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Dear Josh,

APPIN AREA 9 LONGWALL 903 END OF PANEL REPORT - AQUATIC FLORA AND FAUNA REVIEW

Introduction

South32 Illawarra Metallurgical Coal (South32) extracts coal from the Bulli Seam in Area 9 of the Appin Colliery in the Southern Coalfield of New South Wales using longwall mining techniques. Appin Area 9 currently consists of approved Longwalls 901 to 904. The sequence of longwall extraction has been as follows:

- > Longwall 901: 19 January 2016 to 8 September 2017
- > Longwall 902: 12 May 2018 to 3 April 2019; and
- > Longwall 903: 1 November 2019 to 7 April 2021

Extraction of Longwalls 904 is to follow.

Cardno NSW/ACT (Cardno) was commissioned by South32 to undertake an Aquatic Flora and Fauna Review (AFFR) in relation to the extraction of Longwall 903 to support the End of Panel (EoP) reporting for the longwall. Cardno has been undertaking ongoing monitoring of aquatic habitat and biota in the section of the Nepean River in the Appin Area 9 (in conjunction with Appin Area 7) mining area. 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 ecology assessment (Cardno Ecology Lab 2012) and Extraction Plan (EP) for Longwalls 901 to 904 (BHPBIC 2013) that was approved in September 2014. 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 site visits undertaken by Cardno and a comparison with those predicted in the EP; and
- > Recommendations for any management actions associated with aquatic habitat and biota and future monitoring.

This review considers the effects of extraction of Longwall 903 in Appin Area 9 and focuses on the findings of ongoing monitoring by South32 and on data from aquatic ecology monitoring sites on the Nepean River.

Aquatic Ecology Management and Monitoring

The monitoring requirements recommended in the aquatic assessment and included in the EP for Longwalls 901 to 904 included biennial monitoring of the following indicators at impact and control sites as a measure of aquatic health:

- > Aquatic habitat, including fish habitat and riparian vegetation;

- > Aquatic macroinvertebrates sampled in accordance with the Australian River Assessment System (AUSRIVAS) and derived biotic indices;
- > Fish sampled using bait traps and backpack electrofishing;
- > Limited *in-situ* water quality sampling; and
- > Species composition of aquatic macrophytes.

These indicators are assessed at two potential impact sites (X3 and X4) near Appin Area 9 and at control sites (X5 to X8) upstream and downstream of this area on the Nepean River. Sites 1 and 2 located just upstream of Douglas Park Weir also provide a measure of potential downstream impacts. These sites are monitored annually for Appin Area 7.

Table 1-1 summarises the monitoring that has been completed in Appin Area 9 in line with the aquatic assessment and EP. Before-extraction monitoring was undertaken in December 2014 (Cardno Ecology Lab 2015) and November 2015 (Cardno 2016). Subsequent monitoring is undertaken biennially, with surveys in November of 2017 (Cardno 2018) provided after-extraction data for Longwall 901 and further before-extraction monitoring for Longwall 902, with further monitoring undertaken after the commencement of extraction of Longwall 903 in November 2019 (Cardno 2020). Surveys included a literature review on the physical setting, aquatic habitat, water quality, aquatic macroinvertebrates, fish, threatened species, populations and ecological communities in Appin Area 9. Riparian vegetation at sites X3 to X8 is largely undisturbed, consisting of numerous large, established trees with few breaks in cover. The channel is relatively narrow (approximately 10 to 20 m), shallow and faster flowing and the substratum includes coarse pebbles, cobbles, boulders and bedrock. At the downstream sites (Sites 1 and 2), aquatic habitat consists primarily of wide (approximately 30 m) channel, relatively deep and slow flowing water and sand / bedrock substratum (at least along the river edges). Two flow controlling structures occur nearby: Maldon Weir immediately upstream of Site X8; and Douglas Park Weir, just downstream of Site 2. Surveys were also undertaken at Sites 1 and 2 in November 2020 as part of the Appin Area 7 investigations (Cardno 2021). Appin Area 9 sites will be visited again in November 2021.

Table 1-1 Timing of aquatic ecology monitoring events undertaken for Appin Area 9 Longwalls 901 to 904 before and after the commencement of extraction of each longwall.

Longwall	Commencement	Completion	Survey Date and Reference			
			Dec 2014	Nov 2015	Nov 2017	Nov 2019
			Cardno Ecology Lab (2015)	Cardno (2016)	Cardno (2018)	Cardno (2020)
901	Jan 16	Sep 17	Before	Before	After	After
902	May 17	Apr 19	Before	Before	After	After
903	Nov 19	Apr 21	Before	Before	Before	After
904	May 21		Before	Before	Before	Before

The current assessment for the AFFR for the Longwall 903 EoP considers the findings of previous surveys Appin Area 9 Monitoring sites and the recent findings of surveys for physical mining impacts undertaken by the Illawarra Metallurgical Coal Environmental Field Team IMCEFT (South32 2021) and of changes in surface water quality assessed by HGEO (2021). IMCEFT undertake weekly monitoring of landscape and natural features in Appin Area 9 when features are within 400 m of the active longwall, and monthly thereafter. This includes monitoring during extraction of Appin Area 9 longwalls to identify any fracturing, pool water level reduction, changes in flow and water quality in the Nepean River.

The Appin Area 9 Biodiversity Management Plan includes the following triggers as part of the Trigger Action Response Plans (TARPs) relating to aquatic ecology:

- > Level 1: Reduction in aquatic habitat resulting from mining over 1 season
- > Level 2: Reduction in aquatic habitat resulting from mining over 2 seasons; and
- > Level 3: Reduction in aquatic habitat resulting from mining for > 2 consecutive seasons or complete loss of habitat.

Trigger specific management actions aim to minimise any further impacts to the aquatic environment, and include requirements for further monitoring, reporting, application of mitigation measures and notification of relevant stakeholders, as required.

Predicted Impacts

Extraction of Longwalls 901 to 904, which have been set back from the Nepean River at least 125 m, are predicted to result in 30 mm of subsidence and 110 mm of upsidence (MSEC 2012b). The river is not predicted to experience any significant changes in the levels of ponding, flooding or scouring of the river banks, or any significant changes in the water levels or stream alignment due to tilt associated with the longwall extraction. Minor and isolated fracturing of the river bed could occur, however, it is not expected to result in any loss of surface water flows (BHPBIC 2014a). Fracturing could occur in the drainage lines above or immediately adjacent to the proposed longwalls. In areas of exposed bedrock, some diversion of surface water flows and the draining of pools may occur in associated drainage lines. It was considered unlikely that there would be any net loss of water from the catchment.

Minor gas releases, associated iron precipitate and reductions in concentrations of DO may occur due to extraction of Longwalls 901 to 904, but these would have negligible environmental consequences (BHPBIC 2014a). Other environmental consequences due to potential impacts to water quality in the Nepean River and drainage lines due to extraction, such as changes to pH and concentrations of metals following fracturing, would be negligible.

There are unlikely to be any measurable impacts on the availability or connectivity of aquatic habitats in the downstream reach of the Nepean River due to its flooded nature and very low gradient (Cardno Ecology Lab 2012c). In the upstream reach, any fracturing that occurs is expected to be isolated and minor in nature, so the potential for impacts on surface flow is limited. The predicted changes in ponding, flooding or scouring of the river banks would have negligible effects on aquatic habitats or biota in the Nepean River. The effects on aquatic ecology due to the predicted changes in water quality would also be negligible. Effects to aquatic habitat and biota due to any diversion of flows and draining of pools in drainage lines would be minimal, due to the limited aquatic habitat provided by these areas.

Observed Impacts

Physical and Water Quality Impacts

IMCEFT identified one new gas release zone in the Nepean River during extraction of Longwall 903, approximately 1, 140 m from the closest point of Longwall 903 and approximately halfway between Sites 1 and X3. This had an approximate area of 4 m² and was first observed on 23 April 2020. It was still active as of 21 April 2021. As of 21 April 2021, nine other gas release zones previously observed during extraction of Longwalls 901 and 902 were also active in the Nepean River. Gas release zones have been observed from Site 2 upstream to Site X3 (**Figure 1-2**). These gas release zones typically occur over areas of under approximately ten square metres, whilst larger zones can occur scattered over areas up to several hundred square metres.

Monthly monitoring by South32 indicates a decline in pool water levels at site NR0 of 0.49 m from the baseline range during the reporting periods for Longwalls 901, 902 and 903 (HGEO 2021). It should however be noted that higher flow conditions can restrict access meaning higher water level readings are not captured in the water level data. Water levels at site NR110 located 3.5 km further upstream also declined, by 0.25 m from the baseline range over the same period. Additional monitoring at NR0 and NR110 is recommended (HGEO 2021). Electrical conductivity (EC) was elevated (i.e. above trigger levels) at sites NR0 and SW3, however, elevations were also observed at the upstream control site and these changes were not attributed to mining. There was an increase in concentration of iron at NR0 and SW3 and manganese at NR2 and SW3 during extraction of Longwall 903. However, similar changes were observed at the upstream control site and there were no underlying adverse trends in concentrations. Thus, the exceedances were not attributed to mining activities (HGEO 2021).

No other changes (such as evidence of fracturing, other surface impacts or flow diversions) to the appearance of the Nepean River or tributaries were observed during the extraction of Longwall 903.

Aquatic Habitat and Biota

The results of monitoring undertaken by Cardno are compared with the impacts to aquatic habitat and biota predicted to occur in the in the aquatic assessment (Cardno Ecology Lab 2019) and EP in **Table 1-2**.



Figure 1-2 Location of gas releases and monitoring sites in the Nepean River adjacent to Longwalls 901 to 904. Note control sites X5 to X8 located 3 km to 6 km upstream to the west.

Table 1-2 Predicted and observed impacts to aquatic ecology in the Nepean River associated with Longwall 903. Impacts to physical features and surface water quality assessed by IMCEFT (2021) and HGEO (2021), respectively. Impacts to aquatic ecology based on the findings of surveys undertaken at Sites 1, 2 and X3 to X8 in November 2019 and at Sites 1 and 2 during November 2020.

Attribute	Predicted Physical Impacts	Associated Predicted Impacts on Aquatic Ecology	Observed Impacts
Ponding, flooding and scouring of stream banks	The river is not predicted to experience any significant changes in the levels of ponding, flooding or scouring of the river banks, or any significant changes in the water levels or stream alignment due to longwall extraction.	There are unlikely to be any measurable impacts on the availability or connectivity of aquatic habitats in the downstream reach of the Nepean River due to its flooded nature and very low gradient	No changes in ponding flooding and scouring of stream banks observed (South32 2021). No impacts to aquatic ecology identified during observations of aquatic macroinvertebrates, fish and aquatic macrophytes.
Fracturing of bedrock and diversion of surface flows	Minor and isolated fracturing of the river bed could occur, however, it is not expected to result in any loss of surface water flows	It is considered unlikely that there would be any net loss of water from the catchment. No significant changes in the quantity or quality of permanent aquatic habitat.	No fracturing observed (South32 2021). No impacts to aquatic ecology identified during observations of aquatic macroinvertebrates, fish and aquatic macrophytes.
Gas releases	Minor gas releases, associated iron precipitate and reductions in concentrations of dissolved oxygen may occur due to extraction.	Negligible environmental consequences	One new gas release zone identified during extraction of Longwall 903. This and nine other gas zones previously identified during extraction of Longwalls 901 and 902 were active as of 21 April 2021. No associated changes to indicators of aquatic ecology at upstream and downstream monitoring sites have been observed.
Water Flow and Levels	Potential for loss or diversion is very low in the downstream reach. Minor, localised fracturing of rock bars and diversion of flows may occur in the upstream reach. No measurable impact expected in the upstream reach and it is unlikely that there would be any significant change in the downstream reach.	There are unlikely to be any measurable impacts on availability or connectivity of aquatic habitats in the downstream reach of the river due to its flooded nature and very low gradient. In the upstream reach, any fracturing that occurs is expected to be isolated and minor in nature, so the potential for impacts on surface flow is limited. In the downstream reach, subsidence and upsidence may result in small changes in the levels of the river bed and banks. This could lead to minor increases and decreases, respectively in the availability of aquatic habitat, but may be difficult to detect. Dilation of the bedrock in the base of the river could result in a minor decrease in water volume and availability of aquatic habitat. Minor changes in the availability of aquatic habitat could result in a reduction in the abundance of aquatic macroinvertebrates living therein. Losses would be negligible relative to the amount of habitat available within the downstream reach of the river.	A decline in water level of approximately 0.5 m below the baseline at Site NR0 from the start of Longwall 901 throughout the reporting periods for Longwalls 901, 902 and 903. A reduction in water levels was also noted upstream of the mine area. It is noted higher water levels were not captured in data due to access restrictions to NR0 during higher flow conditions. No associated changes to indicators of aquatic ecology at aquatic ecology monitoring sites X3 and X4.
Water Quality	Localised iron staining may occur. Minor changes to water quality may occur.	No more than associated impacts to aquatic biota is expected.	Increases in electrical conductivity (EC) and concentrations of iron and manganese in excess of TARP trigger levels observed in the Nepean River during extraction of Longwall 903. However, similar changes were observed at the upstream control site and these changes were not attributed to mining. Regardless, no associated changes to indicators of aquatic ecology were observed at aquatic ecology monitoring sites.

It is noted these comparisons have been undertaken using data from Sites 1, 2 and X3 to X8 in November 2019 and from Sites 1 and 2 in November 2020 (as part of the annual Appin Area 7 investigations). Changes that may have occurred at Sites X3 and X4 will be assessed following the next survey event at these Sites, currently planned for November/December 2021. There were no observed impacts to indicators of aquatic ecology (number of taxa and biotic indices derived from macroinvertebrate sampling) in November 2019 or November 2020 that could be attributed to extraction of Longwall 903. Aquatic habitat at all sites on the Nepean River was good condition and there was no evidence of any change in the availability of aquatic habitat that could be attributed to mining. There was no evidence that the changes in water levels and water quality had affected aquatic habitat and biota at these sites and there was no evidence of any changes to fish and aquatic macrophytes. The fish assemblage sampled at these sites following the commencement of extraction of Longwall 903 was comparable with that sampled prior to extraction. No fish kills or any other observations that may suggest an impact due to mining were observed. Although sites directly adjacent to Longwalls 901 to 904 were not surveyed in November 2020, based previous experience and the magnitude and changes in water levels and water quality observed in the Nepean River during extraction of Longwall 903, it is considered very unlikely that significant impacts to aquatic ecology have occurred in the Nepean River in Appin Area 9 since November 2020. This will be confirmed following the next survey event planned for November 2021.

Aquatic Ecology TARP

Table 1-3 compares observed impacts to aquatic ecology with the TARP levels to determine if these have been triggered and what management actions associated with extraction of Longwall 903 may be appropriate, if any. No reduction in aquatic habitat was observed on the Nepean River during the aquatic ecology monitoring program that could be attributed to mining. Thus, TARPs have not been triggered.

Table 1-3 TARP levels applicable to aquatic features relevant to Longwall 903 as of November 2020.

TARP	Trigger
Level 1: Reduction in aquatic habitat resulting from mining over 1 season	Not triggered
Level 2: Reduction in aquatic habitat resulting from mining over 2 seasons.	Not triggered
Level 3: Reduction in aquatic habitat resulting from mining for > 2 consecutive seasons or complete loss of habitat	Not triggered

Conclusion and Recommendations

No changes to aquatic ecology indicators that could be associated with extraction of Longwall 903 have been detected in aquatic ecology data collected in November of 2019 and 2020. This was not surprising given no more than minor gas releases and change in water quality have been observed in the Nepean River associated with mining. The gas releases and changes in water quality and water levels identified in the Nepean River active during extraction of Longwall 903 do not appear to have had any measurable effect on macroinvertebrates, fish and macrophytes in the Nepean River.

Further monitoring will be undertaken at all Appin Area 9 potential impact and control sites in November 2021. This will include a full assessment of any changes to aquatic habitat and biota that may have occurred at Appin Area 9 monitoring sites following the completion of Longwall 903.

Yours sincerely,



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