



Illawarra Metallurgical Coal
End of Panel Report



**APPIN AREA 9
LONGWALL 903
END OF PANEL REPORT**

August 2021



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Attachments

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Attachment A2: Appin Area 9 (Longwalls 901 to 904) Built Features Management Plan Approval
Attachment B: End of Panel Subsidence Monitoring Review Report for Appin Longwall 903
Attachment C1: Appin Longwall 903 End of Panel Landscape Report
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Attachment C3: Appin Longwall 903 Property Reports
Attachment D: Appin Longwall 903 End of Panel Surface Water and Groundwater Monitoring review
Attachment E: Appin Longwall 903 End of Panel Report - Aquatic Flora and Fauna Review

Abbreviations

AA7	Appin Area 7
AA9	Appin Area 9
ALS	Airborne Laser Scan
ARTC	Australian Rail and Track Corporation
BFMP	Built Feature Management Plans
BSO	Bulli Seam Operations
DP&E	Department of Planning and Environment
DPIE	Department of Planning, Industry and Environment
EP	Extraction Plan
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

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.

The Department of Planning, Industry and Environment (DPIE) granted approval for the Appin Area 9 (AA9) Longwalls 901 to 904 Extraction Plan (EP) on 10 September 2014. IMC subsequently shortened the commencing (i.e. western) end of Longwall 902 by 911 m from the extent indicated in the EP Application. Extraction of Longwall 903, which is the third longwall in the series, commenced on 1 November 2019 and was completed on 7 April 2021. IMC sought a reduction in the overall length of Longwall 903 by 1,535 m via an EP variation. This was approved by DPIE on 21 March 2019.

The AA9 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 of Late Permian age (Figure 1-1). The Illawarra Coal Measures contain several seams, the uppermost of which is the Bulli Seam.

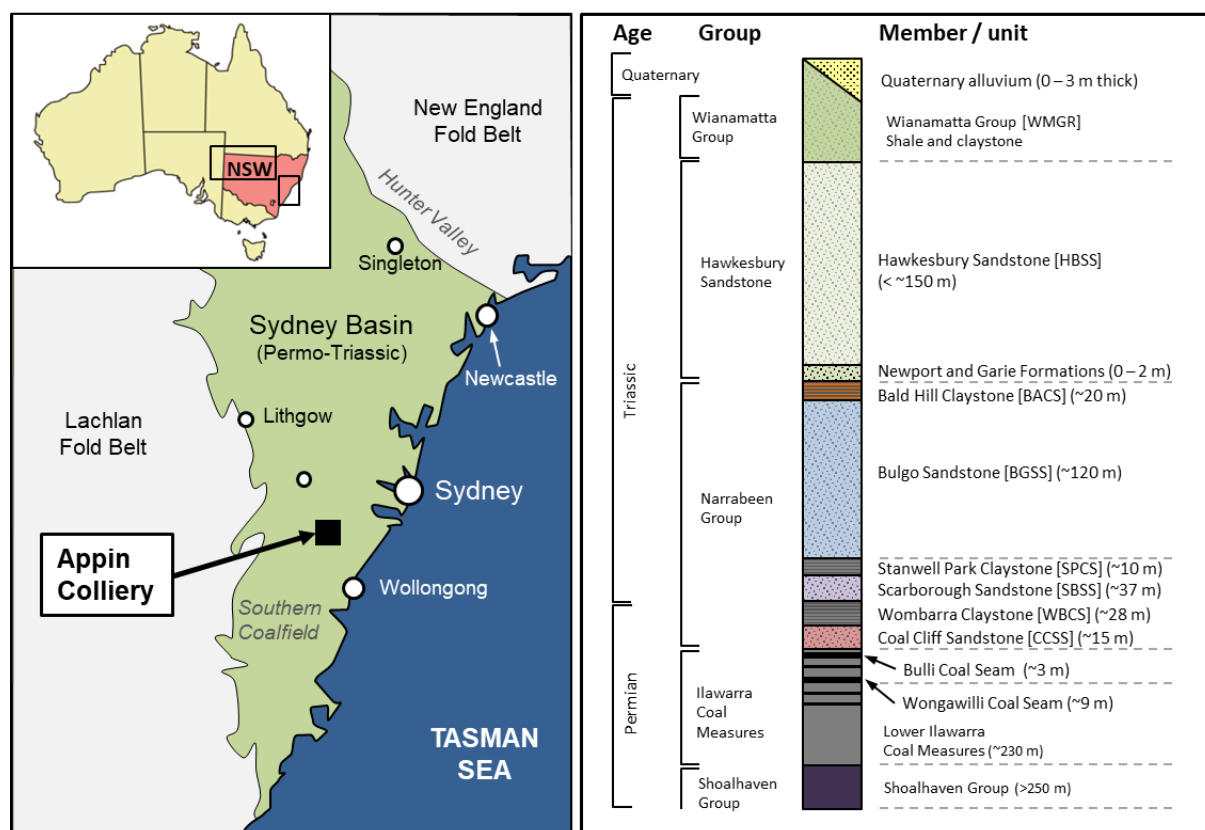


Figure 1-1: Stratigraphy and location of the Southern Coalfields within the Sydney Basin (Source: HGEO 2021).

The depth of cover to the Bulli Seam directly above Longwall 903 varies between a minimum of 510 m above the commencing (western) end of the longwall, and a maximum of 630 m above the eastern end of the longwall. 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 natural surface above the mining area generally falls from the north towards the south. The natural drainage lines above the western end of Longwall 903 flow into the Nepean River which is located approximately 630 m south of the longwall tailgate. The drainage lines above the eastern end of Longwall 903 flow into Harris Creek

which is located approximately 450 m east of the finishing end of the longwall. Razorback Range is located to the north of Longwall 903.

The thickness of the Bulli Seam varies between 2.8 and 3.0 m within the extents of Longwall 903. IMC extracted the full thickness of the seam.

1.1. Study Area

The AA9 Study Area is defined as the surface area that is likely to be affected by the proposed mining of Longwalls 901 to 904 in AA9 (Figure 1-2). The extent of the AA9 Study Area has been calculated by combining the areas bounded by the following limits:

- A 35-degree angle of draw line from the proposed extents of Longwalls 901 to 904; and
- The predicted limit of vertical subsidence, taken as the 20 mm subsidence contour, resulting from the extraction of the proposed Longwalls 901 to 904.

The 35-degree angle of draw line, therefore, has been determined by drawing a line that is a horizontal distance varying between 345 m and 510 m around the limits of the proposed extraction areas.

There are areas that lie outside the Study Area that are expected to experience either far-field movements, or valley related movements. The surface features which could be sensitive to such movements have been identified and have been included in the assessments provided in this report:

- Watercourses, within the predicted limits of 20 mm upsidence and 20 mm closure;
- Cliffs;
- The Twin Bridges over the Nepean River;
- Moreton Park Road Bridge (South) and Harris Creek Bridge;
- Groundwater bores; and
- Survey control marks.

1.2. Economic Outcomes

The extraction of coal reserves from AA9 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 70% 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 (Lawrence Consulting 2016).

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.

Longwall 903 is located within Consolidated Coal Lease 767, which amalgamated a number of long-standing head leases for mining coal in 1991.

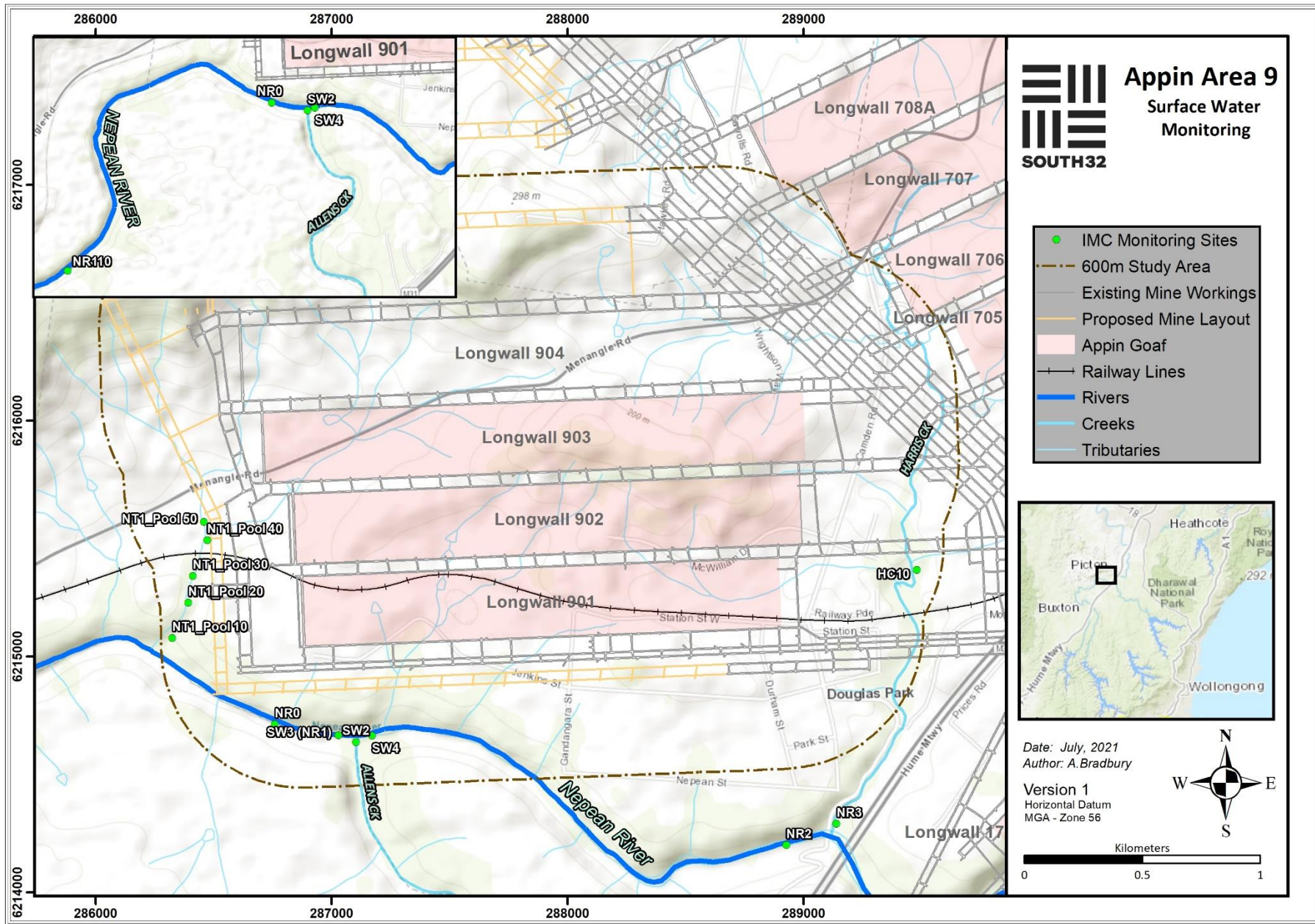


Figure 1-2: Map showing the Appin Area 9 Study Area.

2. Stakeholder Engagement

Monitoring data and other information has been made available to the community by IMC during the extraction of AA9. Information on IMC operations is provided to the community through the following mechanisms:

- Illawarra Metallurgical Coal Community Newsletter – a periodical IMC publication distributed to the community
- South32 website - <https://www.south32.net/our-business/australia/illawarra-metallurgical-coal/>;
- Illawarra Metallurgical Coal Community Consultative Committee meetings for BSOP (meeting minutes provided on the South32 website;
- Landholder relations program;
- 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.	Illawarra Metallurgical Coal Community Consultative Committee meetings for BSOP. 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 IMC operates. The survey aims to determine the community's perception of the company's overall performance.
	Level of satisfaction with the company's subsidence management practices.	Development of individual Built Feature Management Plans (BFMPs) 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 BFMPs. The BFMPs were prepared in consultation with individual property owners. In relation to Longwall 903, property owners were advised to lodge a claim with the Subsidence Advisory NSW where there was effect to built features on the property. Illawarra Metallurgical Coal continues to assist landholders through the Subsidence Advisory NSW claim lodgement process and other effects from mining operations associated with AA9.

3. Comparison of Measured and Predicted Subsidence

The following section provides comparisons between predicted and measured subsidence movements relating to the extraction of Longwall 903. For further details, refer to MSEC 2021, which is provided as **Attachment B**.

Predictions of subsidence movements relating to the extraction of Longwall 903 were obtained by MSEC using the Incremental Profile Method based on prediction curves for the Southern Coalfield Bulli Coal Seam.

Measurements of subsidence movements resulting from the extraction of Longwall 903 were obtained using ground monitoring lines, monitoring points and other methods at the following locations:

- Main Southern Railway, including monitoring associated with the track, embankments, cuttings, culverts, sewer horizontal bore and Douglas Park Station;
- Telstra Optical Fibre Cable monitoring line;
- Menangle Road monitoring line;
- Camden Road monitoring line;
- Nepean River closure lines;
- Harris Creek Cliff Line closure lines;
- Blades Bridge monitoring points;
- Far-field monitoring points;
- Nepean Twin Bridges monitoring points and bridge joint monitoring;
- Moreton Park Road Bridge South monitoring points; and
- Airborne Laser Scan (ALS)/ LiDAR surveys.

Table 3-1: Comparison summary of predicted and measured subsidence during the extraction of Longwall 903.

Feature	Monitoring Types	Approximate Location/ Distance from Longwall 903	Assessment of Measured Subsidence vs Predictions / Trigger Levels (MSEC 2021)
Main Southern Railway	ARTC monitoring line; Automated track monitoring; Embankment monitoring points; Cutting monitoring points; Culvert monitoring points; Sewer horizontal bore monitoring points; Douglas Park Station monitoring points.	Overlies previously extracted Longwall 901.	<p>Maximum measured incremental vertical subsidence (64 mm) greater than predicted values but within order of accuracy of prediction method.</p> <p>Maximum measured incremental tilt (1.2 mm/m) is greater than predicted values, however noted as only localised movements where there is variability in the measured vertical subsidence profile.</p> <p>Maximum compressive strains (0.6 mm/m) and tensile strains (0.4 mm/m) were within the order of survey tolerance.</p> <p>False alarms were triggered due to malfunction or damage. However, mining-induced stress readings did not exceed trigger levels.</p> <p>No adverse impacts observed at cuttings.</p> <p>Minor differential movements at culverts typically similar to the order of survey tolerance.</p> <p>Differential vertical and horizontal movements at Douglas Park Station typically similar to the order of survey tolerance.</p>
Telstra OFC	2D and 3D monitoring line	Outside and adjacent to the commencing end of Longwall 903.	The vertical subsidence is greater than the predicted values in some locations; however, the exceedances are within the order of accuracy of the prediction method (± 50 mm).
Menangle Road	2D and 3D monitoring line	Crosses above the western end of Longwall 903.	<p>Maximum measured incremental vertical subsidence (432 mm) is approximately half of the maximum predicted value (800 mm). Measured vertical subsidence is greater than predicted north of Longwall 903, however the exceedance is within the order of accuracy (50mm) for subsidence predictions outside the mining area.</p> <p>Compressive strain developed gradually between January and February 2020. Localised heaving of road surface developed and the bump was repaired on 17 April 2020.</p>
Camden Road	2D and 3D monitoring line	Minimum distance of 200 m from Longwall 903 finishing end.	Measured incremental vertical subsidence within the order of survey tolerance for absolute level (less than 15 mm).
Nepean River	2D closure monitoring lines	Located 850 m south-west of Longwall 903 at its closest point.	<p>The measured total closure at the Nep X 9B-Line (55 mm) is slightly greater than the maximum predicted total value (50 mm). However, the exceedance is within the order of accuracy of the prediction method.</p> <p>Elsewhere, the measured total closures are less than the predicted total values at each of the other monitoring lines.</p> <p>The maximum measured total closure anywhere along the Nepean River (288 mm) is less than the maximum predicted total value (360 mm).</p>
Harris Creek Cliff Line	2D closure monitoring lines	Located 1.2 km south of the finishing end of Longwall 903 at its closest point.	<p>The maximum measured incremental closure due to Longwall 903 is 5 mm at the HCCL E-Line, which was less than the maximum predicted incremental closure (10 mm).</p> <p>The maximum measured total closure due to the mining of Longwall 901 to 903 (43 mm) was less than the maximum predicted value (50 mm).</p>

Feature	Monitoring Types	Approximate Location/ Distance from Longwall 903	Assessment of Measured Subsidence vs Predictions / Trigger Levels (MSEC 2021)
Blades Bridge	Two fixed prisms	Located 1.2 km south of the finishing end of Longwall 903 at its closest point.	The measured incremental closure due to the mining of Longwall 903 is only 2 mm. Final incremental closure is in the order of survey tolerance and, therefore, is not measurable.
Far-Field Monitoring points	Absolute 3D monitoring points	Various locations in AA9.	Maximum measured incremental horizontal movement is along Menangle Road (113 mm). Measured incremental horizontal movements are generally within range of movements that have been measured elsewhere in the Southern Coalfields. Horizontal movements measured at the sides and top of Razorback Range are at the upper end of the range. Higher movements also measured along ARTC monitoring line and the Douglas Park Station.
Nepean Twin Bridges	Absolute 3D points Relative 3D points Inclinometer Bridge joint monitoring Visual monitoring	1.6 km south of the finishing end of Longwall 903.	The maximum measured absolute horizontal movement (86 mm) at Marks DPBN and DPBS was less than the Level 1 Trigger (100 mm) at the completion of Longwall 903.
Moreton Park Road (South)	Absolute 3D points Relative 3D points Visual monitoring	1 km south-east from the finishing end of Longwall 903.	The maximum measured absolute horizontal movement (130 mm) at Marks MPBE and MPBW was less than the Level 1 Trigger (150 mm) at the completion of Longwall 903. The total changes in horizontal distance between the bridge abutments were less than +/- 3 mm. The total measured movements, therefore, were very close to the survey tolerance at the completion of the Longwall 903.

4. Impacts to Built Features

MSEC provided an assessment of potential built features impacts from the extraction of Longwall 903 (MSEC448 and MSEC829), which supported the EP and Modification Applications. A comparison between potential and observed impacts for built features is provided below (Table 4-1).

Table 4-1: Summary table comparing assessed and reported impacts for built features in relation to the extraction of Longwall 903 (Source: MSEC 2021).

Built Feature	MSEC Assessed Impacts	Observed Impacts
Main Southern Railway	No impacts on the safety or serviceability of the railway after the implementation of the monitoring and management strategies.	No reported impacts on safety or serviceability.
Menangle Road	Minor cracking and localised heaving of the road surface directly above the longwalls.	Localised heaving of road surface observed to gradually develop in January 2020 between Pegs MR9032 and MR9033, where increased compressive strains were observed. The bump was repaired on 17 April 2020.
Camden Road	Impacts unlikely.	No reported impacts.
Nepean Twin Bridges	Impacts unlikely after the implementation of the preventive, monitoring and management strategies.	No reported impacts.
Moreton Park Road Bridge (South) and Blades Bridge	Impacts unlikely.	No reported impacts.
Water and sewer pipelines	Minor leakages could occur.	No reported impacts.
66 kV and 11 kV powerlines	Minor impacts possible requiring some adjustments of cables and poles.	No reported impacts.
Optical fibre and copper telecommunications cables	Impacts unlikely with the implementation of monitoring and management strategies.	No reported impacts.
Survey control marks	Vertical and horizontal movements which could require re-establishment.	No reported damage to the survey control marks. The marks to be re-established after completion of mining.
Business establishments	Adverse impacts unlikely.	No reported impacts.
Rural structures	Minor impacts on rural structures located directly above longwalls.	No reported impacts.
Farm dams	Incidence of impact (cracking and leakage) expected to be extremely low.	No reported impacts.
Groundwater bores	Impacts likely including lowering of piezometric surface, blockage and change in groundwater quality.	Refer to the groundwater assessment.
Aboriginal heritage sites	Adverse impacts unlikely.	No Aboriginal heritage sites located within the Study Area for Longwall 903.
Other Heritage sites	Adverse impacts unlikely.	No reported impacts.
Houses	Remain safe and serviceable, assessed impacts: 92 % no claim or Category R0, 6 % Category R1 or R2, 2 % Category R3 or R4, and <0.5 % Category R5.	Houses have remained in safe and serviceable conditions. There were four claims submitted to SA NSW relating to the houses, being three Category R0 and one Category R1 impacts (i.e. minor non-structural damage).

4.1. Private Properties

Built Feature Management Plans have been prepared by IMC for landholders above AA9. Post-mining inspection of dams, boreholes and natural features set out in the BFMPs are conducted by the IMC Environmental Field Team (IMCEFT) with the consent of the relevant property/infrastructure owner and tenant, if applicable (Figure 4-1).

Post-mining inspections for Longwall 903 were undertaken at five properties; Lot 1 DP810978, Lot 15 DP 803255, Lot 9 DP 810978, Lot 3 DP 1133989 and Lot 59-64 DP1321 (Figure 4-1). The inspections included recording key

observations for private bores and dams, collection of in-situ water quality data and water samples for laboratory analysis. Results of water quality sampling are included in the Surface Water and Groundwater Assessment of the Longwall 903 EoP Report, and summarised below (Table 4-2). Post-mining inspections were unable to be undertaken at property Lot 22 DP203255 due to access issues.

Table 4-2: Summary Table of predicted and observed impacts to private property surface and groundwater quality (Source: HGEO 2021).

Potential Impact	Description	Impact Prediction	Observed Impact
Reduced groundwater yield	Six NoW registered bores within or near the proposed Longwalls 901 to 904 may be affected by subsidence, where the bores predominantly obtain water from the Hawkesbury Sandstone, rather than the overlying Wianamatta Group shale and sandstones. Groundwater levels in the Hawkesbury Sandstone are predicted to reduce by up to 10 m.	Impacts to water level likely (GeoTerra, 2011).	No impacts observed.
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. Monitoring of potentially affected bores within AA9 is conducted in consultation with the owners.	Impacts to groundwater quality likely (GeoTerra, 2011).	Changes to groundwater quality were identified in three bores on private properties. Follow-up sampling to be undertaken as part of the next EOP.
Impacts to streams and farm dams	Many farm dams have been mined under and monitored, with only a small number of dams exhibiting impacts (becoming dry) following mining. It is predicted that the impact on farm dams from mining Longwalls 901 to 904 will be similar.	Impact to dam water levels likely (Ecoengineers, 2012).	No impacts observed.
Gas emissions	There is potential for strata gas emissions into private bores. Any bores with gas releases are decommissioned during the mining period.	Gas releases from any deep bores likely (GeoTerra, 2011).	No impacts observed.

4.2. Cultural Heritage

No Aboriginal Heritage sites are located within the Study Area for Longwall 903.

4.3. Douglas Park Railway Cottage

Heritage Sites listed in the Study Area comprise the Railway Cottage at Douglas Park Station, which is listed in the Wollondilly Local Environmental Plan 1999. No impacts have been reported by the resident.

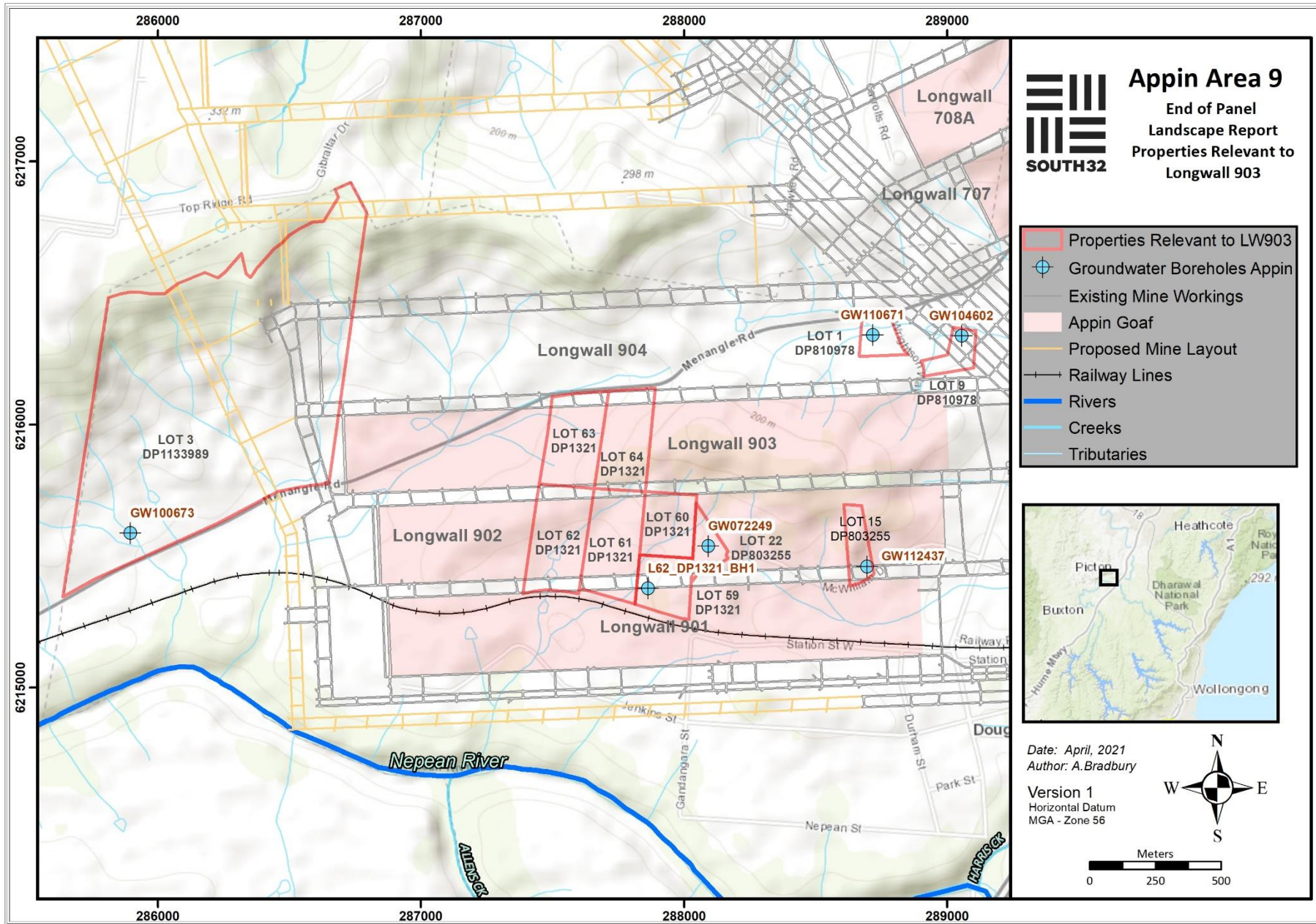


Figure 4-1: Private boreholes relevant to Longwall 903.

5. Impacts to Natural Features

5.1. Surface Water Assessment

Monthly surface water monitoring is undertaken by the IMCEFT along watercourses within and surrounding AA9 (Figure 5-2). The Longwall 903 reporting period was characterised by widely variable water quality in the Nepean River. Some surface water quality triggers were observed in the reporting period however these were not attributed to mining. A summary of these triggers is presented in Appendix A, with details included in the Longwall 903 Surface and Groundwater Assessment. A comparison between potential and observed impacts for Longwall 903 is provided below (Table 5-1).

Table 5-1: Summary table of potential and observed impacts to surface water quality within natural features (Source: HGEO 2021).

Potential Impact	Description	Impact Prediction	Observations	TARP Level
Gas emissions in the Nepean River and other areas	Based on observations at Appin Area 7 (AA7) it is likely that “minor” gas emissions will appear in the Nepean River as a consequence of mining Longwalls 901 to 904. 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, 2012).	One gas release zone and an update to an existing gas zone were observed during the monitoring period for Longwall 903. Six gas release zones were observed during the monitoring period for Longwall 902. Twenty-five gas release zones were observed during the monitoring period for Longwall 901. (Figure 5-1). On the post-mining inspection of Nepean River on 21 April 2021, there were 10 gas zones active.	Each gas release zone constitutes 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 Nepean River gorge or along adjacent tributaries.	The likelihood of ferruginous springs in the Nepean River gorge is low (Ecoengineers, 2012).	None identified	Not triggered.
Sub-bed flow diversions and un-natural pool drainage	Section 1 of the Nepean River is characterised by boulder fields, which are less susceptible to fracturing than rockbars. Two rockbars have been identified in the AA9 Study Area: Rockbar NR-A9-RB01 is located 370 m from the nearest longwall. Rockbar NR-A9RB02 is submerged at times of high flow, and therefore does not restrict the surface water at these times.	The likelihood of impacts to the rockbars is low (Ecoengineers, 2012). Impacts to the Nepean River Tributary are likely.	Decline in water level noted at NR0 however a similar decline also experienced at upstream reference site NR110. Access to NR0 is restricted during high flow events and consequently results appear skewed. Other sites had water levels within baseline range. Gauging at Maldon weir, Menangle weir, and the Cataract River at Broughtons Pass, show zero no-flow days recorded during the extraction of Longwall 903.	No relevant TARP.

5.2. Groundwater Assessment

Groundwater levels and quality are monitored at seven IMC monitoring bores within and surrounding AA9. Groundwater inflow to the mine is also monitored. A comparison between potential and observed impacts for Longwall 903 is provided below (Table 5-2). Details are included in the Longwall 903 Surface and Groundwater Assessment.

Table 5-2: Summary table of potential and observed impacts to groundwater (Source: HGEO 2021).

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.	5 – 10 m water level reduction predicted in the Wianamatta Group. Up to 10 m water level reduction predicted in the Hawkesbury Sandstone (GeoTerra 2011).	Decline in groundwater pressure at borehole S1941 reaching the Level 1 TARP (Figure 5-1). Groundwater pressure later recovered.	Level 1 TARP.
Changes to Groundwater chemistry	Changes to groundwater chemistry within the Wianamatta Group, Hawkesbury Sandstone and Bulgo Sandstone.	It is likely that some changes to groundwater chemistry will occur, although the impact will most likely be negligible (GeoTerra 2011).	No significant change in groundwater chemistry is noted for Longwall 903.	Not triggered.
Groundwater Inflows to the Mine	The horizontal permeability of the Hawkesbury Sandstone and Bulgo Sandstone may be enhanced after subsidence.	The potential for inflow of surface water to mine workings is low. No free draining direct vertical hydraulic connection to the Bulli Seam workings is anticipated.	Groundwater inflows (twenty-day moving average) to the mine fluctuated between ~1.2 and 0 ML/day during the extraction of Longwall 903; below the Level 1 TARP (2.7 ML/day).	Not triggered.

5.3. Aquatic Ecology Assessment

Cardno NSW/ACT (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 (Figure 5-3). 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 for Longwalls 901 to 904 (BHPBIC 2013).

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

Aquatic ecology data was collected in November 2019 following the commencement of Longwall 903 at two potential impact sites (X3 and X4) near Longwalls 901 to 904, and at control sites (X5 to X8) upstream and downstream of AA9 on the Nepean River. Data from Sites 1 and 2, collected in November 2020, located just

upstream of Douglas Park Weir were also used to provide a measure of potential downstream impacts (monitored annually for AA7).

No changes to aquatic ecology indicators, that could be associated with extraction of Longwall 903, were detected.

The gas releases, changes in water quality and water levels identified in the Nepean River during extraction of Longwall 903, do not appear to have had any measurable effect on macroinvertebrates, fish and macrophytes in the Nepean River (Cardno 2021).

Further monitoring will be undertaken at all AA9 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 AA9 monitoring sites following the completion of Longwall 903 (Cardno 2021).

5.4. Terrestrial Ecology Assessment

Potential impacts to terrestrial ecology in the AA9 Study Area were assessed by Biosis (2012), which were largely consistent with those outlined within the BSO Environmental Assessment (EA). Generally, the risks are lower in the Longwall 901 to 904 Study Area when compared to the broader BSO EA area as there are fewer sensitive vegetation communities in the locality and substantial areas of cleared vegetation. The proposed extraction also does not require significant vegetation clearing. Subsidence effects are most likely to result in impacts to natural features through loss of surface water flows and the impacts to groundwater dependant ecological features (PAC 2010).

The IMCEFT did not observe any gas releases other than those in the Nepean River, and did not observe any surface impacts with potential to impact the terrestrial ecology in the AA9 Study Area. The IMCEFT did not observe decreases in vegetation health associated with gas release zones on the Nepean River. Thus, it has been concluded that the extraction of Longwall 903 has resulted in negligible impacts to terrestrial ecology within the AA9 Study Area.

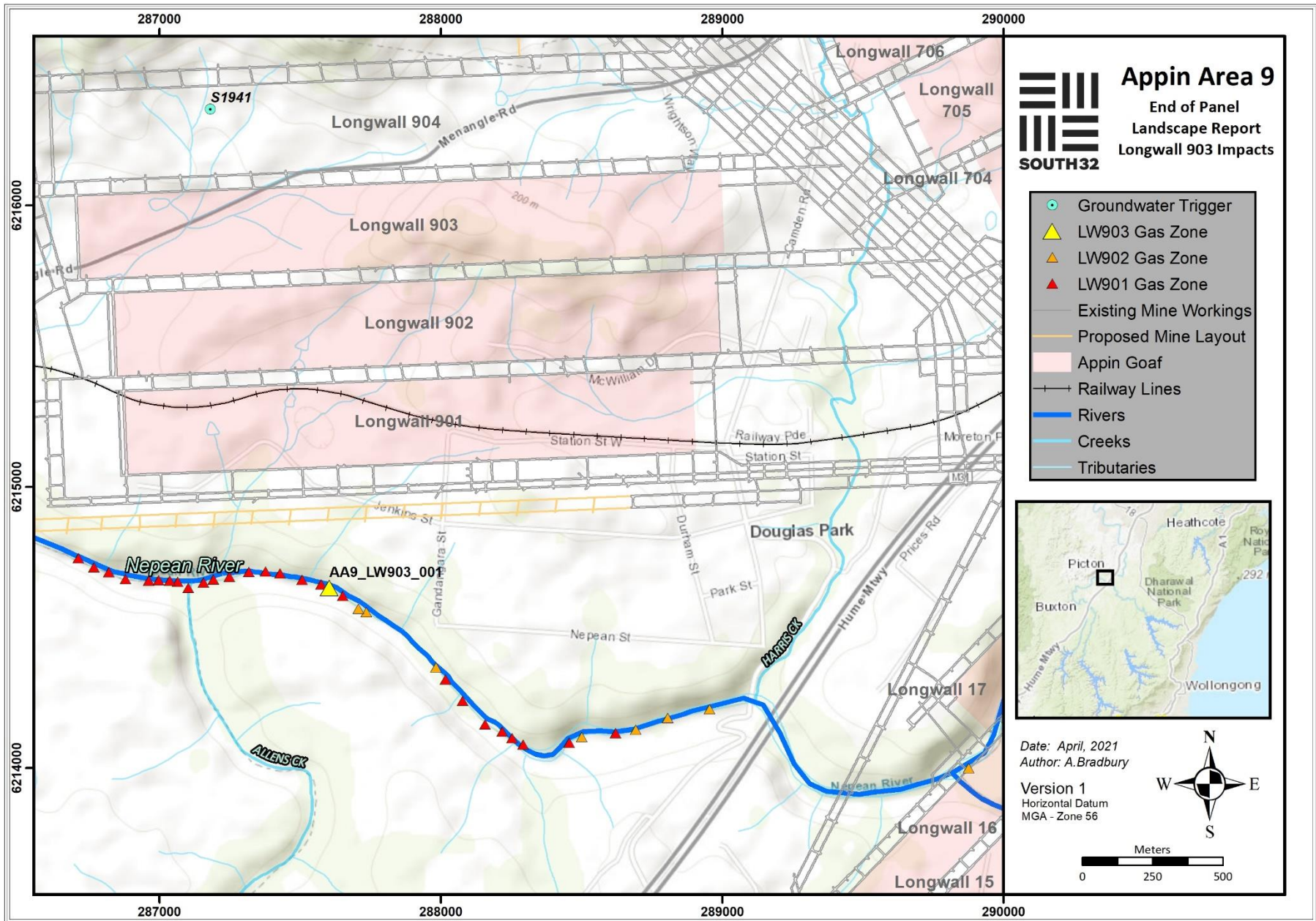


Figure 5-1: Map showing subsidence impacts and triggers relevant to Longwall 903.

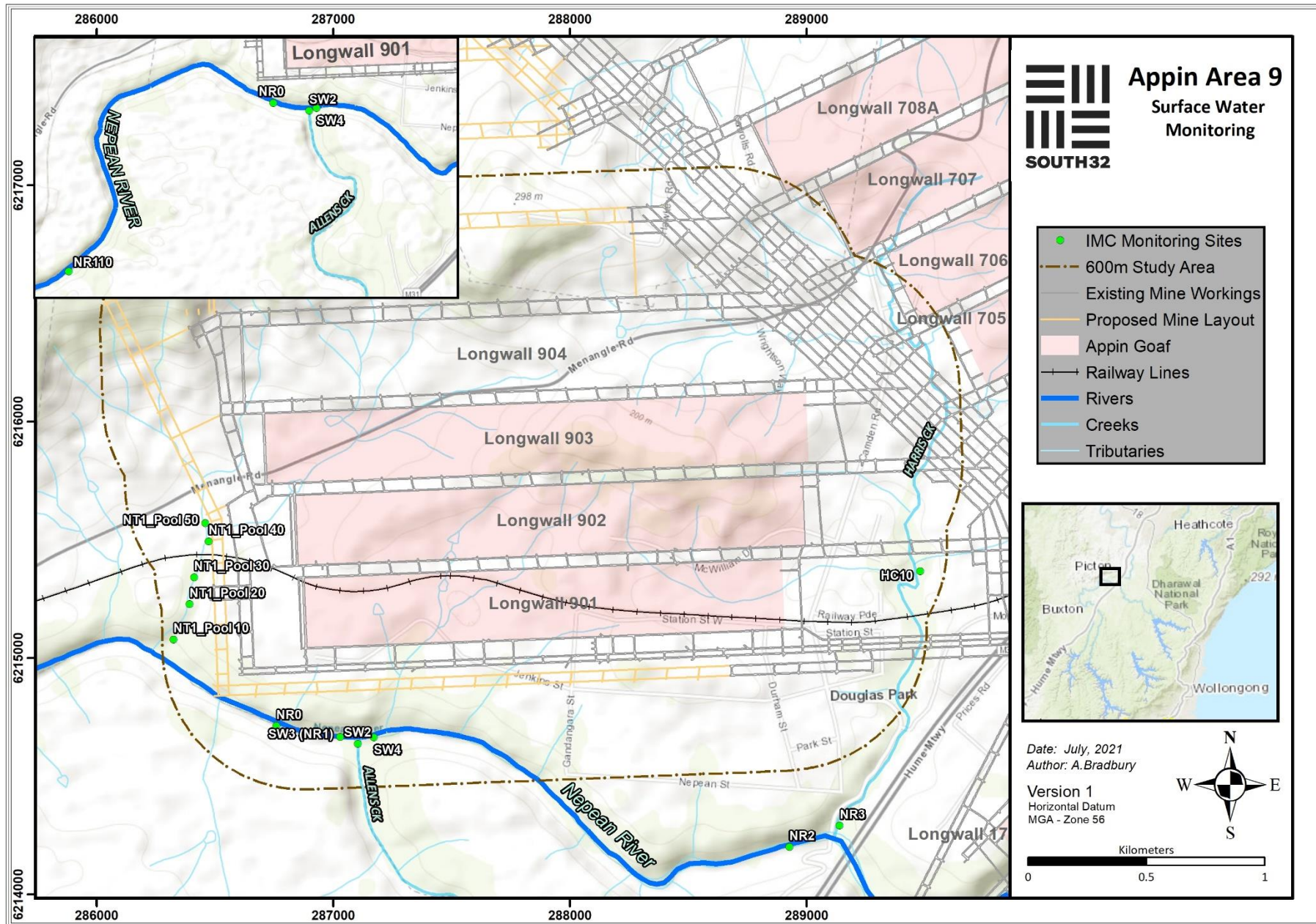


Figure 5-2: Appin Area 9 surface water monitoring sites; upstream reference site NR110 displayed on inset frame.

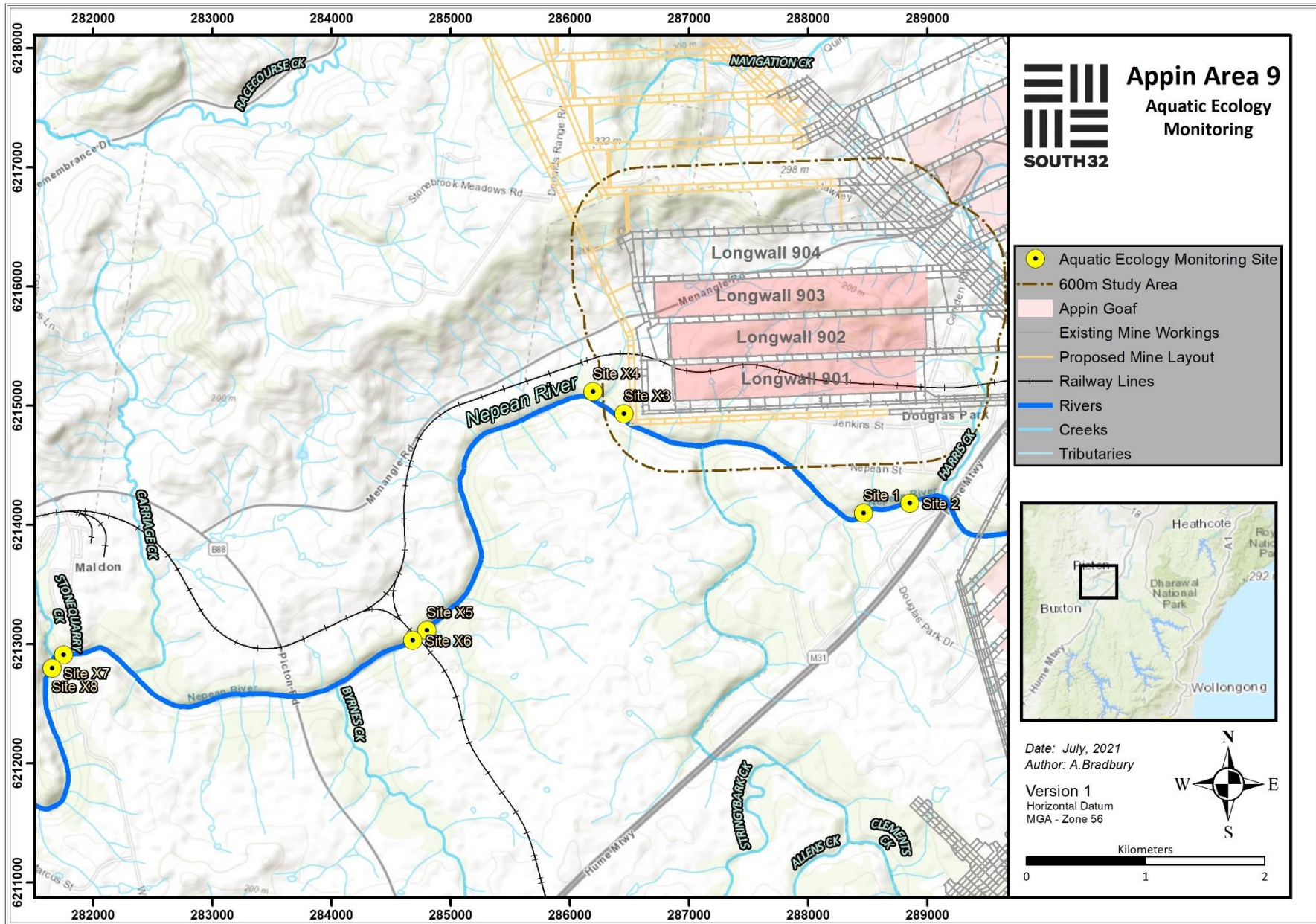


Figure 5-3: Map displaying the aquatic ecology monitoring sites on the Nepean River in relation to Appin Area 9 Longwalls.

6. Longwall 903 Monitoring Program

Table 6-1: Summary of the Longwall 903 monitoring program; observations and recommendations for future monitoring (specifically Longwall 904) are also included

Monitoring Site	Monitoring Type	Monitoring Frequency	Parameters	Future Monitoring (Longwall 904)	
SURFACE WATER					
AREA 9	<p>Nepean River and tributaries</p> <ul style="list-style-type: none"> • NR110 (Lab, Field, Level, Obs) • NR0 (Lab, Field, Level, Obs) • SW2 (Lab, Field, Obs) • SW3 (NR1) (Lab, Field, Obs) • SW4 (Field, Obs) • NR2 (Lab, Field, Obs) • NR3 (Lab, Field, Obs) • NT1_Pool 10 (Lab, Field, Level, Obs) • NT1_Pool 20 (Field, Level, Obs) • NT1_Pool 30 (Field, Level, Obs) • NT1_Pool 40 (Field, Level, Obs) • NT1_Pool 50 (Field, Level, Obs) • If and where strata gas emission plumes above 3000 L/min are detected (Lab, Field, Obs) 	<ul style="list-style-type: none"> • Lab sample • Field parameters • Water levels • Observations 	<ul style="list-style-type: none"> • Monthly baseline monitoring prior to mining • Weekly observations and field analysis during active subsidence • Monthly laboratory analysis during active subsidence • Monthly monitoring for two years post mining 	<p>Field Parameters:</p> <ul style="list-style-type: none"> • Temperature • Dissolved Oxygen (DO) • Specific Conductivity • pH • ORP <p>Standard Lab Sample:</p> <ul style="list-style-type: none"> • pH and EC • Filtered, Na, K, Ca, Mg, Cl, Ni, Zn, Fe, Mn, Al, SO₄ • Total Fe, Mn, Al • Total Alkalinity • TKN, TP, NH₃-N, NO_x-N (TON), FRP, TSS, DOC <p>Lab Sample for Gas Releases:</p> <ul style="list-style-type: none"> • CH₄ • C₂H₆ • Trace Phenols • Sulphide <p>Observations:</p> <ul style="list-style-type: none"> • Iron or salinity staining (e.g. orange or white staining in water or on banks/seeps) • Evidence of springs in the Nepean River • Visual signs of impacts (i.e. cracking, fracturing, vegetation changes, increased erosion, changes in water colour etc) • Stream flow and pool water level • Impacts determined from comparing photo points taken prior to, during and post mining 	<p>No changes</p>

AREA 9	Flow monitoring <ul style="list-style-type: none"> • Maldon Weir • Broughtons Pass Weir • Menangle Weir 	<ul style="list-style-type: none"> • Gauged flow station 	<ul style="list-style-type: none"> • Daily flow 	Analysis: <ul style="list-style-type: none"> • 51 baseline dry weather recession periods for Menangle minus Maldon minus Broughtons Pass Weirs with recession curve slope ranging from 0.76 to 0.99 • Recession curves calculated during and post mining • These recessions will be compared from the period of mining to the pre-mining period 	As per Program
GROUNDWATER					
AREA 9	Private Bores <ul style="list-style-type: none"> • GW 34425 • GW 35033 • GW 72249 • GW 100673 • GW 101133 • GW 102043 • GW 102584 • GW 102798 • GW 103161 • GW 104068 • GW 104602 • GW 104661 • GW 110671 • GW 112437 <i>(in consultation with bore owner)</i>	<ul style="list-style-type: none"> • Lab sample • Field parameters • Water levels • Observations 	<ul style="list-style-type: none"> • Where access is available and granted, water level and water quality monitoring at least once before and once after the bore is mined under 	Field Parameters: <ul style="list-style-type: none"> • Temperature • Dissolved Oxygen (DO) • Specific Conductivity • pH • ORP Standard Lab Sample: <ul style="list-style-type: none"> • pH and EC • Filtered, Na, K, Ca, Mg, Cl, Ni, Zn, Fe, Mn, Al, SO₄ • Total Fe, Mn, Al • Total Alkalinity Lab Sample for Gas Releases: <ul style="list-style-type: none"> • CH₄ • C₂H₆ • Trace Phenols • Sulphide Observations: <ul style="list-style-type: none"> • Iron or salinity staining (e.g. orange or white staining in water or in the bores) • Evidence of inflows to the bores e.g. sound of falling water • Visual signs of impacts (i.e. cracking, fracturing near the bore or changes in water colour etc.) 	No Changes
	BHPBIC Piezometers: <ul style="list-style-type: none"> • Potentiometric head; <ul style="list-style-type: none"> – EAW9 – EAW18 – EAW58 • Piezometers and water samples between Longwall 901 and the Nepean River <ul style="list-style-type: none"> – S2280 (POSP A) – S2281 (POSP B) 	<ul style="list-style-type: none"> • Lab sample • Field parameters • Water levels • Observations 	<ul style="list-style-type: none"> • Water levels to be logged at least twice daily in the pre-mining baseline, impact and post-mining period • At least one appropriately purged sample pre-mining and post mining, where access permits, tested for the analytes in the previous column 		No Changes

	Groundwater inflows to the mine	<ul style="list-style-type: none"> • Mine water budget • Observations 	<ul style="list-style-type: none"> • Flow meters 	Water flow from the goaf to the mine (analyzed as a moving average i.e. 20-day average)	No Changes
AQUATIC ECOLOGY					
AREA 9	Nepean River <ul style="list-style-type: none"> • Sites 1 and 2 (downstream) • Sites X3 and X4 (adjacent to Longwalls 901 and 902) • Sites X5 and X6 (upstream) • Sites X7 and X8 (upstream) 	<ul style="list-style-type: none"> • Water quality - field parameters • Survey and sampling • Observations 	<ul style="list-style-type: none"> • Twice in spring for two years prior to the commencement of mining • Once every two years during mining • Once every two years after mining 	<ul style="list-style-type: none"> • Habitat surveys • Aquatic macrophyte observations • Macroinvertebrate monitoring • AUSRIVAS sampling • Fish sampling • Observations of threatened species • Assessments of: <ul style="list-style-type: none"> ○ Water quality ○ Flow ○ River morphology 	No Changes

TERRESTRIAL ECOLOGY

AREA 9	<ul style="list-style-type: none"> • Inspection of the area will be conducted as outlined in the Landscape TARP 	<ul style="list-style-type: none"> • As indicated in the Landscape TARP 	<ul style="list-style-type: none"> • Prior to mining provide pre-mining baseline survey of vegetation communities and threatened flora populations for comparison with post-mining • Monthly prior to mining • Weekly during active subsidence • In response to any identified impacts on flora/fauna or threatened species, communities or populations 	<ul style="list-style-type: none"> • Observations of threatened species and endangered ecological communities • Changes in vegetation condition • Stressed or dead vegetation not readily explained by natural processes (causes may include rock / cliff falls or mass movement, gas emissions, changes in flooding/ ponding) 	No Changes
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ABORIGINAL ARCHAEOLOGY

AREA 9	<ul style="list-style-type: none"> • Impacts to the cliff lines on the southern side of the Nepean River will trigger an inspection of Bradcorp 1 and any adjacent sections of the river and creek valleys that have not been inspected 	<ul style="list-style-type: none"> • Observational and photographic monitoring 	<ul style="list-style-type: none"> • In accordance with Landscape TARP 	<ul style="list-style-type: none"> • Subsidence Impacts to cliff lines on the southern side of the Nepean River (e.g. directly north of Bradcorp 1) 	No Changes
	<ul style="list-style-type: none"> • Bradcorp 1 (if required) 	<ul style="list-style-type: none"> • Observational and photographic monitoring 	<ul style="list-style-type: none"> • Baseline archival recording (when triggered by above) • During the extraction of Longwalls 901, 902 and 903 • Final impact assessment recording twelve months after final subsidence movement at the site 	<ul style="list-style-type: none"> • Macro and micro recording using digital photography • Detailed elevation plans of shelter walls recording structural and surface features including but not limited to the art, graffiti, joints, bedding planes, exfoliation scars, cracks, mineral and micro-organism growth, drip line and water seepage locations 	No access to property.

EUROPEAN HERITAGE

AREA 9	<ul style="list-style-type: none"> • Douglas Park Railway Cottage – Item 30 	<ul style="list-style-type: none"> • Observational monitoring 	<ul style="list-style-type: none"> • Baseline archival recording prior to commencement of mining • Impact assessment recording following the identification of impacts or when a MSB claim is lodged • Final assessment recording following the completion of mining of Longwalls 901 and 902 and/or after any repairs 	<ul style="list-style-type: none"> • With the consent of the owner, the subsidence monitoring program will include: • Pre-mining inspection and assessment (as part of PSMP) • Observational monitoring to identify potential subsidence impacts to the fabric of the building and/or its interior • Assessment of heritage impacts by a suitably qualified heritage expert (if required) • This assessment would be made available to the MSB and include recommendations for management of heritage value during any repairs 	No Changes
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LANDSCAPE FEATURES

AREA 9	<ul style="list-style-type: none"> • Nepean River cliff lines • Harris Creek cliff lines • Sensitive terrain near built features (Razorback Range, Douglas Park Ridge) <p>Monitoring locations on private properties to be determined as appropriate/required in consultation with landowner/s</p>	<ul style="list-style-type: none"> • Observational and photographic monitoring • Piezometers • Slope inclinometers 	<ul style="list-style-type: none"> • Harris Creek and Nepean River cliff lines <ul style="list-style-type: none"> - Baseline recording once prior to mining. - Monthly routine inspections with weekly inspections during critical periods • Low Terrain Sensitivity (visual inspection) <ul style="list-style-type: none"> - 6 months prior to mining - 6 months after active subsidence • Medium Terrain Sensitivity <ul style="list-style-type: none"> - 6 to 12 months prior to mining - 3 monthly during active subsidence - 6 months after active subsidence • High Terrain Sensitivity <ul style="list-style-type: none"> • 12 months before commencement of subsidence for visual and on ground survey • Monthly for visual during active subsidence • 3-monthly for ground survey during active subsidence • Installation of piezometers and inclinometers as required and in consultation with landowners as part of PSMP process 	<ul style="list-style-type: none"> • Visual inspections • Photographic records • Ground survey (mid to high terrain sensitivity) • Piezometers (high terrain sensitivity) • Slope inclinometers (high terrain sensitivity) 	No Changes
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7. Appendix A

Table 7-1: Summary table of Longwall 903 TARP levels and observed impacts.

Monitoring	Trigger	Action (if impact is observed)	Impacts Observed
WATER QUALITY			
Adjacent and downstream sites: <ul style="list-style-type: none"> • Nepean River: <ul style="list-style-type: none"> – NR0 – SW3 (NR1) – NR2 – If and where strata gas emission plumes above 3000 L/min are detected 	Level 1* Impact monitoring sites when comparing the baseline period to the mining period for that site: <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 	<ul style="list-style-type: none"> • Continue monitoring program • Submit an Impact Report to OEH, DoPI, DPI and other relevant resource managers • Report in the End of Panel Report • Summarise actions and monitoring in AEMR 	<ul style="list-style-type: none"> • 1 new gas release zone identified on the Nepean River, consistent with Level 1 criteria, named 'AA9_LW903_001'. One update to an existing impact. • Level 1 TARP for EC at NR0 and Level 2 at upstream control site (NR110); therefore, not attributed to mining activities. • Level 1 TARP for Total Manganese at NR2, SW3 and upstream control site (NR110); therefore, not attributed to mining activities. • Level 1 TARP for Total Iron at NR0 and SW3. Deviation from baseline of similar magnitude were observed at the upstream control site and no underlying adverse trend in conditions; therefore, not attributed to mining activities.
	Level 2* Impact monitoring sites when comparing the baseline period to the mining period for that site: <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 • DO 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 	<ul style="list-style-type: none"> • Actions stated for Level 1 • Review monitoring program • Notify relevant technical specialists and seek advice on any CMA required • Implement agreed CMAs as approved <p><i>Note: CMAs are to be proposed based on appropriate management of environmental and other consequences of mining impacts i.e. water quality changes with insignificant consequences may not require specific CMAs other than ongoing monitoring to confirm there are no ongoing impacts</i></p> <p><i>Strata Gas Emission Plume:</i></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 site – dissolved sulfide and total phenols from exactly above gas plume and at nearest downriver monitoring site 	<ul style="list-style-type: none"> • Level 2 TARP for EC at SW3 and upstream control site (NR110); therefore, not attributed to mining.
	Level 3* Impact monitoring sites when comparing the baseline period to the mining period for that site: <ul style="list-style-type: none"> • Level 2-type reduction in water quality resulting from the mining observed for more than 6 consecutive months 	<ul style="list-style-type: none"> • Actions stated for Level 2 • Notify OEH, DP&I, NoW, DPI, DRE, relevant resource managers and technical specialists and seek advice on any CMA required • Invite stakeholders for site visit • Develop site CMA (subject to stakeholder feedback) 	<ul style="list-style-type: none"> • No such impacts observed

Monitoring	Trigger	Action (if impact is observed)	Impacts Observed
		<ul style="list-style-type: none"> • Completion of works following approvals, including monitoring and reporting on success • Review the TARP and Management Plan in consultation with key stakeholders <p><i>Note: CMAs are to be proposed based on appropriate management of environmental and other consequences of mining impacts i.e. water quality changes with insignificant consequences may not require specific CMAs other than ongoing monitoring to confirm there are no ongoing impacts</i></p>	
	<p>Exceeding Performance Measures</p> <ul style="list-style-type: none"> • Mining results in more than negligible gas releases, iron staining or water cloudiness 	<ul style="list-style-type: none"> • Actions stated for Level 3 • Investigate reasons for the exceedance • Update future predictions based on the outcomes of the investigation • Provide environmental offset if CMAs are unsuccessful 	<ul style="list-style-type: none"> • No such impacts observed
GROUNDWATER			
<p>Groundwater flow into the mine</p> <p>Groundwater Level:</p> <p>GW 34425 GW 35033 GW 72249 GW 100673 GW 101133 GW 102043 GW 102584 GW 102798 GW 103161 GW 104068 GW 104602 GW 104661 GW 110671</p> <p>BHPBIC Piezometers:</p>	<p>Level 1*</p> <ul style="list-style-type: none"> • Increase in water flow from the goaf between 2.7 to 3 ML/day (over 20-day average) • 5.0 – 7.5 m reduction in the Hawkesbury Sandstone greater than predicted standing water level or pressure (outside of pumping influences in private bores) over a minimum 2-month period 	<ul style="list-style-type: none"> • Continue monitoring program • Submit an Impact Report to OEH, DoPI, DPI and other relevant resource managers • Report in the End of Panel Report • Summarise actions and monitoring in AEMR 	<ul style="list-style-type: none"> • Decline in groundwater pressure at borehole S1941 reaching the Level 1 TARP. Groundwater pressure later recovered.
	<p>Level 2*</p> <ul style="list-style-type: none"> • Increase in water flow from the goaf between 3 to 3.4 ML (over 20-day average) • 7.5 – 10 m reduction in the Hawkesbury Sandstone greater than predicted standing water level or pressure (outside of pumping influences in private bores) over a minimum 2-month period 	<ul style="list-style-type: none"> • Actions stated for Level 1 • Review monitoring program • Notify relevant technical specialists and seek advice on any CMA required • Implement agreed CMAs as approved <p><i>Note: CMAs are to be proposed based on appropriate management of environmental and other consequences of mining impacts i.e. cracking at the surface with insignificant consequences may not require specific CMAs other than ongoing monitoring to confirm there are no ongoing impacts</i></p>	<ul style="list-style-type: none"> • No such impacts observed

Monitoring	Trigger	Action (if impact is observed)	Impacts Observed
NGW3 NGW4 NGW5 NGW6 EAW5 EAW7 EAW9 EAW18 EAW58 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</i> <i>Privately owned water supplies are monitored as agreed with landowners in the Built Feature Management Plans</i>	Level 3* <ul style="list-style-type: none"> • Abnormal increase in water flow from the goaf >3.4 ML (20-day average) • >10 m reduction in the Hawkesbury Sandstone greater than predicted standing water level or pressure (outside of pumping influences in private bores) over a minimum 2-month period • Mining results in groundwater bores unsafe, unserviceable or damaged 	<ul style="list-style-type: none"> • <i>Actions stated for Level 2</i> • Notify OEH, DP&I, DPI, NoW, DRE, relevant resource managers and technical specialists and seek advice on any CMA required. • Invite stakeholders for site visit • Develop site CMA (subject to stakeholder feedback). This may include: <ul style="list-style-type: none"> – Make area safe – Any actions agreed to in the Property Subsidence Management Plan – Provisions of alternate water supply where this has been impacted by mining – MSB to repair any infrastructure damaged by mining • Completion of works following approvals, including monitoring and reporting on success • Review the Groundwater Model, TARP and Management Plan in consultation with key stakeholders <p><i>Note: CMAs are to be proposed based on appropriate management of environmental and other consequences of mining impacts i.e. cracking at the surface with insignificant consequences may not require specific CMAs other than ongoing monitoring to confirm there are no ongoing impacts</i></p>	<ul style="list-style-type: none"> • <i>No such impacts observed</i>
LANDSCAPE FEATURES			
Cliffs and Steep Slopes <ul style="list-style-type: none"> • Nepean River cliff lines • Harris Creek cliff lines • Sensitive terrain near built features (Razorback Range, Douglas Park Ridge) Monitoring locations on private properties to be determined as appropriate/required in consultation with landowner	Level 1 <ul style="list-style-type: none"> • Rock fall from a cliff where the cliff is left mostly intact (<10% length of any single cliff) • Surface movement or rock displacement where any exposed soil surface is stable • Crack at the surface which does not result in ongoing erosion or ground movement • Erosion which stabilises within the period of monitoring without CMA • Crack or fracture up to 100 mm width • Crack or fracture up to 10 m length 	<ul style="list-style-type: none"> • Continue monitoring program • Submit an Impact Report to OEH, DoPI, DPI and other relevant resource managers • Report in the End of Panel Report • Summarise actions and monitoring in AEMR 	<ul style="list-style-type: none"> • <i>No such impacts observed</i>
	Level 2 <ul style="list-style-type: none"> • Rock fall from cliff where the characteristics of the cliff change (>10% length of any single cliff) • Ground disturbance that is unlikely to stabilise within the period of monitoring without CMA • Mass movement of a slope causing areas of exposed soil • Crack or fracture between 100 – 300 mm width • Crack or fracture between 10 – 50 m length 	<ul style="list-style-type: none"> • <i>Actions stated for Level 1</i> • Report trigger to key stakeholders • Review monitoring program • Notify relevant specialists and develop and implement any CMA required. • Provide safety signage and barricades where appropriate in areas as required for public safety (refer PSMP) • Implement agreed CMA's as approved <p><i>Note: CMAs are to be proposed based on appropriate management of environmental and other consequences of mining impacts i.e. cracking at the surface with insignificant consequences may not require specific CMAs other than ongoing monitoring to confirm there are no ongoing impacts</i></p>	<ul style="list-style-type: none"> • <i>No such impacts observed</i>

Monitoring	Trigger	Action (if impact is observed)	Impacts Observed
	<p>Level 3 *</p> <ul style="list-style-type: none"> • Cliff collapse (100% length of any single cliff) • Ground disturbance that does not stabilise within the period of monitoring • Mass movement of a slope causing areas of exposed soil that does not stabilise within the period of monitoring • Crack or fracture over 300 mm width • Crack or fracture over 50 m length 	<ul style="list-style-type: none"> • <i>Actions stated for Level 2</i> • Notify OEH, DP&I, DPI, NoW, DRE, relevant resource managers and technical specialists and seek advice on any CMA required. • Invite stakeholders for site visit • Develop site CMA (subject to stakeholder feedback). This may include: <ul style="list-style-type: none"> – Erosion prevention works – Establishment of vegetation • Completion of works following approvals, including monitoring and reporting on success • Review the TARP and Management Plan in consultation with key stakeholders <p><i>Note: CMAs are to be proposed based on appropriate management of environmental and other consequences of mining impacts i.e. cracking at the surface with insignificant consequences may not require specific CMAs other than ongoing monitoring to confirm there are no ongoing impacts</i></p>	<ul style="list-style-type: none"> • <i>No such impacts observed</i>
	<p>Exceeding Performance Measures</p> <ul style="list-style-type: none"> • For cliffs of 'special significance' and other cliffs flanking the Nepean River - mining results in more than negligible environmental consequences (i.e. more than occasional rockfalls, displacement or dislodgement of boulders or slabs, or fracturing, that in total impact more than 0.5% of the total face area of such cliffs within any longwall mining domain • Other cliffs – mining results in more than minor environmental consequences (that is occasional rockfalls, displacement or dislodgment of boulders or slabs or fracturing, that in total impact more than 3% of the total face area of such cliffs within any longwall mining domain 	<ul style="list-style-type: none"> • <i>Actions stated for Level 3</i> • Make area safe • Investigate reasons for the exceedance • Update future predictions based on the outcomes of the investigation • Provide environmental offset if CMAs are unsuccessful 	<ul style="list-style-type: none"> • <i>No such impacts observed</i>

AQUATIC ECOLOGY			
Nepean River <ul style="list-style-type: none"> Sites 1 and 2 (downstream) Sites X3 and X4 (adjacent to Longwalls 901 and 902) 	Level 1* <ul style="list-style-type: none"> Reduction in aquatic habitat resulting from the mining over 1 season 	<ul style="list-style-type: none"> Continue monitoring program Submit an Impact Report to OEH, DoPI, DPI and other relevant resource managers Report in the End of Panel Report Summarise actions and monitoring in AEMR 	<ul style="list-style-type: none"> No such impacts observed
	Level 2* <ul style="list-style-type: none"> Reduction in aquatic habitat resulting from the mining over 2 seasons 	<ul style="list-style-type: none"> Actions stated for Level 1 Report trigger to key stakeholders Review monitoring program Notify relevant specialists and develop and implement any CMA required. Implement agreed CMA's as approved <p><i>Note: CMAs are to be proposed based on appropriate management of environmental and other consequences of mining impacts i.e. impacts to aquatic habitat with insignificant consequences may not require specific CMAs other than ongoing monitoring to confirm there are no ongoing impacts</i></p>	<ul style="list-style-type: none"> No such impacts observed
	Level 3* <ul style="list-style-type: none"> Reduction in aquatic habitat resulting from the mining for >2 consecutive seasons or complete loss of habitat 	<ul style="list-style-type: none"> Actions stated for Level 2 Notify OEH, DP&I, DPI, NoW, DRE, relevant resource managers and technical specialists and seek advice on any CMA required. Invite stakeholders for site visit Develop site CMA (subject to stakeholder feedback). This may include: <ul style="list-style-type: none"> Grouting of fractures which result in flow diversion Completion of works following approvals Completion of works following approvals, including monitoring and reporting on success Review the TARP and Management Plan in consultation with key stakeholders <i>Note: CMAs are to be proposed based on appropriate management of environmental and other consequences of mining impacts i.e. impacts to aquatic ecology with insignificant consequences may not require specific CMAs other than ongoing monitoring to confirm there are no ongoing impacts</i> 	<ul style="list-style-type: none"> No such impacts observed
	Exceeding Performance Measures <ul style="list-style-type: none"> Mining results in more than negligible environmental consequences for a threatened species, threatened population or endangered ecological communities 	<ul style="list-style-type: none"> Actions stated for Level 3 Investigate reasons for the exceedance Update future predictions based on the outcomes of the investigation Provide environmental offset if CMAs are unsuccessful 	<ul style="list-style-type: none"> No such impacts observed
TERRESTRIAL ECOLOGY			
Visual inspections as part of landscape and water monitoring programs in active mining areas	Level 1* <ul style="list-style-type: none"> Impacts detectable via observational monitoring (e.g. canopy thinning, thinning of shrub layer, minor loss of ground cover) to a single vegetation strata 	<ul style="list-style-type: none"> Continue monitoring program Submit an Impact Report to OEH, DoPI, DPI and other relevant resource managers Report in the End of Panel Report Summarise actions and monitoring in AEMR 	<ul style="list-style-type: none"> No such impacts observed

	<ul style="list-style-type: none"> Subsidence impacts (such as surface cracking, rock falls) resulting in small areas of disturbance that will mitigate without CMA 		
	<p>Level 2*</p> <ul style="list-style-type: none"> Impacts detectable via observational monitoring (e.g. canopy thinning with dead branches present, thinning of the shrub layer with dead branches, loss of ground cover in multiple areas) to multiple vegetation strata Subsidence impacts (such as surface cracking, rock falls) resulting in small areas of disturbance that will not mitigate without CMA 	<ul style="list-style-type: none"> Actions stated for Level 1 Report trigger to key stakeholders Review monitoring program Notify relevant specialists and develop and implement any CMA required. Implement agreed CMA's as approved <p><i>Note: CMAs are to be proposed based on appropriate management of environmental and other consequences of mining impacts i.e. impacts to terrestrial with insignificant consequences may not require specific CMAs other than ongoing monitoring to confirm there are no ongoing impacts</i></p>	<ul style="list-style-type: none"> No such impacts observed
	<p>Level 3*</p> <ul style="list-style-type: none"> Impacts (e.g. canopy thinning with dead branches present, thinning of the shrub layer with dead branches, loss of ground cover in multiple areas) to multiple vegetation strata caused by subsidence effects Subsidence impacts (such as surface cracking, rock falls) resulting in large areas of disturbance that will not mitigate without CMA Negligible environmental consequences to threatened species, populations or EEC 	<ul style="list-style-type: none"> Actions stated for Level 2 Notify OEH, DP&I, DPI, NoW, DRE, relevant resource managers and technical specialists and seek advice on any CMA required. Invite stakeholders for site visit Develop site CMA (subject to stakeholder feedback). This may include: <ul style="list-style-type: none"> Erosion prevention works Establishment of vegetation Completion of works following approvals, including monitoring and reporting on success Review the TARP and Management Plan in consultation with key stakeholders <p><i>Note: CMAs are to be proposed based on appropriate management of environmental and other consequences of mining impacts i.e. impacts to terrestrial ecology with insignificant consequences may not require specific CMAs other than ongoing monitoring to confirm there are no ongoing impacts</i></p>	<ul style="list-style-type: none"> No such impacts observed
	<p>Exceeding Performance Measures</p> <ul style="list-style-type: none"> Mining results in more than negligible environmental consequences on threatened species, threatened populations, or endangered ecological communities 	<ul style="list-style-type: none"> Actions stated for Level 3 Investigate reasons for the exceedance Update future predictions based on the outcomes of the investigation Provide environmental offset if CMAs are unsuccessful 	<ul style="list-style-type: none"> No such impacts observed
ABORIGINAL ARCHAEOLOGY			
Impacts to the cliff lines on the southern side of the Nepean River (directly north of the site) will trigger an inspection of Bradcorp 1	<p>Level 1*</p> <ul style="list-style-type: none"> Change in shelter conditions not attributable to natural weathering or preservation that do not alter the heritage values of the place e.g. mineral growth or micro-organism growth Changes external to shelter conditions that effect the sites context e.g. ground cracking, boulder slumping, rock and/or tree falls 	<ul style="list-style-type: none"> Continue with monitoring program Condition assessment and photographic record Notify relevant specialists and key stakeholders (e.g. Registered Aboriginal Parties) Summarise impacts and report in the End of Panel Report and AEMR 	<ul style="list-style-type: none"> No such impacts observed
	<p>Level 2*</p> <ul style="list-style-type: none"> Change in shelter conditions not attributable to natural weathering or preservation e.g. change in drip line or seepage, cracking or exfoliation of 	<ul style="list-style-type: none"> Actions stated for Level 1 Review monitoring program Review impacts against the Performance Measures 	<ul style="list-style-type: none"> No such impacts observed

	overhang or shelter, movement or opening of existing planes and joints	<ul style="list-style-type: none"> Develop site management plan to mitigate effects in consultation with Registered Aboriginal Parties and the landowner 	
	Level 3* <ul style="list-style-type: none"> Change in shelter conditions not attributable to natural weathering or preservation e.g. cracking or exfoliation of art panel, movement of existing planes and joints at panel, block fall within shelter or overhang, shelter or overhang collapse 	<ul style="list-style-type: none"> <i>Actions stated for Level 2</i> Investigate reasons for impacts Update future predictions based on outcomes of the investigation 	<ul style="list-style-type: none"> <i>No such impacts observed</i>
	Exceeding Performance Measures <ul style="list-style-type: none"> More than 10% of sites across the mining area are affected by subsidence impacts (other than negligible impacts or environmental consequence) 	<ul style="list-style-type: none"> <i>Actions stated for Level 3</i> Investigate reasons for the exceedance Update future predictions based on the outcomes of the investigation 	<ul style="list-style-type: none"> <i>No such impacts observed</i>
EUROPEAN HERITAGE			
Douglas Park Railway Cottage – Item 30 from the BSOP EA	Level 1* <ul style="list-style-type: none"> Cracks or warping of external weatherboards, Cracks or movement < 5 mm in width in any external or internal wall claddings, linings, or finish Isolated cracked, loose, or drummy floor or wall tiles No impact to heritage values of the site 	<ul style="list-style-type: none"> Continue monitoring program Condition assessment and photographic record Notify relevant specialists and key stakeholders Summarise impacts and report in the End of Panel Report and AEMR 	<ul style="list-style-type: none"> <i>No such impacts observed</i>
	Level 2* <ul style="list-style-type: none"> Continuous cracking or warping of weatherboards, Slippage along the damp proof course of 5 to 15 mm Loss of bearing to isolated walls, piers, columns, or other load-bearing elements Loss of stability of isolated structural elements Loss of heritage value no greater than predicted in HMP 	<ul style="list-style-type: none"> <i>Actions stated for Level 1</i> Review monitoring program Review impacts against the Performance Measures Develop site management plan to mitigate effects in consultation with stakeholders, where appropriate 	<ul style="list-style-type: none"> <i>No such impacts observed</i>
	Level 3* <ul style="list-style-type: none"> Continuous cracking or warping of weatherboards Slippage along the damp proof course of 15 mm or greater anywhere in the total external façade Re-levelling of building Loss of stability of several structural elements Loss of heritage value greater than predicted in HMP 	<ul style="list-style-type: none"> <i>Actions stated for Level 2</i> Investigate reason for impacts Notify DP&I and MSB as soon as practicable Seek advice on any CMA required. Consultation with stakeholders (undertake site inspection if required). Review the relevant TARP and Management Plan in consultation with key stakeholders 	<ul style="list-style-type: none"> <i>No such impacts observed</i>
	Exceeding Performance Measures <ul style="list-style-type: none"> Loss of heritage value greater than predicted under the Heritage Management Plan 	<ul style="list-style-type: none"> <i>Actions stated for Level 3</i> Investigate reasons for the exceedance Update future predictions based on the outcomes of the investigation 	<ul style="list-style-type: none"> <i>No such impacts observed</i>

8. References

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- HGEO (2021), *Area 9 Longwall 903 End of Panel Surface Water and Groundwater Monitoring review*, Report by HGEO for South32 Illawarra Metallurgical Coal. Report Number – D21147
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- MSEC (2012), *Appin Colliery - Longwalls 901 to 904: Subsidence predictions and impact assessments for natural features and surface infrastructure in support of the Extraction Plan*, Report by Mine Subsidence Engineering Consultants for BHP Billiton Illawarra Coal. Report Number - MSEC448
- MSEC (2016), *Appin Colliery - Longwalls 901 to 904: Subsidence predictions and impact assessments for natural features and surface infrastructure in support of the Extraction Plan*, Report by Mine Subsidence Engineering Consultants for BHP Billiton Illawarra Coal. Report Number – MSEC829
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- PAC (2010), *Bulli Seam Operations PAC Report*, Planning and Assessment Commission, Sydney.