



Illawarra Metallurgical Coal
End of Panel Report



**APPIN AREA 7
LONGWALL 708
END OF PANEL REPORT**

April 2022



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Attachments

Attachment A-	Appin Area 7 Longwalls 707 – 710 SMP Approval
Attachment B-	LW708 Landscape Report
Attachment C-	Nepean River Gas Zone Update Report
Attachment D-	LW708 Subsidence Assessment
Attachment E-	LW708 Groundwater and Surface Water Assessment
Attachment F-	LW708 Post-mining Property Reports
Attachment G-	LW708 Aquatic Flora and Fauna Assessment

Abbreviations

AA7	Appin Area 7
AA9	Appin Area 9
ARTC	Australian Rail and Track Corporation
BFMP	Built Feature Management Plans
BSO	Bulli Seam Operations
EP&A Act 1979	<i>Environmental Planning and Assessment Act 1979</i>
IMC	Illawarra Metallurgical Coal
IMCEFT	Illawarra Metallurgical Coal Environmental Field Team
PAC	Planning and Assessment Commission
SMP	Subsidence Management Plan

1. Introduction

South32 Illawarra Metallurgical Coal (IMC) operates the Bulli Seam Operations (BSO) Appin Mine, extracting hard coking coal used for steel production. On 22 December 2011, the Planning and Assessment Commission (PAC), under delegation of the Minister for Planning, approved the BSO Project (MP 08_0150) under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act 1979) to continue mining operations until 31 December 2041.

Appin Area 7 is part of the BSO Project area and is located within Consolidated Coal Lease No.767 (CCL767). Longwall 708 is comprised of two sections- Longwall 708A and 708B. The extraction of Longwall 708 commenced on 2 April 2019 and was completed on 3 January 2022, using conventional longwall techniques and equipment. This End of Panel (EoP) Report has been prepared in accordance with Condition 18 of the Longwall 707 to 710 SMP Approval, granted on the 28 September 2012. The EoP Report outlines the measured and observed impacts of Longwall 708 and analyses the monitoring results against relevant impact assessment criteria and predictions made in the SMP and associated management plans.

The AA7 mining area lies in the southern part of the Permo-Triassic Sydney Basin, within which the main coal bearing sequence is the Illawarra Coal Measures, which are Late Permian of age (Figure 1). The Illawarra Coal Measures contain several seams, the uppermost of which is the Bulli Seam from which Appin Area 7 panels are extracted.

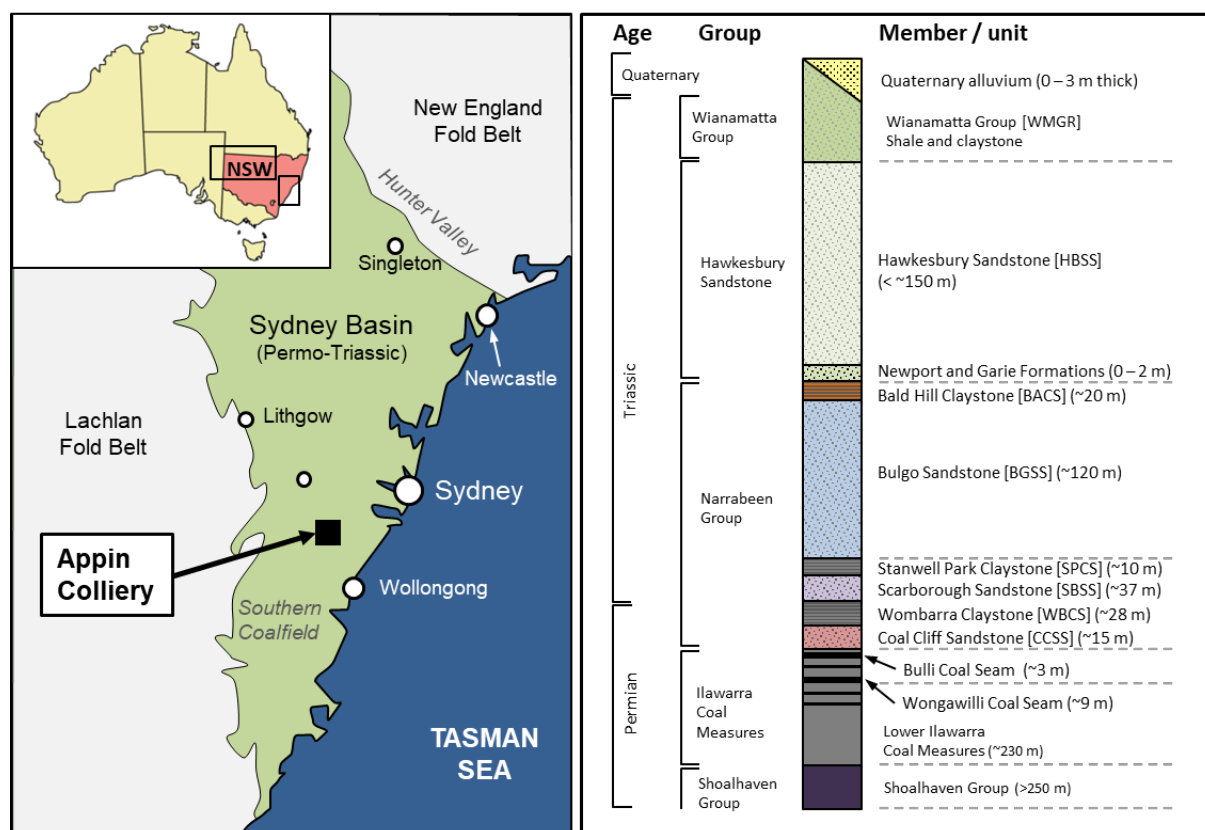


Figure 1: Stratigraphy and location of the Southern Coalfields within the Sydney Basin (Source: HGEO 2022).

The depth of cover to the Bulli Seam directly above Longwall 708 varies between a minimum of 515 m and a maximum of 620 m. The seam floor within the mining area generally dips from the south to the north, with an average dip approximately 2 %, or 1 in 50.

The surface above Appin Area 7 is generally undulating on the plateau and is incised by the Nepean River gorge which can be up to 70 m high, with vertical cliff faces up to 30 m. The gorge is steep sided with sandstone cliffs and

steep slopes. The Nepean River is part of the Hawkesbury-Nepean River system which originates in the uplands west of Wollongong and flows northward past Camden to its junction with the Warragamba Dam near Wallacia.

The Bulli Seam thickness varies between 2.6 m and 3.4 m within the extents of Longwall 708 and IMC extracted the full thickness of the seam.

1.1. Economic Outcomes

The extraction of coal reserves from AA7 provides benefits at national, state and local levels. Illawarra Metallurgical Coal provides coking coal to BlueScope Steel for its domestic steelmaking production, and for export to overseas customers.

South32 IMC provides 60% of BlueScope Steel's coking coal requirements. Mining operations at Appin Colliery represents continuing significant capital and operating investments in the Southern Coalfield of New South Wales.

IMC employees over 1800 employees and contractors, of which 92% live locally. The mining industry tends to have high employment multiplier effects with around 3.5 additional jobs supported by a mining job and up to 5.5 if consumption-induced effects are included. A review of this data is planned for FY23.

Continuing benefits occur through continuity of employment, expendable income, export earnings and government revenue. From the operations of Appin Mine, IMC paid approximately \$43.8 Million and \$32.2 Million in government royalties during the 2020 and 2021 financial years, respectively. Each year IMC spend around \$300 Million in local procurement, working with over 200 local businesses.

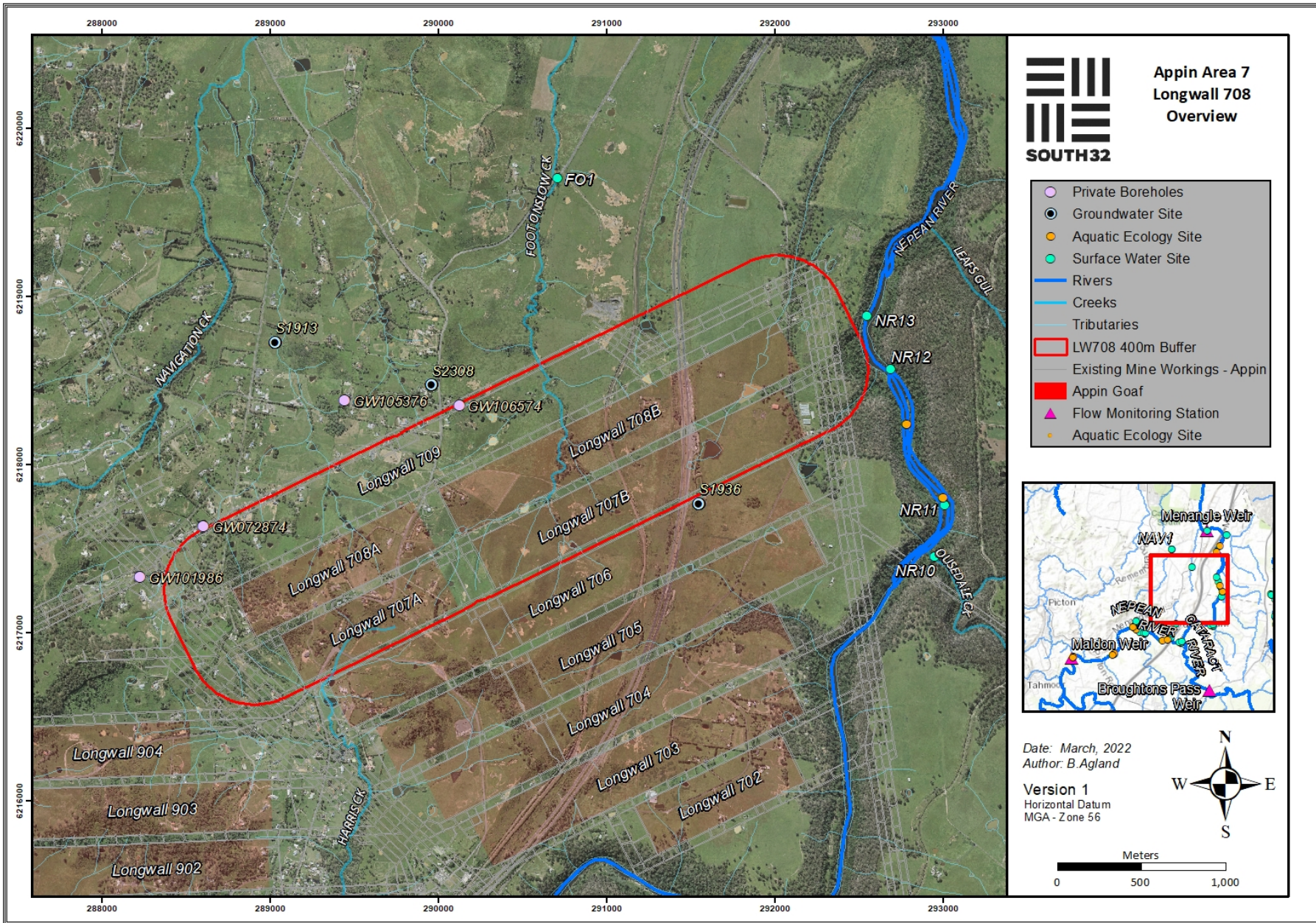


Figure 2: Map showing the Appin Area 7 Study Area.

2. Stakeholder Engagement

Operational monitoring and the provision of ongoing information to the community was undertaken by Illawarra Metallurgical Coal during the extraction of AA7. Information on Illawarra Metallurgical Coal operations is provided to the community through the following mechanisms:

- Illawarra Metallurgical Coal Community Newsletter – a periodical publication distributed to the community
- South32 website - <https://www.south32.net/our-business/australia/illawarra-metallurgical-coal/>;
- Appin Mine Community Consultative Committee (formerly the Illawarra Coal Community Consultative Committee) (meeting minutes provided on the South32 website);
- Individual landowner engagement;
- Community information sheets and letter box drops;
- Notification on local noticeboards;
- Media releases; and
- Annual Environmental Assessment Report.

Illawarra Metallurgical Coal aims to mitigate the potential impacts subsidence may cause to community members through various means outlined in Table 2-1.

Table 2-1: Social Impact Variables Associated with Subsidence.

Potential Impact	Monitoring Variables	Mechanism
Subsidence Impacts	Level of community concern relating to subsidence.	Longwall progress maps displayed on local notice board and included in personalised letters and community newsletters.
	Awareness of subsidence and its effects and management.	Appin Mine Community Consultative Committee. Douglas Park Advisory Panel.
	Level of perceived community risk associated with subsidence effects.	A triennial survey of residents and stakeholders in the communities in which Illawarra Metallurgical Coal operates. The survey aims to determine the community's perception of the company's overall performance (last survey completed in Q4 2021).
	Level of satisfaction with the company's subsidence management practices.	Development of individual Property Subsidence Management Plans (PSMPs) in consultation with landowners within the mine subsidence area.
	The extent to which the community attributes environmental, social and economic change occurring within the community to mining activities.	Pre-mining meetings with landholders 6-12 months prior to mining potentially effecting properties. Meetings include predicted mine subsidence movement, timing and effects, and the offer of pre-mining assessments. On-going contact with landholders during mining and support through the claims process post-mining.

The management of subsidence impacts on private properties is addressed in Property Subsidence Management Plans (PSMP). The PSMPs are prepared in consultation with individual property owners. In relation to Longwall 708, property owners were advised to lodge any claims with the Subsidence Advisory New South Wales (SANSW). Illawarra Metallurgical Coal continues to assist landholders through the SANSW claim process and is continuing to assist in the management of effects from mining operations associated with AA7.

3. Comparison of Measured and Predicted Subsidence

This section provides comparisons between predicted and measured subsidence movements relating to the extraction of Longwall 708. For further details, refer to MSEC 2022, which is provided as Attachment D.

Predictions of subsidence movements relating to the extraction of Longwall 708 were obtained by MSEC using the Incremental Profile Method (IPM) based on prediction curves for the Southern Coalfield Bulli Coal Seam.

The mine subsidence effects due to the mining of LW708 were monitored along several monitoring lines and monitoring points including the:

- Nepean River closure lines;
- Moreton Park Road monitoring line;
- Menangle Road monitoring line;
- M31 Hume Motorway East and West Lines;
- FBG monitoring along the M31 Hume Motorway;
- slot closure monitoring along the M31 Hume Motorway;
- ARTC monitoring line, strain gauges and tilt sensors;
- ARTC embankment points;
- highway cutting points;
- Partridge VC Rest Area monitoring points;
- absolute far-field 3D monitoring points adjacent to the Douglas Park Twin Bridges and Moreton Park Road Bridge (South);
- relative 3D monitoring points on the Douglas Park Twin Bridges and Moreton Park Road Bridge South);
- inclinometer monitoring near the Douglas Park Twin Bridges;
- bridge joint monitoring on the Douglas Park Twin Bridges;
- visual monitoring of the M31 Hume Motorway, Moreton Park Road, Menangle Road, Douglas Park Twin Bridges and Moreton Park Road Bridge (South);
- monitoring lines at WaterNSW infrastructure; and
- Telstra monitoring line.

Table 3-1: Comparison summary of predicted and measured subsidence during the extraction of Longwall 708 (MSEC 2022).

Feature	Monitoring Types	Approximate Location/ Distance from Longwall 708	Assessment of Measured Subsidence vs Predictions / Trigger Levels (MSEC 2022)
Nepean River	2D closure Monitoring lines	Located 400m to the east of LW708B, closest point	The measured total closures at the Nep X Q-Line and Nep X R-Line are greater than the predicted total values. The exceedances of 23 mm for the Nep X Q-Line and 11 mm for the Nep X R-Line represent 23 % and 16 %, respectively, and therefore they are in the order of accuracy of the predictive method for valley closure of ± 25 %. The measured total closure for the Nep X S-Line is less than the predicted total value.
Moreton Park Road	3D monitoring line	Crosses the eastern end of LW708B	The maximum measured incremental vertical subsidence (98mm) and tilt (1.0mm/m) along the Moreton Park Road monitoring line, due to the mining of LW708B only, are the same as, or less than, the predicted values (230mm and 1.0mm/m) The maximum measured incremental strains are 0.7 mm/m tensile and 0.7 mm/m compressive, which is less than the maximum predicted strains based on conventional ground movements of 1 mm/m tensile and 2 mm/m compressive. No localised or irregular ground movements occurred due to the mining of LW708B.
Menangle Road	3D monitoring line	Crosses the eastern end of LW708A	The maximum measured incremental vertical subsidence of 410 mm is approximately half of the maximum predicted incremental vertical subsidence of 725 mm. Away from the valley-related localised irregular movement, the maximum measured tilt is 2.8 mm/m and it is less than the maximum predicted value of 4.0 mm/m. Away from the valley-related closure effects, the maximum measured incremental strains are 0.7 mm/m tensile and 1.3 mm/m compressive. The measured strains away from the irregular ground movements are less than the maximum predicted strains based on conventional ground movements of 1 mm/m tensile and 2 mm/m compressive.
M31 Hume Motorway	3D monitoring line	Crosses directly above LW708B	The maximum measured incremental vertical subsidence along the M31 East and M31 West Lines of 654 mm and 813 mm, respectively, are less than the maximum predicted value of 850 mm. The maximum measured incremental tilts of 5.9 mm/m for the M31 East Line and 6.2 mm/m for the M31 West Line are slightly greater than the maximum predicted value of 5.5 mm/m. The maximum measured tilt for the M31 East Line is due to a localised irregular movement and the predicted profile does not include anomalous movements. The maximum measured tilt along the M31 West Line is due to the slightly lower subsidence measured above the longwall maingate resulting in a slightly steeper profile The maximum measured incremental compressive strains along the M31 East Line are 3.8 mm/m and 3.4 mm/m. these are within the expected range when considering the potential for localised anomalous movements of up to 5.5 mm/m for 97 % of the measured cases.
M31 Hume Motorway	Fibre Bragg Grating (FBG) Strain sensors	Crosses directly above LW708B	The recorded strains exceeded the trigger levels in the management plan at two locations on the southbound carriageway and one location on the northbound carriageway during the mining of LW708B. FBG187.3 on the Southbound pavement exceeded the Blue trigger on 5 May 2021. A small hump was observed to gradually form in the pavement across the travel lanes at this location. Existing cracks in the deceleration lane to the Rest Area were also observed to deteriorate slightly. Compressive strains continued to gradually increase to 2.8 mm/m at this location until December 2021. Average pavement strains over 20 metres, 30 metres and 40 metres increased above the Blue trigger level

Feature	Monitoring Types	Approximate Location/ Distance from Longwall 708	Assessment of Measured Subsidence vs Predictions / Trigger Levels (MSEC 2022)
			<p>due solely to readings from this single FBG, with very little change observed at adjacent FBGs. It was agreed to progressively increase the trigger level as the results were localised to one single FBG and there were no immediate concerns with the pavement. The pavement was resurfaced in September 2021.</p> <p>FBG193.2 on the Southbound pavement exceeded the Blue trigger on 10 August 2021. A small hump was observed to gradually form in the pavement across the travel lanes at this location. The observed strain was also localised to a single FBG. The cause of the compressive strains may have been linked to closure of a slot in the Rest Area deceleration lane. Compressive strains continued to gradually increase to 1.1 mm/m at this location until September 2021, when the cable was broken during resurfacing works.</p> <p>FBG194.3 on the Northbound pavement previously experienced high tensile strains, when the pavement was resurfaced in September 2021. After the resurfacing, pavement strains continued to gradually reduce and continued into compression, exceeding the Blue trigger on 2 November 2021 until it stopped compressing at 2.9 mm/m in February 2022. The observed strains were also localised to a single FBG. Average pavement strains over 20 metres and 30 metres increased above the Blue trigger level due solely to readings from this single FBG, with very little change observed at adjacent FBGs. It was agreed to progressively increase the trigger level as the results were localised to one single FBG and there were no immediate concerns with the pavement.</p> <p>The M31 Hume Motorway remained safe and serviceable during the above events.</p>
M31 Hume Motorway	Slot Displacement Monitoring	Crosses directly above LW708B	The slot displacements did not exceed the management plan trigger levels for closure at any stage during the mining of LW708B. As slot R189 approached the trigger level of 60 mm, the Technical Committee agreed to increase the trigger to 70 mm. The maximum measured closure of the slots located directly above LW708B were 28 mm at SB191, 51 mm at NB190 and 67 mm at R189.
Main Southern Railway	3D ground monitoring lines 3D Embankment monitoring points Railway cutting points Stain gauges	Crosses directly above LW708B	The maximum measured incremental vertical subsidence along the ARTC Line of 990 mm is greater than the maximum predicted value of 900 mm. this is within the order of accuracy of prediction methods for vertical subsidence of $\pm 15\%$ to $\pm 25\%$. The maximum measured incremental tilt of 7.8 mm/m is slightly greater than the maximum predicted value of 5.6 mm/m. The maximum measured incremental strains along the ARTC Line are 1.7 mm/m tensile and 5.5 mm/m compressive.
Highway Cutting 2	3D monitoring points	Located 400m south-east of LW708B	The maximum measured absolute incremental horizontal movement for W114 to W158 was 168mm, for G101 to G110 was 115mm and for E146R to E160R was 125mm. The Highway Cutting 2 Points indicate that the ground has moved uniformly and that there are no irregular or localised movements.
Partridge VC Rest Area	2D and 3D monitoring	Located 100m south of LW708B	The maximum measured total vertical subsidence at the Partridge VC Rest Area after the mining of LW708B is 1154 mm. The measured strains are generally less than 1 mm/m tension and compression. Mark AM03 was observed to move relative to the adjacent pegs, with a compressive strain of 1.3 mm/m measured between Marks AM03 and E168 and a compressive strain of 1.6 mm/m measured between Marks AM03 and E170.

Feature	Monitoring Types	Approximate Location/ Distance from Longwall 708	Assessment of Measured Subsidence vs Predictions / Trigger Levels (MSEC 2022)
Far-Field Monitoring points	3D monitoring points	Various locations around AA7	The maximum measured incremental horizontal movement is 222 mm at MR1. However, that mark is located above the active LW904 and, therefore, its movement is likely due to the concurrent mining in Area 9. The incremental horizontal movements measured at BURRELL1, BURRELL2 and CR1 are greater than those typically measured at similar distances elsewhere in the Southern Coalfield. It is possible that the concurrent mining in Areas 7 and 9 have contributed to the higher levels of movement. Elsewhere, the measured incremental horizontal movements at the other far-field 3D marks and monitoring lines are similar to those typically measured in the Southern Coalfield.
Nepean Twin Bridges	Absolute 3D points Relative 3D points Inclinometer Bridge joint monitoring Visual monitoring	2.8 km south of the commencing end of LW708A	The maximum measured absolute horizontal movement (91 mm) at Marks DPBN and DPBS was less than the Level 1 Trigger (100 mm) at the completion of Longwall 708. The measured differential movements at the inclinometers at Site PSM6 (5.7mm) did not exceed the Level 1 trigger (10mm) during the extraction of Longwall 708.
Moreton Park Road (South)	Absolute 3D points Relative 3D points Visual monitoring	located approximately 2.1 km southeast of the commencing end of LW708A	The maximum measured total absolute horizontal movements at Marks MPBE (111mm) and MPBW (133mm) were less than the Level 1 trigger (150mm) at the completion of LW708B. The measured total changes in horizontal distance between the bridge abutments were +2 mm at the completion of LW708B. The total measured movements, therefore, were similar to the order of survey tolerance at the completion of this longwall.
WaterNSW Infrastructure	Local 3D surveys	Located approximately 1km east of the commencing end of LW708B (Leafs Gully aqueduct)	The maximum measured incremental net subsidence and uplift at the aqueducts and bridges, during the mining of LW708A and LW708B, were similar to the order of survey tolerance (2mm)
Telstra Infrastructure	3D ground monitoring line	Located 200m south-east of LW708A at the closest point	The maximum measured incremental vertical subsidence along the Telstra Line, due to the mining of LW708A only, is less than the maximum predicted value. The maximum measured incremental tilt is slightly greater than that predicted; however, the exceedance is in the order of accuracy of the prediction method. The maximum measured incremental strains are 0.9 mm/m tensile and compressive. which are less than the maximum predicted strains (1 mm/m tensile and 2 mm/m compressive).

4. Impacts to Built Features

The MSEC assessments for the built features, due to the mining of LW705 to LW710, are provided in Reports Nos. MSEC342, MSEC825 and MSEC1133. Comparisons between the assessed and observed impacts for the built features located near LW708A and LW708B, as listed above, are provided in (Table 4-1).

Table 4-1: Summary table comparing assessed and reported impacts for built features in relation to the extraction of Longwall 708 (Source: MSEC 2022).

Built Feature	MSEC Assessed Impacts	Observed Impacts
Moreton Park Road	Minor cracking and localised heaving of the road surface may occur in some locations above the longwalls	Road remained safe and serviceable. No adverse impacts observed due to the mining of LW708B
Menangle Road	Minor cracking and localised heaving of the road surface may occur in some locations above the longwalls	Road remained safe and serviceable. Compressive bumps formed in the section of pavement near Marks MR7063 and MR7064 during the mining of LW708A, the pavement was repaired. Minor changes near Mark MR7053 which was resurfaced twice
M31 Hume Motorway	No impacts on the safety or serviceability of the motorway after the implementation of the management strategies	Road remained safe and serviceable. No adverse impacts to safety or serviceability. Humps formed on both carriageways and these were remediated by re-shaping of the pavement surface as part of Management Plan responses
Main Southern Railway	No impacts on the safety or serviceability of the railway after the implementation of the management strategies	Track remained safe and serviceable. Changes in track geometry recorded during the mining of LW708B and these were remediated in accordance with the Management Plan
Douglas Park Twin Bridges	Impacts unlikely after the implementation of the TARP	No adverse impacts observed due to the mining of LW708A and LW708B
Moreton Park Road Bridge (South)	Impacts unlikely after the detailed investigation, analysis and implementation of the TARP	No adverse impacts observed due to the mining of LW708A and LW708B
Low voltage powerlines	Impacts unlikely, but minor mitigation measures may be required	No adverse impacts observed due to the mining of LW708A and LW708B
Copper telecommunications cables	Impacts unlikely	No adverse impacts observed due to the mining of LW708A and LW708B
Optical fibre cables	Impacts unlikely with the implementation of the management strategies including OTDR monitoring and mitigation	No adverse impacts observed due to the mining of LW708A and LW708B
Building structures	Category A or B tilt impacts Typically Category 0 strain impacts for houses, but with 17 x Category 1 strain impacts and 8 x Category 2 strain impacts.	Building structures remained in safe and serviceable conditions. Impacts observed during the mining of LW708A and LW708B comprise 3 x Category 1 impacts and 1 x Category 5 impact. Claims that have been lodged and are being managed by Subsidence Advisory NSW (SA NSW) through the relevant legislation
Pools	Inground pools could be more susceptible to ground strains	No adverse impacts observed due to the mining of LW708A and LW708B
Water tanks	Impacts unlikely	Claims that have been lodged are being managed by SA NSW through the relevant legislation.
Farm dams	Potential for minor cracking or leakage	No adverse impacts observed due to the mining of LW708A and LW708B
Heritage structures	No heritage structures located near LW708A or LW708B	No adverse impacts observed due to the mining of LW708A and LW708B
Groundwater bores	Potential for blockage or reduction in the capacity of the groundwater bores	No adverse impacts observed due to the mining of LW708A and LW708B. Refer to the accompanying Groundwater Report by HGEO
Pumps in the Nepean River	Impacts unlikely	No adverse impacts observed due to the mining of LW708A and LW708B
The Upper Canal, Cataract Tunnel and associated infrastructure	Impacts unlikely	No adverse impacts observed due to the mining of LW708A and LW708B
Survey control marks	Small fair-field horizontal movements which could require re-establishment	Small far-field horizontal movements

4.1. Private Properties

Built Feature Management Plans (BFMPs) have been prepared by IMC for landholders within the Longwall 705 to 710 mining area. Post-mining inspection of dams, boreholes and natural features set out in the BFMPs are conducted by the IMCEFT with the consent of the relevant property/infrastructure owner and tenant (if applicable). Post-mining inspections were undertaken at properties where access was granted and features accessible. These properties include Lot 10 DP245756, Lot 73 DP883462 and Lot 900 DP1072947 (Figure 3). Inspections include collection of in-situ water quality parameters and water samples for laboratory analysis. Groundwater level logger data was also recorded at private properties Lot 11 DP775437, Lot 10 DP245756 and Lot 73 DP883462. Results of water quality and level data is assessed in the Surface Water and Groundwater Assessment of the Longwall 708 EoP Report (Attachment E). Post-mining inspections were unable to be undertaken at other properties due to access issues.

Table 4-2: Summary Table of predicted and observed impacts to private property surface and groundwater quality (Source: HGEO 2022).

Potential Impact	Description	Impact Prediction	Observed Impact
Reduced groundwater yield	Ten registered bores are within the SMP for Longwalls 705 to 710 and may be affected by subsidence, where the bores predominantly obtain water from the Hawkesbury Sandstone, rather than the overlying Wianamatta Group shale and sandstones.	Impacts to water level likely (GeoTerra, 2008).	No impacts observed/reported.
Groundwater quality impacts	It is likely that some [minor and localised] water quality changes will occur but there is a relatively low level of groundwater resource use in the area. Potential impacts may include increased concentrations of iron and other metals, and precipitation of iron hydroxide. Monitoring of potentially affected bores within AA7 is conducted in consultation with the owners.	Impacts to groundwater quality likely (GeoTerra, 2008).	No impact observed/reported
Impacts to streams and farm dams	Many farm dams have been mined under and monitored, with only a small number of dams exhibiting minor impacts following mining. It is predicted that the impact on farm dams from mining Longwalls 705 to 710 will be similar.	Impact to dam water levels unlikely (Ecoengineers, 2008).	No impacts observed/reported.
Gas emissions	There is potential for strata gas emissions into private bores. Any such emissions are likely to diminish over time. Any bores with gas releases are decommissioned during the mining period.	Gas releases from any deep bores likely (GeoTerra, 2008).	No impacts observed/reported.

4.2. Cultural Heritage

No applicable aboriginal archaeology sites on the Aboriginal Heritage Information Management System (AIHMS) database are within the Longwall 708 mining area.

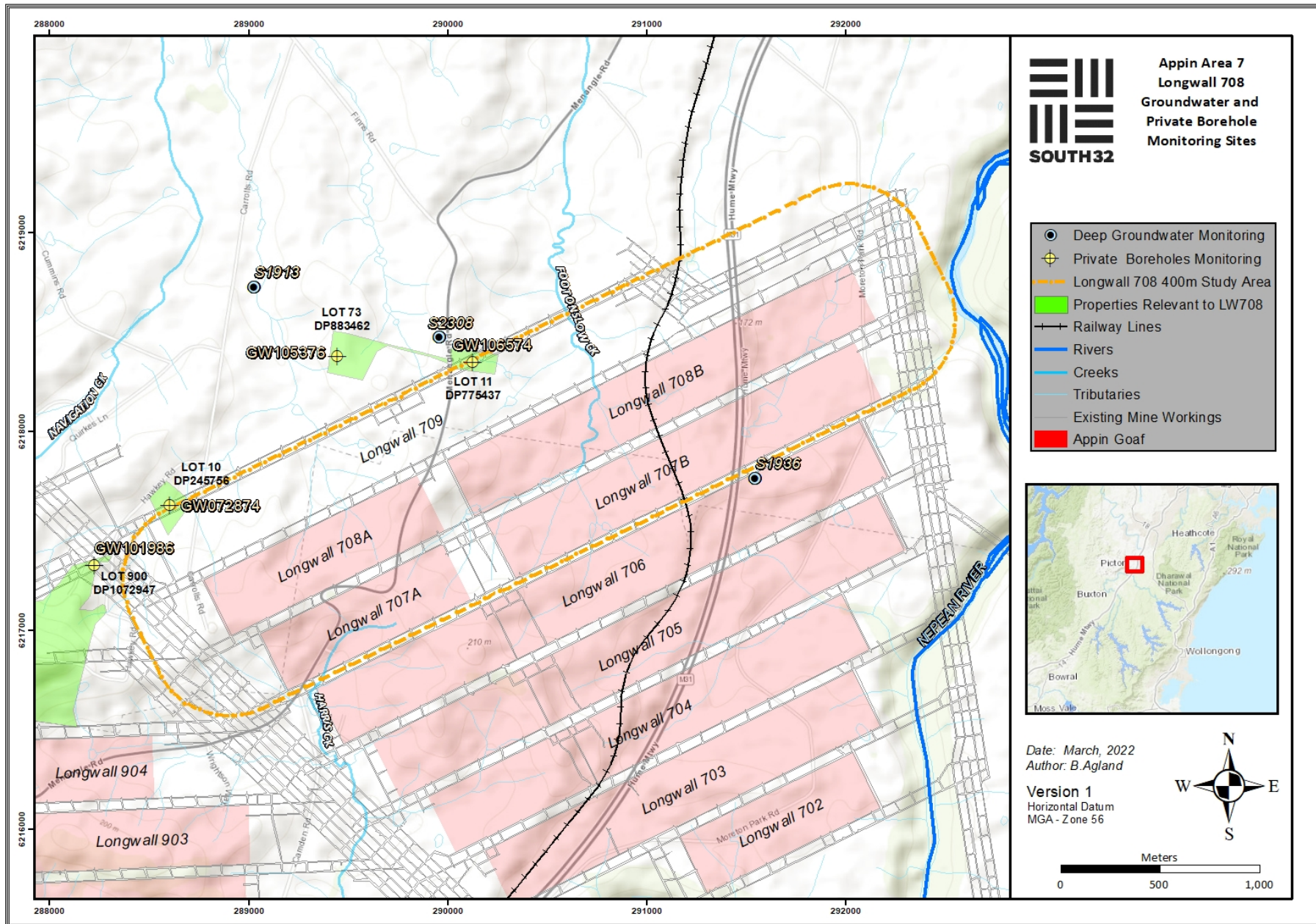


Figure 3: Groundwater monitoring relevant to Longwall 708.

5. Impacts to Natural Features

5.1. Surface Water Assessment

Monitoring and inspections of the Nepean River and its associated tributaries is undertaken in accordance with the approved Appin Longwall 707 to 710 EMP. Monitoring is conducted by the Illawarra Metallurgical Coal Environmental Field Team (IMCEFT) on a monthly basis. Water quality and water levels are recorded along with photographic records and observational notes. Observations of cliffs, steep slopes and terrestrial flora along the Nepean gorge are also undertaken. The assessment of surface water is presented in the Appin Longwall 708 End of Panel Surface Water and Groundwater Monitoring Assessment (Attachment E). A summary of this is included in (Table 5-1).

During the extraction of Longwall 708, no new Nepean River gas zones were identified. Four existing gas zones were observed to be active at some stage during Longwall 708.

Table 5-1: Summary table of potential and observed impacts to surface water quality within natural features (Source: HGEO 2022).

Potential Impact	Description	Impact Prediction	Observations	TARP Level
Gas emissions in the Nepean River and other areas	Based on observations at (AA7) it is likely that one or more zones of gas emission will appear in the Nepean River as a consequence of mining Longwalls 705 to 710. Potential effects may include Dissolved Oxygen “sags”, and visible iron precipitates (localised iron staining).	Minor gas releases in the Nepean River are likely to occur (Ecoengineers, 2008)	During the monitoring period for Longwall 708, gas releases were observed at four pre-existing sites, initially reported during previous longwalls. One gas release zone (AA7_LW703_Gas Zone 10 Update) had changes reported during Longwall 708 however the trigger level did not change.	Each gas release zone remains a Level 1 TARP.
Groundwater outflows and ferruginous springs	The appearance of ferruginous springs due to mining has been noted in some Bulli Seam mining areas especially along margins of outcropping Wianamatta Shale. Ferruginous springs have not been detected in relation to mining of Longwalls 701 and 702, either in	The likelihood of ferruginous springs in the Nepean River gorge is low (Ecoengineers, 2008).	None identified	Not triggered.

Potential Impact	Description	Impact Prediction	Observations	TARP Level
	the walls of the Nepean River gorge or along adjacent tributaries.			
Sub-bed flow diversions and un-natural pool drainage	The potential for the diversion of surface water in the Nepean River due to mining of longwalls 705 to 710 is very low as the riverbed is flooded and the gradient of the river is very flat. Any rockbars present along the riverbed are completely submerged.	The likelihood of impacts is very low (Ecoengineers, 2008).	Water levels are within the baseline range during the reporting period for LW708. Water levels at NR12 and NR13 were below the 5 th percentile value on several occasions at the start of mining of LW708 in 2019. However, returned to within P5-P95 values in 2020 and generally remained within the baseline range for the remaining LW708 Gauging at Maldon weir, Menangle weir, and the Cataract River at Broughtons Pass, show zero no-flow days recorded during the extraction of LW708.	No TARP triggers.

5.2. Groundwater Assessment

HGEO was commissioned by IMC to report on the predicted and any observed groundwater changes resulting from extraction of Longwall 708. A comparison between potential and observed impacts for Longwall 708 is provided below (Table 5-2). Details are included in the Longwall 708 Surface and Groundwater Assessment (Attachment E).

Table 5-2: Summary table of potential and observed impacts to groundwater (Source: HGEO 2022).

Potential Impact	Description	Impact Prediction	Observations	TARP Level
Reduction in groundwater level	Reductions in groundwater level which impact water supply from bores, particularly within the Hawkesbury Sandstone and Wianamatta Group.	Based on observations in the southern coalfields, groundwater levels may be reduced by 10m. There is unlikely to be significant impact to groundwater resources (GeoTerra 2008).	An increasing trend in groundwater pressures occurred in the Hawkesbury Sandstone at VWP S1913 from April 2021 and recovery in groundwater pressures in the Bulgo Sandstone (274 m) and Scarborough Sandstone (505 m) occurred at VWP S1913. No water head changes that could be attributed to Longwall 708 extraction were recorded in the Hawkesbury Sandstone or underlying Bulgo and Scarborough sandstones at S2308. A slight decreasing trend in groundwater pressure in the Hawkesbury Sandstone aquifer was observed at S1936; however, no groundwater level reduction TARP levels were triggered during the extraction of Longwall 708.	Not triggered
Changes to Groundwater chemistry	Changes to groundwater chemistry within the Wianamatta Group, Hawkesbury Sandstone and Bulgo Sandstone.	Previous observations indicate that water quality of subsided boreholes in the Southern Coalfields have not been adversely affected. May be increased iron and/or manganese carbonates and changes in pH. (GeoTerra 2008).	Groundwater salinity and total iron concentrations increased at GW105376 following Longwall 708. No signs of iron, salinity staining, or gas were observed in the water or around the borehole on post-mining inspection. No significant impacts from mining were identified in bores or dams on private properties	Not triggered.
Groundwater Inflows to the Mine	The horizontal permeability of the Hawkesbury Sandstone and Bulgo Sandstone may be enhanced after subsidence.	Horizontal permeability above the Bald Hill Claystone may be enhanced after subsidence but there is no additional vertical permeability connectivity and hydrological systems above and below the claystone will remain separate. (GeoTerra 2008)	The 20-day moving average mine inflow remained low, fluctuating between 0 and 1.1 ML/day during and following the extraction of Longwall 708, below the TARP Level 1 trigger of 2.7 ML/day. There has been no significant increase in groundwater inflow to Appin Area 7 during the assessment period, compared to the previous longwall periods.	Not triggered.

5.3. Aquatic Ecology Assessment

Cardno NSW/ACT (Cardno) now Stantec (Cardno) was commissioned by IMC to assess the potential impact of mine subsidence on ecological indicators of the Nepean River within the AA7 and AA9 mine areas through the implementation of an aquatic ecological monitoring program. 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 (The Ecology Lab 2004) and Subsidence Management Plan (SMP) for Longwalls 705 to 710 (Cardno Forbes Rigby 2008)

The monitoring program focuses on the following indicators:

- 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;
- Limited in-situ water quality sampling; and
- Species composition of aquatic macrophytes.

IMCEFT identified no new impacts or triggers associated with the extraction of Longwall 708. No gas releases, fracturing, changes in water levels and flow or changes in water quality have been attributed to mining of Longwall 708. Four existing gas zones, identified during previous panels, were observed to be active during the Longwall 708 mining period.

No changes to aquatic ecology indicators that could be associated with extraction of Longwall 708 have been detected in aquatic ecology data collected in December 2021. This was not surprising given no more than minor gas releases or changes in water quality have been observed in the Nepean River associated with mining. The gas releases in the Nepean River observed to be active during extraction of Longwall 708 do not appear to have had any measurable effect on macroinvertebrates, fish or macrophytes in the River. Further details can be found in the Appin Area 7 Longwall 708 End of Panel Report - Aquatic Flora and Fauna Review (Attachment G).

Further monitoring will be undertaken at all Appin Area 7 impact and control sites in Spring 2022. This will include a further assessment of any changes to aquatic habitat and biota that may have occurred at Appin Area 7 monitoring sites following the completion of Longwall 708 (Cardno 2022).

5.4. Terrestrial Ecology Assessment

Terrestrial ecology in Appin Area 7 is monitored by IMCEFT in conjunction with general observational monitoring. Aspects that are considered whilst monitoring include: changes in vegetation condition and vegetation that may have been impacted by rockfalls, soil slippage or gas emissions. No impacts or changes to terrestrial ecology was observed during monitoring for Longwall 708. It is therefore concluded that the extraction of Longwall 708 has had negligible impact on terrestrial ecology.

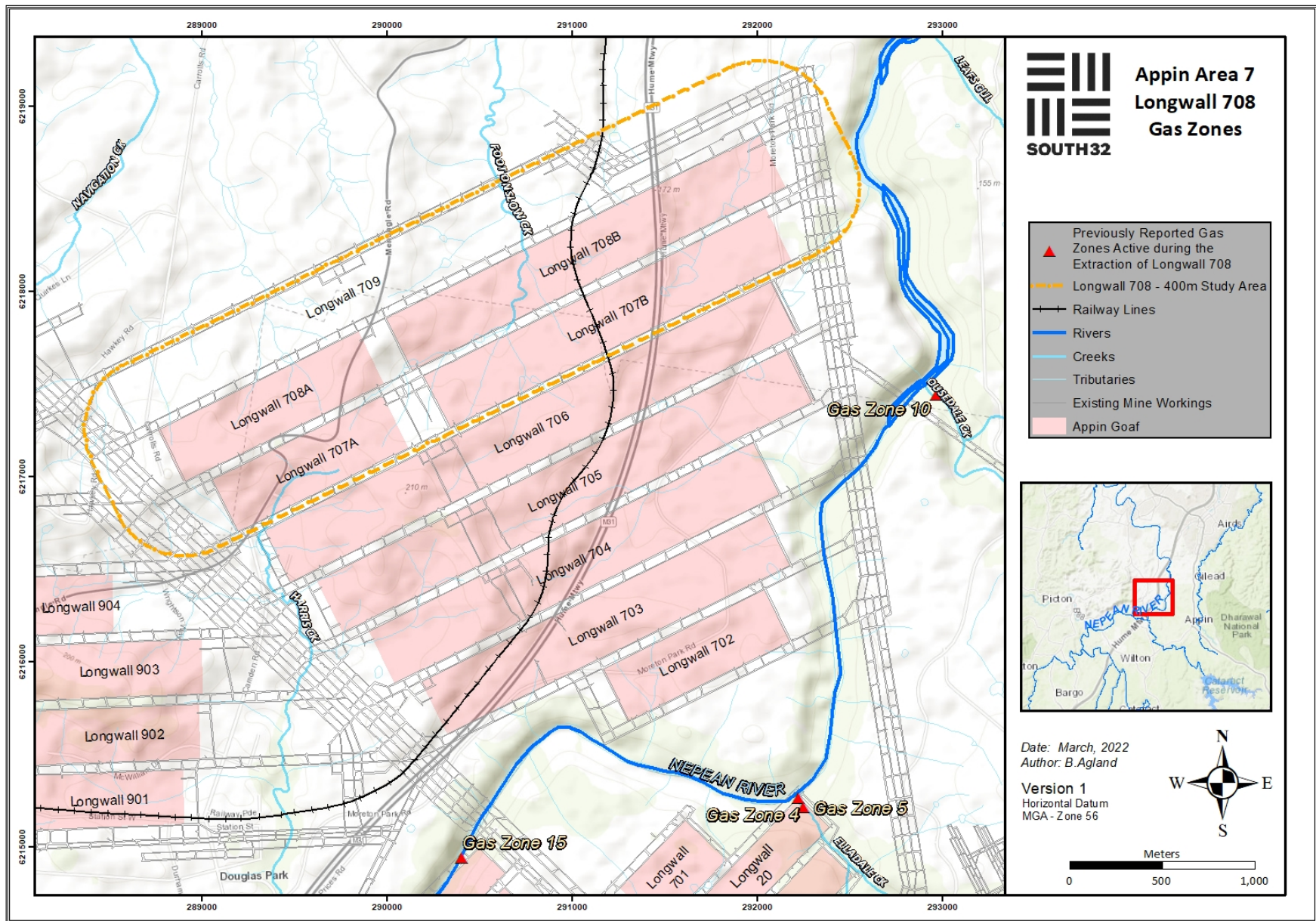


Figure 4: Map showing gas zones observed on the Nepean River during Longwall 708. Note- all zones were initially reported during previous longwalls.

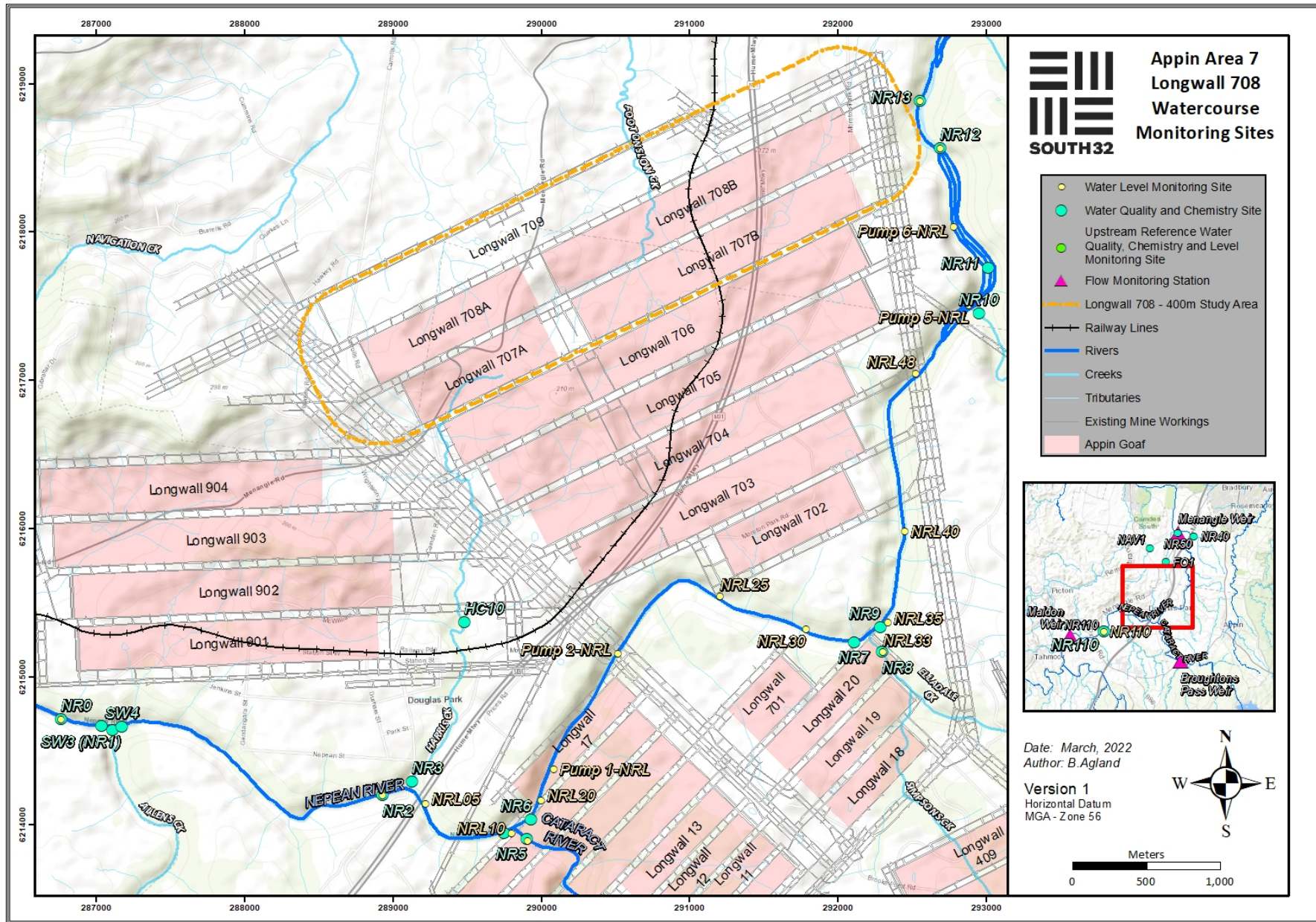


Figure 5: Surface water monitoring sites relevant to Appin Area 7 and 9.

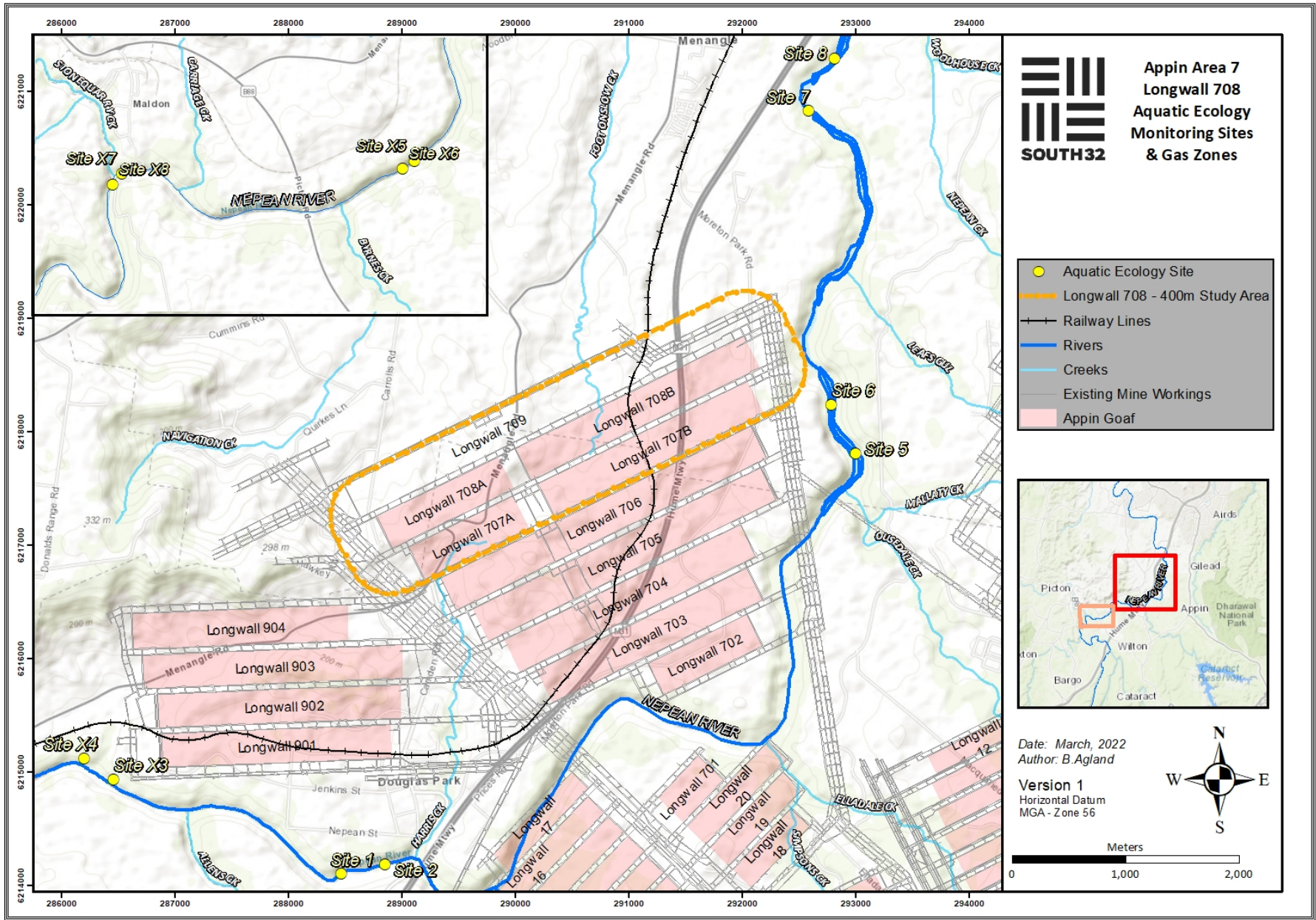


Figure 6: Map displaying the aquatic ecology monitoring sites on the Nepean River in relation to Appin Area 7 and 9.

6. Longwall 708 Monitoring Program

Table 6-1: Longwall 707 to 710 Environmental management Plan

Monitoring Site	Monitoring Type	Monitoring Frequency	Parameters
<p>Nepean River Baseline upriver sites for crosschecking for upriver perturbations: • NR110 Impact monitoring sites adjacent to each longwall: • NR12 • NR13 Downstream site: • NR50 Other sites: • NR0 • NR2 • NR4 • NR6 • NR7 • NR9 • NR11</p>	<p>Grab Sample and Field measurements</p>	<ul style="list-style-type: none"> • Monthly baseline monitoring prior to mining • Monthly observations and field analysis during mining ⁽¹⁾ • Monthly detailed laboratory analysis during mining • Monthly monitoring for 2 years post mining (or as otherwise required/approved) • If required as a results of assessment of mining impacts 	<p>Field Parameters:</p> <ul style="list-style-type: none"> • Temperature • Electrical Conductivity (EC) • pH • ORP • Time • Dissolved Oxygen (DO) • General Comments <p>Laboratory analysis of:</p> <ul style="list-style-type: none"> • pH and EC • Filtered, Na, K, Ca, Cl, Pb, Ni, Zn, Fe, Mn, AS, Br, Cu, I, Se, Al, SO₄ • Total Fe, Al • Total Alkalinity • TKN, TP, NH₃-N, NO_x-N, TRP, TDS, DOC • CH₄, Trace Phenols, Sulphide ⁽²⁾

<p>1st and 2nd Order Watercourses</p> <ul style="list-style-type: none"> • Lower Harris Creek (NR3) • Cataract River (NR5) • Elladale Creek (NR8) • Ousedale Creek (NR10) • Menangle Creek (NR40) • Upper Harris Creek (HC10) • Foot Onslow Creek (FO1) • Navigation Creek (NAV1) 	<p>Grab Sample and Field measurements</p>	<ul style="list-style-type: none"> • Prior to mining of longwall underlying watercourse or mining of any immediately adjacent longwall • Monthly detailed laboratory analysis during mining • Following the development of incremental subsidence for each longwall that will impact on the feature 		
<p>Nepean River At benchmark sites and water pump sites:</p>	<ul style="list-style-type: none"> • Water Level • Water flow (measured at WaterNSW weirs) 	<ul style="list-style-type: none"> • Monthly baseline prior to mining (data has been recorded for most sites since 2007) • Monthly manual monitoring at benchmarks during mining ⁽¹⁾ • Flow monitoring at weirs (data supplied by WaterNSW) • Ongoing monthly monitoring for 2 years post mining (or as otherwise required/ approved) 	<ul style="list-style-type: none"> • Areas of dry riverbed compared with baseline • Areas of flooded riverbed compared with baseline • Measurement of water level compared with baseline (where benchmark is available) • Photo points 	
<ul style="list-style-type: none"> • NR110 • NR0 • NRL05 • NRL10 • NRL15 • NR12 • NR13 • NRL20 • Pump 1- NRL • Pump 2-NRL 				<ul style="list-style-type: none"> • NRL25 • NRL30 • NRL33 • NRL35 • NRL40 • NRL45 • NRL48 • Pump 5-NRL • Pump 6-NRL
<p>WaterNSW flow monitoring sites:</p> <ul style="list-style-type: none"> • Maldon Weir • Broughtons Pass Weir • Menangle Weir 				
<p>1st and 2nd Order Watercourses</p> <ul style="list-style-type: none"> • Lower Harris Creek (NR3) • Cataract River (NRL15) • Elladale Creek (NRL33) • Ousedale Creek (NRL50) • Menangle Creek (NR40) • Upper Harris Creek (HC10) • Foot Onslow Creek (F01) • Navigation Creek (NAV1) 	<ul style="list-style-type: none"> • Water Level 	<ul style="list-style-type: none"> • Prior to mining of longwall underlying watercourse or mining of any immediately adjacent longwall • Following the development of incremental subsidence for each longwall that will impact on the feature 	<ul style="list-style-type: none"> • Areas of dry riverbed compared with baseline • Areas of flooded riverbed compared with baseline • Measurement of water level compared with baseline (where benchmark is available) • Photo points 	

<p>Nepean River Observations along the length of the Nepean River within the active mining area</p>	<p>Observational and photographic monitoring</p>	<ul style="list-style-type: none"> • Monthly baseline prior to mining (data has been recorded for most sites since 2003) • Monthly observations and field analysis during mining ⁽¹⁾ • Monthly monitoring for 2 years post mining (or as otherwise required/approved) • If required as a result of assessment of mining impacts 	<ul style="list-style-type: none"> • Iron or salinity staining (e.g. orange or white staining in water or on banks/seeps) • Water cloudiness • Evidence of springs in Nepean River • Visual signs of impacts (e.g. cracking, vegetation changes, increased erosion, changes in water colour etc.) • Impacts determined from comparing photo points taken prior to, during and post mining • Erosion and/or sedimentation compared with baseline
<p>1st and 2nd Order Watercourses</p> <ul style="list-style-type: none"> • Lower Harris Creek (NR3) • Cataract River (NR5) • Elladale Creek (NR8) • Ousedale Creek (NR10) • Menangle Creek (NR40) • Upper Harris Creek (HC10) • Foot Onslow Creek (FO1) • Navigation Creek (NAV1) 	<p>Observational and photographic monitoring</p>	<ul style="list-style-type: none"> • Prior to mining of longwall underlying watercourse or mining of any immediately adjacent longwall • Following the development of incremental subsidence for each longwall that will impact on the feature 	<ul style="list-style-type: none"> • Iron or salinity staining (e.g. orange or white staining in water or on banks/seeps) • Water cloudiness • Evidence of springs in Nepean River • Visual signs of impacts (e.g. cracking, vegetation changes, increased erosion, changes in water colour etc.) • Impacts determined from comparing photo points taken prior to, during and post mining • Erosion and/or sedimentation compared with baseline
<p>Water Pumps</p> <ul style="list-style-type: none"> • Pump 1 NRL • Pump 2 NRL • Pump 3 • Pump 4 • Pump 5 NRL • Pump 6 NRL 	<p>Observational and photographic monitoring</p>	<ul style="list-style-type: none"> • Pre-mining photographs • Monthly visual inspection during mining • If required as a result of assessment of mining impacts 	<p>Pump submergence and disturbance</p>
<p>Nepean River</p> <ul style="list-style-type: none"> • Sites 1 and 2 • Sites 5 and 6 • Sites 7 and 8 • Sites X3 and X4 (AA9 Monitoring) • Sites X5 and X6 	<p>Quantitative and observational monitoring</p>	<ul style="list-style-type: none"> • Two Baseline monitoring campaigns prior to mining • Annual monitoring campaigns (spring) during mining • Two monitoring campaigns post mining 	<ul style="list-style-type: none"> • Photographic records • Macro-invertebrate Assessment • Fish sampling • Water Quality • Monitored in conjunction with: <ul style="list-style-type: none"> - Flow - River Morphology • Dissolved oxygen- assessed in consultation with surface water specialist.
<p>Water Level IMC Monitoring Bores</p> <ul style="list-style-type: none"> • S1913 (EAW5) • S1936 (EAW7) <p>Additional Bulli Seam piezometers located throughout the mining area</p>	<p>Groundwater level</p>	<p>IMC Bores</p> <ul style="list-style-type: none"> • Pre-mining • Water level logged hourly • Post-mining – following the development of incremental subsidence for each longwall that will potentially impact on the borehole • Monitoring to continue for at least 12 	<p>Grouted monitoring holes</p> <ul style="list-style-type: none"> • Piezometric head in various strata <p>Private bores</p> <ul style="list-style-type: none"> • Water level measured with dip meter (where access to property is available and in agreement with landholder)

<p>Private Bores (10 registered bores)</p> <ul style="list-style-type: none"> • GW104602 • GW104661 • GW105376 • GW105388 • GW105574 • GW101986 • GW105339 • GW106574 • GW072874 • GW105534 		<p>months post mining depending on borehole functionality</p> <p>Private Bores</p> <ul style="list-style-type: none"> • Prior to mining of longwall underlying bore or mining of any immediately adjacent longwall (if in agreement with landholder) • Post-mining – following the development of incremental subsidence for each longwall that will impact on the borehole (if in agreement with landholder) • As requested by landholder or if physical impacts to bore identified (landholder to observe during use of bore) 	
<p>Cliffs</p> <ul style="list-style-type: none"> • Along Nepean Gorge Steep Slopes • Along Nepean Gorge, associated tributaries and above western end of the proposed longwalls • Along Nepean River, near the finishing end of Longwall 708B ⁽³⁾ 	<p>Observational and photographic monitoring</p>	<ul style="list-style-type: none"> • Once prior to mining. Photographic records taken • Monthly visual inspections • Photographic monitoring to continue 6 monthly for 2 years following the completion of mining (or as otherwise required/ approved) • As required when specific impacts are identified or when concern is raised by a landowner • As required, in accordance with Built Feature Management Plans and landholder agreement 	<ul style="list-style-type: none"> • Cliff and steep slopes will be observed for any instability (e.g. rock falls, mass movement) and seeps
<p>Monitored in conjunction with general observational monitoring for the Nepean River, watercourse and landscape</p>		<ul style="list-style-type: none"> • Monthly observations during mining • If required as a result of assessment of mining impacts • General observation of active mining areas during all other monitoring 	<ul style="list-style-type: none"> • Vegetation communities • Vegetation condition • Changes in vegetation • Tree health • Threatened species
<p>There are no applicable aboriginal archaeology sites on the AIHMS database within the Appin Longwalls 707 to 710 mining area.</p>			<p>Any sites identified during the mining period would be monitored as required by the Bulli Seam Operations Heritage Management Plan</p>

1 Fortnightly targeted monitoring of relevant sites when impacts are observed.

2 Analytes tested at closest downstream sample site following Level 2 and above trigger for gas release.

3 Photo point monitoring sites have been established near the steep slopes near the finishing end of Longwall 708B. These sites will be monitored on a monthly basis during mining, subject to site safety requirements.

7. Appendix A

Appendix A: Appin Longwalls 707 to 710 Trigger Action Response Plan.

MONITORING	TRIGGER	ACTION																																																				
Water Quality																																																						
<p>Nepean River Impact monitoring sites adjacent to longwalls:</p> <ul style="list-style-type: none"> NR12 NR13 <p>Refer to Figure 1</p> <p>Notes: Baseline upriver site NR110 will be used for cross-checking upriver perturbations⁽³⁾</p> <table border="1"> <thead> <tr> <th></th> <th>MEAN</th> <th>1 STDEV</th> <th>2 STDEV</th> </tr> </thead> <tbody> <tr> <td colspan="4">Impact Site</td> </tr> <tr> <td colspan="4">NR12</td> </tr> <tr> <td>pH</td> <td>7.54</td> <td>0.34</td> <td>0.68</td> </tr> <tr> <td>DO (%)</td> <td>88.03</td> <td>10.62</td> <td>21.23</td> </tr> <tr> <td>SpC (uS.cm)</td> <td>180</td> <td>50</td> <td>100</td> </tr> <tr> <td>Tot Fe (mg/L)</td> <td>0.421</td> <td>0.135</td> <td>0.270</td> </tr> <tr> <td>Tot Mn (mg/L)</td> <td>0.034</td> <td>0.012</td> <td>0.0023</td> </tr> <tr> <td colspan="4">NR13</td> </tr> <tr> <td>pH</td> <td>7.43</td> <td>0.35</td> <td>0.70</td> </tr> <tr> <td>DO (%)</td> <td>86.99</td> <td>12.82</td> <td>25.63</td> </tr> <tr> <td>SpC (uS.cm)</td> <td>180</td> <td>49</td> <td>98</td> </tr> <tr> <td>Tot Fe (mg/L)</td> <td>0.407</td> <td>0.129</td> <td>0.259</td> </tr> </tbody> </table>		MEAN	1 STDEV	2 STDEV	Impact Site				NR12				pH	7.54	0.34	0.68	DO (%)	88.03	10.62	21.23	SpC (uS.cm)	180	50	100	Tot Fe (mg/L)	0.421	0.135	0.270	Tot Mn (mg/L)	0.034	0.012	0.0023	NR13				pH	7.43	0.35	0.70	DO (%)	86.99	12.82	25.63	SpC (uS.cm)	180	49	98	Tot Fe (mg/L)	0.407	0.129	0.259	<p>Level 1⁽¹⁾ Impact monitoring sites:</p> <ul style="list-style-type: none"> pH reduction greater than 1 standard deviation but less than 2 standard deviation from pre-mining mean resulting from the mining for two consecutive months DO reduction greater than 1 standard deviation but less than 2 standard deviation from pre-mining mean resulting from the mining for two consecutive months Identification of strata gas plume of flow rate < 3000 L/min⁽²⁾ <p>Level 2⁽¹⁾ Impact monitoring sites:</p> <ul style="list-style-type: none"> pH reduction greater than 2 standard deviation from pre-mining mean resulting from the mining for two consecutive months reduction greater than 2 standard deviation from pre-mining mean resulting from the mining for two consecutive months EC, total Fe and total Mn increases greater than 2 standard deviation from pre-mining mean resulting from the mining for two consecutive months Identification of strata gas plume of flow rate >3000 L/min⁽²⁾ 	<ul style="list-style-type: none"> Continue monitoring program Report impacts to key stakeholders Summarise impacts and record <p><i>Actions as stated for Level 1</i></p> <ul style="list-style-type: none"> Review monitoring program Notify relevant specialists (South32 IMC) and develop and implement remedial action if necessary <p>Strata Gas Emission Plume:</p> <ul style="list-style-type: none"> Estimate gas emission flow rates. Re-estimate should significant change be observed Take sample of plume (if possible) for: <ul style="list-style-type: none"> - chemical composition - dissolved methane from exactly above gas plume and at established downriver monitoring sites - dissolved sulphide and total phenols from exactly above gas plume and at nearest downriver monitoring site(s)
	MEAN	1 STDEV	2 STDEV																																																			
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Tot Mn (mg/L)	0.034	0.013	0.026	<p>Level 3⁽¹⁾ Impact monitoring sites:</p> <ul style="list-style-type: none"> Level 2-type reduction in water quality resulting from the mining observed for six consecutive months 	<p><i>Actions as stated for Level 2</i></p> <ul style="list-style-type: none"> Notify BCD, DPE, Resources Regulator and WaterNSW and any other relevant specialist. Consultation with stakeholders. Collect laboratory samples and analyse for: <ul style="list-style-type: none"> pH, EC, Total Fe and Mn Suite of Filterable metals Dissolved methane, sulphide and total phenols (if relevant) Develop any site management measures as soon as practically possible (pending stakeholder availability) and seek any approvals required to implement Review the relevant TARP and management plan in consultation with key stakeholders
Control Site NR110					
pH	7.90	0.42	0.84		
DO (%)	84.19	15.22	30.44		
SpC (uS.cm)	240	92	184		
Tot Fe (mg/L)	0.328	0.131	0.262		
Tot Mn (mg/L)	0.025	0.015	0.031		
				<p>Exceeding Prediction</p> <ul style="list-style-type: none"> More than negligible gas releases 	<p><i>Actions as stated for Level 3</i></p> <ul style="list-style-type: none"> Investigate reasons for the exceedance Update future predictions based on the outcomes of the investigation
Water Level and Flow					
Nepean River Visual observations along the Nepean River within the active mining area				<p>Level 1⁽¹⁾</p> <ul style="list-style-type: none"> Observation of areas of dry and/or flooded riverbed in comparison to baseline observations and flows, for less than two consecutive months 	<ul style="list-style-type: none"> Continue monitoring program Report impacts to key stakeholders Summarise impacts and record
				<p>Level 2⁽¹⁾</p> <ul style="list-style-type: none"> Observation of areas of dry and/or flooded riverbed in comparison to baseline observations and flows, for more than two consecutive months 	<p><i>Actions as stated for Level 1</i></p> <ul style="list-style-type: none"> Review monitoring program Notify relevant specialists (South32 IMC) and develop and implement remedial action if necessary

	<p>Level 3⁽¹⁾</p> <ul style="list-style-type: none"> • Observation of areas of dry and/or flooded riverbed in comparison to baseline observations and flows, for six consecutive months 	<p><i>Actions as stated for Level 2</i></p> <ul style="list-style-type: none"> • Notify relevant government agencies, other resource managers and relevant technical specialists and seek advice on any CMA required. • Site visits with stakeholders if required • Develop any site management measures as soon as practically possible (pending stakeholder availability) and seek any approvals required to implement • Review the relevant TARP and Management Plan in consultation with key stakeholders
Appearance		
<p>Nepean River Observations along the Nepean River within the active mining area</p>	<p>Level 1⁽¹⁾</p> <ul style="list-style-type: none"> • Iron staining resulting from the mining for two consecutive months • Water cloudiness resulting from the mining for two consecutive months 	<ul style="list-style-type: none"> • Continue monitoring program • Report impacts to key stakeholders • Summarise impacts and record
	<p>Level 2⁽¹⁾</p> <ul style="list-style-type: none"> • Iron staining greater than baseline monitoring resulting from the mining for two consecutive months • Water cloudiness greater than baseline monitoring resulting from the mining for two consecutive months 	<p><i>Actions as stated for Level 1</i></p> <ul style="list-style-type: none"> • Review monitoring program • Notify relevant specialists (South32 IMC) and develop and implement remedial action if necessary
	<p>Level 3⁽¹⁾</p> <ul style="list-style-type: none"> • Iron staining greater than baseline monitoring resulting from the mining for six consecutive months • Water cloudiness greater than baseline monitoring resulting from the mining for six consecutive months 	<p><i>Actions as stated for Level 2</i></p> <ul style="list-style-type: none"> • Notify relevant government agencies, other resource managers and relevant technical specialists and seek advice on any CMA required. • Site visits with stakeholders if required • Develop any site management measures as soon as practically possible (pending stakeholder availability) and seek any approvals required to implement • Review the relevant TARP and Management Plan in consultation with key stakeholders

	<p>Exceeding Prediction</p> <ul style="list-style-type: none"> • More than negligible iron staining resulting from the mining • More than negligible increase in water cloudiness resulting from the mining 	<p><i>Actions as stated for Level 3</i></p> <ul style="list-style-type: none"> • Investigate reasons for the exceedance • Update future predictions based on the outcomes of the investigation
<p>1st and 2nd Order Watercourses</p> <ul style="list-style-type: none"> • Upper Harris Creek (HC10) • Foot Onslow Creek (FO1) • Navigation Creek (NAV1) 	<p>Level 1⁽¹⁾</p> <ul style="list-style-type: none"> • Fracturing with no observable loss of surface water flow • Fracturing with no reduction in pool water level when compared to baseline period • Increase in turbidity, iron staining, algal growth, or other visible water quality parameters resulting from the mining for two consecutive months determined by comparing baseline photos with photos during the mining period 	<ul style="list-style-type: none"> • Continue monitoring program • Report impacts to key stakeholders • Summarise impacts and record
	<p>Level 2⁽¹⁾</p> <ul style="list-style-type: none"> • Fracturing resulting in loss of surface flow in some creeks or tributary • Fracturing resulting in water loss from some permanent pools • Reduced water retention time in pools • Increase in turbidity, iron staining, algal growth, or other visible water quality parameters resulting from the mining for two consecutive months determined by comparing baseline photos with photos during the mining period 	<p><i>Actions as stated for Level 1</i></p> <ul style="list-style-type: none"> • Review monitoring program • Notify relevant specialists (South32 IMC) and develop and implement remedial action if necessary
	<p>Level 3⁽¹⁾</p> <ul style="list-style-type: none"> • Iron staining greater than baseline monitoring resulting from the mining for six consecutive months • Water cloudiness greater than baseline monitoring resulting from the mining for six consecutive months 	<p><i>Actions as stated for Level 2</i></p> <ul style="list-style-type: none"> • Notify relevant government agencies, other resource managers and relevant technical specialists and seek advice on any CMA required. • Site visits with stakeholders if required

		<ul style="list-style-type: none"> Develop any site management measures as soon as practically possible (pending stakeholder availability) and seek any approvals required to implement Review the relevant TARP and Management Plan in consultation with key stakeholders
Water Pumps <ul style="list-style-type: none"> Pump 1 Pump 2 Pump 3 Pump 4 Pump 5 Pump 6 	Pump not functioning due to water level changes or physical disturbance from subsidence	<ul style="list-style-type: none"> Continue monitoring program Report impacts to key stakeholders Summarise impacts and record Develop and implement CMA (if required) in consultation with key stakeholders
Aquatic Ecology		
Nepean River <ul style="list-style-type: none"> Sites 5 and 6 Sites 7 and 8 	Level 1⁽¹⁾ <ul style="list-style-type: none"> Reduction in aquatic habitat resulting from mining (when comparing to baseline conditions) for 1 year 	<ul style="list-style-type: none"> Continue monitoring program Report impacts to key stakeholders Summarise impacts and record
	Level 2⁽¹⁾ <ul style="list-style-type: none"> Reduction in aquatic habitat resulting from mining (when comparing to baseline conditions) for 2 consecutive years 	<i>Actions as stated for Level 1</i> <ul style="list-style-type: none"> Review monitoring program Notify relevant specialists (South32 IMC) and develop and implement remedial action if necessary
	Level 3⁽¹⁾ <ul style="list-style-type: none"> Reduction in aquatic habitat resulting from the mining (when comparing to baseline conditions) for > 2 consecutive years or complete loss of habitat 	<i>Actions as stated for Level 2</i> <ul style="list-style-type: none"> Notify relevant government agencies, other resource managers and relevant technical specialists and seek advice on any CMA required. Site visits with stakeholders if required Develop any site management measures as soon as practically possible (pending stakeholder availability) and seek any approvals required to implement Review the relevant TARP and Management Plan in consultation with key stakeholders
	Exceeding Prediction	<i>Actions as stated for Level 3</i> <ul style="list-style-type: none"> Investigate reasons for the exceedance

	<ul style="list-style-type: none"> • More than negligible environmental consequences for a threatened species, threatened population or endangered ecological community 	<ul style="list-style-type: none"> • Update future predictions based on the outcomes of the investigation
Groundwater		
<p>Water Level IMC monitoring bores:</p> <ul style="list-style-type: none"> • EAW5 • EAW7 <p>Private Bores (10 registered bores- where accessible)</p> <p>Notes: <i>Impact monitoring data during longwall mining is compared to predicted groundwater levels from the BSOP (or later updates) groundwater model, during preparation of the End of Panel Report. Privately owned water supplies are monitored as agreed with landowners in the Built Feature Management Plans</i></p> <p>Refer Figure 1</p>	<p>Level 1⁽¹⁾</p> <ul style="list-style-type: none"> • 5.0 – 7.5m reduction greater than predicted standing water level or pressure in the Hawkesbury Sandstone (outside of pumping influences in private bores) over a minimum 2 month period 	<ul style="list-style-type: none"> • Continue monitoring program • Report impacts to key stakeholders • Summarise impacts and record
	<p>Level 2⁽¹⁾</p> <ul style="list-style-type: none"> • Between 7.5m and 10m additional reduction from the predicted standing water level or pressure in Hawkesbury Sandstone (outside of pumping influences) over 2 consecutive months 	<p><i>Actions as stated for Level 1</i></p> <ul style="list-style-type: none"> • Review monitoring program • Notify relevant specialists (South32 IMC) and develop and implement remedial action if necessary
	<p>Level 3⁽¹⁾</p> <ul style="list-style-type: none"> • Greater than 10m of additional reduction from the predicted standing water level or pressure in the Hawkesbury Sandstone (outside of pumping influences) over 2 consecutive months • Mining results in private groundwater bores unsafe, unserviceable or damaged 	<p><i>Actions as stated for Level 2</i></p> <ul style="list-style-type: none"> • Notify relevant government agencies, other resource managers and relevant technical specialists and seek advice on any CMA required. • Site visits with stakeholders if required • Develop any site management measures as soon as practically possible (pending stakeholder availability) and seek any approvals required to implement • Review the relevant TARP and Management Plan in consultation with key stakeholders

Mine Water Inflows	Level 1⁽¹⁾	<ul style="list-style-type: none"> Abnormal rise in water flow from the goaf between 2.7 and 3ML/day (over 20 day average)Fracturing with no observable loss of surface water flow 	<ul style="list-style-type: none"> Continue monitoring program Report impacts to key stakeholders Summarise impacts and record
	Level 2⁽¹⁾	<ul style="list-style-type: none"> Abnormal rise in water flow from the goaf between 3 and 3.4ML/day (over 20 day average) 	<p><i>Actions as stated for Level 1</i></p> <ul style="list-style-type: none"> Review monitoring program Notify relevant specialists (South32 IMC) and develop and implement remedial action if necessary
	Level 3⁽¹⁾	<ul style="list-style-type: none"> Abnormal rise in water flow from the goaf >3.4ML/day (over 20 day average) 	<p><i>Actions as stated for Level 2</i></p> <ul style="list-style-type: none"> Notify relevant government agencies, other resource managers and relevant technical specialists and seek advice on any CMA required. Site visits with stakeholders if required Develop any site management measures as soon as practically possible (pending stakeholder availability) and seek any approvals required to implement Review the relevant TARP and Management Plan in consultation with key stakeholders
Water Pumps	Pump not functioning due to water level changes or physical disturbance from subsidence	<ul style="list-style-type: none"> Pump 1 Pump 2 Pump 3 Pump 4 Pump 5 Pump 6 	<ul style="list-style-type: none"> Continue monitoring program Report impacts to key stakeholders Summarise impacts and record Develop and implement CMA (if required) in consultation with key stakeholders
Landscape Features			

<p>Cliffs</p> <ul style="list-style-type: none"> • Along Nepean Gorge <p>Steep Slopes</p> <ul style="list-style-type: none"> • Along Nepean Gorge, associated tributaries and above western end of the proposed longwalls <p><i>Refer Figure 19.1 in LW705-710 SMP</i></p>	<p>Level 1⁽¹⁾</p> <ul style="list-style-type: none"> • Any rock fall, displacement, dislodgement of boulders or slabs or fracturing of a cliff line flanking the Nepean River resulting from mining • Erosion resulting from mining localised to a small area that should naturally stabilise within the monitoring period • Surface movement resulting from mining with no more than negligible soil surface exposed 	<ul style="list-style-type: none"> • Continue monitoring program • Report impacts to key stakeholders • Summarise impacts and record
	<p>Level 2⁽¹⁾</p> <ul style="list-style-type: none"> • Any rock falls, displacements, dislodgements of boulders or slabs or fracturing of a cliff line(s) flanking the Nepean River resulting from mining that in total impacts 0.3% of the total cliff line face area of the mining domain • Erosion resulting from mining likely to naturally stabilise within the monitoring period • Surface movement or rock displacement resulting from mining with no more than minor soil surface exposed 	<p><i>Actions as stated for Level 1</i></p> <ul style="list-style-type: none"> • Review monitoring program • Notify relevant specialists (South32 IMC) and develop and implement remedial action if necessary
	<p>Level 3⁽¹⁾</p> <ul style="list-style-type: none"> • Any rock falls, displacements, dislodgements of boulders or slabs or fracturing of a cliff line(s) flanking the Nepean River resulting from mining that in total impacts up to 0.5% of the total cliffline face area of the mining domain • Any rock falls, displacements, dislodgements of boulders or slabs or fracturing of a cliffline(s) flanking the Nepean River resulting from mining that in total impacts 0.4% of the total cliffline face area of the mining domain after 1 longwall • Mass movement of a slope causing large areas of exposed soil 	<p><i>Actions as stated for Level 2</i></p> <ul style="list-style-type: none"> • Notify relevant government agencies, other resource managers and relevant technical specialists and seek advice on any CMA required. • Site visits with stakeholders if required • Develop any site management measures as soon as practically possible (pending stakeholder availability) and seek any approvals required to implement • Review the relevant TARP and Management Plan in consultation with key stakeholders

	<ul style="list-style-type: none"> Any form of rockfall or erosion that poses a threat to public safety 	
Cliffs flanking the Nepean River	<p>Exceeding Prediction</p> <ul style="list-style-type: none"> More than negligible environmental consequences (that is occasional rockfalls, displacement or dislodgement of boulders or slabs, or fracturing, that in total impacts more than 0.5% of the total face area of such cliffs within the longwall mining domain) Rockfall or erosion that poses more than a negligible increased risk to public safety 	<p><i>Actions as stated for Level 3</i></p> <ul style="list-style-type: none"> Investigate reasons for the exceedance Update future predictions based on the outcomes of the investigation
Terrestrial Ecology		
Monitored in conjunction with observational monitoring for the Nepean River, 1st and 2nd Order watercourses and active mining area	<p>Level 1⁽¹⁾</p> <ul style="list-style-type: none"> Vegetation impacted by mining (by rockfalls, soil slippage, gas emissions) that is likely to naturally regenerate within the monitoring period 	<ul style="list-style-type: none"> Continue monitoring program Report impacts to key stakeholders Summarise impacts and record
	<p>Level 2⁽¹⁾</p> <ul style="list-style-type: none"> Vegetation impacted by mining (by rockfalls, soil slippage, gas emissions) that is unlikely to naturally regenerate within the monitoring period 	<p><i>Actions as stated for Level 1</i></p> <ul style="list-style-type: none"> Review monitoring program Notify relevant specialists (South32 IMC) and develop and implement remedial action if necessary
	<p>Level 3⁽¹⁾</p> <ul style="list-style-type: none"> Vegetation impacted by mining that is not responding to CMAs 	<p><i>Actions as stated for Level 2</i></p> <ul style="list-style-type: none"> Notify relevant government agencies, other resource managers and relevant technical specialists and seek advice on any CMA required. Site visits with stakeholders if required Develop any site management measures as soon as practically possible (pending stakeholder availability) and seek any approvals required to implement Review the relevant TARP and Management Plan in consultation with key stakeholders
	<p>Exceeding Prediction</p>	<p><i>Actions as stated for Level 3</i></p> <ul style="list-style-type: none"> Investigate reasons for the exceedance

	<ul style="list-style-type: none"> More than negligible environmental consequences on threatened species, threatened populations, or endangered ecological communities 	<ul style="list-style-type: none"> Update future predictions based on the outcomes of the investigation
Aboriginal Archaeology		
<p>No sites currently applicable</p> <p>Any other newly identified Aboriginal Archaeology sites</p> <p><i>Refer to Figure 5-22 of Bulli Seam Operations EA and Figure 3 Bulli Seam Operations Appendix G (Aboriginal Cultural Heritage Assessment)</i></p>	<p>Level 1⁽¹⁾</p> <ul style="list-style-type: none"> Change in shelter conditions not attributable to natural weathering or preservation – mineral growth or microorganism growth (as observed by comparing pre-mining photographs with post-subsidence/mining photographs) Changes external to the shelter that affect the site context – ground cracking, boulder slumping, rock and/or tree falls 	<ul style="list-style-type: none"> Continue monitoring program Report impacts to key stakeholders Summarise impacts and record
	<p>Level 2⁽¹⁾</p> <ul style="list-style-type: none"> Change in shelter conditions not attributable to natural weathering or preservation – change in drip line or seepage, cracking or exfoliation of overhang or shelter, movement or opening of existing planes and joints at panel, block fall within shelter or overhang 	<p><i>Actions as stated for Level 1</i></p> <ul style="list-style-type: none"> Review monitoring program Notify relevant specialists (South32 IMC) and develop and implement remedial action if necessary
	<p>Level 3⁽¹⁾</p> <ul style="list-style-type: none"> Shelter or overhang collapse not attributable to natural weathering Level 2 impacts at greater frequency than predicted Level 2 impacts attributable to mining remote from the mining area 	<p><i>Actions as stated for Level 2</i></p> <ul style="list-style-type: none"> Notify relevant government agencies, other resource managers and relevant technical specialists and seek advice on any CMA required. Site visits with stakeholders if required Develop any site management measures as soon as practically possible (pending stakeholder availability) and seek any approvals required to implement Review the relevant TARP and Management Plan in consultation with key stakeholders
<p>Sites determined to hold high or moderate significance as a result of studies required for Extraction Plans</p>	<p>Exceeding Prediction</p>	<p><i>Actions as stated for Level 3</i></p> <ul style="list-style-type: none"> Investigate reasons for the exceedance

	<ul style="list-style-type: none"> More than negligible environmental consequences on threatened species, threatened populations, or endangered ecological communities 	<ul style="list-style-type: none"> Update future predictions based on the outcomes of the investigation
Other Aboriginal heritage sites	<ul style="list-style-type: none"> Less than 10% of such sites (or 1 such site, whichever is the greater) within any longw all mining domain are/is affected by subsidence impacts (other than minor impacts or environmental consequence) 	

(1) These may be revised in consultation with DPE and other key stakeholders

(2) If strata gas emission plumes are detected – particularly coinciding with low river flow and significant gas evolution

(3) Baseline upriver sites for cross-checking for upriver perturbations impacting Area 7 monitoring sites:

- NR110 - possible upstream perturbations (>2 standard deviations)

- Checks at Upriver sites NR4, NR5 and NR6 for possible Cataract River-based perturbations (>2 standard deviation)

Current Values

Level 1

NR12

pH>

DO>

NR13

pH>

DO>

Upstream check

NR110

pH>

DO>

Level 2 and 3

NR12

pH>

DO>

EC>280 µS/cm

Total Fe >0.691 mg/L

Total Mn>0.057 mg/L

NR13

pH>

DO>

EC>279 µS/cm

Total Fe>0.666 mg/L

Total Mn>0.060 mg/L

Upstream check

NR110

pH>

DO>

EC<424 µS/cm

Total Fe<0.590 mg/L

Total Mn<0.056 mg/L

8. References

- Cardno Forbes Rigby (2008). Appin Colliery Area 7 Longwalls 705 to 710. Subsidence Management Plan Application. Volume 1/3 Report prepared for BHPBIC.
- Cardno (2022), Appin Area 7 Longwall 708 End of Panel Report - Aquatic Flora and Fauna Review, Report by Cardno for South32 Illawarra Metallurgical Coal.
- Ecoengineers (2008) Assessment of Water Flow and Quality Effects Appin Colliery Longwalls 705-710, Report by Ecoengineers for BHBilliton Illawarra Coal
- The Ecology Lab (2004). Appin Workings (Longwalls 701-715): Effects of Mine Subsidence on Aquatic Ecology in the Nepean River System between Douglas Park and Menangle. Report No. 08/0304A. Report prepared for BHP Billiton, September 2004.
- Geoterra (2008) Appin Area 7 Longwalls 705-710 Groundwater Assessment Douglas Park NSW, Report by Geoterra for BHBilliton Illawarra Coal
- HGEO (2022), Appin Longwall 708 End of Panel Surface Water and Groundwater Monitoring Assessment, Report by HGEO for South32 Illawarra Metallurgical Coal. Report Number – D22173
- IMC (2022), Appin Longwall 708 Landscape Report, March 2022
- MSEC (2022), End of Panel Subsidence Monitoring Report for Appin Longwalls 708A and 708B, Report by Mine Subsidence Engineering Consultants for South32 Illawarra Metallurgical Coal. Report Number – MSEC1250