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South32 Illawarra Metallurgical Coal

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Dear Billy,

LONGWALL 17 END OF PANEL REPORT AQUATIC FLORA AND FAUNA REVIEW

Introduction

South 32 Illawarra Metallurgical Coal (South32) extracts coal using longwall mining techniques from the Dendrobium Coal Mine, situated approximately 15 km to 20 km west of Wollongong. Consent for the mine, granted in November 2001, allows extraction from three longwall domains, known as Areas DA1, DA2 and DA3. DA3, situated to the west of Lake Cordeaux, is currently being mined. A modification to the mine layout of DA3, approved in December 2008, allowed the mine to be expanded, with Area 3 divided into three smaller domains, DA3A, DA3B and DA3C. Longwalls in DA3B have been extracted as follows:

- Longwall 9 commenced 9 February 2013; completed on 2 June 2014;
- Longwall 10 commenced 21 January 2014; completed 20 January 2015;
- Longwall 11 commenced 18 February 2015; completed 26 January 2016;
- Longwall 12 commenced 22 February 2016, completed 31 January 2017;
- Longwall 13 commenced 3 March 2017, completed on 19 April 2018;
- Longwall 14 commenced 22 May 2018, completed 26 February 2019;
- Longwall 15 commenced 4 April 2019, completed 22 January 2020;
- Longwall 16 commenced 25 February, completed 4 November 2020; and
- Longwall 17 commenced 12 December 2020, completed 13 October 2021.

Longwall 18 commenced 3 December 2021 and is currently underway.

Cardno NSW/ACT now Stantec (Cardno) was commissioned by South32 to undertake a review of the status of aquatic flora and fauna in relation to the extraction of Longwall 17 to support the End of Panel reporting. Cardno has been undertaking ongoing monitoring of watercourses within the DA3B mining area including the perennial Wongawilli Creek, Donalds Castle Creek and several associated first and second order ephemeral / intermittent tributaries (referred to hereafter as tributaries). The overall objective of the monitoring is to determine whether the extent and nature of observed impacts, primarily subsidence-induced fracturing of bedrock, flow diversion and loss of aquatic habitat, if any, are consistent with the predictions made in the Aquatic Flora and Fauna Assessment (AFFA) (Cardno Ecology Lab 2012) and Subsidence Management Plan (SMP) (BHPBIC 2012) for DA3B. This review includes:

- An overview of the management of aquatic flora and fauna including monitoring proposed and undertaken;

- Review of observed impacts to aquatic habitat, flora and fauna from South32 impact reports and a comparison with those predicted in the SMP; and
- Recommendations for any Corrective Management Actions (CMA) and future aquatic flora and fauna monitoring.

This review focuses on any physical and water quality impacts to watercourses overlaying and within 400 m of Longwall 17 and any associated potential impacts to aquatic habitat and biota that may have occurred during extraction of Longwall 17. The aquatic ecology impact assessment is based on the findings of ongoing field surveys in these watercourses by the Illawarra Metallurgical Coal Environmental Field Team (IMCEFT) and on Cardno's experience of undertaking monitoring and assessment of aquatic habitat and biota in the Dendrobium Mine Area.

During extraction of Longwall 17, some physical and water quality impacts were also observed in LA4, LA5, WC21 and Wongawilli Creek outside of the 400 m boundary of Longwall 17. These impacts were first observed during extraction of previous longwalls and have not been attributed to Longwall 17. Nevertheless, they are included in this review. The potential impacts to aquatic ecology attributed to extraction of Longwall 17 are also placed in context of the cumulative impacts to aquatic ecology experienced in the Dendrobium Mine. A full assessment of impacts due to extraction of all longwalls in DA3B will be provided in the latest biennial monitoring report due to be completed in early 2022 (Cardno *in prep*).

Any impacts to swamps and amphibians are considered by other specialist consultants.

Aquatic Ecology Management and Monitoring

The monitoring requirements recommended in the AFFA for DA3B and included in the SMP for DA3B incorporates a Before, After, Control, Impact (BACI) sampling design. The program monitors mine subsidence impacts on the aquatic environment with collection of at least two years of baseline data followed by monitoring during extraction, and at least two years of post-extraction monitoring. The following indicators were monitored at impact and control sites within and outside the SMP area for DA3B as a measure of aquatic health:

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

It was recommended that monitoring in DA3B be undertaken once every two years (Cardno Ecology Lab, 2012).

Table 1-1 summarises the monitoring that has been completed in DA3B in line with the AFFA and SMP. Baseline surveys were undertaken in DA3B in 2010 and 2011 (Cardno Ecology Lab 2011), followed by the during-extraction monitoring in 2013 (Cardno Ecology Lab 2014), 2015 (Cardno 2016), 2017 (Cardno 2018), 2019 (Cardno 2020a) and 2021 (Cardno, *in prep*). Additional monitoring was undertaken in DA3B in 2011 to support the AFFA, including more extensive fish surveys in WC21 and during the 2014 investigations in DA3A (Cardno Ecology Lab 2015). The AFFA also included a literature review on the physical setting, aquatic habitat, water quality, aquatic macroinvertebrates, fish, threatened species, populations and ecological communities in DA3B.

South32 undertake weekly monitoring of landscape and natural features in DA3B when within 400 m of the active longwall, and monthly thereafter. This includes monitoring during extraction of DA3B longwalls to identify any fracturing, pool water level reduction, changes in flow and water quality in Wongawilli Creek and its tributaries and Lake Avon tributaries.

The SMP includes the following triggers as part of the Trigger Action Response Plans (TARPs) relating to aquatic ecology:

- Level 1 – Reduction in aquatic habitat for 1 year;
- Level 2 – Reduction in aquatic habitat for 2 years following the active subsidence period (i.e. when a longwall is within 400 m of a feature, such as a creek, is completed); and
- Level 3 – Reduction in aquatic habitat for >2 years or complete loss of habitat following the active subsidence period.

Table 1-1 Monitoring undertaken for DA3B longwalls in line with the DA3B SMP Requirements and Recommendation in Cardno Ecology Lab (2012)

Report	Survey Date	Sampling Component
Baseline Monitoring		
Dendrobium Areas 3A and 3B. Aquatic Ecology Monitoring 2008 to 2013 (Cardno Ecology Lab 2014)	Mar / May / Sep / Nov 2010 Apr / Jun / Sep / Oct 2011	Habitat assessment, fish, macroinvertebrates, water quality
During Extraction Monitoring		
Dendrobium Areas 3A and B. Aquatic Ecology Monitoring 2008 to 2013 (Cardno Ecology Lab 2014)	Apr / Jun / Sep / Nov 2013	Habitat assessment, fish, macroinvertebrates, water quality
Dendrobium Area 3A Aquatic Ecology Monitoring 2008 to 2014 (Cardno Ecology Lab 2015)	Throughout 2014	Observations of mining impacts and effects on aquatic habitat in WC21 in 2014 that were attributed to extraction of Longwalls 9 and 10, undertaken as part of DA3A monitoring fieldwork
Dendrobium Area 3B Aquatic Ecology 2010 to 2015 (Cardno 2016)	May / Jun / Oct / Nov 2015	Habitat assessment, fish, macroinvertebrates, water quality
Dendrobium Area 3B Aquatic Ecology 2010 to 2017 Cardno (2018)	Apr / May / Oct / Nov 2017	Habitat assessment, fish, macroinvertebrates, water quality
Dendrobium Area 3B Aquatic Ecology 2010 to 2019 Cardno (2020a)	May / Jun / Oct / Nov 2019	Habitat assessment, fish, macroinvertebrates, water quality
Dendrobium Area 3B Aquatic Ecology 2010 to 2021 Cardno (*in prep*)	May / Jun / Oct / Nov 2021	Habitat assessment, fish, macroinvertebrates, water quality

These trigger specific management actions aim to minimise any further impacts to the aquatic environment, and include requirements for further monitoring, reporting, application of corrective management actions (CMAs), such as grouting and repair of fractures, and notification of relevant stakeholders, as required.

Predicted and Observed Impacts

Physical and Water Quality Mining Impacts

Details of the physical and associated water level, flow and quality triggers identified in watercourses by IMCEFT (South32, 2021) during extraction of Longwall 17 are provided in **Table 1-2** and **Figure 1-2**. Ten impacts were identified in LA2, which overlays Longwall 17. These impacts were observed during February to September 2021 while extraction of Longwall 17 was underway and consisted of a rock fractures in the channel, in Rockbars 10, 14, 24 and 25, and in Pools 9, 12, 14 and 25. No flow diversions were observed at the time of the inspections, but it is expected flow diversion could occur during flow events. These fractures were classified as a Level 2 Trigger as per the DA3B Watercourse TARP (i.e. crack or fracture that (could) result in observable loss of surface water or erosion).

Other watercourse and water quality impacts observed during extraction of Longwall 17 were not attributed to this longwall. These were increases and decreases in electrical conductivity (EC) and pH, respectively, in LA4. EC was 195 µS/cm, 134 µS/cm and 152 µS/cm and above the TARP level of 129.8 µS/cm, and pH was 4.3, 4.2, 4.5 and below the TARP level of 4.9 at site LA4_S1 between February and July 2021. LA4 was mined beneath by Longwalls 12 and 13 and is at least 1.3 km north of Longwall 17. Iron straining was also observed in LA5, WC21 and Wongawilli Creek. Although iron straining was first observed in LA5 in July 2021, this drainage line is at least 1.3 km from Longwall 17 and was mined under by Longwall 12 in March 2016. Similarly, iron straining in WC21 was first observed in December 2013 and in Wongawilli Creek it was first observed in March 2018 following extraction of previous DA3A and DA3B Longwalls. The iron staining in WC21 and Wongawilli Creek is at least 2.3 km downstream of Longwall 17. Changes in water quality in LA4 and iron straining in LA5 and WC21 are very unlikely to be associated with extraction of Longwall 17 given this longwall is not located within 400 m of their catchments. Although the upstream sections of some other Wongawilli Creek tributaries are located above Longwall 17, it is unlikely extraction of this longwall has contributed to iron staining downstream in Wongawilli Creek given it is at least 2.3 km away.

Table 1-2 Physical and water quality impacts observed in watercourses by IMCEFT during extraction of DA3B Longwall 17

Site ID	Impact Type	Watercourse	Identification	Description
DA3B_LW17_034	Rock Fracturing	LA2	10/09/2021	Rock fracturing and cracking to LA2 tributary
DA3B_LW17_013	Rock Fracturing	LA2	13/04/2021	Rock fracturing to LA2_Channel 8
DA3B_LW17_012	Rock Fracturing	LA2	13/04/2021	Rock fracturing and displacement around LA2_Pool 9 and upstream rockbar
DA3B_LW17_007	Rock Fracturing	LA2	10/03/2021	Rock fracturing and uplift to LA2_Rockbar 14.
DA3B_LW17_006	Rock Fracturing, uplift and Soil Cracking	LA2	10/03/2021	Rock fracturing, soil cracking and uplift to LA2_Pool 14.
DA3B_LW17_005	Rock Fracturing	LA2	10/03/2021	Rock fracturing to LA2_Pool 12.
DA3B_LW17_004	Rock Fracturing	LA2	10/03/2021	Rock fracturing and uplift to LA2_Rockbar 10.
DA3B_LW17_003	Rock Fracturing, uplift and fragmentation	LA2	14/04/2021	Rock fracturing, uplift and fragmentation to LA2_Rockbar 24.
DA3B_LW17_003	Rock Fracturing, uplift and Rockfall	LA2	10/03/2021	Rock fracturing, uplift and rockfall to LA2_Rockbar 24.
DA3B_LW17_003	Rock Fracturing and uplift	LA2	10/02/2021	Rock fracturing, uplift and fragmentation to LA2_Rockbar 24.
DA3B_LW17_002	Rock Fracturing, Uplift and Fragmentation	LA2	10/03/2021	Rock fracturing, uplift and fragmentation to LA2_Rockbar 25 and Pool 25
DA3B_LW17_002	Rock Fracturing, Uplift and Fragmentation	LA2	10/02/2021	Rock fracturing, uplift and fragmentation to LA2_Rockbar 25.
DA3B_LW17_001	Rock Fracturing, Uplift and Fragmentation	LA2	5/02/2021	Rock fracturing, uplift and fragmentation to LA2_Channel
LA4_S1	Water Quality	LA4	1/07/2021	Trigger for electrical conductivity
LA4_S1	Water Quality	LA4	7/06/2021	Trigger for pH
LA4_S1	Water Quality	LA4	18/02/2021	Trigger for pH
LA4_S1	Water Quality	LA4	18/02/2021	Trigger for electrical conductivity
DA3B_LW17_025	Iron Staining	LA5	1/07/2021	Iron staining in tributary LA5.
DA3B_LW9_019	Iron Staining	WC21	2/08/2021	Iron staining in WC21
DA3B_LW17_031	Iron Staining	Wongawilli	2/08/2021	Iron staining in Wongawilli Creek

Impacts on Aquatic Habitat and Biota

The assessment of impacts to aquatic habitat and biota due to the physical and water quality impacts observed by South32 and described above are summarised in **Table 1-3**. The findings are compared with the impacts to aquatic habitat and biota predicted to occur in the AFFA (Cardno Ecology Lab 2012). These predictions were based on the maximum predicted subsidence parameters for the sections of Wongawilli Creek, Donalds Castle Creek and tributaries that flow through the DA3B SMP Area, their predicted impacts on the physical and water chemistry characteristics of the waterways (MSEC 2011), and the assessment of potential impacts on surface water quality (Ecoengineers 2011).

The physical mining impacts resulting in fracturing, flow diversions and pool drainage in LA2 is expected to be associated with some reduction in the amount of ephemeral aquatic habitat. Although severe at the scale of individual pools and tributaries, based on the abundance of first and second order stream habitat in the local area, in isolation these impacts are considered relatively minor in the context of the Metropolitan Catchment Special Area. LA2 is naturally ephemeral and therefore provides relatively limited aquatic habitat compared with larger watercourses such as Wongawilli Creek. The cumulative impact to tributaries due to extraction of longwalls in DA3B and the wider Metropolitan Catchment should however, be considered. Mapping by IMCEFT indicates that approximately 62 km, or 8.6 %, of the total 716 km length of watercourse habitat within the Upper Avon and Cordeaux Catchments is within 400 m of extracted longwalls and could have experienced mine subsidence movements. This could result in loss of flow and reduction in pool water

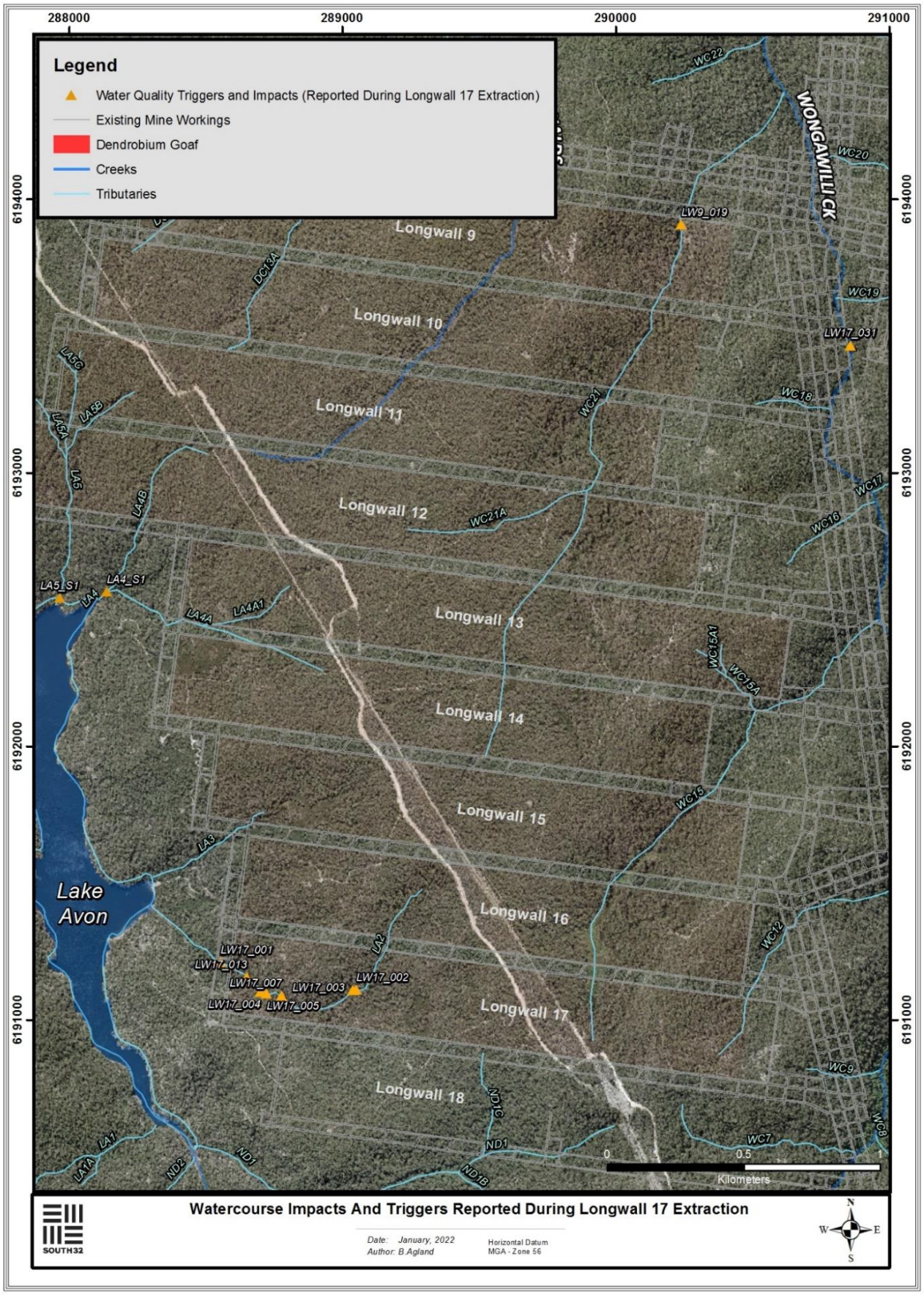

Figure 1-2 Location of watercourse impacts observed by IMCEFT during extraction of Longwall 17.

Table 1-3 Predicted and observed impacts to aquatic ecology associated with Longwall 17.

Attribute	Predicted Physical Impacts	Predicted Impacts on Aquatic Ecology	Observed Impacts to Aquatic Ecology
Wongawilli Creek			
Ponding, flooding and scouring of stream banks due to tilt	No significant change predicted.	No measurable effects due to tilt.	None identified by IMCEFT during extraction of Longwall 17.
Fracturing of bedrock and diversion of surface flows	No significant fracturing resulting in surface water flow diversions. Minor, isolated fractures of the streambed may occur within 400 metres from the proposed Longwalls. Minor fracturing of the creek bed and subsequent diversion of flows would not have significant geochemical effects. Formation of ferruginous springs is unlikely, but could occur at the margins or upslope of swamps (Ecoengineers 2011).	No significant changes in the quantity or quality of permanent aquatic habitat due to fracturing of bedrock and diversion of surface flows.	No reductions in pool water levels and flow or changes in water quality observed by South32 during extraction of Longwall 17, and, thus no suggestion of impacts occurring to aquatic habitat and biota Iron staining observed in Wongawilli Creek is unlikely to be related to Longwall 17 extraction. Nevertheless, previous assessment (Cardno 2020b) does not suggest significance impacts to aquatic ecology occurred. This will be confirmed following completion of the latest ongoing monitoring report (Cardno *in prep*).
Donalds Castle Creek and Tributaries (as appropriate to each longwall)			
Ponding, flooding and scouring of stream banks due to tilt	Reversals in grade may occur along Tributary WC21, adjacent to the tailgates of Longwalls 10 and 11. These could result in small increases in the levels of ponding, flooding and scouring of stream banks in highly localised areas along the tributaries. The impacts resulting from such changes are expected to be small relative to those that occur naturally during floods.	Localised changes in habitat availability and connectivity may occur along the tributaries due to tilt, but will be difficult to detect because of the large variability in natural flows within these ephemeral systems.	No impacts observed due to tilt.
Fracturing of bedrock and diversion of surface flows	Fracturing of the bedrock is likely to occur. In ephemeral creeks with alluvial deposits, fractures are likely to be in-filled by deposits during flow events. In areas with exposed bedrock, some diversion of surface flows into underlying strata and drainage of pools may occur, particularly during low flows. It is unlikely, that this would result in a significant impact on the overall quantity or quality of water flowing from the catchment.	There is unlikely to be any significant long-term changes in the quantity, quality or connectivity of aquatic habitats. Any losses of habitat and connectivity that do occur would be minor, localised and transient.	None observed in Donalds Castle Creek during extraction of Longwall 17. Fracturing of bedrock and diversion of flows in LA2 (a drainage line of Avon River) would have resulted in a reduction in quantity and connectivity of ephemeral aquatic habitat in this drainage line. Given the abundance of comparable first and second order stream habitat in the upper Avon and Cordeaux Catchments, associated impacts to aquatic biota is expected to be minor. Iron staining observed in WC21 and LA5 is unlikely to be related to Longwall 17 extraction. Nevertheless, previous assessment (Cardno 2020b) does not suggest significant impacts to aquatic ecology occurred. This will be confirmed following completion of the latest ongoing monitoring report (Cardno *in prep*).

level. It is noted that a large proportion of this is expected to be ephemeral and intermittent first and second order watercourses that provide more limited habitat for aquatic biota compared with larger and more permanent watercourses such as Wongawilli Creek. Nevertheless, these watercourses would still provide habitat and connectivity for some species at times of high rainfall. Given that LA2 is ephemeral, and thus, provides disconnected habitat irrespective of mining, any further reduction in connectivity associated with flow diversions would not be expected to result in significant impacts to aquatic habitat and biota. It is also expected that that connectivity would occur during high rainfall events.

Although not directly associated with extraction of Longwall 17, the changes in water quality identified in LA4 are unlikely to result in significant impacts to aquatic biota. Although reductions in pH in LA4 (site LA4_S1) were below the ANZECC Default Trigger Values (DTVs) for pH (lower DTV for pH 6.5) (ANZECC/ARMCANZ 2000), this was also the case during the baseline period. The elevated EC recorded in LA4 did not exceed

the lower DTV (350 µS/cm). Iron straining and iron precipitate has been noted in several watercourses following mining in DA3B and DA3A. This precipitate appears related to the release of iron from unweathered sandstone exposed during fracturing, which encourages the growth of iron-oxidising bacteria that convert the dissolved iron to an insoluble form. Although associated increases in the concentration of dissolved iron and manganese were noted in Wongawilli Creek previously in August 2021, these did not exceed ANZECC/ARMCANZ (2000) trigger values for protection of 95% aquatic species (HGEO 2021). Increases in aluminium and zinc above 95 % trigger values were noted in WC12, but these increased were localised to this tributary (HGEO 2021). During extraction of Longwall 17, iron staining was not associated with TARP triggers for water quality (HGEO 2022). Potential impacts to aquatic ecology appear more likely to be associated with changes in habitat quality following the infilling of interstices (holes between unconsolidated substratum such as gravel where many aquatic biota reside) by the flocculent. A post-mining assessment of recovery in water levels in SC10C in DA3A undertaken in 2020 (Cardno 2020b) suggested that some aquatic macroinvertebrates appear unaffected by the precipitate. Others, however, such as Leptophlebiidae (a type of mayfly) did demonstrate some reduction in abundance. There is some evidence that Leptophlebiidae may be particularly sensitive to environmental disturbance (Cardno 2020b). The precipitate that has been observed in Wongawilli Creek and WC21 does not appear to be as substantial as that in SC10C (authors personnel observations), and based on preliminary field observations during aquatic ecology surveys in Wongawilli Creek in 2021, it does not appear to be associated with a significant impact to aquatic habitat and biota in Wongawilli Creek. Any potential impacts to aquatic ecology associated with iron straining in Wongawilli Creek and WC21 will be assessed and reported as part of the ongoing aquatic ecology monitoring program for the Dendrobium Mine Area. The latest round of sampling in DA3A and DA3B, and including Wongawilli Creek and WC21 at the sites where iron staining has been observed, was undertaken in 2021, with the report due in early 2022 (Cardno *in prep*). Water quality impacts, including reference to the Dendrobium SMP TARPs are provided in HGEO (2022).

It is very unlikely that the threatened Macquarie perch previously identified downstream in Wongawilli Creek has been put at risk by extraction in DA3B. Macquarie perch has been recorded in Dendrobium Area 3 in the mid to lower reaches of Wongawilli Creek, including pools just upstream and downstream of the Fire Road 6 crossing (Cardno 2018 and references therein). However, this species was not identified further upstream in Wongawilli Creek near where iron straining has been observed or near Longwall 17, nor were any impacts observed here during extraction of Longwall 17. This was despite extensive sampling here as part of this and previous surveys in Wongawilli Creek for the DA3B monitoring program. It is possible that this species is unable to pass the natural barrier in the form of a cascade / waterfall present a few hundred metres upstream of the Fire Road 6 crossing, at least not in any appreciable numbers.

It is difficult to quantify the additional impact to aquatic habitat and biota in DA3B due to extraction of Longwall 17 only. The physical mining impacts observed during extraction of this longwall occurred following several other mining related impacts during extraction of previous DA3A and DA3B longwalls. It is probable that the additional fracturing observed in DA3B, and any that was not observed, has increased the existing impacts to water levels and flow associated groundwater depressurisation in DA3B.

Physical mining impacts that have occurred can be associated with individual longwalls or a cumulative effect of several longwalls. In such cases, it is difficult to determine if aquatic ecology impacts are due to a delayed response following extraction of earlier longwalls, a cumulative effect of extracting multiple longwalls, or a combination of mining impacts with prevailing environmental conditions e.g. prolonged reduced rainfall periods.

Aquatic Ecology TARP

Table 1-4 compares observed impacts to aquatic ecology with the TARP levels to determine if any have been triggered and what management actions associated with extraction of Longwall 17 and previous longwalls may be appropriate, if any. These TARPS are applicable to watercourses where aquatic ecology monitoring sites are located (Wongawilli Creek, Donalds Castle Creek, and WC21). For Site X1 on Donalds Castle Creek, the active subsidence period ended on 24 October 2013 when Longwall 9 was more than 400 m away from this site. It is noted that the TARP triggers here relate to mining of the domain as a whole, rather than individual longwalls. Thus, the reduction in aquatic habitat observed at these sites constitute a Level 3 Trigger. Actions for a Level 3 Trigger include notification of stakeholders and the development and implementation of CMAs. Longwall 17 is not within the Donalds Castle Creek or WC21 catchments. Extraction of this longwall is not expected to have affected the availability of aquatic habitat in this creek. The reductions in pool water levels and aquatic habitat in Wongawilli Creek during 2018 occurred for less than 1 year and did not constitute a trigger.

Table 1-4 TARP triggers and current status in Wongawilli Creek and Donalds Castle Creek

TARP	Donalds Castle Creek	WC21	Wongawilli Creek
Level 1 – Reduction in aquatic habitat for 1 year	Triggered: September 2014	Triggered: December 2014	Not triggered
Level 2 – Reduction in aquatic habitat for 2 years following the active subsidence period (i.e. when a longwall within 400 m of a feature, such as a creek, is completed)	Triggered: 24 October 2015	Triggered: 20 January 2017	Not triggered
Level 3 – Reduction in aquatic habitat for >2 years or complete loss of habitat following the active subsidence period	Triggered: During 2017 Aquatic Ecology Surveys (Cardno 2018)	Triggered: During 2017 Aquatic Ecology Surveys (Cardno 2018)	Not triggered

Conclusion and Recommendations

Fracturing was observed in drainage line LA2 during extraction of Longwall 17. Flow diversions would likely occur during flow events in this drainage line. In isolation, these impacts represent relatively minimal impacts to aquatic habitat and biota in this watercourse. Due to the limited aquatic habitat provided by LA2, and the abundance of drainage line habitat in the Metropolitan Special Area, the fracturing observed in LA2 also represents minor impacts to aquatic ecology at the scale of the Cordeaux River and Avon River catchments. The minor changes in water quality in LA4 also represent relatively minimal impacts to aquatic ecology. Potential impacts associated with iron staining will be further assessed and reported as part of the ongoing monitoring program, but, at present, do not appear to be associated with a significant impact to aquatic ecolgy. At this stage, no specific actions associated with Longwall 17 or LA2 are recommended.

Longwall 17 added to existing physical mining impacts, reduction in availability of aquatic habitat and assumed loss of some associated aquatic biota in tributaries in DA3B. It would be expected that extraction of Longwall 17 would have contributed to mining induced groundwater depressurisation in DA3B (HGEO 2022b). This could result in a greater potential for and severity of any future similar reductions in pool water levels and flow in tributaries and Wongawilli Creek. It is noted that previous reductions in flow observed in Wongawilli Creek have been within predictions. No aquatic ecology TARPs have been triggered with respect to Wongawilli Creek. Level 3 triggers were in place for WC21 and Donalds Castle Creek prior to extraction of Longwall 17, and remain in place.

It is recommended that further during- and post-mining aquatic ecology monitoring is completed in DA3B in Wongawilli Creek and its tributaries in line with the AFFA and SMP. South32 should continue to monitor watercourses (as required by the SMP) that have been affected by extraction of Longwall 17 and previous longwalls. The findings of these will be used to assess whether TARPs will subsequently be triggered.

Yours sincerely,

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References

Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand (2000). *Australian guidelines for water quality monitoring and reporting.* National water quality management strategy, No. 7. Prepared for: Australian & New Zealand Governments. ANZECC//ARMCANZ, Australia.

BHP Billiton-Illawarra Coal (BHPBIC) (2012). Dendrobium Area 3B. Subsidence Management Plan. Volume 2-Subsidence Management Plan

Department of Planning and Environment (DPE) (2015). Mining Impacts at Dendrobium Coal Mine Area 3B. http://www.planning.nsw.gov.au/~/media/Files/DPE/Reports/mining-impacts-at-dendrobium-coal-mine-area-3b-2015-12.ashx

Cardno Ecology Lab (2011). Dendrobium Area 3 – Baseline Aquatic Ecology Monitoring Spring 2008 – Spring 2010. Report Prepared for BHPBIC. Report No. EL0607058C.

Cardno Ecology Lab (2012). Dendrobium Area 3B SMP – Aquatic Flora and Fauna Assessment. Report Prepared for BHPBIC. Report No. EL1112029A

Cardno Ecology Lab (2014). Dendrobium Areas 3A and B. Aquatic Ecology Monitoring 2008 to 2013.

Cardno Ecology Lab (2015). Dendrobium Area 3A Aquatic Ecology Monitoring 2008 to 2014.

Cardno (2016). Dendrobium Area 3B – Aquatic Ecology Monitoring 2010 to 2015.

Cardno (2018). Dendrobium Area 3B. Aquatic Ecology Monitoring 2010 to 2017.

Cardno (2020a). Dendrobium Area 3B. Aquatic Ecology Monitoring 2010 to 2019.

Cardno (2020b). SC10C Recovery Assessment. Dendrobium Area 3A.

Cardno (*in prep*). Dendrobium Area 3B. Aquatic Ecology Monitoring 2010 to 2021.

Chessman, B.C Growns, J.E and Kotlash, A.R. (1997). Objective derivation of macroinvertebrate family sensitivity grade numbers for the SIGNAL biotic index: Application to the Hunter River system, New South Wales. Marine and Freshwater Research, 48, pp. 159-172.

Ecoengineers (2011). Dendrobium Area 3B Subsidence Management Plan. Surface and Shallow Groundwater Assessment. Report prepared for BHPBIC.

HGEO (2021). Iron-staining in Wongawilli Creek, August 2021. Dendrobium Mine.

HGEO (2022a). Dendrobium Mine. End of Panel Surface Water and Shallow Groundwater Assessment: Longwall 17 (Area 3B).

HGEO (2022b). Dendrobium Mine. End of Panel Groundwater Assessment for Longwall 17 (Area 3B).

MSEC (2011). Dendrobium Area 3B – Longwalls 9 to 18. Subsidence Predictions and Impact Assessments for the Natural Features and Surface Infrastructure in Support of the SMP Application. Report prepared for BHPBIC.

South32 (2021). End of Panel Landscape Report Dendrobium Area 3B. Dendrobium Area 3B Longwall 17 End of Panel Landscape Report. November 2021.