock Fracturing	LA4S1	19/04/2017	2	Rock fracturing and uplift to base of LA4S1, approx. 0.5m length, 0.01m width.	3/05/2017
DA3B_LW13_002	288810	6192558	Surface Cracking	Access Track	22/05/2017	1	Soil Cracking on access track, approx. 5m length, 0.02m width, 0.1m depth.	30/05/2017
DA3B_LW13_003	289033	6192557	Surface Cracking	FR6A	26/06/2017	2	Discontinuous surface cracking on FR6A, 70m in length, 0.03m wide, 0.45m depth.	27/06/2017
DA3B_LW13_004	289025	6192506	Surface Cracking	FR6A	14/07/2017	1	Discontinuous surface cracking on FR6A, 3m length, 0.01m width, uplift of 0.2m.	17/7/2017
DA3B_LW13_005	289382	6192739	Surface Cracking	AT6AA	19/07/2017	2	Surface cracking on Access Track 6AA, 2.3m long, average width 0.05m, 0.2m max width, 2.34m depth.	20/07/2017
DA3B_LW13_006	289685	6192540	Rock Fracturing	WC21	25/09/2017	2	Rock fracture to the base of WC21_Pool 48. 5m length, 0.03m width. Also associated with an absence of water in pool.	05/10/2017
DA3B_LW13_007	289883	6192878	Iron Staining	WC21	03/10/2018	1	Iron staining at subsurface outflow, downstream from WC21_Pool 38, at BF37.	05/10/2017
DA3B_LW13_008	289584	6192414	Surface Cracking	Access Track	10/10/2017	1	Consists of two small zones of surface cracking and uplift on access track adjacent to WC21. Max length 1.4m, width 0.06m, depth 0.1m.	24/10/2017
DA3B_LW13_009	289592	6192392	Rock Fracturing	WC21	23/10/2017	1	Rock fracturing to the downstream extent of WC21_Pool 54, 0.38m long, 0.22m wide, 0.37m deep.	24/10/2017
DA3B_LW13_010	289591	6192424	Rock Fracturing	WC21	23/10/2017	2	Rock fracturing to the step at the upstream extent of WC21_Pool 53, 2.5m long, 0.01m wide, and 0.03m deep.	24/10/2017
DA3B_LW13_011	289697	6192561	Rock Fracturing	WC21	23/10/2017	2	Rock fracturing to the base of WC21_Pool 47.	24/10/2017
DA3B_LW13_012	289585	6192416	Surface Cracking	Access Track	30/10/2017	1	Surface cracking on access track adjacent to WC21. Max 1m long, 0.05m wide and 0.12m wide.	14/11/2017
DA3B_LW13_013	289571	6192425	Surface Cracking	Access Track	30/10/2017	1	Surface cracking on access track adjacent to WC21. Max 2m long, 0.02m wide and 0.1m wide.	14/11/2017

DA3B_LW13_014	289579	6192407	Surface Cracking	Access Track	13/11/2017	1	Surface cracking on access track adjacent to WC21. Max 0.64m long, 0.1m wide and 0.16m deep.	14/11/2017
DA3B_LW13_015 (Wongawilli Creek)	290802	6193644	Pool Level	Wongawilli Creek	20/11/2017	3	WC_Pool 43a water level below baseline. Fracture was identified in the pool during LW9.	28/11/2017 24/02/2018 31/05/2018
DA3B_LW13_016	289578	6192429	Surface Cracking	Access Track	20/11/2017	1	Surface cracking and minor slumping on access track adjacent to WC21. Max 2m long, 0.03m wide and 0.1m deep.	09/01/2018
DA3B_LW13_017	289719	6192502	Rock Fracturing	WC21	08/01/2018	2	Rock fracturing across Pool 45 in tributary WC21, 2m long, 0.03m wide and 0.22m at its deepest measurable point.	09/01/2018
DA3B_LW13_018	289719	6192576	Rock Fracturing	WC21	12/02/2018	2	Rock fracturing across Pool 46 in tributary WC21. Max, 0.5m long, 0.01m wide and 0.05m.	23/02/2018
DA3B_LW13_019	290243	6192458	Surface Cracking	FR6P	02/03/2018	2	Surface cracking on FR6P, 8.5m long, 0.45m max depth 0.45m, max width 0.15m.	05/03/2018
DA3B_LW13_020	289899	6192305	Surface Cracking	Access Track	16/03/2018	1	Soil cracking on seismic track adjacent to FR6P, 0.35m long, 0.12m max depth, 0.07m width.	19/03/2018
DA3B_LW13_021	290466	6192007	Rock Fracturing	WC15	29/03/2018	2	Rock fracturing to the upstream extent of WC15_Rockbar 18, 5.7m long, up to 0.015m wide, depth 0.06m.	03/04/2018
DA3B_LW13_022	290496	6192026	Rock Fracturing	WC15	29/03/2018	2	Rock fracturing to WC15_Rockbar 18. Comprised of approx. 10 fractures. Max 3m long, up to 0.015m wide, depth 0.04m.	03/04/2018
DA3B_LW13_023	290482	6192033	Rock Fracturing	WC15	29/03/2018	2	Rock fracturing to WC15_Rockbar 18. Max 5.6m long, up to 0.03m wide, depth 0.16m.	03/04/2018
DA3B_LW13_024	289456	6192429	Surface Cracking	Access Track	04/04/2018	2	Soil cracking on access track adjacent to FR6P, 40m length, 0.2m wide, 0.85m depth.	06/04/2018
DA3B_LW13_025	290430	6192426	Surface Cracking	Access Track	04/04/2018	1	Soil cracking on access track adjacent to FR6P, 5.7m length, 0.08m wide, 0.16m depth.	06/04/2018
DA3B_LW13_026	290370	6192430	Surface Cracking	Access Track	04/04/2018	1	Soil cracking on access track adjacent to FR6P, 0.95m length, 0.01m wide, 0.01m depth.	06/04/2018
DA3B_LW13_027	290254	6192478	Surface Cracking	Access Track	04/04/2018	1	Soil cracking on access track adjacent to FR6P, 2.1m length, 0.02m wide, 0.01m depth.	06/04/2018

DA3B_LW13_028	290485	6192067	Rock Fracturing	WC15	05/04/2018	1	Rock fracturing to WC15_Pool 18. Max 1.4m long, up to 0.018m wide. No evidence of flow diversion.	06/04/2018
DA3B_LW13_029	290498	6192444	Surface Cracking	Access Track	09/04/2018	2	Surface cracking on access track adjacent to FR6P, 9m length, 0.15m wide, 5m depth.	10/04/2018
DA3B_LW13_030	290470	6192438	Surface Cracking	Access Track	09/04/2018	2	Surface cracking on access track adjacent to FR6P, 10m length, 0.15m wide, 0.25m depth.	10/04/2018
DA3B_LW13_031	290135	6192331	Surface Cracking & Rock Fracturing	FR6P	09/04/2018	1	Surface cracking and rock fracturing on FR6P, 4.8m length, 0.06m width, 2.2m depth.	10/04/2018
DA3B_LW13_032	290125	6192330	Surface Cracking	FR6P	09/04/2018	1	Surface cracking on FR6P, 3.2m length, 0.1m width, 0.4m depth.	10/04/2018
DA3B_LW13_033	290116	6192281	Surface Cracking	FR6P	09/04/2018	1	Surface cracking on FR6P, 4.1m length, 0.1m width, 0.4m depth.	10/04/2018
DA3B_LW13_034	290237	6192451	Surface Cracking	FR6P	09/04/2018	1	Surface cracking on FR6P, 1.5m length, 0.04m width, 0.8m depth.	10/04/2018
DA3B_LW13_035	290406	6191915	Rock Fracturing	WC15	23/04/2018	1	Rock fracturing to WC15_Rockbar 21. Max 1.6m long, up to 0.002m wide. Small section of uplift and plating. No evidence of flow diversion.	27/04/2018
DA3B_LW13_036	290515	6192442	Rock Fracturing	Sandstone Outcrop	23/04/2018	1	Rock fracturing to sandstone outcrop. Max 5.5m long, 0.05m width. 1.64m depth.	27/04/2018
DA3B_LW13_037	290539	6192466	Surface Cracking	Access Track	23/04/2018	1	Soil cracking on access track adjacent to FR6P, 2.1m length, 0.09m width, 0.34m depth.	27/04/2018
DA3B_LW13_038	290282	6192409	Surface Cracking	Access Track	23/04/2018	1	Soil cracking on access track adjacent to FR6P, 1.96m length, 0.03m width, 0.11m depth.	27/04/2018
DA3B_LW13_039	290212	6192396	Surface Cracking	Access Track	23/04/2018	1	Soil cracking on access track adjacent to FR6P, 2.12m length, 0.025m width, 0.46m depth.	27/04/2018
DA3B_LW13_040	290902	6192425	Rock Fracturing	WC15	07/05/2018	2	Rock fracturing and uplift zone of 20m. Longest continuous fracture is 5.5m, 0.05m width, 0.24m depth.	08/05/2018
DA3B_LW13_041	290905	6192427	Rock Fracturing & Rock Fall	WC15	07/05/2018	2	Rock fracturing across step on WC15, 12m length, 0.05m width. Rockfall 3m x 3m x 0.2m. Ironing staining present	08/05/2018

<i>DA3B_LW13_042</i>	290772	6192286	Rock Fracturing & Rock Fall & Iron Staining	<i>WC15</i>	16/05/2018	2	Impacts to <i>WC15_Rockbar 7</i> . Combination of rock fracturing, iron staining and a rock fall. Max length of fracturing is 4.5, depth 0.19m and width 0.01m. Multiple rock fractures under rockbar. Estimated to be 1m x1 mx 0.3m.	17/05/2018
<i>DA3B_LW13_043</i>	288106	6192537	Rock Fracturing & Rock Fall & Iron Staining	<i>LA4</i>	16/05/2018	2	Rock fracturing, rockfall and iron staining evident to the base of <i>LA4_Step 0</i> on <i>LA4</i> . Fracture is 2m length, 0.02m width. rock fragment is 1.5m in length, 0.5m in width and 0.3m in height.	17/05/2018
<i>11_H1</i>	288657	6192423	Shallow Groundwater	<i>Swamp 11</i>	01/06/2017	1	Rate of recession greater than baseline.	27/06/2017
<i>11_H1</i>	288657	6192423	Shallow Groundwater	<i>Swamp 11</i>	16/07/2018	1	Water level below baseline.	20/07/2018
<i>Wongawilli Creek (FR6)</i>	290960	6197376	Water Quality	<i>Wongawilli Creek</i>	23/01/2018, 12/02/2018	3	Dissolved oxygen trigger.	3/01/2018 15/02/2018
<i>Wongawilli Creek (FR6)</i>	290960	6197376	Water Quality	<i>Wongawilli Creek</i>	23/01/2018, 12/02/2018	3	Electrical conductivity trigger.	15/02/2018

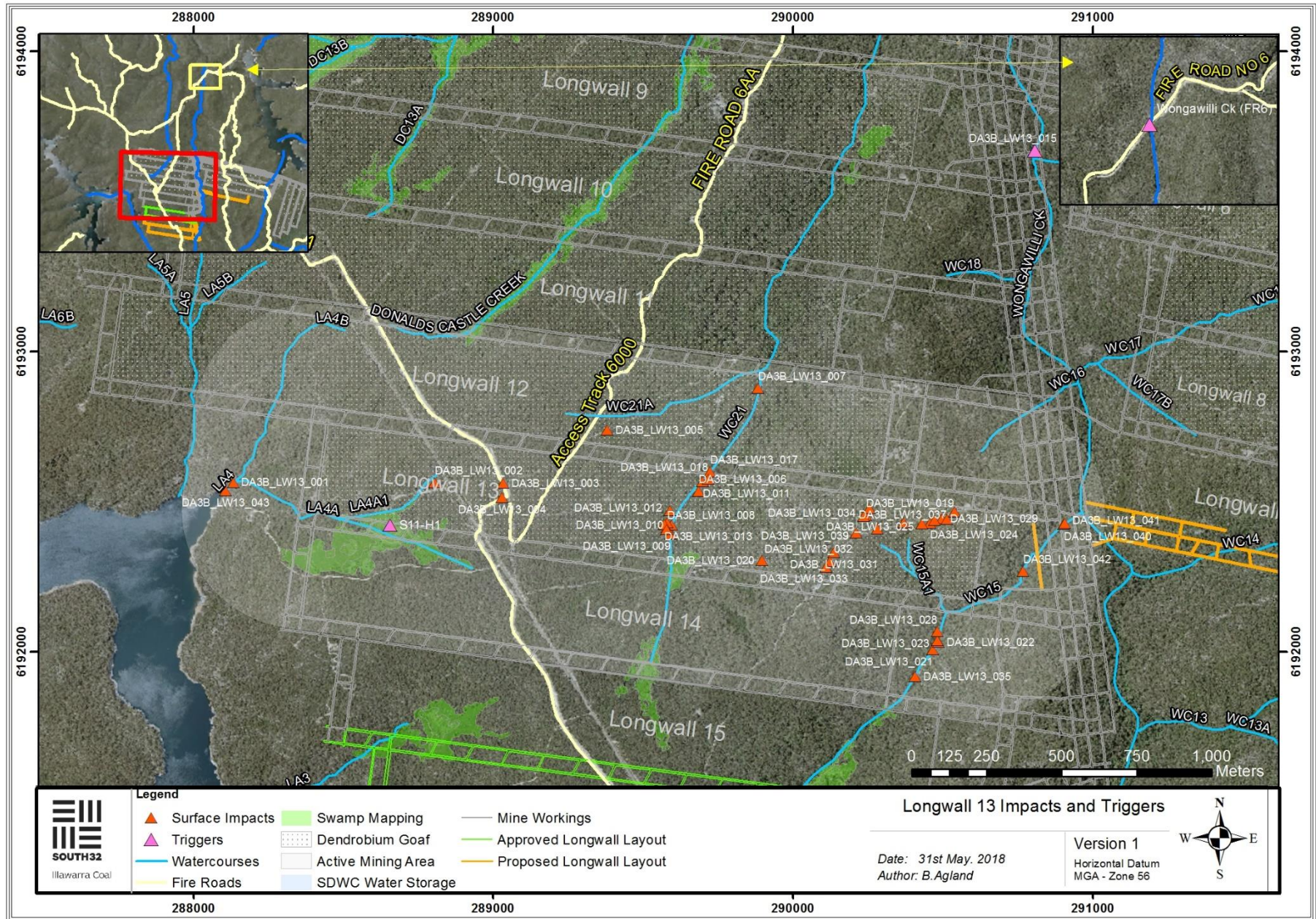


Figure 2: Map showing surface impacts and triggers recorded during Longwall 13.

5 IMPACTS TO FIRST AND SECOND ORDER STREAMS

Ten first and second order streams were monitored as part of the Longwall 13 monitoring program; LA4, LA4B, LA4A, LA4A1, WC21, WC21A, WC16, WC15, WC15A and WC15A1. Impacts observed at these streams during Longwall 13 are described below.

5.1 LA4

Impact DA3B_LW13_001

Rock fracturing to the downstream end of LA4 was reported for the first time on 4th May 2016. Heavy rainfall dislodged rock fragments at this site. An inspection on the 19th April 2017 revealed fracturing to the base of the pool at monitoring site LA4S1 (Photo 5 and Photo 6). Active flow diversion is evident through fracturing, directly upstream from the installed concrete weir, which forms part of the flow monitoring installation at the site (Photo 7 and Photo 8).

Level 2: Crack or fracture between 100 and 300mm width at its widest point or any fracture which results in observable loss of surface water or erosion.



Photo 5: Fracturing downstream from concrete weir, looking upstream. Taken on 19/04/2017.



Photo 6: Fracturing downstream from concrete weir, looking downstream. Taken on 19/04/2017.



Photo 7: Flow diversion adjacent to monitoring equipment at LA4S1. Taken on 3/05/2017.



Photo 8: Flow diversion through fracturing in base of pool. Taken on 3/05/2017.

Impact DA3B_LW13_043

Impact *DA3B_LW13_043* is located on *LA4*, a tributary to *Lake Avon*, 300m from the commencing end of Longwall 13, and 300m from the southern edge of Longwall 12. The impact was identified on the 18th May 2018. The impact is comprised of rock fracturing, associated rock fragmentation and iron staining to *LA4_Step 0* (Photo 9), which is the most downstream feature before entering *Lake Avon*. The fracturing is 2m in length and 0.02m in width; the rock fragment is 1.5m in length, 0.5m in width and 0.3m in height (Photo 9). These impacts are not evident in baseline photos from 2011 (Photo 10). There was no surface flow at the site during the inspection; however, diversion of flow is likely to occur to some degree. Given the proximity of the site to the commencing end of Longwall 13 and previously recorded impacts (i.e. *DA3B_LW13_001*), it is probable that the impact originated approximately one year before it was first identified. Previously the site has been inundated by reservoir water, which would have obscured identification of the impact.

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



Photo 9: LA4_Step 0, looking across stream; the pooling to the left of the image is *Lake Avon reservoir* water. Taken 18th May 2018.



Photo 10: LA4_Step 0, looking across stream; the pooling to the left of the image is *Lake Avon reservoir* water. Taken during baseline mapping of the area 14th November 2011.

5.2 WC15

Impact DA3B_LW13_021

DA3B_LW13_021 is located towards the upstream extent of WC15_Rockbar 18. The site was passed by Longwall 13 at an approximate distance of 185m on the 29th March 2018. The impact consists of a rock fracture, which extends across the extent of the rockbar (Photo 11 to Photo 14). The fracture is approximately 5.7m in length, with widths ranging from hairline to a maximum of 0.015m. The maximum measurable depth is 0.06 m. Additionally, there is a small section of plating, which measures approximately 0.3m by 0.15m.

Level 2: Crack or fracture between 100 and 300mm width at its widest point or any fracture which results in observable loss of surface water or erosion.



Photo 11: DA3B_LW13_021, looking at the widest section of fracturing. Taken 29th March 2018.



Photo 12: DA3B_LW13_021, looking at the widest section of fracturing. Taken 29th March 2018.



Photo 13: DA3B_LW13_021, looking at the small section plating. Taken 29th March 2018.



Photo 14: DA3B_LW13_021, looking at the narrowest section of fracturing. Taken 29th March 2018.

Impact DA3B_LW13_022

DA3B_LW13_022 is located on WC15_Rockbar 18, approximately 35m downstream of DA3B_LW13_021. The site was passed by Longwall 13 at an approximate distance of 157m on the 29th March 2018. The impact is a rock fracture zone, which is comprised of approximately 10 fractures, with associated uplift (Photo 15 to Photo 18) and rock fragmentation (Photo 17), within an area of approximately 7.2m by 6m. Each fracture within the zone is greater than 0.5m in length, the longest of which, is approximately 3m. The fractures range from hairline to a maximum of 0.015m in width; the maximum measurable depth is approximately 0.04m. Additionally, there are lateral fractures to the face of a 0.3m high step (Photo 18).

Level 2: Crack or fracture between 100 and 300mm width at its widest point or any fracture which results in observable loss of surface water or erosion.



Photo 15: DA3B_LW13_022, looking across stream towards section of uplift. Taken 29th March 2018.



Photo 16: DA3B_LW13_022, looking downstream towards longest fracture. Taken 29th March 2018.



Photo 17: DA3B_LW13_022, looking upstream towards a small rock fragment. Taken 29th March 2018.



Photo 18: DA3B_LW13_022, looking upstream towards lateral fracturing on face of step. Taken 29th March 2018.

Impact DA3B_LW13_023

DA3B_LW13_023 is located on WC15_Rockbar 18, approximately 7m downstream of DA3B_LW13_022. The site was passed by Longwall 13 at an approximate distance of 150m on the 29th March 2018. The impact is comprised of a rock fracture approximately 5.6m in length and 0.03m at its widest point (Photo 19 to Photo 22); the maximum measurable depth of the fracture is 0.16m (Photo 22). There was no observable surface flow at WC15_Rockbar 18 during the inspection, however, surface flow has previously been observed at the feature. Given the extent and nature of the fractures, it is likely that these impacts would cause some degree of flow diversion if surface flow was present at WC15_Rockbar 18.

Level 2: Crack or fracture between 100 and 300mm width at its widest point or any fracture, which results in observable loss of surface water or erosion.



Photo 19: DA3B_LW13_023, widest section of fracturing. Taken 29th March 2018.



Photo 20: DA3B_LW13_023, widest section of fracturing. Taken 29th March 2018.



Photo 21: DA3B_LW13_023, closeup of the widest section of fracturing. Taken 29th March 2018.



Photo 22: DA3B_LW13_023, closeup of the deepest section of fracturing. Taken 29th March 2018.

Impact DA3B_LW13_028

DA3B_LW13_028 was identified on the 5th April 2018 and is located on the tributary WC15; the site was passed by Longwall 13 on the 29th March 2018 at an approximate distance of 124 m. The impact is comprised of lateral fractures, with associated uplift and plating, to the rockbar shelf on the northern extent of WC15_Pool 18. The largest fracture is 1.4m in length and 0.018m in width (Photo 23 and Photo 24). There was no evidence of flow diversion at the site.

Level 1: Crack or fracture up to 100mm 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



Photo 23: DA3B_LW13_028, looking upstream at the extent of the impact. Taken 5th April 2018.



Photo 24: DA3B_LW13_028, looking upstream at largest section of fracturing. Taken 5th April 2018.

Impact DA3B_LW13_035

DA3B_LW13_035 was identified on the 23rd April 2018 and is located on the tributary WC15; the site was passed by Longwall 13 on the 18th March 2018 at an approximate distance of 280 m. The impact is comprised of multiple small fractures near the upstream extent of WC15_Rockbar 21 (Photo 25 and Photo 26). The largest fracture is 1.6m in length and 0.002m in width. Additionally, there is a small section of plating and uplift (approximately 0.1m by 0.05m) at the site. There was no evidence of flow diversion at the site.

Level 1: Crack or fracture up to 100mm 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.



Photo 25: DA3B_LW13_035, looking across stream at the largest fracture. Taken 23rd April 2018.



Photo 26: DA3B_LW13_035, looking across stream at the section of plating and uplift. Taken 23rd April 2018.

Impact DA3B_LW13_040

DA3B_LW13_040 is situated on *Wongawilli Creek* tributary *WC15*. The impact zone extends 20m from the top of *WC15_Step 0* to *WC15_Pool 2* which is approximately 80m from the confluence with *Wongawilli Creek*. The site is approximately 262m from the end of Longwall 13. The impact is comprised of rock fracturing and uplift, which has a maximum measurable length of 5.5m, a maximum width of 0.05m and a maximum measurable depth of 0.24m (Photo 27 to Photo 30). While not evident during the inspection, flow diversion would occur if surface flow was present.

Level 2: Crack or fracture between 100 and 300mm width at its widest point or any fracture which results in observable loss of surface water or erosion.



Photo 27: DA3B_LW13_040, looking at a section of rock fracturing and uplift. Taken 7th May 2018.



Photo 28: DA3B_LW13_040, looking at a section of rock uplift. Taken 7th May 2018.



Photo 29: DA3B_LW13_040, looking at a section of rock fracturing and uplift. Taken 7th May 2018.



Photo 30: DA3B_LW13_040, looking at the maximum measurable depth of the rock fracturing. Taken 7th May 2018.

Impact DA3B_LW13_041

DA3B_LW13_041 is situated on Wongawilli Creek tributary WC15, specifically across WC15_Step 0, which is approximately 75m from the confluence with Wongawilli Creek. The site is situated approximately 267m from the end of Longwall 13. The impact is comprised of rock fracturing which has resulted in a rockfall. The rock fracturing has a maximum length of 12m, a maximum width of 0.05m and the maximum depth is unknown due to access difficulties (Photo 31 to Photo 34).

Level 2: Crack or fracture between 100 and 300mm width at its widest point or any fracture which results in observable loss of surface water or erosion. Crack or fracture between 10m and 50m length.



Photo 31: DA3B_LW13_041, an overview of the area impacted by the rockfall. Taken 7th May 2018



Photo 32: DA3B_LW13_041, looking at the extent of the rockfall. Taken 7th May 2018



Photo 33: DA3B_LW13_041, looking at the rock fracturing from the top of the step. Taken 7th May 2018



Photo 34: DA3B_LW13_041, looking the accumulation of rock that resulted from the rockfall. Taken 7th May 2018

Impact DA3B_LW13_042

Impact *DA3B_LW13_042* is situated on *WC15*, approximately 150m from the end of Longwall 13. The impact is comprised of multiple rock fractures, with associated rock fragmentation and iron staining to *WC15_Rockbar 7*, an undercut rockbar (Photo 35), approximately 295m from the *WC15* confluence with *Wongawilli Creek*. The impact zone extends 15m across the upper extent of *WC15_Rockbar 7* (Photo 36 and Photo 37), below *WC15_Step 7B*. The rock fracturing has a maximum length of 4.5 m, a maximum width of 0.01m and a maximum measurable depth of 0.19 m. Two large rock fragments have been displaced from the underside of the rockbar, the largest of which is approximately 1m in length, 1m width and 0.30m height. Flow diversion through the fractures was observed at the site. Downstream of the flow diversion in the pool below *WC15_Rockbar 7*, iron staining was observed (Photo 38 and Photo 39).

Level 2: Crack or fracture between 100 and 300mm width at its widest point or any fracture which results in observable loss of surface water or erosion.



Photo 35: *WC15_Rockbar 7*, looking upstream, highlighting the undercut nature of the rockbar.



Photo 36: *DA3B_LW13_042*, looking at a section of rock fracturing and uplift. Taken 16th May 2018.



Photo 37: *DA3B_LW13_042*, looking at a section of rock fracturing. Taken 16th May 2018.



Photo 38: *DA3B_LW13_042*, looking at largest rock fragment and iron staining. Taken 16th May 2018.



Photo 39: *DA3B_LW13_042*, looking at a section of iron staining. Taken 16th May 2018.

5.3 WC21

Impact DA3B_LW13_006

Fracturing was observed to the upstream end of *WC21_Pool 48*. Fracturing is up to 5m long and 0.03m wide, with some dislodged fragments (Photo 40 and Photo 41). Prior to the fracturing the pool held water. The pool is now dry (Photo 40). The absence of surface water extends downstream, before reappearing from beneath a step directly downstream from *WC21_Pool 38* (see *Impact DA3B_LW13_007*).

Level 2: Crack or fracture between 100 and 300mm width at its widest point or any fracture which results in observable loss of surface water or erosion.



Photo 40: Impact *DA3B_LW13_006*, looking upstream. Taken on 3/10/2017.



Photo 41: Impact *DA3B_LW13_006*, looking across pool at fracturing. Taken on 3/10/2017.

Impact DA3B_LW13_007

Re-emergence of surface flow is evident beneath a step directly downstream from *WC21_Pool 38*. Surface flow is associated with iron staining at this location (Photo 42 and Photo 43). The surface flow continues for approximately 2m, before becoming subsurface again. The iron staining ceases at this point (Photo 43).

Level 1: Observable increase in iron staining within the mining area.



Photo 42: Impact *DA3B_LW13_007*, looking upstream. Taken on 3/10/2017.



Photo 43: Impact *DA3B_LW13_007*, looking downstream. Taken on 3/10/2017.

Impact *DA3B_LW13_009*

Impact *DA3B_LW13_009* was identified on the 27th of October 2017. This impact consists of fracturing and fragmentation to the rockbar at the downstream extent of *WC21_Pool 54*, which was mined beneath by Longwall 13 on the 24th of September 2017. The largest fracture is 0.22m wide, 0.37m deep and 0.38m long (Photo 44 and Photo 45). Surface water was not present at the site during the inspection.

Level 1: Crack or fracture up to 100mm at its widest point with no observable loss of surface water or erosion.



Photo 44: Impact *DA3B_LW13_009*, looking across stream, taken on 23/10/2017.



Photo 45: Impact *DA3B_LW13_009*, looking upstream, taken on 23/10/2017.

Impact DA3B_LW13_010

Impact *DA3B_LW13_010* was identified on the 27th of October 2017. This impact consists of lateral fracturing to the step at the upstream extent of *WC21_Pool 53*, which was mined under by Longwall 13 on the 24th of September 2017. The largest fracture is approximately 2.5m long, 0.01m wide, and 0.03m at its deepest measurable point (Photo 46). The portion of sandstone below the fracture has been displaced laterally by approximately 0.03m (Photo 47). A smaller, approximately 1m long, hairline fracture is present adjacent to the largest fracture (Photo 48). No flow diversion was observed at the site; however, the water level at *WC21_Pool 53* has lowered considerably following being mined under by Longwall 13 (Photo 49 to Photo 51). It is likely there is an unobservable fracture at the base of the pool diverting water.

Level 2: Crack or fracture between 100 and 300mm width at its widest point or any fracture which results in observable loss of surface water or erosion.



Photo 46: Impact *DA3B_LW13_010* looking upstream, taken 27/10/2017.



Photo 47: Impact *DA3B_LW13_010* looking top-down at the displaced rock, taken 27/10/2017.

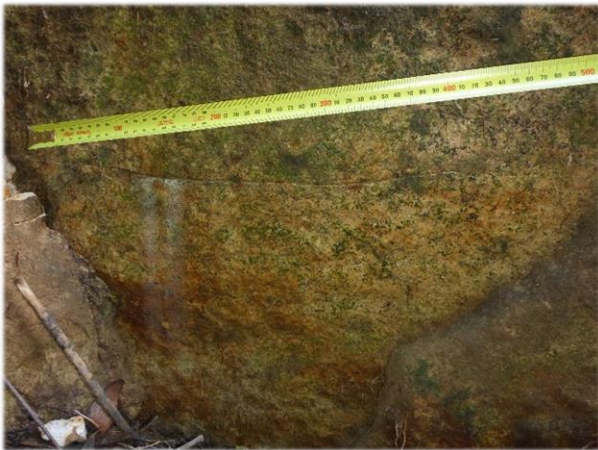


Photo 48: Impact *DA3B_LW13_010* looking across stream, taken 27/10/2017.



Photo 49: *WC21_Pool 53*, looking upstream, taken 11/09/2017.



Photo 50: *WC21_Pool 53*, looking upstream, taken 10/10/2017.



Photo 51: *WC21_Pool 53* looking upstream, taken 27/10/2017.

Impact DA3B_LW13_011

Impact *DA3B_LW13_011* was identified on the 27th of October 2017. This impact consists of fracturing to the rockbar base of *WC21_Pool 47*, which was mined under by Longwall 13 on the 8th of October 2017. The fracturing is 1.1m long, 0.01m wide and 0.3m at its deepest measurable point (Photo 52 and Photo 53). Flow diversion has likely occurred at the site given the change in pool level over a relatively short period. Observations show water at *WC21_Pool 47* as of the 25th of September 2017 (Photo 54. *Note photo shows 20th of September 2017*). The following observation, on the 3rd of October 2017, shows no water within the pool (Photo 55).

Level 2: Crack or fracture between 100 and 300mm width at its widest point or any fracture which results in observable loss of surface water or erosion.



Photo 52: *DA3B_LW13_011*, looking top-down, taken 23/10/2017.



Photo 53: *DA3B_LW13_011*, looking upstream, taken 23/10/2017.



Photo 54: *WC21_Pool 47*, looking downstream, taken 20/09/2017



Photo 55: *WC21_Pool 47*, looking across stream, taken 3/10/2017.

Impact DA3B_LW13_017

Impact DA3B_LW13_017 was identified during an inspection on the 8th of January 2018. The impact consists of rock fracturing across tributary WC21. The crack is approximately 2m long, 0.03m wide and 0.22m at its deepest measurable point (Photo 56 and Photo 57). While there was no surface flow during the inspection it is likely that the fracture would result in diversion of flow. Longwall 12 passed adjacent to the site in November 2016 with Longwall 13 passing the site in October 2017.

Level 2: Crack or fracture between 100 and 300mm width at its widest point or any fracture which results in observable loss of surface water or erosion.



Photo 56: Impact DA3B_LW13_017, overall extent. Taken on 8/01/2018.



Photo 57: Impact DA3B_LW13_017, overall extent. Taken on 8/01/2018.

Impact DA3B_LW13_018

The impact consists of rock fracturing across WC21_Pool 46. The largest fracture is approximately 0.5m long, 0.01m wide and 0.05m at its deepest measurable point (Photo 58 and Photo 59). Whilst there was no surface flow at the site during the inspection, it is possible that the fracture would result in flow diversion. The site was mined beneath by Longwall 13 on the 15th October 2017.

Level 2: Crack or fracture between 100 and 300mm width at its widest point or any fracture which results in observable loss of surface water or erosion.

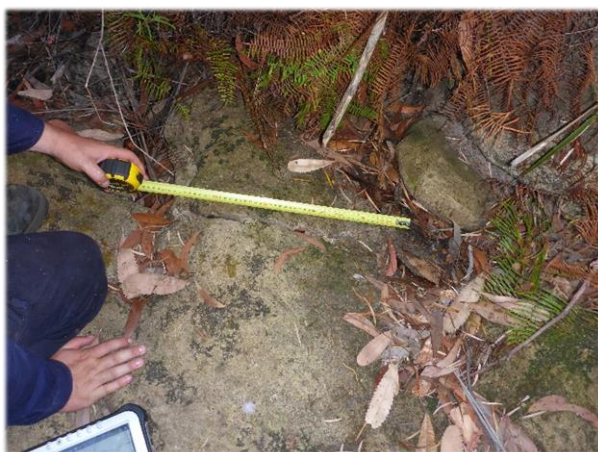


Photo 58: DA3B_LW13_018, looking across stream at the largest fracture. Taken on 12/02/2018.



Photo 59: DA3B_LW13_018, looking top-down at the largest fracture. Taken on 12/02/2018.

6 WONGAWILLI CREEK

Impact DA3B_LW13_015

On 28th November 2017, DA3B_LW13_015 was reported as a Level 3 trigger in accordance with the Dendrobium Area 3B Watercourse TARP, specifically: Fracturing resulting in diversion of flow such that <10% of the pools have water levels lower than baseline period. Fracturing was observed in WC_Pool 43a on 18 December 2013, as Longwall 9 approached it's finishing end, towards Wongawilli Creek. No observed change in pool level was associated with the fracturing at the time. In November 2017, WC_Pool 43a recorded its lowest levels (**Figure 3**) (Photo 60 and Photo 61). In accordance with the CMAs, additional monitoring was implemented; two water level loggers (WCS1 in pool WC_Pool 32 and WCS2 in WC_Pool 43a) were installed on the 27th December 2017. Furthermore, pool water levels and flows in Wongawilli Creek were detailed in an update report 14th February 2018.

An additional report published on the 31/05/2018 provides an update on Wongawilli Creek following recent inspections on the 21st and 28th May 2018. During these inspections, discontinuous surface flows were observed along a greater portion of Wongawilli Creek than previously observed. This portion of the creek is approximately 1426m in length and includes WC_Pool 44 to downstream of WC_Pool 41. The conditions within this portion of Wongawilli Creek range from essentially no surface water to large pools with discontinuous surface flow. Surface flow recommences at WCS1, just downstream of the Wongawilli Creek – WC21 confluence. No fracturing additional to DA3B_LW13_015 has been observed within this section of the creek.

Monthly rainfall data shows that the Dendrobium area has experienced prolonged dry conditions (Table 4). These conditions are a significant contributor to the current low water levels in WC_Pool 43a (HGEO 2018). This impact is addressed in more detail in the Surface and Shallow Groundwater Assessment.

Level 3: Fracturing resulting in diversion of flow such that <10% of the pools have water levels lower than baseline period.

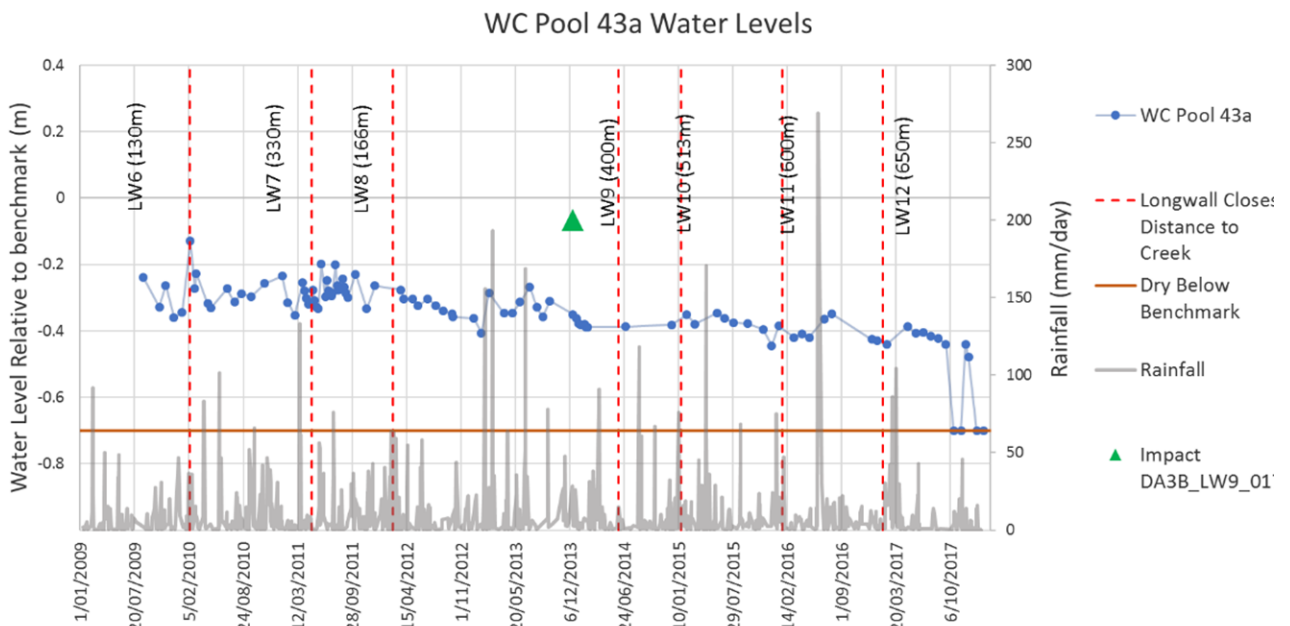


Figure 3: Pool water levels recorded in *WC_Pool 43a*. Initial observation date of impact DA3B_LW9_017 is also displayed.



Photo 60: *WC_Pool 43a*, looking upstream. Taken on 12/12/2017.



Photo 61: *WC_Pool 43a*, looking upstream. Taken on 10/01/2018

Table 4: Monthly rainfall recorded at Dendrobium Area 3B Weather Station, July 2017 to May 2018.

Month	Rainfall (mm)
Jul-17	1.5
Aug-17	26
Sep-17	0
Oct-17	30
Nov-17	91.5
Dec-17	32
Jan-18	44.5
Feb-18	91
Mar-18	80.5
Apr-18	10
May-18	6

7 IMPACTS TO OTHER LANDSCAPE FEATURES

DA3B_LW13_036

DA3B_LW13_036 was identified on the 23rd April 2018; the site was mined beneath by Longwall 13 on the 24th March 2018. The impact is comprised of fracturing to a sandstone outcrop, measuring 5.5m in length, 0.05m in width and 1.64m at its deepest measurable point (Photo 62).

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



Photo 62: Photo DA3B_LW13_036, looking at the extent of the fracture. Taken 23rd April 2018

8 TARP TRIGGERS

8.1 Shallow Groundwater

Two Level 1 shallow groundwater triggers were recorded at borehole 11_H1 during analysis of piezometer data for Swamp 11. This site was passed by Longwall 13 on 16th April 2017. One trigger refers to the post-mining rate of water level recession exceeding the rate recorded before mining (Figure 4). The other trigger refers to the water level receding below baseline levels (Figure 4). These triggers are will be addressed in more detail in the Surface Water and Shallow Groundwater Assessment.

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).

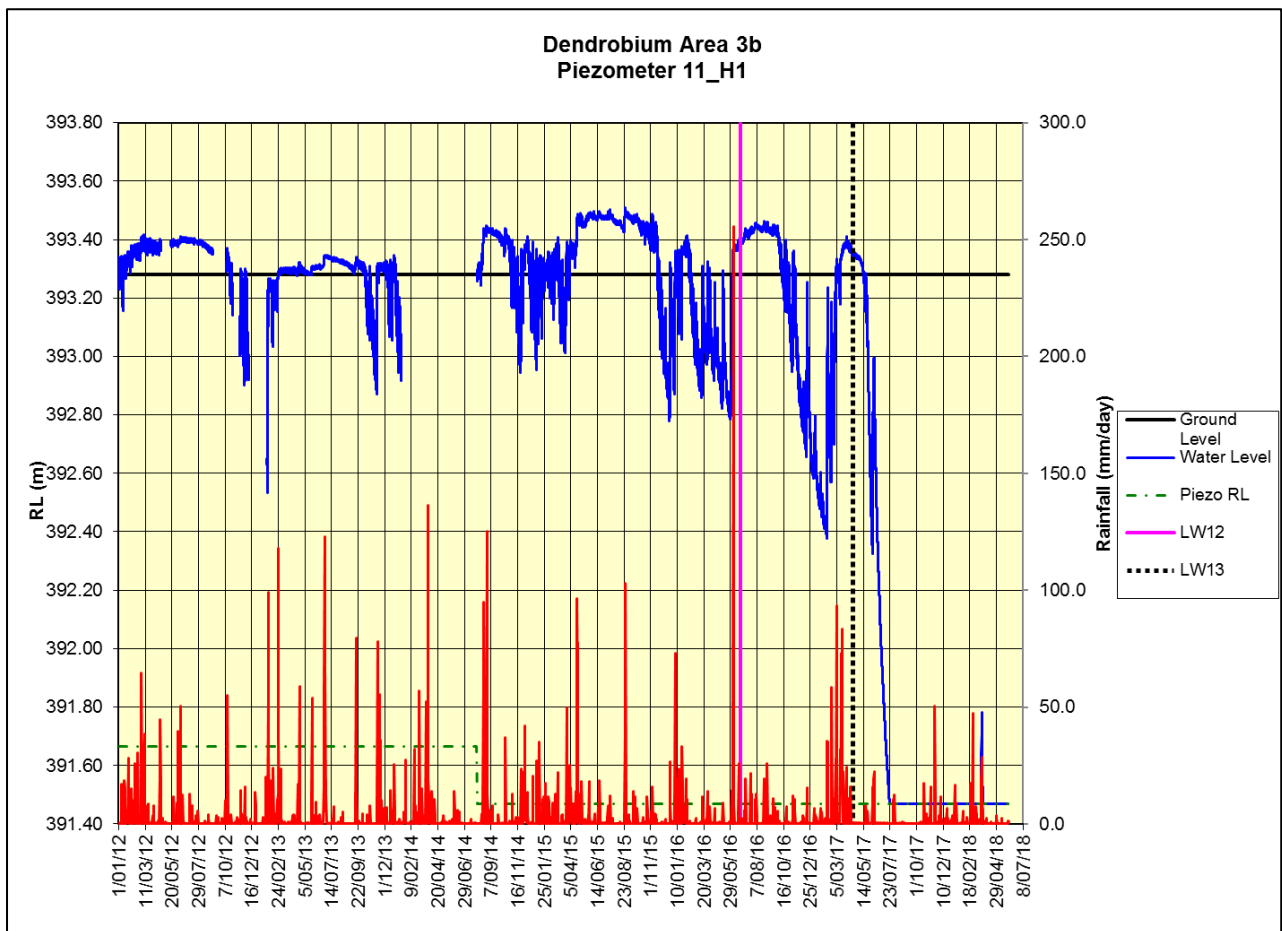


Figure 4: Shallow groundwater levels at 11_01, logged hourly, date range: (Jan 2012 to June 2018).

8.2 Water Quality

Wongawilli Creek (FR6)

Wongawilli Ck (FR6) is a water quality monitoring site approximately 3.5km downstream from DA3B. Water quality triggers for dissolved oxygen (DO, % saturation) and electrical conductivity (EC) were identified on the 23rd January 2018 and the 12th February 2018 (Figure 5 and Figure 6). The readings were below the 50.5% DO trigger and above the 154.1 $\mu\text{S}/\text{cm}$ EC trigger for Wongawilli Creek. DO and EC trigger thresholds have previously been recorded during the baseline and mining periods (Figure 5 and Figure 6). No surface flow was present at Wongawilli Ck (FR6) during these inspections. Additionally, following these inspections, the water level at the monitoring site was too shallow to obtain field measurements. These triggers are addressed in more detail in the Surface Water and Shallow Groundwater Assessment.

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%**

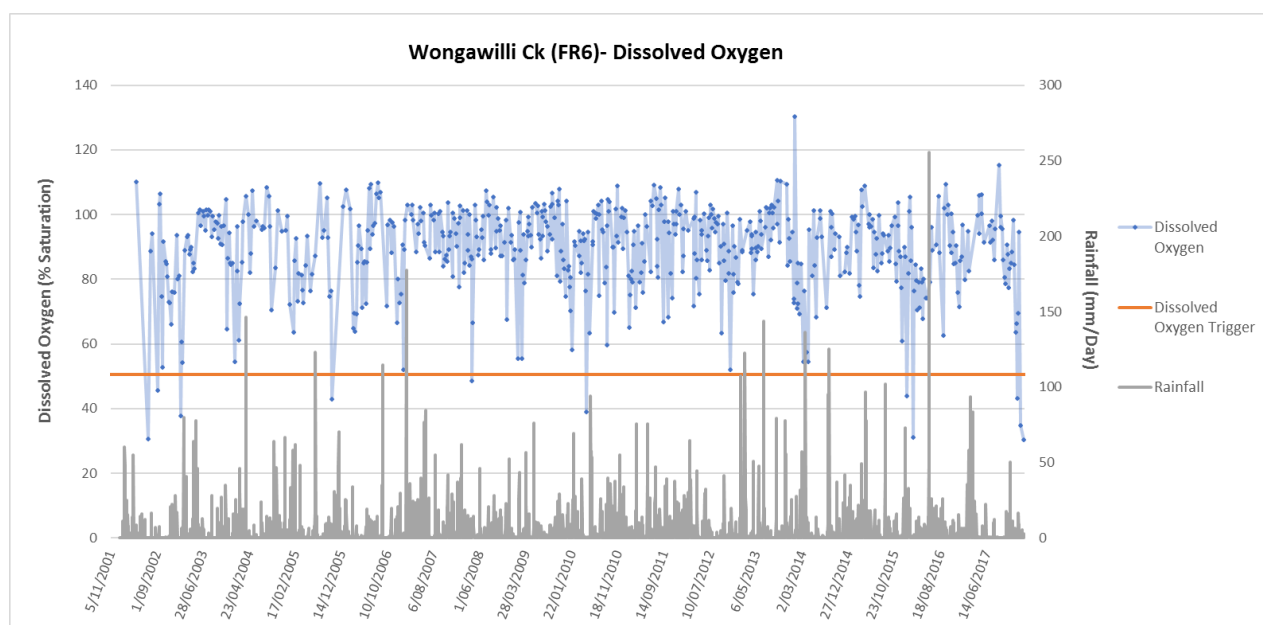


Figure 5: Dissolved oxygen results recorded at site Wongawilli Ck (FR6), downstream from DA3B operations.

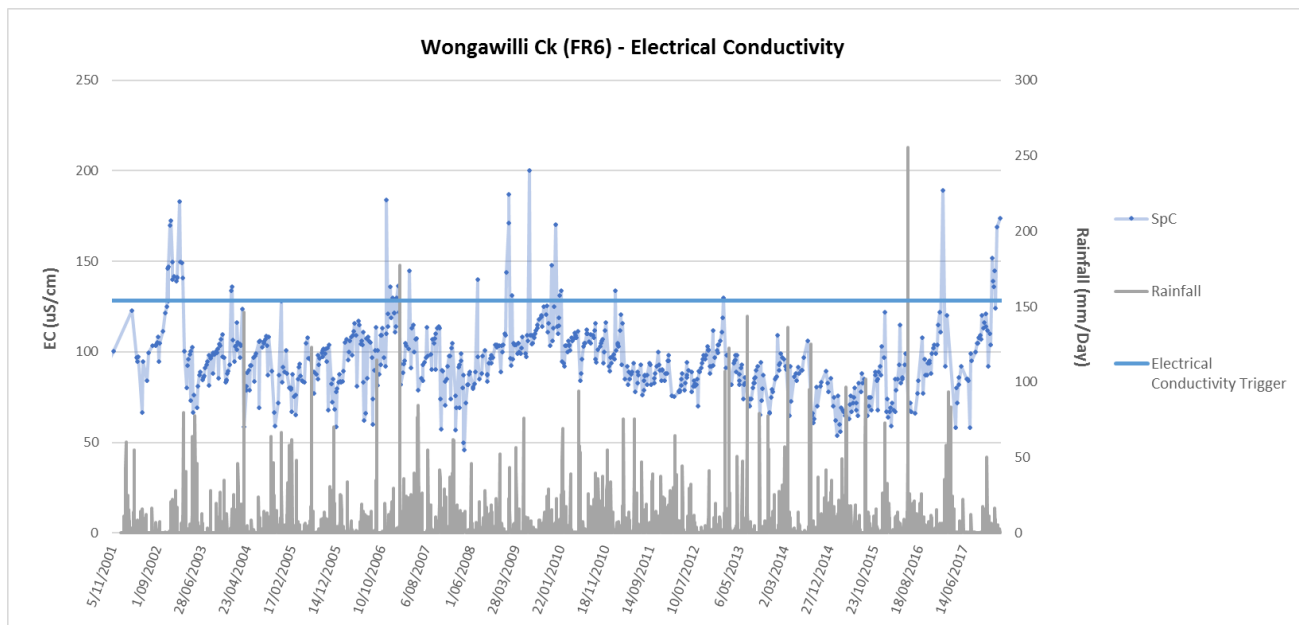


Figure 6: Electrical conductivity results recorded at site *Wongawilli Ck (FR6)*, downstream from DA3B operations.

9 IMPACTS TO BUILT FEATURES

Twenty-three surface impacts associated with built features were identified during the extraction of Longwall 13 (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.

9.1 Level 1 Surface Cracking

Eighteen impacts (Table 3) (Photo 63 to Photo 66) to built features were reported as Level 1 impacts 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 63: DA3B_LW13_032, soil cracking across Fire Road 6P. Taken 9th April 2018.



Photo 64: DA3B_LW13_012, largest section of surface cracking. Taken on 30/10/2017.



Photo 65: DA3B_LW13_034, close up of the widest section of the soil cracking impact. Taken 9th April 2018.



Photo 66: DA3B_LW13_020, looking across the access track. Taken on 16/03/2018.

9.2 Level 2 Surface Cracking

Six impacts (Table 3) (Photo 67 to Photo 70) to built features were reported as Level 2 impacts 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 67: DA3B_LW13_003, showing the longest continuous section of cracking on FR6A, taken 26/06/2017.



Photo 68: DA3B_LW13_029, close up of the widest section of cracking. Taken 9th April 2018.



Photo 69: DA3B_LW13_024, looking across track. Taken 4th March 2018.



Photo 70: DA3B_LW13_019, looking inside soil crack. Taken on 2/03/2018

9.3 Remediation

Following approval from WaterNSW, surface cracking across *Fireroad 6* and *Fireroad 6AA* was remediated. Further remediation will take place on all other access tracks that are accessed by vehicles. Minor soil cracks in other areas are expected to infill through natural processes.

10 RECOMMENDATIONS FOR FUTURE MONITORING

Recommendations for future monitoring in Dendrobium Area 3B, particularly concerning Longwall 14, are outlined in Table 5. 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 5: Monitoring associated with Longwall 13 and recommendations for monitoring during the extraction of Longwall 14.

ASPECT	MONITORING SITES ASSOCIATED WITH LONGWALL 13	MONITORING REQUENCY	RECOMMENDED FUTURE MONITORING FOR LONGWALL 14
Watercourses	Observational, Photo Point and Water Monitoring		
	<ul style="list-style-type: none"> • Wongawilli Creek • Donalds Castle Creek • WC21 • WC15 • WC16 • LA4 • LA4A • LA4B • Swamps 4, 5, 8, 10,11,13 and 14 	<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"> • WC15 • LA3 • Swamp 23 • Wongawilli Creek – Continue as required • Donalds Castle Creek – Continue as required • WC21, WC16 and WC18 – Continue as required • LA4, LA4A, LA4B - continue as required • Swamps 4, 5, 8, 10, 11,13 and 14 – Continue as required
	Water Quality		
	<ul style="list-style-type: none"> • 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) • WC15_Pool 9 [<i>Previously named WC15S1</i>] (Wongawilli 	<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>Creek tributary downstream of mining)</p> <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>Donalds Castle Creek:</p> <ul style="list-style-type: none"> • Donalds Castle Ck (FR6) [<i>Previously named DCU3</i>] (Donalds Castle Creek lower) • DCL3 (Donalds Castle Creek @ Cordeaux River) • DC_Pool 22 [<i>Previously named DCS2</i>] (Donalds Castle Creek downstream of mining) • DC13_Pool 2b [<i>Previously named DC13S1</i>] (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 and 14 	<p>Pre and post mining for two years, monthly when longwall is within 400m of monitoring site</p>	<ul style="list-style-type: none"> • Swamp 23 • Swamps 3, 4, 5, 8, 10, 11 13 and 14 - 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 	<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 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
	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 	<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 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

	<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"> • Swamp 23: 23_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
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 Fire road 6A (Across Longwalls 10-18)</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> <ul style="list-style-type: none"> • DA3-CF19 • DA3-CF20 • DA3-CF21 • DA3-CF22 • DA3-CF23 <p>Fire Trails Fire Road 6A (across LWs 10-18) - Continue as required by the SMP Fire Road 6N</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>

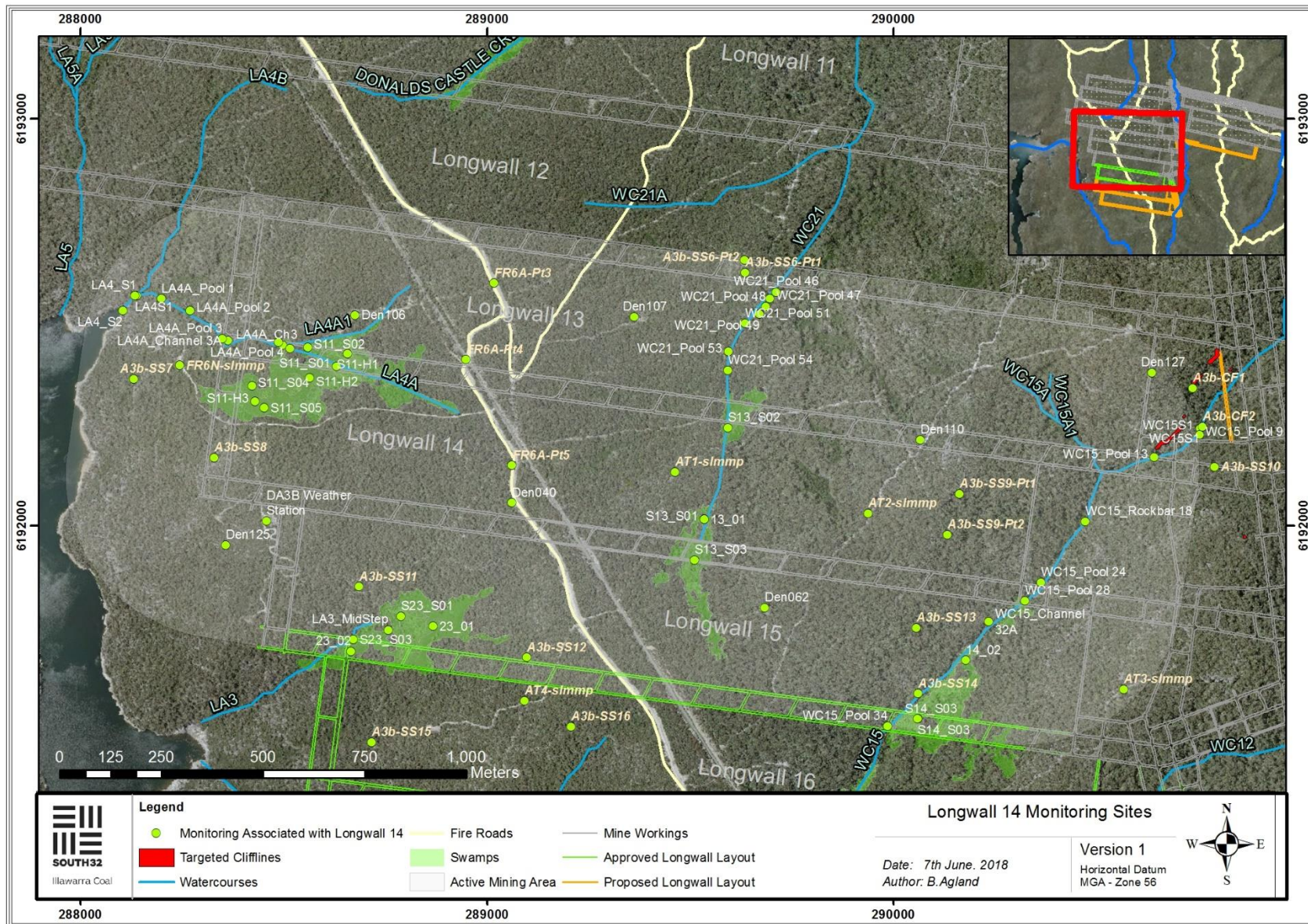


Figure 7: Monitoring sites relevant to Longwall 14.

11 APPENDIX A – LONGWALL 13 MONITORING PROGRAM

Table 6: Overview of surface monitoring for Longwall 13

ASPECT	MONITORING SITE	MONITORING FREQUENCY	MONITORED SITES ASSOCIATED WITH LONGWALL 13
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, LC7B, 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, 8, 10, 11, 13, 14
	Water Quality		
	<p>Wongawilli Creek</p> <ul style="list-style-type: none"> • WWU1 (Wongawilli Creek headwaters) • WWU4 (Wongawilli Creek upstream) • WC Pool 49 (Wongawilli Creek adjacent to LW15) • WC_Pool 46 (Wongawilli Creek adjacent to LW12) • WWM2 (Wongawilli Creek adjacent to LW11) • WC_Pool 43b (Wongawilli Creek downstream of LW9) • Wongawilli Ck (FR6) (Wongawilli Creek downstream) • WC21_Pool 5 (Wongawilli Creek tributary downstream of mining) • WC21 Pools 30 and 53 (Wongawilli Creek tributaries over 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) • WC21_Pool 5, Pool 30 and Pool 53 • WC15_Pool 9

	<p>Lake Avon</p> <ul style="list-style-type: none"> • LA4_S1, LA4_S2, LA5_S1, LA5_S2, LA3 Pool 4, LA2 Pool 5 and LA_1 (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, LA5_S1, LA5_S2, LA3 Pool 4, LA2 Pool 5 and LA_1 • 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 	<ul style="list-style-type: none"> • Swamps 4, 5, 8, 10, 11, 13, 14
	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</p> <p>Ground based surveys to be completed for each longwall after each longwall or to define any</p>	<ul style="list-style-type: none"> • Swamps 4, 5 8, 10, 11, 13, 14

new
erosions identified by ALS survey

Shallow Groundwater Level

Impact Sites:

- 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
- Swamp 08: 08_01, 08_02, 08_03, 08_04, 08_05, 08_06
- Swamp 10: 10_01
- Swamp 11: S11-HI, 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

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

Reference Sites:

- 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

For open hole sites:

- Monthly monitoring pre, during and post mining for two years to be reviewed annually
- Reference sites 6 monthly

For instrumented sites:

- Automatic groundwater level monitoring pre, during and post mining (4 hour interval or similar)
- Monitoring post mining for five years to be reviewed annually

- Swamps 4, 5 8, 10, 11, 13, 14

- 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

Soil Moisture

Impact Sites:

- 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
- Swamp 23: 23_01, 23_02
- Swamp 35A: 35a_01
- Swamp 35B: 35b_01

Reference Sites:

- Swamp 2: S02_S01
- Swamp 7: S07_S05, S07_S06
- Swamp 15A: S15a_S01, S15a_Piezo, S15a_S04, S15a_S06
- Swamp 22: 22_01, 22_02
- Swamp 24: S24_S01
- Swamp 25: S25_S01
- Swamp 33: S033_S01, S033_S03
- Swamp 84: S84_S02
- Swamp 85: S85_S01, S85_S02

For manually measured sites:

- Monthly monitoring for 2 years baseline and post mining and 6 monthly reference site
- Weekly monitoring when longwall is within 400m of monitoring site

For instrumented sites:

- Automatic soil moisture monitoring pre, during and post
- Monitoring post mining for five years to be reviewed annually

•Swamps 4, 5 8, 10, 11, 13, 14

	<ul style="list-style-type: none"> • 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 (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	
<ul style="list-style-type: none"> • All mapped cliff, steep slopes, watercourse, swamp and fire trail sites in subsidence area • General observation of active mining areas 	<ul style="list-style-type: none"> • 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 7: Dendrobium Area 3B Impacts, TARPs & Performance Measures – Longwall 13 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 	<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>See impact report dated: - 3/01/2018 - 15/02/2018</p>

Performance Measure	Potential Impacts	Exceeding Prediction	TARP Trigger Level	Observed Impacts	Additional Comments
			<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 		
		<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 <ul style="list-style-type: none"> • Fracturing not resulting in diversion of flow 	No Level 1 impacts observed	
			Level 2 <ul style="list-style-type: none"> • Fracturing resulting in diversion of flow 	No Level 2 impacts observed	
			Level 3 <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 	Impact DA3B_LW13_015 – WC_Pool 43a water level below baseline. Fracture was identified in the pool during LW9.	See impact report dated: - 28/11/2017 - 24/02/2018 - 31/05/2018

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_007 – Iron staining at subsurface outflow, downstream from WC21_Pool 38. • Impact DA3B_LW13_009 – Rock fracturing to the downstream extent of WC21_Pool 54. • Impact DA3B_LW13_028 – Rock fracturing to WC15_Pool 18 • Impact DA3B_LW13_035 – Rock fracturing to WC15_Rockbar 21. 	<p>See impact report dated: - 05/10/2017</p> <p>See impact report dated: - 24/10/2017</p> <p>See impact report dated: - 06/04/2018</p> <p>See impact report dated: - 27/04/2018</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_001 – Rock fracturing and uplift to LA4AS1 on tributary LA4A. Impact DA3B_LW13_006 – Rock fracture to the base of WC21_Pool 48. Impact DA3B_LW13_010 – Rock fracture to the step at the upstream extent of WC21_Pool 48. Impact DA3B_LW13_011 – Rock fracturing to the base of WC21_Pool 47. Impact DA3B_LW13_017 – Rock fracturing across WC21_Pool 45. Impact DA3B_LW13_018 – Rock fracturing across WC21_Pool 46. Impact DA3B_LW13_021 – Rock fracturing to the upstream extent of WC15_Rockbar 18 Impact DA3B_LW13_022 – Rock fracturing to WC15_Rockbar 18. Impact DA3B_LW13_023 – Rock fracturing to WC15_Rockbar 18. 	<ul style="list-style-type: none"> See impact report dated: - 03/05/2017 See impact report dated: - 05/10/2017 See impact report dated: - 24/10/2017 See impact report dated: - 24/10/2017 See impact report dated: - 09/01/2018 See impact report dated: - 23/02/2018 See impact report dated: - 03/04/2018 See impact report dated: - 03/04/2018 See impact report dated: - 03/04/2018

Performance Measure	Potential Impacts	Exceeding Prediction	TARP Trigger Level	Observed Impacts	Additional Comments
				<ul style="list-style-type: none"> • Impact DA3B_LW13_040 – Rock fracturing and uplift to WC15 between Step0 and Step 2 • Impact DA3B_LW13_041 – Rock fracturing to WC15_Step 0 which has resulted in a rock fall. • Impact DA3B_LW13_042 – Rock fracturing, rockfall and iron staining evident at WC15_Rockbar 7. • Impact DA3B_LW13_043 – Rock fracturing, rockfall and iron staining evident at LA4_Step0 	<p>See impact report dated: - 08/05/2018</p> <p>See impact report dated: - 08/05/2018</p> <p>See impact report dated: - 17/05/2018.</p> <p>See impact report dated: - 17/05/2018</p>

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>	<ul style="list-style-type: none"> • Swamp 11 (11_H1): Groundwater reduction rates exceed that during the baseline period. • Swamp 11 (11_H1): Groundwater level lower than what was recorded during the baseline period. 	<p>See impact report dated: - 27/06/2017</p> <p>See impact report dated: - 20/07/2017</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>No new Level 2 impacts observed.</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>	No new Level 2 impacts observed.	
	<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>	No new Level 1 impacts observed.	
			<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.	

Performance Measure	Potential Impacts	<i>Exceeding Prediction</i>	TARP Trigger Level	Observed Impacts	Additional Comments
			<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>	<p>No new Level 3 impacts observed.</p>	

Performance Measure	Potential Impacts	Exceeding Prediction	TARP Trigger Level	Observed Impacts	Additional Comments
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, 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</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"> • Impact DA3B_LW13_002 – Soil cracking on seismic track. • Impact DA3B_LW13_004 – Soil cracking on FR6A • Impact DA3B_LW13_008 – Soil cracking on seismic track. • Impact DA3B_LW13_012 – Soil cracking on seismic track. • Impact DA3B_LW13_013 – Soil cracking on seismic track. • Impact DA3B_LW13_014 – Soil cracking on seismic track. • Impact DA3B_LW13_016 – Soil cracking on seismic track. • Impact DA3B_LW13_020 – Soil Cracking on seismic track. • Impact DA3B_LW13_025 – Soil cracking on seismic track • Impact DA3B_LW13_026 – Soil cracking on seismic track. • Impact DA3B_LW13_027 – 	<p>See impact report dated: - 30/05/2018</p> <p>See impact report dated: - 17/07/2017</p> <p>See impact report dated: - 24/10/2017</p> <p>See impact report dated: - 24/10/2017</p> <p>See impact report dated: - 14/11/2017</p> <p>See impact report dated: - 14/11/2017</p> <p>See impact report dated: - 09/01/2018</p> <p>See impact report dated: - 19/03/2018</p> <p>See impact report dated: - 06/04/2018</p> <p>See impact report dated: - 06/04/2018</p> <p>See impact report dated: - 06/04/2018</p>

Performance Measure	Potential Impacts	Exceeding Prediction	TARP Trigger Level	Observed Impacts	Additional Comments
	<p>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>			<p>Soil cracking on seismic track</p> <ul style="list-style-type: none"> • Impact DA3B_LW13_031 – Soil cracking on FR6P. • Impact DA3B_LW13_032 – Soil cracking on FR6P. • Impact DA3B_LW13_033 – Soil cracking on FR6P. • Impact DA3B_LW13_034 – Soil cracking on FR6P. • Impact DA3B_LW13_036 – Rock fracturing to sandstone outcrop • Impact DA3B_LW13_037 – Soil cracking on seismic track. • Impact DA3B_LW13_038 – Soil cracking on seismic track. • Impact DA3B_LW13_039 – Soil cracking on seismic track. 	<p>See impact report dated: - 10/04/2018</p> <p>See impact report dated: - 10/04/2018</p> <p>See impact report dated: - 10/04/2018</p> <p>See impact report dated: - 10/04/2018</p> <p>See impact report dated: - 27/04/2018</p> <p>See impact report dated: - 27/04/2018</p> <p>See impact report dated: - 27/04/2018</p> <p>See impact report dated: - 27/04/2018</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 • Surface movement or rock displacement that has exposed 	<ul style="list-style-type: none"> • Impact DA3B_LW13_002 – Soil cracking on FR6A. • Impact DA3B_LW13_005 – Soil Cracking on AT6AA. • Impact DA3B_LW13_019 – Soil Cracking on FR6P. 	<p>See impact report dated: - 27/06/2017</p> <p>See impact report dated: - 20/07/2017</p> <p>See impact report dated: - 05/03/2018</p>

Performance Measure	Potential Impacts	Exceeding Prediction	TARP Trigger Level	Observed Impacts	Additional Comments
			<p>significant areas of soil</p> <ul style="list-style-type: none"> • 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"> • Impact DA3B_LW13_024 – Soil Cracking on seismic track. • Impact DA3B_LW13_029 – Soil Cracking on seismic track. • Impact DA3B_LW13_030 – Soil Cracking on seismic track. 	<p>See impact report dated: - 06/04/2018</p> <p>See impact report dated: - 10/04/2018</p> <p>See impact report dated: - 10/04/2018</p>

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 8: 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>			
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		<p><u>Exceeding Prediction:</u> 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.</p>			
<p>Maintenance or restoration of the structural integrity of the bedrock base of any significant permanent pool or controlling rockbar within the swamps</p>	<p>Subsidence impacts (i.e. cracking) on bedrock base or controlling rockbar</p>	<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>	<p>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>	<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>	
<p>Minor changes in the</p>	<p>Falls in surface or near-surface</p>	<p><u>Level 1:</u> Groundwater level lower than baseline level at any monitoring site within a swamp (in comparison to reference swamps); and/or</p>	<p>a) upfront mine planning</p>		<p>Triggers for groundwater</p>

ecosystem functionality of the swamps	groundwater levels in swamps <i>N.B. Not linked specifically to a PM and would not be considered a breach if predictions were exceeded.</i>	<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>	<ul style="list-style-type: none"> b) groundwater monitoring c) implementation of swamp research program d) weeding e) fire management f) reporting g) update future predictions 		decline result in increased intensity and frequency of vegetation monitoring and/or further investigations of subsidence impacts on bedrock base and rockbars
Minor changes in the ecosystem functionality of the swamps	Falls in soil moisture levels in swamps <i>N.B. Not linked specifically to a PM and would not be considered a breach if</i>	<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>	<ul style="list-style-type: none"> a) upfront mine planning b) soil moisture monitoring c) water spreading d) weeding e) fire management f) reporting 		Triggers of soil moisture decline result in increased intensity and frequency of vegetation monitoring and/or further investigations of

	<i>predictions were exceeded.</i>	<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).	g) update future predictions		subsidence impacts on bedrock base and rockbars
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Table 9: 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

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 	<ul style="list-style-type: none"> 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>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"> <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
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>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% 	<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"> Wongawilli 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 4.45 EC 154.1 uS/cm DO 50.5% 	<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 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

Monitoring	Trigger	Action
<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>Relevant Performance Measure(s):</p> <ul style="list-style-type: none"> • Donalds Castle 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 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"> • 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"> • <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 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 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

Monitoring	Trigger	Action
	<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
<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:

Monitoring	Trigger	Action
		<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 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"> • <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
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

Monitoring	Trigger	Action
		<p>pool where it is appropriate to do so in consultation with OEH, DoPE, T&I, Water NSW and other stakeholders</p> <ul style="list-style-type: none"> • 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 • 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>Exceeding Prediction</p>	<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>Relevant Performance Measure(s):</p> <ul style="list-style-type: none"> • Waterfall WC-WF54 – negligible environmental consequences 	<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
<p>MODELLED PERIODS OF RECESSIONAL, BASEFLOW AND SMALL STORM UNIT HYDROGRAPH PERIODS</p>		
<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

Monitoring	Trigger	Action
		<ul style="list-style-type: none"> • 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>Relevant Performance Measure(s):</p> <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 	<p>Exceeding Prediction</p> <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"> • <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

* 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 10: Dendrobium Landscape Impacts, Triggers and Response

Monitoring	Trigger	Action
LANDSCAPE FEATURES		
<p>DENDROBIUM AREA 3B Cliffs All mapped cliff sites in subsidence area Refer to Dendrobium Area 3B SMP 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 	<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>likely to naturally stabilise within the monitoring period</p> <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</p> <p><i>Refer Dendrobium Area 3A SMP Figure 21.1, 21.2 and 21.3 and Dendrobium Area 3B Figure 20.1 for location of sites</i></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 <p>Level 2 *</p>	<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>• Actions as stated for Level 1</p> <p>• Review monitoring frequency</p>

Monitoring	Trigger	Action
General observation of active mining areas	<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 Statistically significant difference between Before After Control Impact sites as a result of mining 	<ul style="list-style-type: none"> Notify relevant technical specialists and seek advice on any CMA required Implement agreed CMAs as approved
	<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.