



# LONGWALLS 709 TO 711 AND 905 SUBSIDENCE MONITORING PROGRAM

*This document UNCONTROLLED once printed*

<b>Document ID</b>		<b>Version</b>	1.2	Page 1 of 34
<b>Last Date Updated</b>	July 2022	<b>Next Review Date</b>	October 2025	



# Table of Contents

<b>1. INTRODUCTION.....</b>	<b>4</b>
1.1 Project Background.....	4
1.2 Scope.....	4
1.3 Objectives.....	6
1.4 Consultation.....	6
<b>2. STATUTORY REQUIREMENTS .....</b>	<b>6</b>
2.1 BSO Approval.....	6
2.2 Legislation and Guidelines.....	6
2.3 Relevant Leases and Licences.....	7
<b>3. PLAN ADMINISTRATION.....</b>	<b>8</b>
3.1 Review and Update.....	8
3.2 Extraction Sequence.....	8
<b>4. SURFACE FEATURES INCLUDED IN THE MONITORING PROGRAM.....</b>	<b>9</b>
4.1 The Study Area.....	9
4.2 Overview of Potentially Affected Features.....	9
<b>5. REVISED SUBSIDENCE PARAMETERS AND SUBSIDENCE IMPACTS DUE TO LONGWALLS 709 TO 711 AND 905 EXTRACTION .....</b>	<b>12</b>
5.1 Predicted Subsidence Parameters and Impacts for the Natural Features and Items of Surface Infrastructure Within the Study Area.....	13
<b>6. MONITORING.....</b>	<b>13</b>
6.1 Subsidence Movements.....	13
6.2 Environmental Consequences of Subsidence .....	14
<b>7. MONITORING VALIDATION.....</b>	<b>22</b>
7.1 Reporting.....	22
7.2 Review.....	22
<b>8. CONTINGENCY RESPONSE PLAN .....</b>	<b>23</b>
<b>9. REFERENCES.....</b>	<b>24</b>
<b>10. ATTACHMENT A: MASTER TARPS.....</b>	<b>25</b>

## FIGURES

Figure 1 Appin Area 7 – 9 (Longwalls 709 to 711 and 905) Study Area.....	5
Figure 2 Appin Area 7 – 9 (Longwalls 709 to 711 and 905) Monitoring Locations .....	15

<i>This document UNCONTROLLED once printed</i>				Page 2 of 34
<b>Document ID</b>		<b>Version</b>	1.2	
<b>Last Date Updated</b>	July 2022	<b>Next Review Date</b>	October 2025	



## TABLES

Table 1 Appin Mine Leases, Licences and Other Reference Documents.....	7
Table 2 Expected Schedule for Longwall Extraction 709 to 711 and 905.....	8
Table 3 Monitoring Directory.....	16

## DOCUMENT REVISION LOG

### Persons authorising this Plan

Name	Title	Date
Gary Brassington	Manager Approvals	July 2022

### Document Revisions

Revision	Description of Changes	Date
<b>ICH Document</b>		
1.0	Original Document	July 2021
1.1	Updated to address Agency comments	October 2021
1.2	Administrative updates	July 2022

### Persons involved in the review of this Plan

Name	Title	Company	Exp (yrs)
Cody Brady	Principal Approvals	South32	5
Gary Brassington	Manager Approvals	South32	25
Richard Walsh	Superintendent Infrastructure	South32	30+

<i>This document UNCONTROLLED once printed</i>				Page 3 of 34
<b>Document ID</b>		<b>Version</b>	1.2	
<b>Last Date Updated</b>	July 2022	<b>Next Review Date</b>	October 2025	



# 1. INTRODUCTION

## 1.1 Project Background

South32 Illawarra Metallurgical Coal (IMC) operates the Bulli Seam Operations (BSO) 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 BSO (MP 08\_0150) under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act) to continue mining operations until 2041.

This Subsidence Monitoring Program supports the Longwalls 709 to 711 and 905 Extraction Plan for mining of coal in Appin Areas (AA) 7 and 9 mining domains. The relationship between this Monitoring Program and the other components of the Extraction Plan is shown in Figure 1 of the Extraction Plan.

## 1.2 Scope

This Monitoring Program has been prepared in accordance with the BSO Approval (MP 08\_0150) Condition 5 (m), Schedule 3 as follows:

5. The Proponent shall prepare and implement an Extraction Plan for first and second workings within each longwall mining domain to the satisfaction of the Secretary. Each extraction plan must:
- m) Include a Subsidence Monitoring Program, which has been prepared in consultation with DRE, OEH and SCA to:
    - provide data to assist with the management of the risks associated with subsidence;
    - validate the subsidence predictions;
    - analyse the relationship between the predicted and resulting subsidence effects and the predicted and resulting impacts under the plan and any ensuing environmental consequences; and
    - inform the contingency plan and adaptive management process.

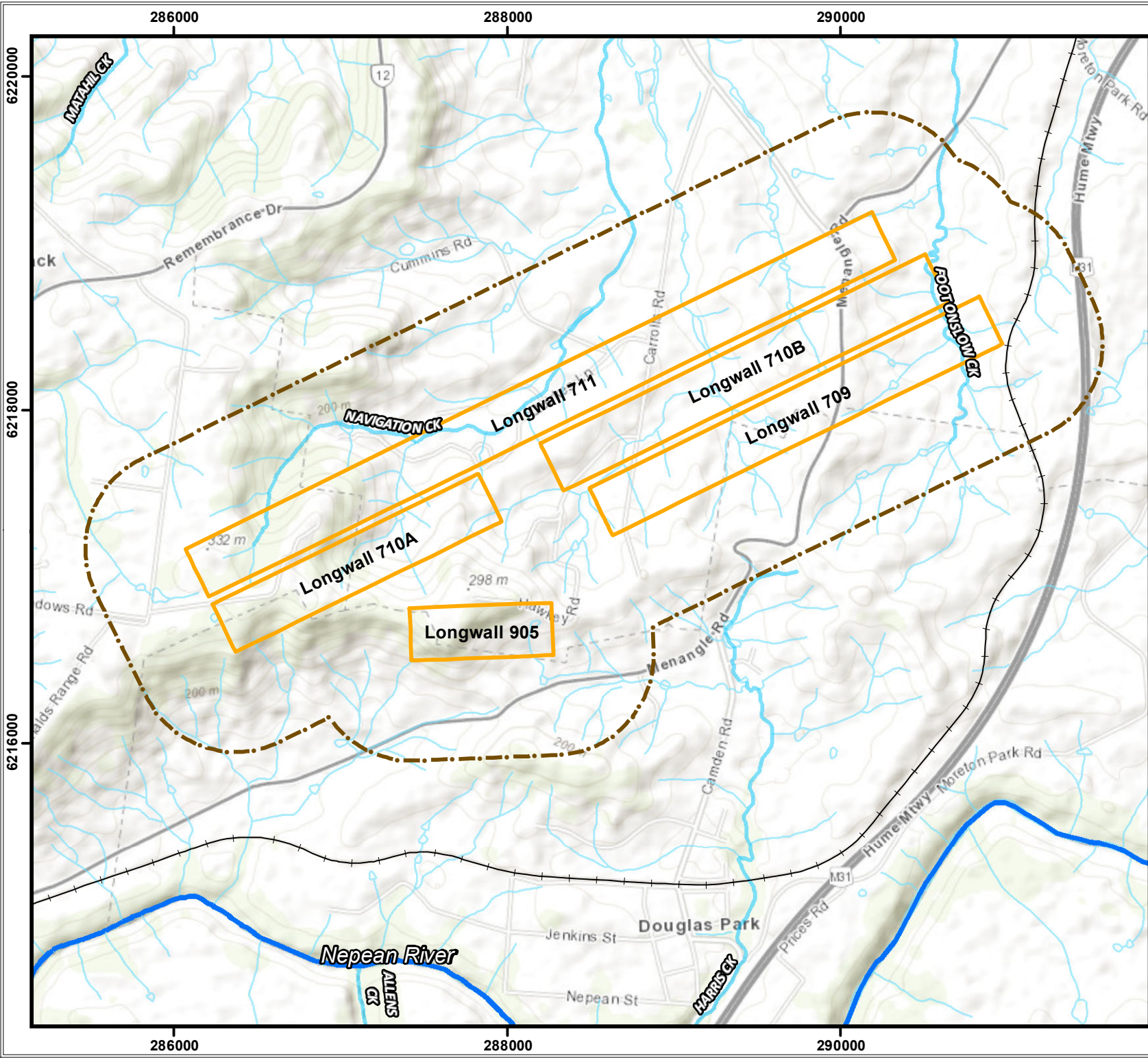
The Study Area for the Extraction Plan is defined in accordance with MSEC (2021) as the surface area predicted to be affected by the proposed mining of Longwalls 709 to 711 and 905 and encompasses the areas bounded by the following limits (Figure 1):

- A 35° angle of draw line from the maximum depth of cover, which equates to a horizontal distance varying between 530 m and 750 m around the limits of the proposed extraction areas for Longwalls 709 to 711 and 905, and
- The predicted limit of vertical subsidence, taken as the 20 mm subsidence contour, resulting from the extraction of the proposed Longwalls 709 to 711 and 905.

The features that are located within but not limited to 600 m of the proposed longwalls and are predicted to experience valley-related effects and could be sensitive to these movements have also been included in the assessments provided in this report.

<i>This document UNCONTROLLED once printed</i>				Page 4 of 34
<b>Document ID</b>		<b>Version</b>	1.2	
<b>Last Date Updated</b>	July 2022	<b>Next Review Date</b>	October 2025	





**SOUTH32**

# Appin Areas 7 and 9

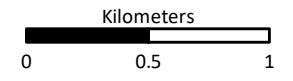
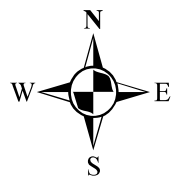
Longwalls 709-711  
and 905  
Study Area

Figure 1

- Longwalls 709-711 and 905
- 600 m Study Area
- Railway Lines
- Rivers
- Creeks
- Tributaries



Date: December, 2020  
 Author: B. Agland  
 Version 1  
 Horizontal Datum  
 MGA - Zone 56





### 1.3 Objectives

The key objective of this Monitoring Program is to satisfy Condition 5(m) of the BSO Approval in relation to the potential impacts and/or environmental consequences from the proposed mining to sensitive environmental and built features within the Longwalls 709 to 711 and 905 Study Area. In order to achieve this, the Plan:

- Provides consolidated monitoring parameters based on the recommendations and commitments in the Management Plans (refer to Annexes C – H of the Extraction Plan).
- Details the process undertaken to validate subsidence predictions.
- Reviews predicted subsidence impacts in the context of ongoing monitoring.
- Provides contingency and management processes responsive to monitoring results.

### 1.4 Consultation

This Monitoring Program will be developed in consultation with:

- Biodiversity and Conservation Division (BCD);
- Department of Planning and Environment (DPE);
- Resources Regulator; and
- WaterNSW.

South32 will make the Monitoring Program and associated documentation publicly available on the South32 website in accordance with Condition 11, Schedule 6 of the BSO Approval.

## 2. STATUTORY REQUIREMENTS

Extraction of coal from Longwalls 709 to 711 and 905 will be in accordance with the conditions set out in the BSO Approval, applicable legislation as detailed in Section 2.2 and the requirements of relevant licences and permits (including conditions attached to mining leases).

### 2.1 BSO Approval

Condition 5 (m), Schedule 3 of the BSO Approval requires the preparation of a Monitoring Program to provide data to assist with the management of the risks associated with subsidence, validate the subsidence predictions, analyse the relationship between the subsidence effects and impacts under the Plan and any ensuing environmental consequences and inform the Contingency Plan adaptive management process.

### 2.2 Legislation and Guidelines

This Monitoring Program has been developed taking account of the requirements of the following legislation and associated advisory documents and guidelines where applicable including:

- *Contaminated Land Management Act, 1997*

<i>This document UNCONTROLLED once printed</i>				Page 6 of 34
Document ID		Version	1.2	
Last Date Updated	July 2022	Next Review Date	October 2025	



- *Dangerous Goods Act, 1975*
- *Mining Act, 1992*
- *Biosecurity Act, 2015*
- *Rail Safety National Law (NSW), 2012*
- *Roads Act, 1993*
- *Protection of the Environment Operations Act, 1997*
- *Biodiversity Conservation Act, 2016*
- *National Parks and Wildlife Act, 1974*
- *Environmental Protection Biodiversity and Conservation Act, 1999*
- *WaterNSW Act, 2014*
- *Coal Mine Health and Safety Amended Act, 2010*
- *Crown Lands Management Act, 2016*
- *Dams Safety Act, 2015*
- *Energy and Utilities Administration Act, 1987*
- *Fisheries Management Act, 1994*
- *Water Management Act, 2000*
- *Work Health and Safety Act, 2011.*

Further details of applicable advisory documentation and guidelines can be found in the relevant management plans appendices to the Extraction Plan (Appendix C – I of the Extraction Plan).

### 2.3 Relevant Leases and Licences

The following licences or permits applicable to South32’s operations in AA7 and 9:

- Mining Leases as per Table 1.
- Environment Protection Licence (EPL) 2504 which applies to BSO, including Appin and West Cliff Mines. A copy of the licence can be accessed at the EPA website via the following link <http://www.epa.nsw.gov.au/prpoeo/index.htm>
- BSO Mining Operation Plan (MOP) 1/10/2020 to 30/09/2024 (V1.3).
- All relevant Occupational Health, Safety, Environment and Community approvals.
- Any additional leases, licences and approvals resulting from the BSO Approval.

**Table 1 Appin Mine Leases, Licences and Other Reference Documents**

Mining Lease - Document Number	Start	Finish
CCL 767	29 Oct 1991	08 Jul 2029
CL 388	22 Jan 1992	22 Jan 2034

<i>This document UNCONTROLLED once printed</i>				Page 7 of 34
Document ID		Version	1.2	
Last Date Updated	July 2022	Next Review Date	October 2025	



ML 1382	20 Dec 1995	20 Dec 2037
ML 1433	24 Jul 1998	23 Jul 2019 <sup>1</sup>
ML 1678	27 Sep 2012	26 Sep 2033

### 3. PLAN ADMINISTRATION

#### 3.1 Review and Update

This Monitoring Program will be reviewed on a regular basis to ensure that it incorporates any recommended measures to improve the environmental performance of the project.

If deficiencies in the Monitoring Program and/or Extraction Plan are identified throughout the course of extraction the plans will be modified as required. This process will ensure that environmental documentation continues to meet current environmental requirements, including changes in technology and operational practice, as well as the expectations of stakeholders.

#### 3.2 Extraction Sequence

Extraction of longwalls will occur in a staged process commencing with Longwall 709 and finishing with Longwall 711 in AA7 and extraction of the final longwall in AA9. The scheduled mining of Longwalls 709 to 711 and 905 is provided below in Table 2.

**Table 2 Expected Schedule for Longwall Extraction 709 to 711 and 905**

Longwall	Start	Finish	Dimensions (void length and width)
709	December 2021	June 2023	2615 x 324 (m)
710A	June 2023	February 2024	1787 x 324 (m)
710B	March 2024	December 2024	2529 x 324 (m)
711	December 2024	May 2026	4469 x 324 (m)
905	July 2022	December 2022	858 x 324 (m)

The geology, seam structure, and depth of cover are described in the Extraction Plan. The depth of cover directly above the proposed longwalls varies between 530 and 750 m. The minimum depth of cover occurs along Foot Onslow Creek where it crosses the finishing (i.e. eastern) end of Longwall 709. The maximum depth of cover occurs along the Razorback

<sup>1</sup> Application for the renewal of Mining Lease 1433 which was lodged with the NSW Department of Planning and Environment – Division of Resources and Geoscience (Division) on 18 July 2018.

<i>This document UNCONTROLLED once printed</i>				Page 8 of 34
Document ID		Version	1.2	
Last Date Updated	July 2022	Next Review Date	October 2025	





Range above the western end of Longwall 711. The seam floor within the Study Area generally dips from the south to the north.

The seam thickness within the proposed longwalls varies between 2.8 m and 3.3 m. The proposed longwalls will extract the full seam height.

## 4. SURFACE FEATURES INCLUDED IN THE MONITORING PROGRAM

### 4.1 The Study Area

The Study Area is defined by MSEC (2021) in Section 1.2 and includes features within the 35° angle of draw of the proposed longwalls and those features that lie outside the Study Area that are expected to experience either far-field movements, or valley related upsidence and closure movements. The features assessed include:

- Watercourses within 600 m of the proposed longwall;
- Cliffs and rock outcrops;
- Steep slopes;
- The Main Southern Railway;
- M31 Hume Motorway;
- Nepean Twin Bridges;
- Moreton Park Road Bridges (North and South);
- Buildings, structures and public infrastructure;
- Groundwater bores; and
- Survey control marks.

### 4.2 Overview of Potentially Affected Features

The features identified by the Management Plans are discussed in detail in MSEC (2021) and summarised below to provide context for the development of the monitoring programs.

#### 4.2.1 Natural Features

Watercourses within the Study Area are shown in MSEC (2021) Drawing No. MSEC1107-07 and include:

- Nepean River<sup>2</sup>;
- Foot Onslow Creek;

---

<sup>2</sup> There are no rivers within the Study Area. The Nepean River is located to the south east and at a distance of 1.5 km at its closest point. It is included due to its significance.

<i>This document UNCONTROLLED once printed</i>				Page 9 of 34
Document ID		Version	1.2	
Last Date Updated	July 2022	Next Review Date	October 2025	



- Harris Creek;
- Navigation Creek;
- Navigation Creek Tributary 1; and
- Other small drainage lines.

A comprehensive survey of the above watercourses is provided in MSEC (2021) and SLR (2021b).

Cliffs and rock outcrops within the Study Area are shown in MSEC (2021) Drawing No. MSEC448-08 and include:

- The cliffs located along Razorback Range in the western part of the Study Area formed in the sandstone members of the Wianamatta Group.
- Rock outcrops located across the Study Area, primarily along the Razorback Range and the incised creeks and tributaries.

Steep slopes within the Study Area are shown in MSEC (2021) Drawing No. MSEC448-08 and include:

- Razorback Range above Longwall 710A, the western end of Longwall 711 and above Longwall 905. The surface soils for the steep slopes along Razorback Range have formed from the Wianamatta Group.

There are no swamps, wetlands and water related ecosystems within the Study Area. There are minor water related ecosystems within the Study Area associated with the streams.

Protected or Threatened Species which have been declared as critical habitat under the *Biodiversity Conservation Act 2016*, are not located within the Study Area. There are, however, threatened and protected species within the Study Area which are described in the report by Niche (2021) and Cardno (2021).

Natural Vegetation in the Study Area can be seen from the aerial photograph provided in Figure 2 of the Biodiversity Management Plan (Extraction Plan Appendix D). A survey of the natural vegetation within the Study Area has been undertaken and details are provided in the report by Niche (2021).

#### 4.2.2 Public Utilities

Railway infrastructure within the Study Area ((MSEC (2021) Drawing No. MSEC1117-09) includes:

- Approximately 1.3 km of the Main Southern Railway, which extends between kilometrages 68.2 km and 69.5 km.
- Culverts, embankments and cuttings

Bridges potentially affected by subsidence include:

- The Nepean Twin Bridges located outside the Study Area for Longwalls 709 to 711 and 905. However, they could experience far-field horizontal movements and could be sensitive to these effects.
- Moreton Park Road Bridge (North and South) located outside the Study Area for Longwalls 709 to 711 and 905. However, they could experience far-field horizontal movements and could be sensitive to these effects.

<i>This document UNCONTROLLED once printed</i>				Page 10 of 34
<b>Document ID</b>		<b>Version</b>	1.2	
<b>Last Date Updated</b>	July 2022	<b>Next Review Date</b>	October 2025	



Major Roads either located within or potentially affected by far field movements include:

- The M31 Hume Motorway located outside and to the east of the Study Area. The motorway is located 470 m from the south-eastern corner of Longwall 709, at its closest point to the proposed longwalls.

Local roads are shown in MSEC (2021) Drawing No. MSEC1117-09.

- The main local road within the Study Area is Menangle Road. This road provides a connection between the township of Campbelltown, located north-east of the Study Area, and Picton Road, to the south-west of the Study Area. There are also a number of other local roads located across the Study Area.

Road culverts are located across the Study Area.

Water, gas and sewage infrastructure is shown in MSEC (2021) Drawing No. MSEC1117-12.

The electrical infrastructure within the Study Area comprises 66 kV powerlines, 11 kV powerlines and low voltage powerlines. There are no transmission lines located within the Study Area. The locations of the electrical infrastructure are shown in Drawing No. MSEC1117-10.

The locations of the telecommunications infrastructure are shown in Drawing No. MSEC1117-11.

#### 4.2.3 **Farm Land and Facilities**

The locations of the rural structures are shown in Drawing No. MSEC1117-13. There are 581 rural structures that have been identified within the Study Area. These structures include sheds, garages, carports and other non-residential building structures.

Tanks and farm dams are located across the Study Area as shown in MSEC (2021) Drawings No's. MSEC1117-13.

- There are 339 tanks that have been identified within the Study Area. These include water storage and gas tanks on the properties.
- There are 239 farm dams that have been identified within the Study Area. The farm dams are generally shallow, with the dam wall heights generally less than 3 m.

Groundwater bores within the Study Area are detailed within the Water Management Plan and SLR (2021a) and comprise 14 registered bores.

#### 4.2.4 **Industrial Commercial and Business Establishments**

The locations of the commercial structures are shown in Drawing No. MSEC1117-13. There are two commercial structures identified within the Study Area on property F17 (Refs. F17C01 and F17C01). These structures are associated with the telecommunications tower located near the maingate of the proposed Longwall 905.

#### 4.2.5 **Areas of Archaeological or Heritage Significance**

The locations of the Aboriginal heritage sites are shown in Drawing No. MSEC1117-14 and Biosis (2021).

<i>This document UNCONTROLLED once printed</i>				Page 11 of 34
<b>Document ID</b>		<b>Version</b>	1.2	
<b>Last Date Updated</b>	July 2022	<b>Next Review Date</b>	October 2025	



#### 4.2.6 **Permanent Survey Control Marks**

Survey control marks are located across the Study Area and are shown in Drawing No. MSEC1117-14.

#### 4.2.7 **Residential Establishments**

There are 175 houses that have been identified within the Study Area (at the time of writing). The locations of the houses are shown in Drawing No. MSEC1117-13.

There are 70 privately owned swimming pools that have been identified within the Study Area.

There are 9 tennis courts that have been identified within the Study Area.

The Longwall 709 Structures Management Plan and Longwalls 905 Structures Management Plan are included in Attachment A to the LMP. These subordinate documents clearly reference structures with quantitative triggers and commitments to defined corrective actions for Longwalls 709 and 905. Both management plans are considered “live” documents which may be subject to changes by the IMC Structural Review Group to allow for decisive response in managing structures which are subject to subsidence influence to ensure they are safe and serviceable. These TARPs have not been included in the master TARP document.

The Structures Management Plans will be updated prior to the commencement of each longwall included in the Extraction Plan application.

## 5. **REVISED SUBSIDENCE PARAMETERS AND SUBSIDENCE IMPACTS DUE TO LONGWALLS 709 TO 711 AND 905 EXTRACTION**

MSEC (2021) provides a detailed description of the mine subsidence process and methods used to predict subsidence movements resulting from the extraction of the longwalls. The report includes the maximum predicted systematic subsidence parameters for the longwalls (Chapter 4 of MSEC [2021]) including:

- Incremental subsidence parameters, which are the predicted subsidence parameters due to the extraction of a single Longwall.
- Cumulative subsidence parameters, which are the accumulated parameters which result from the extraction of a series of longwalls.
- Total subsidence parameters, which include the predicted subsidence parameters resulting from the extraction of Longwalls 709 to 711 and 905 and also include the predicted total subsidence parameters from previously extracted longwalls.

The maximum predicted incremental systematic subsidence parameters for the Extraction Plan Layout are generally less than or equal to those for the BSO EA Layout. The greatest maximum incremental subsidence of 950 millimetres (mm) has been predicted over Longwalls 709 and 711, and the lowest maximum incremental subsidence of 425 mm has been predicted for Longwall 710A.

<i>This document UNCONTROLLED once printed</i>				Page 12 of 34
<b>Document ID</b>		<b>Version</b>	1.2	
<b>Last Date Updated</b>	July 2022	<b>Next Review Date</b>	October 2025	





## 5.1 Predicted Subsidence Parameters and Impacts for the Natural Features and Items of Surface Infrastructure Within the Study Area

MSEC (2021) provides a comprehensive description of revised (since the BSO EA) site specific predicted subsidence parameters and impact assessments for each of the natural features and items of surface infrastructure that are located within the Study Area, due to the extraction of Longwalls 709 to 711 and 905. Additionally, natural features and items of surface infrastructure located outside the Study Area, which may be subjected to far-field movements and may be sensitive to the predicted subsidence parameters, were also included in the revised assessments undertaken by MSEC (2021). An overview of the surface features assessed is provided in Section 4 of this Monitoring Program.

The monitoring described below was developed in consideration of the predicted subsidence parameters and subsidence impacts outlined in MSEC (2021) as well as the findings, recommendations and commitments within specific management plans (refer to the Extraction Plan Appendices C – I).

## 6. MONITORING

The objectives of the Monitoring Program are discussed in Section 1.3. This Monitoring Program is comprised of two components:

- The monitoring of subsidence movements (refer to Section); and
- The monitoring of subsequent environmental and other effects and consequences of those movements (refer to Section 6.2).

### 6.1 Subsidence Movements

A program of monitoring and management of subsidence movements has been established and effectively implemented for AA7 and 9. Monitoring of the Longwalls 709 to 711 and 905 Study Area has been based on the previous AA7 and 9 programs.

The Monitoring Program will illustrate if subsidence movements, effects or impacts are greater than predicted. If subsidence movements, effects or impacts are greater than predicted, IMC will initiate management and/or contingency actions, including investigating reasons for the occurrence.

All data from the Monitoring Program will be available to technical experts and government agencies. IMC has provided significant quantities of data for the refinement of predictive models and research related to mining induced subsidence and will continue to do so.

Subsidence movement monitoring supports other components of the Monitoring Program. This is important for impact assessment, mitigation and rehabilitation. Regular reviews of subsidence data will be undertaken and an End of Panel (EoP) report reviewing subsidence in the area will be undertaken at the completion of each longwall panel.

The Monitoring Program would include a number of components as detailed below.

#### 6.1.1 Airborne Laser Scanning

Due to the efficiencies of remote sensing, the primary method of monitoring the subsidence bowl over AA7 and 9 will be via Airborne Laser Scanning (ALS). This technique generates

<i>This document UNCONTROLLED once printed</i>				Page 13 of 34
<b>Document ID</b>		<b>Version</b>	1.2	
<b>Last Date Updated</b>	July 2022	<b>Next Review Date</b>	October 2025	



a complete topographic model of the terrain. A number of base surveys for AA7 and 9 have been conducted. A base survey will be conducted prior to extraction for each panel.

Contours of the complete subsidence bowl from each longwall will be provided. A survey is generally undertaken after the completion of each longwall and 12 months after the completion of longwall extraction in each mining domain.

### 6.1.2 3D Survey Points

Selected 3D survey marks will be established and monitored to augment the ALS data. The points will be established in accessible areas as control for the ALS and at selected features sensitive to subsidence movements.

### 6.1.3 2D Survey Points

Monitoring of 2D subsidence will be undertaken at selected lines throughout the Study Area. Where applicable these lines will be integrated with the existing 2D Monitoring Lines in AA 7 and 9.

## 6.2 Environmental Consequences of Subsidence

Monitoring of the environmental and other consequences of subsidence is comprised of the recommended monitoring regimes detailed in the management plans and associated Trigger Action Response Plans (TARPs). The master TARPs containing a consolidated monitoring program and TARPs table are located at Attachment A of this report. Table 3 provides a directory to each of the feature specific monitoring regimes.

The AA7 and 9 monitoring sites which have been (or will be) installed to identify the effects and consequences of mining are provided in Figure 2.

<i>This document UNCONTROLLED once printed</i>				Page 14 of 34
Document ID		Version	1.2	
Last Date Updated	July 2022	Next Review Date	October 2025	

286000

288000

290000

292000

6220000

6218000

6216000

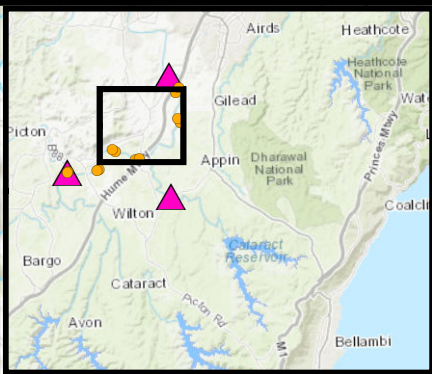
6214000

286000

288000

290000

292000



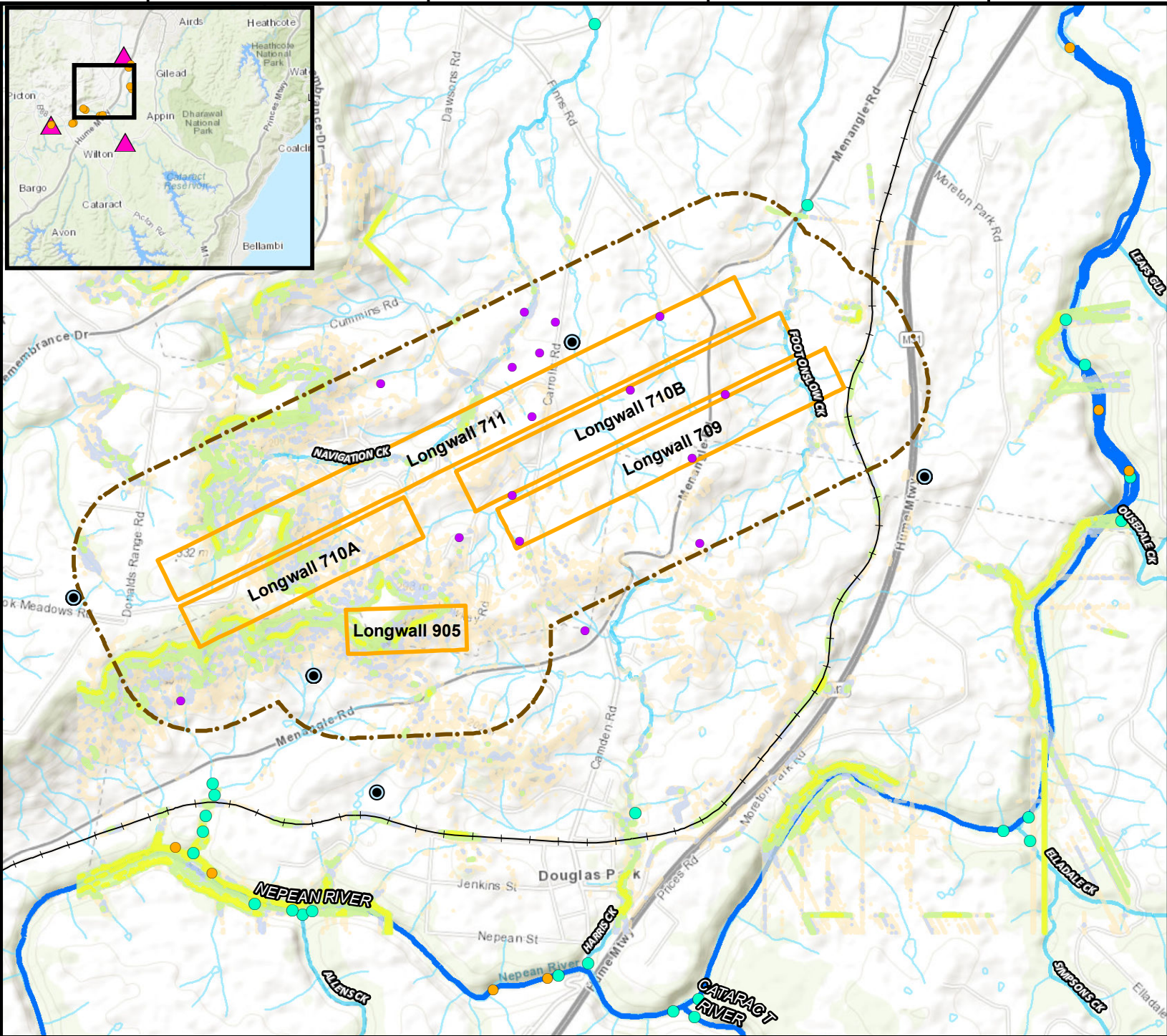
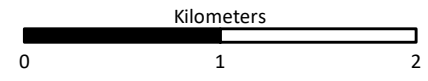
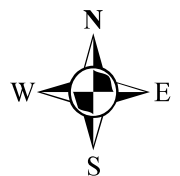
# Appin Area 7 and 9 Longwall 905 and Longwalls 709-711 Monitoring Locations Overview Figure 2

**Steep Slopes at -**

- 1 in 1
- 1 in 1.5
- 1 in 2
- 1 in 3
- Groundwater Site
- Aquatic Ecology Site
- Surface Water Site
- Private Boreholes
- Flow Monitoring Station
- Longwalls 905 and 709-711
- 600m Study Area
- Railway Lines
- Rivers
- Creeks
- Tributaries

Date: July, 2021  
Author: B.Aglan

Version 1  
Horizontal Datum  
MGA - Zone 56







**Table 3 Monitoring Directory**

Monitoring Component	Documentation	Monitoring Summary	Location
<b>Natural Features</b>			
<b>Rivers or Creeks</b>	<p>A Water Management Plan will be developed in consultation with DPE, Resources Regulator and BCD to manage the potential impacts on watercourses (including the Nepean River) as a result of the extraction of the longwalls in AA7 and 9.</p> <p>The Water Management Plan includes both surface and groundwater monitoring sites, which have been reviewed and extended to include the proposed Longwalls 709 to 711 and 905.</p>	<p>The approach to monitoring surface water flow for the Longwalls 709 to 711 and 905 is proposed to be the same as for mining of the previous AA7 and 9. Baseline water quality monitoring is occurring in the Nepean River upstream and adjacent to the proposed Longwalls 709 to 711 and 905. Monitoring also occurs in creeks within the Study Area in Harris Creek, Navigation Creek and Foot Onslow Creek. Six new surface water monitoring sites are proposed to be installed.</p> <p>The stream surface flow and quality monitoring program would continue during extraction of Longwalls 709 to 711 and 905 and until 2 years post mining.</p>	<p>Extraction Plan Appendix C - Water Management Plan SLR (2021b) <i>Appin Mine Extraction Plan Surface Water Assessment Longwalls 709 to 711 and 905</i>. Prepared for South 32 - Illawarra Metallurgical Coal. April 2021.</p>
<b>Cliffs, Steep Slopes</b>	<p>IMC has developed a Cliff and Steep Slope Management Plan for Longwalls 701 to 708B and 901 to 904. The existing Management Plan addresses monitoring, response action, reporting and public safety. The management plan will be reviewed and, where required, revised to include the proposed Longwalls 709 to 711 and 904, prior to extraction.</p>	<p>Geotechnical investigations to assess the potential for instabilities in the cliffs and steep slopes have been undertaken. Monitoring will be undertaken on the Razorback Range and is designed in consideration of surveys undertaken prior to mining, discussions with landholders and infrastructure owners and where built features are</p>	<p>Extraction Plan Appendix E – Land Management Plan GHD (2021) <i>Appin Area 7 and 9 Proposed Longwalls Landslide Risk Assessment relating</i></p>

<i>This document UNCONTROLLED once printed</i>				Page 16 of 34
<b>Document ID</b>		<b>Version</b>	1.2	
<b>Last Date Updated</b>	July 2022	<b>Next Review Date</b>	October 2025	





		located near steep slopes that may be susceptible to failure.  Detailed infrastructure and property specific management plans will be developed in consultation with the stakeholders prior to mining.	<i>to Mine Subsidence Influences</i> , Report for South32 Illawarra Metallurgical Coal. July 2021.  Extraction Plan Appendix H – Built Features Management Plan
<b>Public Utilities</b>			
<b>Railways</b>	<p>IMC and the Australian Rail Track Corporation (ARTC) have developed detailed risk management plans for managing potential mine subsidence impacts on the Main Southern Railway due to the extraction of Longwalls 703 to 710 and 905 at Appin Mine.</p> <p>A Rail Technical Committee has been coordinated to develop the risk management strategies. This Technical Committee includes representatives from ARTC, IMC, and specialist consultants in the fields of railway track engineering, geotechnical engineering, structural engineering, track signalling, mine subsidence, risk assessment and project management. The Technical Committee consults with the Resources Regulator, Department of Regional NSW and the Office of the National Rail Safety Regulator.</p>	<p>As per the current management plans the revised plan will:</p> <ul style="list-style-type: none"> <li>- Assess pre-mining conditions to understand all rail track and associated structure (i.e. culverts, cuttings, embankments, signalling infrastructure, etc.) issues which may be influenced by the development of subsidence;</li> <li>- Identify potential sites of non-systematic movement, such as creeks and geological structures,</li> <li>- Assess the required mitigation;</li> <li>- Install the mitigation;</li> <li>- Install a monitoring system, which includes, among other things, the monitoring of ground movements, rail stress, rail temperature, switch displacement and track geometry;</li> </ul>	Extraction Plan Appendix H – Built Features Management Plan

<i>This document UNCONTROLLED once printed</i>				Page 17 of 34
<b>Document ID</b>		<b>Version</b>	1.2	
<b>Last Date Updated</b>	July 2022	<b>Next Review Date</b>	October 2025	



	The existing management plans will be reviewed and revised in consultation with key stakeholders to include the proposed Longwalls 709 to 711 and 905.	<ul style="list-style-type: none"> <li>- Regularly review and assess the monitoring data;</li> <li>- Conduct regular visual inspections; and</li> <li>- Adjust the track in response to monitoring results during mining and implement management plan and contingency strategies as required.</li> </ul>	
<b>Bridges</b>	<p>The Nepean Twin Bridges are located outside the Study Area for Longwalls 709 to 711 and 905. However, they could experience far-field horizontal movements and could be sensitive to these effects.</p> <p>Moreton Park Road Bridges (North and South) are located outside the Study Area for Longwalls 709 to 711 and 905.</p> <p>IMC has an approved management plans for the Nepean Twin Bridges and Moreton park Bridges (North and South) for Longwalls 701 to 708B and 901 to 903. These existing management strategies will be reviewed, in consultation with the Transport NSW based on the potential movements resulting from the extraction of the proposed longwalls.</p>	<p>The management measures will include a combination of:</p> <ul style="list-style-type: none"> <li>- Mitigation measures prior to mining;</li> <li>- Installation of a monitoring system, which would be likely to include the monitoring of ground movements, structure movements, sub-surface ground movements, bridge joint displacements and visual inspections;</li> <li>- Implementation of a response plan, where actions are triggered by monitoring results; and</li> <li>- Implementation of a reporting and communication plan.</li> </ul>	Extraction Plan Appendix H – Built Features Management Plan
<b>Major Roads</b>	The M31 Hume Motorway is located outside and to the east of the Study Area. The motorway is located 470 m from the south-eastern corner of	Subsidence movement monitoring will be installed prior to mining to measure far field subsidence movements at sensitive features in proximity to Longwalls 709 to 711 and 905. Management is	Extraction Plan Appendix H – Built Features Management Plan

<i>This document UNCONTROLLED once printed</i>				Page 18 of 34
<b>Document ID</b>		<b>Version</b>	1.2	
<b>Last Date Updated</b>	July 2022	<b>Next Review Date</b>	October 2025	



	Longwall 709, at its closest point to the proposed longwalls.	anticipated to be undertaken in accordance with the management plan.	
<b>Local Roads and Culverts</b>	<p>The main local road within the Study Area is Menangle Road. This road provides a connection between the township of Campbelltown, located north-east of the Study Area, and Picton Road, to the south-west of the Study Area. There are also a number of local roads located across the Study Area; including: Cummins Road, Carrols Road, Donalds Range Road, Finns Road, Hawkey Road, Menangle Road, Quirkles Road, Top Ridge/Gibraltar Road.</p> <p>Existing management measures are in place for the local roads and culverts and these will be reviewed, in consultation with Wollondilly Shire Council (WSC) and Transport NSW, based on the potential movements resulting from the extraction of the proposed longwalls.</p>	IMC has developed management strategies for the local roads and culverts for Longwalls 709-711 and 905 Public Road Management Plan.	Extraction Plan Appendix G – Public Safety Management Plan
<b>Sydney Water Infrastructure</b>	Water pipelines are located more than 1.1 km from the proposed Longwalls 709 to 711 and 905. At this distance, the potable water pipelines are not predicted to experience measurable conventional subsidence effects. It is not anticipated, therefore, that adverse impacts would occur to these pipelines due to the proposed mining.	No monitoring proposed or visual inspections.	-
<b>Integral Energy</b>	The electrical infrastructure within the Study Area comprises 66 kV powerlines, 11 kV powerlines	IMC has an approved management plan for the powerlines, TransGrid Management Plan and the	Extraction Plan Appendix H – Built

<i>This document UNCONTROLLED once printed</i>				Page 19 of 34
<b>Document ID</b>		<b>Version</b>	1.2	
<b>Last Date Updated</b>	July 2022	<b>Next Review Date</b>	October 2025	



	and low voltage powerlines. There are no transmission lines located within the Study Area.	Longwalls 709-711 and 905 Endeavour Energy Management Plan.  This existing management plan will be reviewed, in consultation with the infrastructure owner based on the potential movements resulting from the extraction of the proposed longwalls. All necessary management measures will be in place before mine subsidence impacts occur on the infrastructure.	Features Management Plan
<b>Telecommunication Lines or Associated Plant</b>	IMC has developed specific telecommunication infrastructure management plans for AA7 and 9 to manage the potential impacts on copper and optical fibre cables.	IMC has an approved management plan for the telecommunications infrastructure for Longwalls 701 to 710 and 901 to 905. This existing management plan will be reviewed, in consultation with the infrastructure owner based on the potential movements resulting from the extraction of the proposed longwalls. All necessary management measures will be in place before mine subsidence impacts occur on the infrastructure.	Extraction Plan Appendix H – Built Features Management Plan
<b>Residential Establishments</b>			
<b>Houses</b>	IMC has developed a number of management strategies for houses which have been directly mined beneath by previously extracted longwalls at Appin, Tower and West Cliff Mines. Similar management strategies will be developed for the houses within the potentially affected area.	The PSMPs will include any recommendations from structural and geotechnical assessments of the houses and broader properties. The PSMPs are also anticipated to include the following where access is provided to the property:	Extraction Plan Appendix H – Built Features Management Plan

<i>This document UNCONTROLLED once printed</i>				Page 20 of 34
<b>Document ID</b>		<b>Version</b>	1.2	
<b>Last Date Updated</b>	July 2022	<b>Next Review Date</b>	October 2025	





	<p>IMC will send letters to all residents located in close proximity to the longwall layout (based on subsidence predictions) to commence the Built Features Management Plan (BFMP) process. This process involved first trying to establish one to one meeting with landholders in the study area to discuss the mine plan layout, impact predictions at property dwellings, and proposed timetable for longwall mining in the region.</p>	<ul style="list-style-type: none"> <li>- Inspection of houses by a structural engineer prior to the longwall mining directly beneath them;</li> <li>- Implementing any mitigation measures, where necessary to address specific identified risks to landholder safety;</li> <li>- Undertaking detailed monitoring of ground movements at or around structures, where necessary to address specific identified risks to landholder safety;</li> <li>- Periodic inspections of structures that are considered to be at risk. These may include: <ul style="list-style-type: none"> <li>• Structures in close proximity to steep slopes (or other geotechnical hazards) where recommended by a geotechnical engineer,</li> <li>• Structures identified as being potentially unstable where recommended by a structural engineer, and</li> <li>• Pool fences and gates.</li> </ul> </li> </ul>	
<p><b>Associated Structures</b></p>	<p>As above.</p>	<p>As above.</p>	<p>As above.</p>

<p><i>This document UNCONTROLLED once printed</i></p>				<p>Page 21 of 34</p>
<p><b>Document ID</b></p>		<p><b>Version</b></p>	<p>1.2</p>	
<p><b>Last Date Updated</b></p>	<p>July 2022</p>	<p><b>Next Review Date</b></p>	<p>October 2025</p>	



## 7. MONITORING VALIDATION

The performance of the Monitoring Program is validated through ongoing reporting and review as outlined below; with contingency measures in place should environmental consequences exceed predictions.

### 7.1 Reporting

The Monitoring Program survey results are typically reported within 48 hours of the completion of a survey. Results will be forwarded electronically in an “Excel” spread sheet to asset owners, technical experts and regulators as prescribed in the various management plans. Particular presentation formats i.e. coordinate listings, relative / absolute movements, and graphical presentation will be defined in consultation with key stakeholders, including asset owners. Embedded within the spreadsheet is a plan showing the nominal position of the longwall currently being mined at the time of the survey.

Individual management plans contain monitoring and reporting protocols. Reporting is generally undertaken at the completion of baseline data collection, as well as annually in the Annual Review (AR), in accordance with Condition 4, Schedule 6 of the BSO approval. The AR details the outcomes of monitoring undertaken, as well as providing results of visual inspections to determine whether performance indicators have been exceeded and whether mitigation/contingency measures are required.

EoP reports will be prepared on completion of extraction from each longwall. The EoP reports will detail the findings of the monitoring programs and inspections associated with the longwall extraction.

### 7.2 Review

All survey results are checked, reviewed and assessed prior to reporting, with further review performed by IMC’s Subsidence Management Committee which meets on a monthly basis. The analysis undertaken by the Subsidence Management Committee includes:

- Comparison of predicted subsidence effects and measured parameters.
- Comparison of predicted subsidence impacts and measured impacts.
- Analysis of any variations between predicted and measured subsidence effects and impacts (e.g. consideration of underlying parameters to determine the predicted subsidence profile); analysis of variations between predicted and measured non-systematic subsidence effects and impacts.
- Analysis of the 3D movement associated with longwall extraction with particular reference to the transverse and longitudinal movements versus distance in advance of the longwall panel.

The analysis will be used to assess the validity of the subsidence predictions detailed in the MSEC Report (2021) (refer to Extraction Plan, Appendix A) and to provide feedback and data to MSEC to refine the predictive methods where appropriate.

<i>This document UNCONTROLLED once printed</i>				Page 22 of 34
<b>Document ID</b>		<b>Version</b>	1.2	
<b>Last Date Updated</b>	July 2022	<b>Next Review Date</b>	October 2025	



Should the movements be classed as ‘greater than predicted’ a review of the potential causes of the exceedance will be undertaken and if there are associated impacts, mitigation/contingency measures will be considered and implemented (with the agreement of the landholder) if required (refer to Section 7.3). The mitigation/contingency measures will be implemented to limit potential environmental consequences, improving the environmental performance of the project.

If deficiencies in the Monitoring Program are identified in the interim period, the plans will be modified as required. This process has been designed to ensure that all environmental documentation continues to meet current environmental requirements, including changes in technology, operational practice, and the expectations of stakeholders.

## 8. CONTINGENCY RESPONSE PLAN

Contingency and emergency response options are available and will be implemented if it is demonstrated that environmental consequences are greater than those predicted or authorised by the BSO Approval. This will involve:

- Capture photographic record.
- Notify relevant stakeholders soon as practicable.
- Notify relevant agencies and specialists soon as practicable.
- Offer site visits with stakeholders.
- Contract specialists to investigate and report on changes identified.
- Provide incident report to relevant agencies.
- Establish weekly monitoring frequency until stabilised.
- Updates from specialists on investigation process.
- Inform relevant agencies and stakeholders of results of investigation.
- Develop site Corrective Management Action (CMA) in consultation with key stakeholders if required, (pending stakeholder availability) and seek approvals.
- Implement CMA as agreed with stakeholders following approvals.
- Conduct initial follow up monitoring and reporting of CMA completion.
- Review Management Plan.
- Report in regular reporting and AR.

IMC will consult with appropriate specialists and relevant agencies in order to devise an appropriate response in respect to any identified exceedance.

The development and implementation of contingency measures will be specifically designed to address the specific circumstances of the exceedance and assessment of environmental consequences.

If the contingency measures implemented by IMC fail to remediate the impact or the Secretary determines that it is not reasonable or feasible to remediate the impact South32 will provide a suitable offset to compensate for the impact to the satisfaction of the Secretary of DPE in accordance with the BSO Approval Conditions 2 and 4, Schedule 3.

<i>This document UNCONTROLLED once printed</i>				Page 23 of 34
<b>Document ID</b>		<b>Version</b>	1.2	
<b>Last Date Updated</b>	July 2022	<b>Next Review Date</b>	October 2025	



## 9. REFERENCES

Biosis Research, 2021. *Appin Area 7 - 9 Longwalls 709 to 711 and 905 Heritage Impact Assessment*. Report prepared for South32.

Mine Subsidence Engineering Consultants, 2009, *Bulli Seam Operations Subsidence Assessment*. Report for BHP Billiton Illawarra Coal.

MSEC 2021, *Appin Longwalls 709 to 711 and 905: Subsidence Predictions and Impact Assessments for the Natural and Built Features due to the Extraction of the Proposed Longwalls 709 to 711 and 905 at Appin Colliery*. Report for South32 IMC.

NSW National Parks and Wildlife Service. 1997. *Aboriginal Cultural Heritage: Standards and Guidelines Kit. Standards for Archaeological Practice in Aboriginal Heritage Management*. NSW NPWS, Hurstville.

SLR (2021b) *Appin Mine Extraction Plan Groundwater Impact Assessment*. Prepared for South 32 - Illawarra Metallurgical Coal. April 2021.

SLR (2021b) *Appin Mine Extraction Plan Surface Water Assessment Longwalls 709 to 711 and 905*. Prepared for South 32 - Illawarra Metallurgical Coal. April 2021.

<i>This document UNCONTROLLED once printed</i>				Page 24 of 34
<b>Document ID</b>		<b>Version</b>	1.2	
<b>Last Date Updated</b>	July 2022	<b>Next Review Date</b>	October 2025	





## 10. ATTACHMENT A: MASTER TARPs

MONITORING SITE		MONITORING TYPE	MONITORING FREQUENCY	PARAMETERS
<b>SURFACE WATER</b>				
<b>Area 7 and 9</b>	<b>Foot Onslow Creek</b> FO1 (Lab, Field, Level, Obs) FO2 (Obs) <b>Harris Creek</b> HC20 (Level, Obs) HC30 (Obs) <b>Navigation Creek</b> NAV1 (Lab, Field, Level, Obs) NAV2 (Obs) NAV3 (Obs) <b>Nepean River</b> NR110 (Lab, Field, Level, Obs) NR0 (Lab, Field, Level, Obs) SW2 (Lab, Field, Obs) NR2 (Lab, Field, Level, Obs) NR3 (Lab, Field, Obs) NR4 (Lab, Field, Obs) NR5 (Lab, Field, Obs) NR8 (Lab, Field, Obs) NR10 (Lab, Field, Obs) NR12 (Lab, Field, Obs) NR13 (Lab, Field, Obs) NR40 (Lab, Field, Obs) NR50 (Lab, Field, Obs) <b>Remembrance Drive</b> RC1 (Lab, Field, Level, Obs) – Reference Site	<ul style="list-style-type: none"> <li>Laboratory analysis (Lab)</li> <li>Field parameters (Field)</li> <li>Observations (Obs)</li> <li>Water level (Level) (where a suitable structure exists)</li> </ul>	<ul style="list-style-type: none"> <li>Monthly baseline monitoring prior to mining</li> <li>Weekly observations and field analysis during active subsidence</li> <li>Monthly laboratory analysis during active subsidence</li> <li>Monthly monitoring for two years post mining</li> <li>If required as a result of assessment of mining impacts</li> </ul>	<b>Field Parameters:</b> <ul style="list-style-type: none"> <li>Temperature</li> <li>Dissolved Oxygen (DO)</li> <li>Specific Conductivity</li> <li>pH</li> <li>ORP</li> </ul> <b>Laboratory analysis:</b> <ul style="list-style-type: none"> <li>pH and EC</li> <li>Filtered, Na, K, Ca, Mg, Cl, Ni, Zn, Fe, Mn, Al, SO4</li> <li>Total Fe, Mn, Al</li> <li>Total Alkalinity</li> <li>TKN, TP, NH3-N, NOx-N (TON), FRP, TSS, DOC</li> </ul> <b>Lab Sample for Gas Releases:</b> <ul style="list-style-type: none"> <li>CH4</li> <li>C2H6</li> <li>Trace Phenols</li> <li>Sulphide</li> </ul> <b>Observations:</b> <ul style="list-style-type: none"> <li>Iron or salinity staining (e.g. orange or white staining in water or on banks/seeps)</li> <li>Evidence of springs in the Nepean River</li> <li>Visual signs of impacts (i.e. cracking, fracturing, vegetation changes, increased erosion, changes in water colour etc)</li> <li>Stream flow and pool water level</li> <li>Impacts determined from comparing photo points taken prior to, during and post mining</li> </ul>
	<b>Flow Monitoring</b> Maldon Weir Broughtons Pass Weir Menangle Weir	<ul style="list-style-type: none"> <li>Gauged flow station</li> </ul>	<ul style="list-style-type: none"> <li>Daily flow</li> </ul>	Monitoring undertaken by WaterNSW. Observational data to be compared with flow records at weir sites.

<i>This document UNCONTROLLED once printed</i>				Page 25 of 34
<b>Document ID</b>		<b>Version</b>	1.2	
<b>Last Date Updated</b>	July 2022	<b>Next Review Date</b>	October 2025	



Groundwater				
<b>Area 7 and 9</b>	<b>Private Bores</b> GW108990 GW100289 GW072874 GW100673 GW101986 GW105531 GW105534 GW106675 GW111781 GW112381 GW105376 GW105574 GW106574 GW107791 GW108907 GW108990 GW072196 GW110671 (in consultation with bore owner and if assessible and access is granted)	<ul style="list-style-type: none"> <li>• Lab sample</li> <li>• Field parameters</li> <li>• Water levels</li> <li>• Observations</li> </ul>	<ul style="list-style-type: none"> <li>• Where access is available and granted, water level and water quality monitoring at least once before and once after the bore is mined under</li> </ul>	<b>Field Parameters:</b> <ul style="list-style-type: none"> <li>• Temperature</li> <li>• Dissolved Oxygen (DO)</li> <li>• Specific Conductivity</li> <li>• pH</li> <li>• ORP</li> </ul> <b>Laboratory analysis:</b> <ul style="list-style-type: none"> <li>• pH and EC</li> <li>• Filtered, Na, K, Ca, Mg, Cl, Ni, Zn, Fe, Mn, Al, SO4</li> <li>• Total Fe, Mn, Al</li> <li>• Total Alkalinity</li> <li>• TKN, TP, NH3-N, NOx-N (TON), FRP, TSS, DOC</li> </ul> Lab Sample for Gas Releases: <ul style="list-style-type: none"> <li>• CH4</li> <li>• C2H6</li> <li>• Trace Phenols</li> <li>• Sulphide</li> </ul> <b>Observations:</b> <ul style="list-style-type: none"> <li>• Iron or salinity staining (e.g. orange or white staining in water or on banks/seeps)</li> <li>• Evidence of springs in the Nepean River</li> <li>• Visual signs of impacts (i.e. cracking, fracturing, vegetation changes, increased erosion, changes in water colour etc)</li> <li>• Stream flow and pool water level</li> <li>• Impacts determined from comparing photo points taken prior to, during and post mining</li> </ul>
	<b>IMC Boreholes</b> S1913 S1941 S1954 S2157 S2536 S2536A S2537 S2538		<ul style="list-style-type: none"> <li>• Water levels to be logged at least twice daily in the pre-mining baseline, impact and post-mining period</li> <li>• At least one appropriately purged sample pre-mining and post mining, where access permits, tested for the analytes in the previous column</li> </ul>	
	<b>Groundwater inflows to the mine</b>	<ul style="list-style-type: none"> <li>• Mine water balance</li> <li>• Observations</li> </ul>	<ul style="list-style-type: none"> <li>• Flow meters</li> </ul>	Water flow from the goaf to the mine (analysed as a moving average i.e. 20 day average)
Aquatic Ecology				

<i>This document UNCONTROLLED once printed</i>				Page 26 of 34
<b>Document ID</b>		<b>Version</b>	1.2	
<b>Last Date Updated</b>	July 2022	<b>Next Review Date</b>	October 2025	



Area 7 and 9	<p><b>Impact Sites:</b> Sites 5, 6, X3 and X4</p> <p><b>Control Sites:</b> Sites 1, 2, 7, 8, X5, X6, X7 and X8</p>	<ul style="list-style-type: none"> <li>Water quality – field parameters</li> <li>Survey and sampling</li> <li>Observations</li> </ul>	<ul style="list-style-type: none"> <li>Twice in spring for two years prior to the commencement of mining</li> <li>Once every two years during mining</li> <li>Once every two years after mining</li> </ul>	<ul style="list-style-type: none"> <li>Habitat surveys</li> <li>Aquatic macrophyte observations</li> <li>Macroinvertebrate monitoring</li> <li>AUSRIVAS sampling</li> <li>Fish sampling</li> <li>Observations of threatened species</li> <li>Assessments of:                             <ul style="list-style-type: none"> <li>Water quality</li> <li>Flow</li> <li>River morphology</li> </ul> </li> </ul>
<b>TERRESTRIAL ECOLOGY</b>				
Area 7 and 9	<ul style="list-style-type: none"> <li>Inspection of the area will be conducted as outlined in the Landscape TARP</li> </ul>	<ul style="list-style-type: none"> <li>As indicated in the Landscape TARP</li> </ul>	<ul style="list-style-type: none"> <li>Prior to mining provide pre-mining baseline survey of vegetation communities and threatened flora populations for comparison with post-mining</li> <li>Monthly prior to mining</li> <li>Weekly during active subsidence</li> <li>In response to any identified impacts on flora/fauna or threatened species, communities or populations</li> </ul>	<ul style="list-style-type: none"> <li>Observations of threatened species and endangered ecological communities</li> <li>Changes in vegetation condition</li> <li>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)</li> </ul>
<b>LANDSCAPE FEATURES</b>				
Area 7 and 9	<p>Nepean River cliff lines</p> <ul style="list-style-type: none"> <li>Sensitive terrain near built features (Razorback Range)</li> <li>Razorback Range Cliffs</li> <li>Monitoring locations on private properties to be determined as appropriate/required in consultation with landowner/s</li> </ul>	<ul style="list-style-type: none"> <li>Observational and photographic monitoring</li> <li>Piezometers</li> <li>Slope inclinometers</li> </ul>	<p><b>Nepean River and Razorback Range cliff lines</b></p> <ul style="list-style-type: none"> <li>Baseline recording once prior to mining.</li> <li>Monthly routine inspections with weekly inspections during critical periods</li> </ul> <p><b>Low Terrain Sensitivity</b> (visual inspection)</p> <ul style="list-style-type: none"> <li>6 months prior to mining</li> <li>6 months after active subsidence</li> </ul> <p><b>Medium Terrain Sensitivity</b></p> <ul style="list-style-type: none"> <li>6 to 12 months prior to mining</li> </ul>	<ul style="list-style-type: none"> <li>Visual inspections</li> <li>Photographic records</li> <li>Ground survey (mid to high terrain sensitivity)</li> <li>Piezometers (high terrain sensitivity)</li> <li>Slope inclinometers (high terrain sensitivity)</li> </ul>

<i>This document UNCONTROLLED once printed</i>				Page 27 of 34
<b>Document ID</b>		<b>Version</b>	1.2	
<b>Last Date Updated</b>	July 2022	<b>Next Review Date</b>	October 2025	



			<ul style="list-style-type: none"> <li>• 3 monthly during active subsidence</li> <li>• 6 months after active subsidence</li> </ul> <p><b>High Terrain Sensitivity</b></p> <ul style="list-style-type: none"> <li>• 12 months before commencement of subsidence for visual and on ground survey</li> <li>• Monthly for visual during active subsidence</li> <li>• 3 monthly for ground survey during active subsidence</li> <li>• Installation of piezometers and inclinometers as required and in consultation with landowners as part of PSMP process.</li> </ul>	
--	--	--	--	--

MONITORING	TRIGGER	ACTION
<b>Surface Water Quality<sup>#</sup></b>		
Nepean River N110 (Upstream perturbations) SW2 (Upstream perturbations from Allens Creek) NR5 (Upstream perturbations from Cataract River) NR8 (Upstream perturbations from Elladale Creek) NR10 (Upstream perturbations from Ouesdale Creek)	<p><b>Level 1*</b></p> <p>Impact monitoring sites:</p> <ul style="list-style-type: none"> <li>• 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</li> <li>• 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</li> <li>• Identification of strata gas plume of flow rate &lt;3000 L/min</li> <li>• Trend analysis shows deviation from baseline post mining.</li> </ul>	<ul style="list-style-type: none"> <li>• Continue monitoring program</li> <li>• Submit an Impact Report to BCD, DPE, DPI Fisheries and other relevant stakeholders</li> <li>• Report in the End of Panel Report</li> <li>• Summarise actions and monitoring in AR</li> </ul>

<i>This document UNCONTROLLED once printed</i>				Page 28 of 34
<b>Document ID</b>		<b>Version</b>	1.2	
<b>Last Date Updated</b>	July 2022	<b>Next Review Date</b>	October 2025	



NR40 (Upstream perturbation from Menangle Creek) Impact Sites: NR0 NR4 (assess influence from Harris Creek) NR12 NR13 NR50  Creeks and Tributaries NAV1 FO1 HC10 NR3	<b>Level 2*</b> Impact monitoring sites: <ul style="list-style-type: none"> <li>pH reduction greater than 2 standard deviation from pre-mining mean resulting from the mining for two consecutive months</li> <li>DO reduction greater than 2 standard deviation from pre-mining mean resulting from the mining for two consecutive months</li> <li>EC increases greater than 2 standard deviation from pre-mining mean resulting from the mining for two consecutive months</li> <li>Identification of strata gas plume of flow rate &gt;3000 L/min</li> <li>Trend analysis shows significant deviation from baseline post mining.</li> </ul>	<ul style="list-style-type: none"> <li>Actions as stated for Level 1</li> <li>Review monitoring program</li> <li>Notify relevant technical specialists and seek advice on any CMA required</li> <li>Implement agreed CMAs as approved</li> </ul> <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>Strata Gas Emission Plume:</p> <ul style="list-style-type: none"> <li>Estimate gas emission flow rates. Re-estimate should significant change be observed</li> <li>Take sample of plume (if possible) for:                         <ul style="list-style-type: none"> <li>chemical composition</li> <li>dissolved methane from exactly above gas plume and at established downriver monitoring site</li> <li>dissolved sulphide and total phenols from exactly above gas plume and at nearest downriver monitoring site</li> </ul> </li> </ul>
	<b>Level 3*</b> Impact monitoring sites when comparing the baseline period to the mining period for that site: <ul style="list-style-type: none"> <li>Level 2-type reduction in water quality resulting from mining observed for six consecutive months</li> </ul>	<ul style="list-style-type: none"> <li>Actions stated for Level 2</li> <li>Notify BCD, DPE, DPI - Fisheries, relevant resource managers and technical specialists and seek advice on any CMA required</li> <li>Invite stakeholders for site visit</li> <li>Develop site CMA (subject to stakeholder feedback)</li> <li>Completion of works following approvals, including monitoring and reporting on success</li> <li>Review the TARP and Management Plan in consultation with key stakeholders</li> </ul> <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>
	<b>Exceeding Performance Measures</b> <ul style="list-style-type: none"> <li>Mining results in more than negligible gas releases, iron staining or water cloudiness</li> </ul>	<ul style="list-style-type: none"> <li>Actions stated for Level 3</li> <li>Investigate reasons for the exceedance</li> <li>Update future predictions based on the outcomes of the investigation</li> <li>Provide environmental offset if CMAs are unsuccessful</li> </ul>
<b>Groundwater</b>		

<i>This document UNCONTROLLED once printed</i>				Page 29 of 34
<b>Document ID</b>		<b>Version</b>	1.2	
<b>Last Date Updated</b>	July 2022	<b>Next Review Date</b>	October 2025	





S1913 S1941 S1954 S2157 S2536 S2536A S2537 S2538	<b>Level 1**</b> <ul style="list-style-type: none"> <li>Increase in water flow from the goaf between 2.7 to 3 ML/day (over 20 day average)</li> <li>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</li> </ul>	<ul style="list-style-type: none"> <li>Continue monitoring program</li> <li>Submit an Impact Report to BCD, DPE, Resources Regulator and other relevant stakeholders</li> <li>Report in the End of Panel Report</li> <li>Summarise actions and monitoring in Annual Review</li> </ul>
	<b>Level 2*</b> <ul style="list-style-type: none"> <li>Increase in water flow from the goaf between 3 to 3.4 ML (over 20 day average)</li> <li>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</li> </ul>	<ul style="list-style-type: none"> <li>Actions as stated for Level 1</li> <li>Review monitoring frequency</li> <li>Notify relevant technical specialists and seek advice on any CMA required</li> <li>Implement agreed CMAs as approved</li> </ul> <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>
	<b>Level 3*</b> <ul style="list-style-type: none"> <li>Abnormal increase in water flow from the goaf &gt;3.4ML (20 day average)</li> <li>&gt;10m reduction in the Hawkesbury Sandstone standing water level or pressure (outside of pumping influences in private bores) over a minimum 2 month period</li> <li>Mining results in groundwater bores unsafe, unserviceable or damaged</li> </ul>	<ul style="list-style-type: none"> <li>Actions as stated for Level 2</li> <li>Notify BCD, DPE, Resources Regulator, relevant resource managers and technical specialists and seek advice on any CMA required</li> <li>Invite stakeholders for site visit</li> <li>Develop site CMA (subject to stakeholder feedback). This may include:                             <ul style="list-style-type: none"> <li>Make area safe</li> <li>Any actions agreed to in the Property Subsidence Management Plan</li> <li>Provisions of alternate water supply where this has been impacted by mining</li> </ul> </li> <li>Completion of works following approvals, including monitoring and reporting on success</li> <li>Review the Groundwater Model, TARP and Management Plan in consultation with key stakeholders</li> </ul> <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>
<b>Landscape Features</b>		
<b>Cliffs and Steep Slopes</b>	<b>Level 1*</b>	<ul style="list-style-type: none"> <li>Continue monitoring program</li> </ul>

<i>This document UNCONTROLLED once printed</i>				Page 30 of 34
<b>Document ID</b>		<b>Version</b>	1.2	
<b>Last Date Updated</b>	July 2022	<b>Next Review Date</b>	October 2025	



<ul style="list-style-type: none"> <li>• Nepean River cliff lines</li> <li>• Razorback Range cliffs</li> <li>• Sensitive terrain near built features (Razorback Range)</li> </ul> <p>Monitoring locations on private properties to be determined as appropriate/required in consultation with landowner</p>	<ul style="list-style-type: none"> <li>• Rock fall from a cliff where the cliff is left mostly intact (&lt;10% length of any single cliff)</li> <li>• Surface movement or rock displacement where any exposed soil surface is stable</li> <li>• Crack at the surface which does not result in ongoing erosion or ground movement</li> <li>• Erosion which stabilises within the period of monitoring without CMA</li> <li>• Crack or fracture up to 100 mm width</li> <li>• Crack or fracture up to 10 m length</li> </ul>	<ul style="list-style-type: none"> <li>• Submit an Impact Report to BCD, DPE and MEG</li> <li>• Report in the End of Panel Report</li> <li>• Summarise actions and monitoring in AR</li> </ul>
	<p><b>Level 2*</b></p> <ul style="list-style-type: none"> <li>• Rock fall from cliff where the characteristics of the cliff change (&gt;10% length of any single cliff)</li> <li>• Ground disturbance that is unlikely to stabilise within the period of monitoring without CMA</li> <li>• Mass movement of a slope causing areas of exposed soil</li> <li>• Crack or fracture between 100 – 300 mm width</li> <li>• Crack or fracture between 10 – 50 m length</li> </ul>	<ul style="list-style-type: none"> <li>• <i>Actions as stated for Level 1</i></li> <li>• Report trigger to key stakeholders</li> <li>• Review monitoring frequency</li> <li>• Notify relevant technical specialists and seek advice on any CMA required</li> <li>• Provide safety signage and barricades where appropriate in areas as required for public safety (refer PSMP)</li> <li>• Implement agreed CMAs as approved</li> </ul> <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>
	<p><b>Level 3*</b></p> <ul style="list-style-type: none"> <li>• Cliff collapse (100% length of any single cliff)</li> <li>• Ground disturbance that does not stabilise within the period of monitoring</li> <li>• Mass movement of a slope causing areas of exposed soil that does not stabilise within the period of monitoring</li> <li>• Crack or fracture over 300 mm width</li> <li>• Crack or fracture over 50 m length</li> </ul>	<ul style="list-style-type: none"> <li>• <i>Actions as stated for Level 2</i></li> <li>• Notify BCD, DPE, Resources Regulator, relevant resource managers and technical specialists and seek advice on any CMA required.</li> <li>• Invite stakeholders for site visit</li> <li>• Develop site CMA (subject to stakeholder feedback). This may include: <ul style="list-style-type: none"> <li>– Erosion prevention works</li> <li>– Establishment of vegetation</li> </ul> </li> <li>• Completion of works following approvals, including monitoring and reporting on success</li> <li>• Review the TARP and Management Plan in consultation with key stakeholders</li> </ul> <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>
	<p><b>Exceeding Prediction</b></p>	<ul style="list-style-type: none"> <li>• <i>Actions as stated for Level 3</i></li> </ul>

<i>This document UNCONTROLLED once printed</i>				Page 31 of 34
<b>Document ID</b>		<b>Version</b>	1.2	
<b>Last Date Updated</b>	July 2022	<b>Next Review Date</b>	October 2025	



	<ul style="list-style-type: none"> <li>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</li> <li>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</li> </ul>	<ul style="list-style-type: none"> <li>Make area safe</li> <li>Investigate reasons for the exceedance</li> <li>Update future predictions based on the outcomes of the investigation</li> <li>Provide environmental offset if CMAs are unsuccessful</li> </ul>
<b>Aquatic Ecology</b>		
<b>Impact Sites:</b> 5, 6, X3 and X4  <b>Control Sites:</b> 1, 2, 7, 8, X5, X6, X7 and X8	<b>Level 1*</b> <ul style="list-style-type: none"> <li>Reduction in aquatic habitat resulting from the mining over 1 season</li> </ul>	<ul style="list-style-type: none"> <li>Continue monitoring program</li> <li>Submit an Impact Report to BCD, DPE, DPI Fisheries and other relevant resource managers</li> <li>Report in the End of Panel Report</li> <li>Summarise actions and monitoring in AR</li> </ul>
	<b>Level 2*</b> <ul style="list-style-type: none"> <li>Reduction in aquatic habitat resulting from the mining over 2 seasons</li> </ul>	<ul style="list-style-type: none"> <li><i>Actions as stated for Level 1</i></li> <li>Report trigger to key stakeholders</li> <li>Review monitoring program</li> <li>Notify relevant technical specialists and seek advice on any CMA required</li> <li>Implement agreed CMAs as approved</li> </ul> <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>
	<b>Level 3*</b> <ul style="list-style-type: none"> <li>Reduction in aquatic habitat resulting from the mining for &gt;2 consecutive seasons or complete loss of habitat</li> </ul>	<ul style="list-style-type: none"> <li><i>Actions as stated for Level 2</i></li> <li>Notify BCD, DPE, DPI Fisheries, relevant resource managers and technical specialists and seek advice on any CMA required.</li> <li>Invite stakeholders for site visit</li> <li>Develop site CMA (subject to stakeholder feedback). This may include:               <ul style="list-style-type: none"> <li>Grouting of fractures which result in flow diversion</li> <li>Completion of works following approvals</li> </ul> </li> <li>Completion of works following approvals, including monitoring and reporting on success</li> </ul>

<i>This document UNCONTROLLED once printed</i>				Page 32 of 34
<b>Document ID</b>		<b>Version</b>	1.2	
<b>Last Date Updated</b>	July 2022	<b>Next Review Date</b>	October 2025	



		<ul style="list-style-type: none"> <li>Review the TARP and Management Plan in consultation with key stakeholders</li> </ul> <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>
	<p><b>Exceeding Prediction</b></p> <ul style="list-style-type: none"> <li>Mining results in more than negligible environmental consequences for a threatened species, threatened population or endangered ecological communities</li> </ul>	<ul style="list-style-type: none"> <li>Actions as stated for Level 3</li> <li>Investigate reasons for the exceedance</li> <li>Update future predictions based on the outcomes of the investigation</li> <li>Provide environmental offset if CMAs are unsuccessful</li> </ul>
<b>Terrestrial Ecology</b>		
Visual inspections as part of landscape and water monitoring programs in active mining areas	<p><b>Level 1*</b></p> <ul style="list-style-type: none"> <li>Impacts detectable via observational monitoring (e.g. canopy thinning, thinning of shrub layer, minor loss of ground cover) to a single vegetation strata</li> <li>Subsidence impacts (such as surface cracking, rock falls) resulting in small areas of disturbance that will mitigate without CMA</li> </ul>	<ul style="list-style-type: none"> <li>Continue monitoring program</li> <li>Submit an Impact Report to BCD, DPE and other relevant resource managers</li> <li>Report in the End of Panel Report</li> <li>Summarise actions and monitoring in AR</li> </ul>
	<p><b>Level 2*</b></p> <ul style="list-style-type: none"> <li>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</li> <li>Subsidence impacts (such as surface cracking, rock falls) resulting in small areas of disturbance that will not mitigate without CMA</li> </ul>	<ul style="list-style-type: none"> <li>Actions as stated for Level 1</li> <li>Report trigger to key stakeholders</li> <li>Review monitoring program</li> <li>Notify relevant technical specialists and seek advice on any CMA required</li> <li>Implement agreed CMAs as approved</li> </ul> <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 habitat with insignificant consequences may not require specific CMAs other than ongoing monitoring to confirm there are no ongoing impacts</i></p>
	<p><b>Level 3*</b></p> <ul style="list-style-type: none"> <li>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</li> <li>Subsidence impacts (such as surface cracking, rock falls) resulting in large areas of disturbance that will not mitigate without CMA</li> </ul>	<ul style="list-style-type: none"> <li>Actions as stated for Level 2</li> <li>Notify BCD, DPE, relevant resource managers and technical specialists and seek advice on any CMA required.</li> <li>Invite stakeholders for site visit</li> <li>Develop site CMA (subject to stakeholder feedback). This may include:                             <ul style="list-style-type: none"> <li>Erosion prevention works</li> <li>Establishment of vegetation</li> </ul> </li> <li>Completion of works following approvals, including monitoring and reporting on success</li> </ul>

<i>This document UNCONTROLLED once printed</i>				Page 33 of 34
<b>Document ID</b>		<b>Version</b>	1.2	
<b>Last Date Updated</b>	July 2022	<b>Next Review Date</b>	October 2025	



	<ul style="list-style-type: none"> <li>Negligible environmental consequences to threatened species, populations or EEC Reduction in aquatic habitat resulting from the mining for &gt;2 consecutive seasons or complete loss of habitat</li> </ul>	<ul style="list-style-type: none"> <li>Review the TARP and Management Plan in consultation with key stakeholders</li> </ul> <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 habitat with insignificant consequences may not require specific CMAs other than ongoing monitoring to confirm there are no ongoing impacts</i></p>
	<p><b>Exceeding Prediction</b></p> <ul style="list-style-type: none"> <li>Mining results in more than negligible environmental consequences for a threatened species, threatened population or endangered ecological communities</li> </ul>	<ul style="list-style-type: none"> <li>Actions as stated for Level 3</li> <li>Investigate reasons for the exceedance</li> <li>Update future predictions based on the outcomes of the investigation</li> <li>Provide environmental offset if CMAs are unsuccessful</li> </ul>

\* These may be revised in consultation with DPE and other key stakeholders following analysis of natural variability within the pre-mining baseline data.

# the upstream (NR110) monitoring site and a series of sites within tributaries of the Nepean River are utilised to indicate perturbation at the proposed Longwalls 709 to 711 and 905 impact monitoring sites within the Nepean River. This provides a means of distinguishing upstream effects unrelated to the mining of the proposed longwalls. The following premise applies:

- A TARP at River site NR0 should only be considered to have been triggered whenever an equivalent change (from the long term mean) is not exhibited for the same parameter at the upstream site NR110.
- A TARP at River site NR4 should only be considered to have been triggered whenever an equivalent change (from the long term mean) is not exhibited for the same parameter at the upstream sites NR110 or SW2 (monitors for upstream perturbation from Allens Creek).
- A TARP at River site NR12 and NR13 should only be considered to have been triggered when an equivalent change (from the long term mean) is not exhibited for the same water quality analyte at the upriver sites; NR110, SW2, NR5, NR8 or NR10 (monitors upstream perturbation from Allens Creek, Cataract River, Elladale Creek and Ousedale Creek).
- A TARP at River site NR50 should only be considered to have been triggered when an equivalent change (from the long term mean) is not exhibited for the same water quality analyte at the upriver sites; NR110, SW2, NR5, NR8, NR10 or NR40 (monitors upstream perturbation from Allens Creek, Cataract River, Elladale Creek, Ousedale Creek and Menangle Creek).

Department of Planning and Environment (DPE)

Department of Primary Industries – Fisheries (DPI Fisheries)

Biodiversity and Conservation Division (BCD)

Department of Mining, Exploration and Geosciences (MEG)

Resources Regulator

WaterNSW

<i>This document UNCONTROLLED once printed</i>				Page 34 of 34
<b>Document ID</b>		<b>Version</b>	1.2	
<b>Last Date Updated</b>	July 2022	<b>Next Review Date</b>	October 2025	