



APPIN MINE LONGWALL 708
END OF PANEL
LANDSCAPE REPORT
March 2022



EXECUTIVE SUMMARY

This report has been prepared by the South32 Illawarra Metallurgical Coal Environmental Field Team (IMCEFT) to summarise the observed and measured subsidence effects on water, landscape features and terrestrial ecology, resulting from the extraction of Longwall 708.

Extraction of Longwall 708 commenced on 2 April 2019 and was completed on 3 January 2022. The panel was extracted in two sections- Longwall 708A and Longwall 708B- with an approximately 170m section of unmined coal left in between. The panel will hereon be referred to as Longwall 708.

The IMCEFT conducts detailed monitoring and inspections of landscape features including the Nepean River, tributaries, cliffs and steep slopes, and private properties. This monitoring is conducted in accordance with the Appin Longwall 707 to 710 Environmental Management Plan (EMP), dated August 2021.

IMCEFT identified no new impacts/triggers associated with the extraction of Longwall 708. One update to an existing gas release on the Nepean River was identified.

TABLE OF CONTENTS

Executive Summary	2
List of Figures.....	4
List of Tables.....	4
Abbreviations	4
1 Introduction.....	5
2 Summary of Monitoring Program.....	5
3 Summary of Impacts	7
3.1 Water Quality.....	7
3.1.1 Gas Releases.....	7
3.1.2 Water Level and Flow.....	8
3.1.3 Appearance.....	8
3.1.4 Groundwater	8
3.1.5 Landscape Features.....	9
3.1.6 Terrestrial Ecology	9
3.1.7 Private Property Inspections	9
3.1.8 Aboriginal Archaeology	9
4 Future Monitoring	13
5 Appendix A.....	14
6 Appendix B.....	18

LIST OF FIGURES

Figure 1: Map showing IMC surface water monitoring sites relevant to Longwall 708.	6
Figure 2: Map showing subsidence impacts and triggers relevant to Longwall 708.	11
Figure 3: Map showing IMC and private properties boreholes relevant to Longwall 708.	12

LIST OF TABLES

Table 1: Summary of Longwall 708 impacts and triggers.	10
---	----

ABBREVIATIONS

CMA – Corrective Management Action

DPE - Department of Planning and Environment

DPI – Department of Primary Industries

DRE - Department of Trade and Investment, Division of Resources and Energy

EoP – End of Panel

EP – Extraction Plan

IMCEFT – Illawarra Metallurgical Coal Environmental Field Team

OEH - Office of Environment and Heritage (now BCD)

BCD- Biodiversity and Conservation Division (formerly OEH)

SCA – Sydney Catchment Authority (now WaterNSW)

SA NSW – Subsidence Advisory NSW

TARP – Trigger Action Response Plan

1 INTRODUCTION

This report outlines monitoring of landscape features relevant to Longwall 708 and forms part of the Appin Area 7 Longwall 708 End of Panel Report (EoP Report). Monitored features include the Nepean River and its tributaries, cliffs and steep slopes, terrestrial flora, as well as private properties (farm dams and private boreholes). Monitoring of landscape features relevant to Longwall 708 has been carried out in accordance with the Appin Longwall 707 to 710 Environmental Management Plan (EMP), dated August 2021. The Trigger Action Response Plan (TARP) set out in the EMP provides the actions required for any subsidence impacts identified (Appendix B).

Extraction of Longwall 708 commenced on 2 April 2019 and was completed on 3 January 2022.

Monitoring was conducted for landscape features for Longwall 708 during baseline, active mining and post-mining periods. This monitoring involves measurement of surface water quality and levels, groundwater quality and levels (from Illawarra Metallurgical Coal (IMC) and private boreholes), and general observations of landscape features within the mining area. The results of the monitoring are outlined in the relevant sections below.

2 SUMMARY OF MONITORING PROGRAM

The Appin Area 7 monitoring program has been designed to identify impacts and consequences of mining and is presented in Figure 1 and Appendix A. Monitoring is conducted during baseline, active mining and post-mining periods. Baseline inspections are undertaken up until the longwall is within 400m of a feature. During active mining, inspections increase to weekly for any features within 400m of the longwall. Monthly post-mining inspections continue as outlined in the EMP.

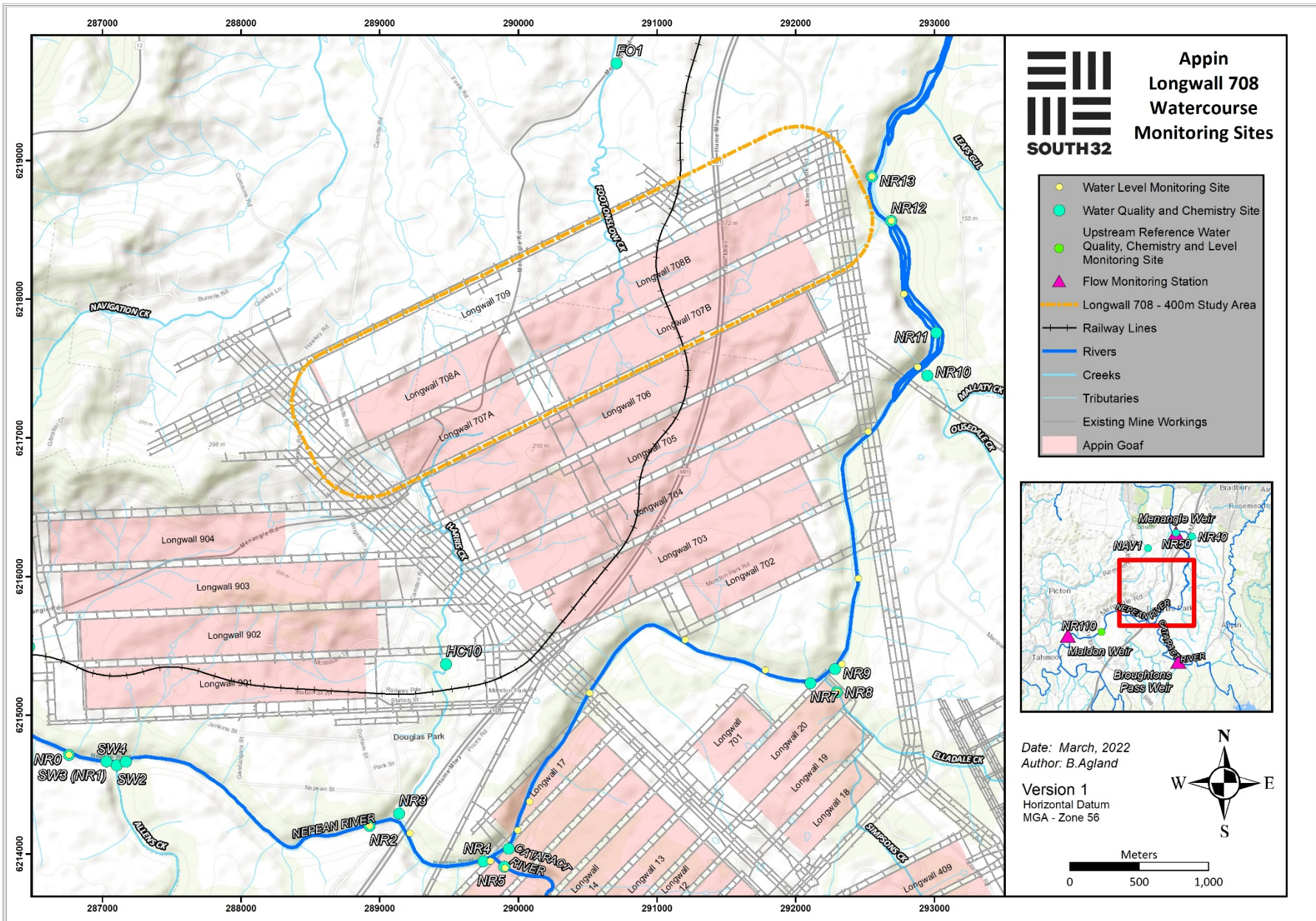


Figure 1: Map showing IMC surface water monitoring sites relevant to Longwall 708.

3 SUMMARY OF IMPACTS

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.

During the extraction of Longwall 708, no new impacts were observed. An update to one update to an existing impact, labelled "AA7_LW703_Gas Zone 10", was observed (Table 1).

3.1 Water Quality

In-situ water quality parameters are measured at the relevant monitoring sites on the Nepean River and its tributaries. In-situ water quality parameters include: temperature, electrical conductivity (EC), oxidation-reduction potential (ORP), pH, dissolved oxygen (DO) as well as visual observations. Water samples are also taken for laboratory analysis. Specialist assessment of water quality results will be included in the Surface Water and Groundwater Assessment of the Longwall 708 EoP Report.

3.1.1 Gas Releases

One update to a gas release zone was reported during the extraction of Longwall 708. The update remains as a Level 1 Trigger in accordance with the Trigger Action Response Plan (TARP) in the Appin Longwall 707 to 710 EMP (Appendix B); specifically:

- Identification of strata gas plume of flow rate <3000 L/min

The following actions were initiated in response to these impacts:

- Continue monitoring program
- Submit an Impact Report to relevant stakeholders
- Report in the End of Panel Report
- Summarise actions and monitoring in the AEMR

AA7_LW703_Gas Zone 10 Update (E 292967, N 6217438)

AA7_LW703_Gas Zone 10 is a historical gas release zone on Ousedale Creek that was first identified on 21 May 2010 during the extraction of Longwall 703. The site is approximately 2050m from Longwall 708B at its closest point (Figure 2). The gas zone was initially observed as three separate intermittent releases. During inspection on 2 November 2020, 10 to 12 light, intermittent releases were identified in a 15m by 5m area of the creek, towards the confluence with the Nepean River (Photo 1).



Photo 1: Gas release zone AA7_LW703_Gas Zone 10 Update. Taken on 2/11/2020.

Continued monitoring of gas release zones previously reported during the extraction of Appin Area 7 also occurred. Details of active gas releases during Longwall 708 are summarised in Table 1 and displayed in Figure 2.

3.1.2 Water Level and Flow

Water levels in the Nepean River and its tributaries are monitored by the IMCEFT using photo observations and installed benchmark measurements where available. Inspections are undertaken where access is safe and granted. No subsidence induced flooding of river banks was observed. For assessment of water level and flow refer to the Surface Water and Groundwater Assessment of the Longwall 708 EoP Report.

3.1.3 Appearance

The appearance of the Nepean River and its tributaries are monitored by the IMCEFT where access is safe and granted. Photographs are taken of monitoring sites, gas zones and any other potential impact site. Apart from the previously mentioned gas release zones, no impacts to the appearance of the Nepean River or tributaries were observed during the extraction of Longwall 708.

3.1.4 Groundwater

Boreholes relevant to Longwall 708 are: EAW5 (S1913) and EAW7 (S1936). Specialist assessment of groundwater level data will be included in the Surface Water and Groundwater Assessment of the Longwall 708 EoP Report.

3.1.5 Landscape Features

Observations of clifflines and steep slopes along the Nepean Gorge and associated tributaries were conducted by the IMCEFT on a monthly basis. Observational and photographic monitoring is conducted for cliff/ steep slope instability and seeps. No impacts to cliffs were identified during the extraction of Longwall 708. Observations above the active longwall were conducted where access is available. Results of ground movement recorded to built features above Longwall 708, including roads and railway, will be included in the Subsidence Assessment of the LW708 EoP Report.

3.1.6 Terrestrial Ecology

Terrestrial ecology in Appin Area 7 is monitored by the 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.

3.1.7 Private Property Inspections

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. These 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. Piezometer data was also collected at private property Lot 11 DP775437. Results of water quality and piezometer data will be assessed in the Surface Water and Groundwater Assessment of the Longwall 708 EoP Report. Post-mining inspections were unable to be undertaken at other properties due to access issues.

3.1.8 Aboriginal Archaeology

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

Table 1: Summary of Longwall 708 impacts and triggers.

Site ID	Easting	Northing	Impact/Trigger Type	Identification Date	Status (as of 17/01/2022)	Description	Impact Level	Report Date
AA7_LW701_Gas Zone 4	292230	6215262	Gas Release	15/01/2008	Inactive	Six constant, moderate gas releases within a 2m ² surface area. Identified on one inspection during Longwall 708.	1	11/12/2008
AA7_LW701_Gas Zone 5	292243	6215209	Gas Release	1/02/2008	Active	Light to moderate intermittent gas release within a 2m by 5m surface area. Identified on two inspections during Longwall 708.	1	11/12/2008
AA7_LW703_Gas Zone 10 (Update)	292967	6217438	Gas Release	21/05/2010 & 2/11/2020	Active	10 to 12 light, intermittent releases within a 15m by 5m surface area. Identified on 26 inspections during Longwall 708.	1	27/05/2010 & 5/11/2020
AA7_LW704_Gas Zone 15	290407	6214940	Gas Release	2/08/2012	Inactive	20 light to moderate gas releases within a 20m by 10m surface area. Identified on one inspection during Longwall 708.	1	10/08/2012

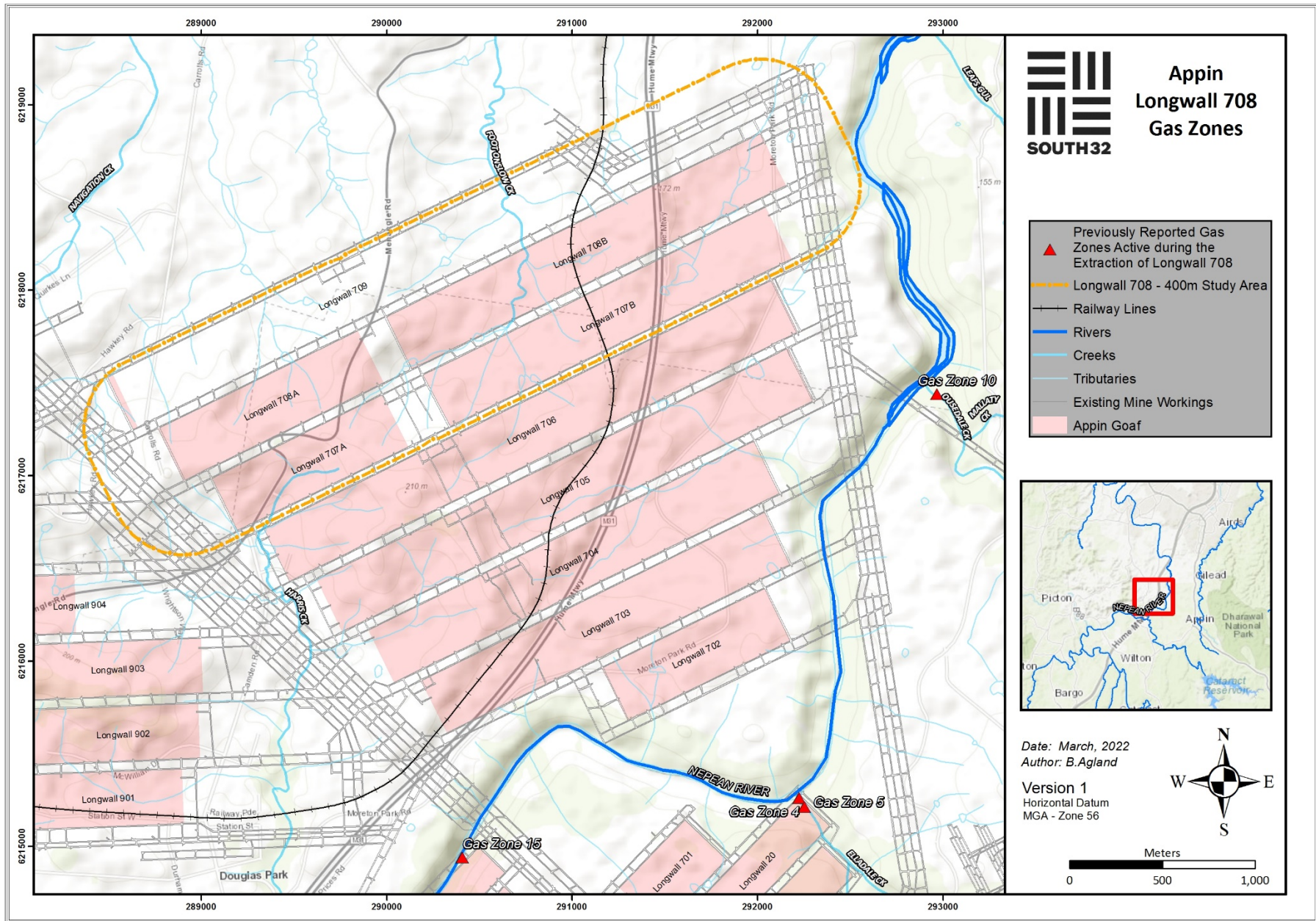


Figure 2: Map showing subsidence impacts and triggers relevant to Longwall 708.

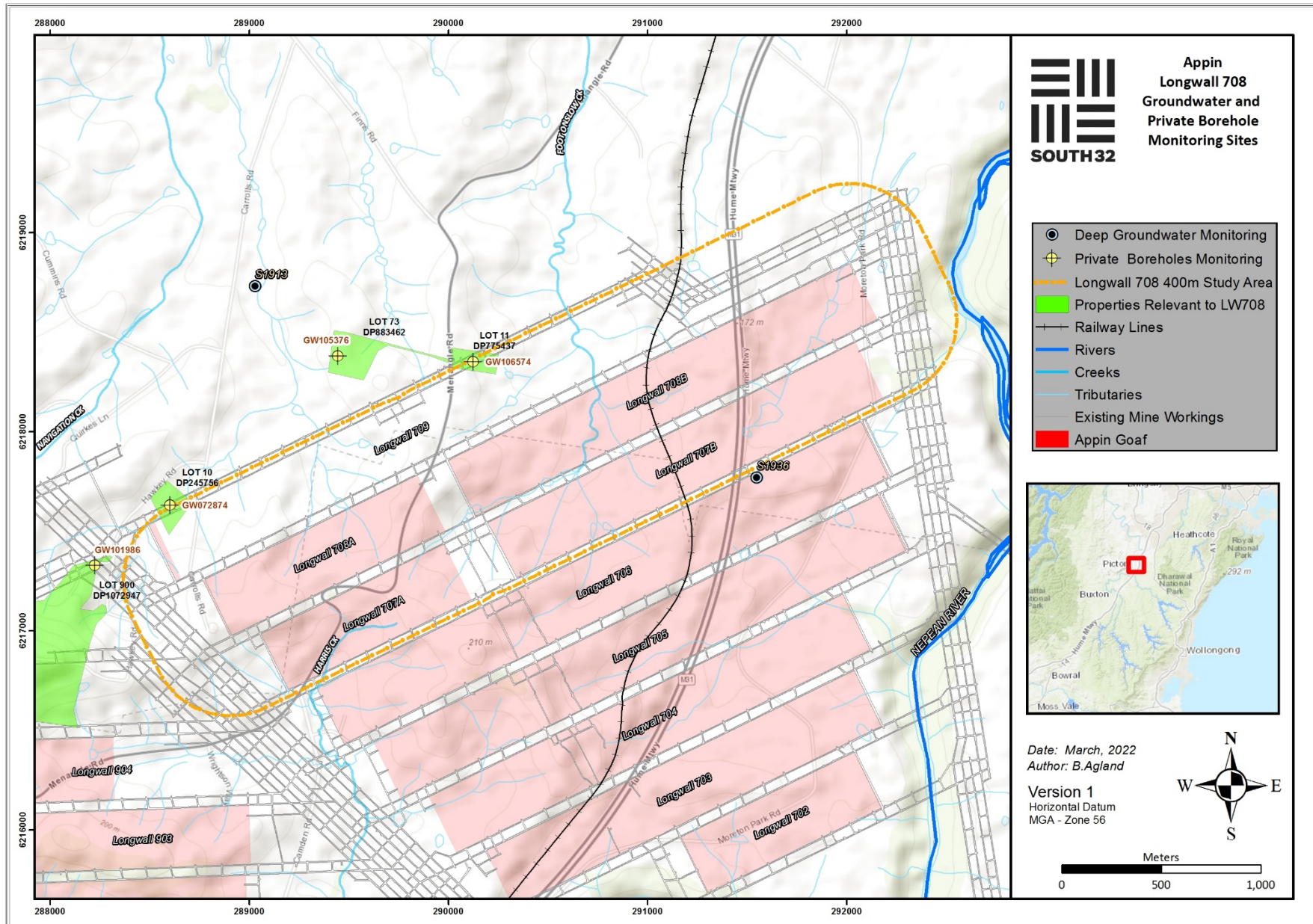


Figure 3: Map showing IMC and private properties boreholes relevant to Longwall 708.

4 FUTURE MONITORING

Future monitoring in Appin Area 7, particularly concerning Longwall 709, is outlined in Appendix A. These are based on monitoring commitments outlined in the EMP.

5 APPENDIX A

Appendix A: 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⁾ 	<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)

<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 		<ul style="list-style-type: none"> • 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"> • Photo points
<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 		<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>

<ul style="list-style-type: none"> • Pump 5 NRL • Pump 6 NRL 			
<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</p> <p>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>Private Bores (10 registered bores)</p> <ul style="list-style-type: none"> • GW104602 • GW104661 • GW105376 • GW105388 • GW105574 • GW101986 • GW105339 • GW106574 • GW072874 • GW105534 	<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 months post mining depending on borehole functionality <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>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>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 	<ul style="list-style-type: none"> • Vegetation communities • Vegetation condition • Changes in vegetation • Tree health

		areas during all other monitoring	• Threatened species
There are no applicable aboriginal archaeology sites on the AIHMS database within the Appin Longwalls 707 to 710 mining area.			Any sites identified during the mining period would be monitored as required by the Bulli Seam Operations Heritage Management Plan

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.

6 APPENDIX B

Appendix B: 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">NR2</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				NR2				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																																																			
Impact Site																																																						
NR2																																																						
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																																																			

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, DPIE, 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 NR111					
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) 	<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"> Abnormal rise in water flow from the goaf >3.4ML/day (over 20 day average) 	<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
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
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⁽⁷⁾</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⁽⁷⁾</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⁽⁷⁾</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		Upstream check		Level 2 and 3		Upstream check	
NR12	NR13	NR110		NR12	NR13	NR110	
pH>	pH>	pH>		pH>	pH>	pH>	
DO>	DO>	DO>		DO>	DO>	DO>	
				EC>280 µS/cm	EC>279 µS/cm	EC<424 µS/cm	
				Total Fe >0.691 mg/L	Total Fe>0.666 mg/L	Total Fe<0.590 mg/L	
				Total Mn>0.057 mg/L	Total Mn>0.060 mg/L	Total Mn<0.056 mg/L	