

METROPOLITAN COAL LONGWALLS 311-316

SUBSIDENCE MONITORING PROGRAM



METROPOLITAN COAL

LONGWALLS 311-316

SUBSIDENCE MONITORING PROGRAM

Revision Status Register

Section/Page/ Annexure	Revision Number	Amendment/Addition	Distribution	DPHI Approval Date
All	SMP-R01-A	Original	DPHI, NSW Resources Regulator	-
All	SMP-R01-B	Updated to reflect amendments to the Longwalls 311-316 longwall layout and to address agency comments	DPHI	-
All	SMP-R01-C	Updated to reflect Longwall 311 Approval	DPHI	

November 2024

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1 INTRODUCTION

Metropolitan Collieries Pty Ltd (Metropolitan Coal) is a wholly owned subsidiary of Peabody Energy Australia Pty Ltd (Peabody). Metropolitan Coal was granted approval for the Metropolitan Coal Project (the Project) under section 75J of the New South Wales (NSW) *Environmental Planning and Assessment Act, 1979* (EP&A Act) on 22 June 2009. A copy of the Project Approval is available on the Peabody website (<http://www.peabodyenergy.com>).

The Project comprises the continuation, upgrade and extension of underground coal mining operations (Longwalls 20-27 and Longwalls 301-317) and surface facilities at the Metropolitan Colliery (Metropolitan Coal Mine) (Figure 1). Longwalls 311-316 are situated to the west of Longwalls 301-310 and define the next mining sub-domain within the Project underground mining area (Figures 1 to 3). Longwall 317 will be subject to future Extraction Plans.

This Subsidence Monitoring Program (SMP) describes the subsidence monitoring program (subsidence effects and subsidence impacts) that forms part of the overall management of the consequential environmental impacts associated with the extraction of Longwalls 311-316. Where relevant, this SMP includes the post-mining requirements for Longwalls 20-22, Longwalls 23-27, Longwalls 301-303, Longwall 304 and Longwalls 305-307. The Longwall 308-310 Subsidence Monitoring Program will be superseded by this document following the completion of Longwall 310 consistent with the recommended approach in the NSW Department of Planning and Environment (DPE) (now known as the Department of Planning, Housing and Infrastructure¹ [DPHI]) (2022) *Extraction Plan Guideline*.

1.1 PURPOSE AND SCOPE

Condition 6, Schedule 3 of the Project Approval requires the preparation of various documents as a component of Extraction Plan(s) for second workings. Condition 6(e), Schedule 3 states:

SECOND WORKINGS

Extraction Plan

6. *The Proponent shall prepare and implement an Extraction Plan for all second workings in the mining area to the satisfaction of the Director-General. This plan must:*

...

(e) *include the following to the satisfaction of DRE:*

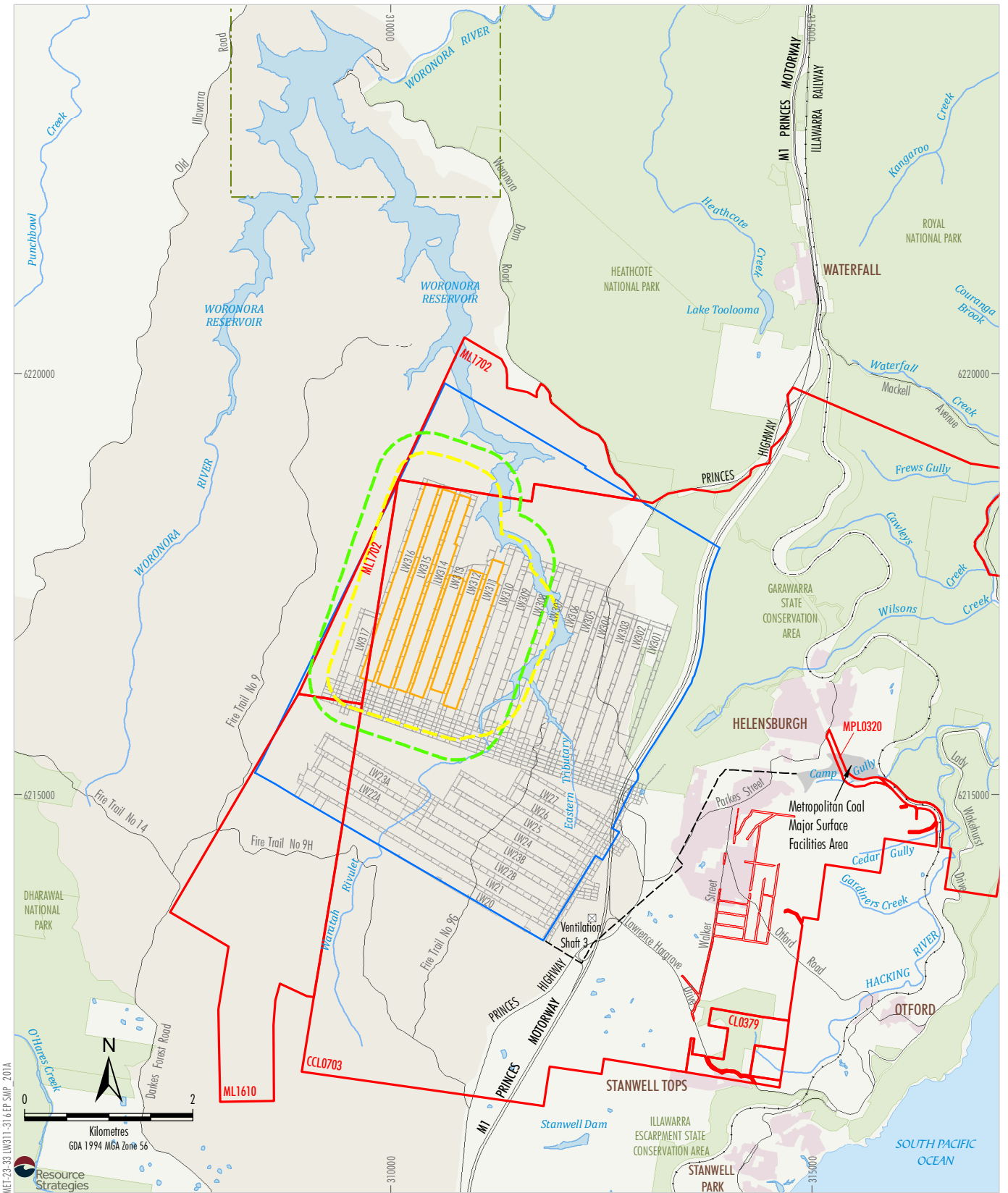
...

- *a Subsidence Monitoring Program to:*
 - *validate the subsidence predictions; and*
 - *analyse the relationship between the subsidence effects and subsidence impacts of the Extraction Plan and any ensuing environmental consequences;*

...

¹ The former Department of Planning and Environment (DPE) was renamed to the Department of Planning, Housing and Infrastructure on 1 January 2024. References to DPE have been retained throughout the remainder of this document.

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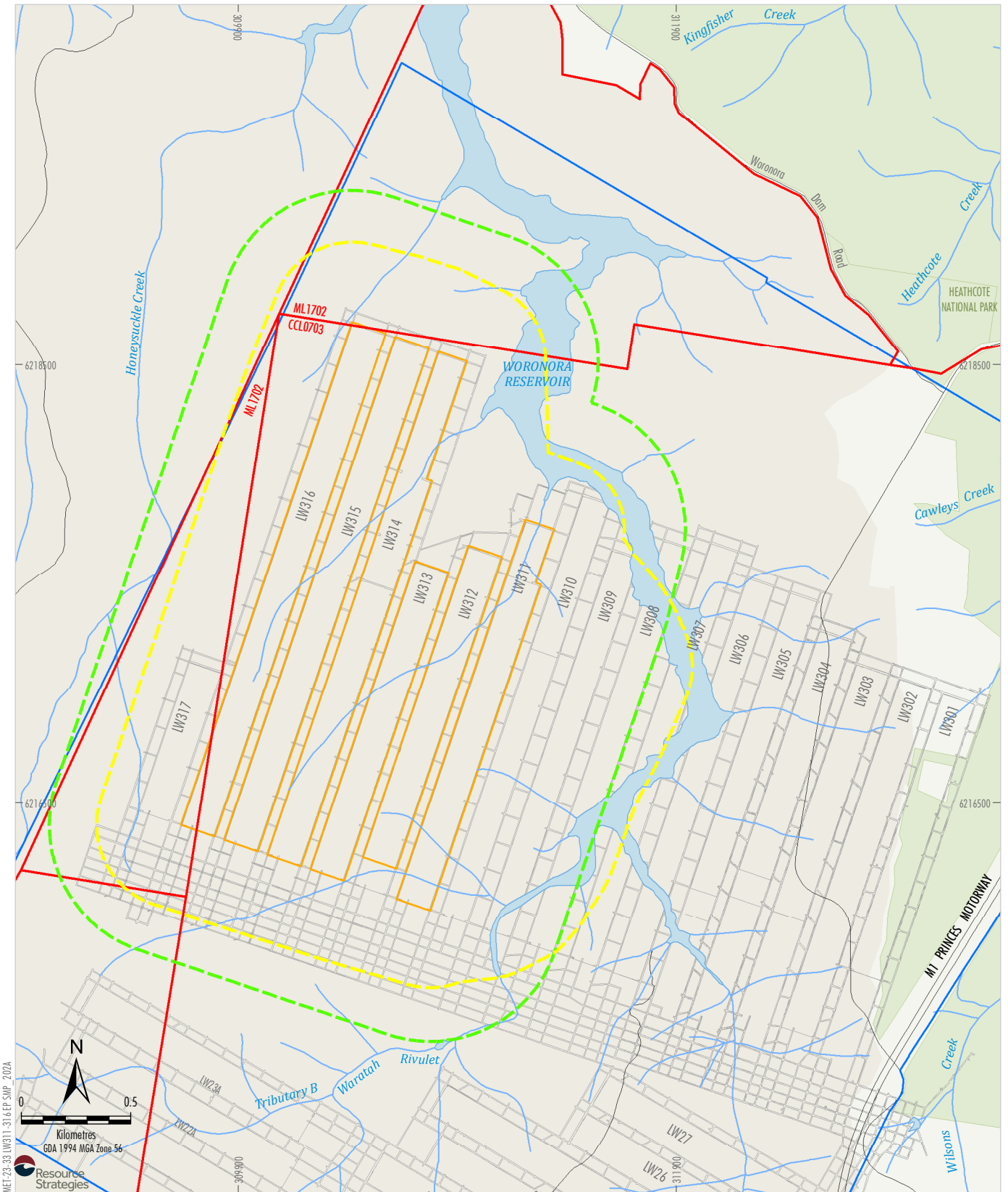


- LEGEND**
- Mining Lease Boundary
 - Woronora Special Area
 - Railway
 - Project Underground Mining Area
 - Longwalls 20-27 and 301-317
 - Longwalls 311-316 Secondary Extraction
 - Longwalls 311-316 35° Angle of Draw and/or Predicted 20 mm Subsidence Contour
 - 600 m from Longwalls 311-316 Secondary Extraction
 - Woronora Notification Area
 - Existing Underground Access Drive (Main Drift)

Source: Land and Property Information (2015); Department of Industry (2015); DPE (2023); Metropolitan Coal (2023); MSEC (2024)

Peabody
 METROPOLITAN COAL
 Longwalls 311-316 and
 Project Underground Mining Area

Figure 1



Source: Land and Property Information (2015); Department of Industry (2015); DPE (2023); Metropolitan Coal (2023); MSEC (2024)

LEGEND

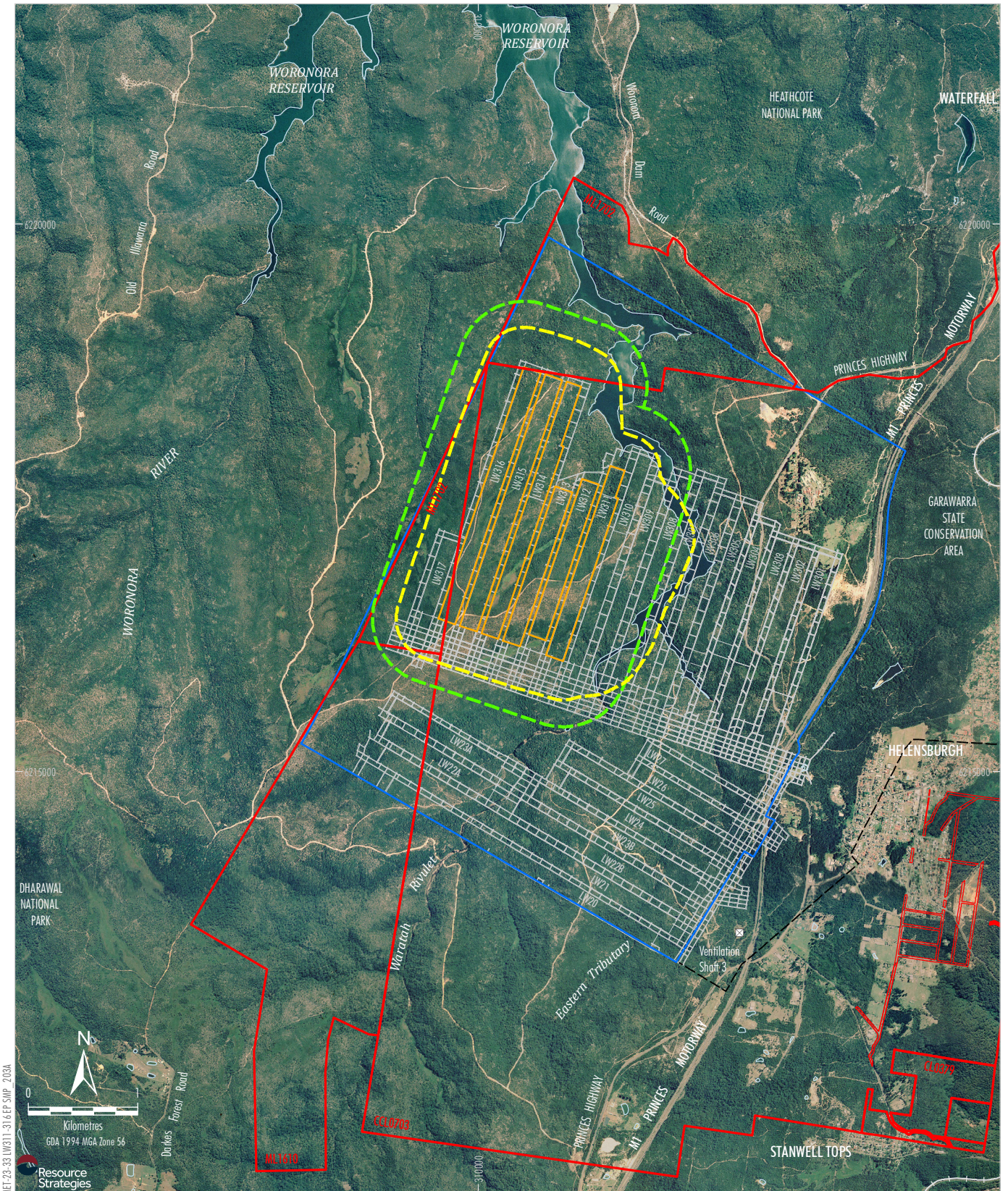
- ▭ Mining Lease Boundary
- ▭ Woronora Special Area
- ▭ Project Underground Mining Area
- ▭ Longwalls 20-27 and 301-317
- ▭ Longwalls 311-316 Secondary Extraction
- - - Longwalls 311-316 35° Angle of Draw and/or Predicted 20 mm Subsidence Contour
- - - 600 m from Longwalls 311-316 Secondary Extraction

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Longwalls 311-316 Layout

Figure 2



- LEGEND
- Mining Lease Boundary
 - Railway
 - Project Underground Mining Area
Longwalls 20-27 and 301-317
 - Longwalls 311-316 Secondary Extraction
 - Longwalls 311-316 35° Angle of Draw and/or
Predicted 20 mm Subsidence Contour
 - 600 m from Longwalls 311-316
Secondary Extraction
 - Existing Underground Access Drive (Main Drift)

Source: Land and Property Information (2015); Date of Aerial Photography 1998;
Department of Industry (2015); Metropolitan Coal (2023); MSEC (2024)

Peabody

METROPOLITAN COAL
Longwalls 311-316 and
Project Underground Mining Area -
Aerial Photograph

Figure 3

The following graphical plans have been prepared in accordance with DPE (2022) *Extraction Plan Guideline* and are provided separately in the Longwalls 311-316 Coal Resource Recovery Plan (CRRP), Appendix G of the Longwalls 311-316 Extraction Plan):

- Plan 1: Existing, Proposed and Future Workings.
- Plan 2: Surface Features.
- Plan 3: Geological and Seam Data.
- Plan 5: Mining Titles and Land Ownership.
- Plan 6: Geological Section and Geotechnical Logs.

Plan 7 (Subsidence Monitoring Locations) referred to in the DPE (2022) *Extraction Plan Guideline* is included as Attachment 1 to this SMP.

The document *Metropolitan Coal Mine - Longwalls 311 to 316 Subsidence Predictions and Impact Assessments for the Natural and Built Features in Support of the Extraction Plan* prepared by Mine Subsidence Engineering Consultants Pty Ltd (MSEC) (2024) (Appendix H of the Longwalls 311-316 Extraction Plan) includes revised predictions of the conventional and non-conventional subsidence effects and subsidence impacts of the Extraction Plan, incorporating any relevant information that has been obtained since Project Approval.

This SMP outlines the subsidence monitoring program prepared to satisfy that component of Condition 6(e), Schedule 3 of the Project Approval relating to subsidence monitoring. The SMP is, among other things, designed to compare and validate the subsidence predictions outlined in MSEC (2024).

The relationship of this SMP to the Metropolitan Coal Environmental Management Structure and to the Metropolitan Coal Longwalls 311-316 Extraction Plan is shown on Figure 4.

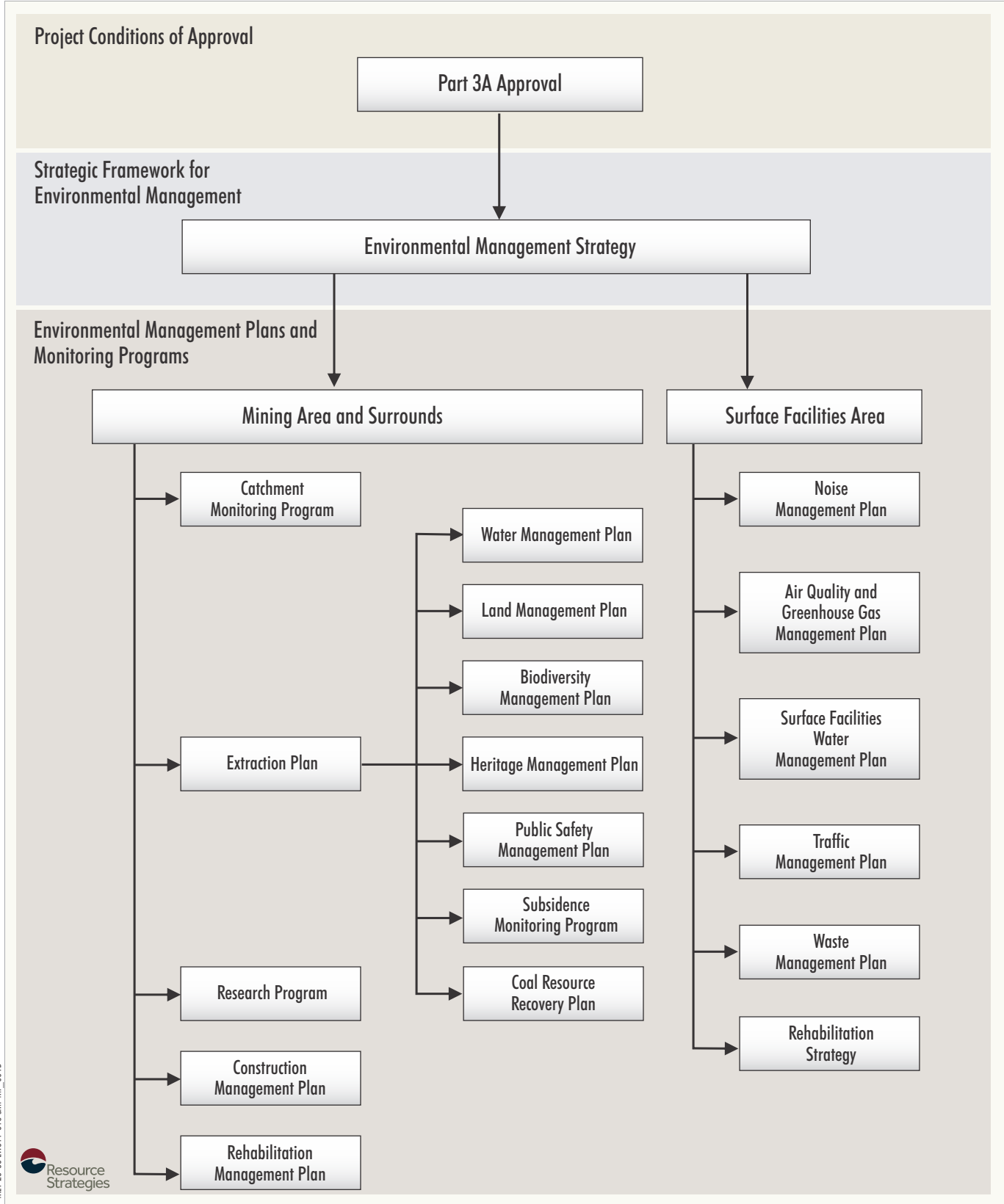
In accordance with Condition 6, Schedule 3 of the Project Approval, this SMP has been prepared by Metropolitan Coal, with assistance from MSEC.

1.2 STRUCTURE OF THE SMP

The remainder of the SMP is structured as follows:

- Section 2: Describes the SMP revision status and distribution list.
- Section 3: Describes the Longwalls 311-316 extraction layout.
- Section 4: Describes the natural and built features.
- Section 5: Summarises the revised predicted subsidence parameters and impacts for the longwalls.
- Section 6: Describes the monitoring program.
- Section 7: Describes the program to analyse subsidence effects, subsidence impacts, and environmental consequences.
- Section 8: Lists the references cited.

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Figure 4

2 SMP REVIEW AND UPDATE

In accordance with Condition 4, Schedule 7 of the Project Approval, this SMP will be reviewed within three months of the submission of:

- (a) an audit under Condition 8, Schedule 7;
- (b) an incident report under Condition 6, Schedule 7;
- (c) an annual review under Condition 3, Schedule 7; and

if necessary, revised to the satisfaction of the Director-General (now Secretary) of the DPE, to ensure the SMP is updated on a regular basis and to incorporate any recommended measures to improve environmental performance.

The SMP will also be reviewed within three months of approval of any Project modification and if necessary, revised to the satisfaction of the DPE.

Certain details of the monitoring program will be reviewed and amended as required in consultation with the NSW Resources Regulator, to the satisfaction of the Secretary of the DPE.

The revision status of this plan is indicated on each copy of the SMP. The distribution register for controlled copies of the SMP is described in Section 2.1.

Revisions to any documents listed within this SMP will not necessarily constitute a revision of this document.

2.1 DISTRIBUTION REGISTER

In accordance with Condition 10, Schedule 7 'Access to Information', Metropolitan Coal will make the SMP publicly available on the Peabody website.

Metropolitan Coal recognises that various regulators have different distribution requirements, both in relation to whom documents should be sent and in what format.

An Environmental Management Plan and Monitoring Program Distribution Register has been established in consultation with the relevant agencies and infrastructure owners that indicates:

- to whom the Metropolitan Coal plans and programs, such as the SMP, will be distributed;
- the format (i.e. electronic or hard copy) of distribution; and
- the format of revision notification.

Metropolitan Coal will make the Distribution Register publicly available on the Peabody website.

Metropolitan Coal will be responsible for maintaining the Distribution Register and for ensuring that the notification of revisions is sent by email or post as appropriate.

In addition, Metropolitan Coal employees with local computer network access will be able to view the controlled electronic version of this SMP on the Metropolitan Coal local area network. Metropolitan Coal will not be responsible for maintaining uncontrolled copies beyond ensuring the most recent version is maintained on Metropolitan Coal's computer system and the Peabody website.

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3 LONGWALLS 311-316 EXTRACTION LAYOUT

Longwalls 311-316 and the area of land within 600 metres (m) of Longwalls 311-316 secondary extraction is shown on Figures 1, 2 and 3. A summary of the longwall dimensions for Longwalls 311-316 is provided in Table 1. The layout of Longwalls 311-316 includes both 163 m and 138 m panel widths (void) and 45 m and 70 m pillar widths (solid), consistent with the Preferred Project Layout (Figure 2). As the mine progresses west of the reservoir it will transition to 163 m panel widths, with 138 m panel widths remaining at the northern commencing ends beneath the reservoir.

Table 1
Summary of Longwall Dimensions for Longwalls 311-316

Longwall	Longwall Length (m)	Total Void Width (m)	Tailgate Chain Pillar Width (m)
Longwall 311	1,829	138 / 163	45 / 70
Longwall 312	1,502	138 / 163	45 / 70
Longwall 313	1,487	138 / 163	45 / 70
Longwall 314	2,427	138 / 163	45 / 70
Longwall 315	2,427	138 / 163	45 / 70
Longwall 316	2,427	138 / 163	45 / 70

m = metres.

Longwall extraction will occur from north to south. The provisional extraction schedule for Longwalls 311-316 is provided in Table 2.

Table 2
Provisional Extraction Schedule

Longwall	Estimated Start Date	Estimated Duration	Estimated Completion Date
Longwall 311	October 2024	8 months	June 2025
Longwall 312	July 2025	6 Months	December 2025
Longwall 313	January 2026	5 months	June 2026
Longwall 314	August 2026	9 months	June 2027
Longwall 315	July 2027	8 months	March 2028
Longwall 316	April 2028	8 months	December 2028

The dimensions of the headings would be approximately 5.2 m wide and 3.2 m in height. The headings are connected approximately every 130 m by driving a cut-through from one heading to another which forms pillars of coal along the length of the gate road.

The geology, seam structure, and depth of cover are described in the Longwalls 311-316 CRRP.

The depth of cover within the Longwalls 311-316 35 degree (°) angle of draw and/or predicted 20 millimetres (mm) subsidence contour varies between a minimum of 405 m and a maximum of 550 m.

The seam floor within the Longwalls 311-316 35° angle of draw and/or predicted 20 mm subsidence contour generally dips from the south-west to the north-east. The seam thickness within the Longwalls 311-316 goaf area varies between approximately 2.5 m at the southern end and to 2.65 m at the northern end. Longwalls 311-316 will extract the full height of the seam with a minimum design cut height of 2.8 m.

4 SURFACE FEATURES INCLUDED IN MONITORING PROGRAM

4.1 THE STUDY AREA

The Study Area in MSEC (2024) is defined as the surface area that is likely to be affected by the mining of Longwalls 311-316 in the Bulli Seam at Metropolitan Coal Mine. The surface features included in the Study Area are those features within areas bounded by the following limits:

- a 35° angle of draw line from the extent of Longwalls 311-316; and
- the predicted limit of vertical subsidence, taken as the predicted incremental 20 mm subsidence contour resulting from the extraction of Longwalls 311-316.

Natural features identified within the Study Area include:

- streams (including first and second order tributaries);
- cliffs and overhangs, steep slopes and land in general (including ledges and rock outcrops);
- upland swamps; and
- other natural vegetation.

Aboriginal heritage sites have also been identified within the Longwalls 311-316 Study Area. The full supply level of the Woronora Reservoir is also located within the Longwalls 311-316 Study Area.

Built features identified within the Longwalls 311-316 Study Area include:

- fire trails and four wheel drive tracks; and
- boreholes.

There are features that lie outside the Study Area that are expected to experience either far-field movements, or valley related movements. The surface features which are sensitive to such movements have been identified and have been included in the assessments provided in MSEC (2024). The features included within the assessment beyond the extent of the Study Area include:

- M1 Princes Motorway bridge (Bridge 2 – Old Princes Highway Underpass);
- M1 Princes Motorway bridge (Cawley Road Overbridge);
- Woronora Dam; and
- Old Princes Highway.

These are discussed in detail in MSEC (2024) and summarised below.

The surface features are shown on Plan 2 in Attachment 1 of the Longwalls 311-316 CRRP.

4.1.1 Streams

There are a number of tributaries within the Study Area for Longwalls 311-316. These streams consist of shallow drainage lines from the topographical high points, forming streams where valley heights increase and drain into the Woronora Reservoir.

The Eastern Tributary flows into the full supply level of the Woronora Reservoir approximately 1.4 kilometres (km) (at the Full Supply Level) to the east of Longwall 311 outside the Study Area.

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The Waratah Rivulet flows into the full supply level of the Woronora Reservoir approximately 550 m to the south-east of Longwalls 311 to 316 outside the Study Area.

4.1.2 Cliffs and Associated Overhangs

Six cliff and overhang sites are located within the Longwalls 311-316 Study Area (namely COH10, COH11, COH12, COH13, COH18 and COH19). COH18 is located above Longwall 312 and COH19 is located above Longwall 314. COH11, COH12, and COH13 are located above previously extracted Longwalls 307 and 308. Detailed baseline recordings of these cliff and overhang sites have been completed and are included in the Longwalls 311-316 Land Management Plan (LMP) (Appendix B).

4.1.3 Steep Slopes and Land in General

Steep slopes have been identified to highlight areas where existing ground slopes may be marginally stable. However, no significant slope failures have been observed in the Southern Coalfield as a result of longwall mining. Land in general refers to the general landscape other than cliffs and steep slopes and includes rock ledges/rock outcrops and minor cliffs.

4.1.4 Upland Swamps

The mapped extents of the upland swamps are based on field inspection and validation by Eco Logical Australia (2016, 2018) and EcoPlanning (2021, 2024). There are 36 swamps located within the Study Area. Detailed descriptions of the swamps within the Study Area are provided in the Metropolitan Coal Longwalls 311-316 Biodiversity Management Plan (BMP).

4.1.5 Other Natural Vegetation

The vegetation within the Study Area generally consists of native bushland. A summary of the vegetation communities present is provided in the Metropolitan Coal Longwalls 311-316 BMP.

4.2 PUBLIC UTILITIES

4.2.1 Railways

There are no railways within the Study Area. The Illawarra Railway is located to the east of the Study Area, more than 3.0 km from Longwalls 311-316.

4.2.2 Roads and Culverts

The locations of roads including the M1 Princes Motorway, Old Princes Highway, Woronora Dam Road, private roads, access roads, fire trails and four-wheel drive tracks within and adjacent to the Study Area are shown on Plan 2 in the Longwall 311-316 CRRP.

The M1 Princes Motorway is located more than 2.2 km from Longwalls 311-316 finishing (southern) ends.

The Old Princes Highway is located more than 1.2 km from Longwall 311 and is outside the Study Area.

Woronora Dam Road is located more than 1.4 km from Longwall 313 and is outside the Study Area.

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All other roads within the Study Area are unsealed fire trails or access roads which are used by WaterNSW and other asset owners and groups for firefighting and other activities.

4.2.3 Bridges

The features along the M1 Princes Motorway considered to be most sensitive to relative movements arising from far-field effects are Bridge 2 (at the location where the Old Princes Highway passes below the M1 Princes Motorway) and Cawley Road Overbridge.

Bridge 2 (Old Princes Highway Underpass) is located outside the Study Area and approximately 2.2 km from Longwall 311.

The Cawley Road Overbridge is located approximately 2.5 km from the northern end of Longwall 311.

Extensive monitoring for previous extraction plans has been progressively discontinued in consultation with Transport for NSW. Transport for NSW has supported the discontinuation of all monitoring at the conclusion of Longwall 310, in line with its requirements of five times depth of cover and more broadly as a result of the absence of measurable subsidence at its asset during recent extraction plans.

4.2.4 Electrical Services

There are no aboveground or buried electrical services within the Study Area.

4.2.5 Telecommunications Services

There are no aboveground or underground telecommunication lines within the Study Area.

4.2.6 Dams, Reservoirs and Associated Works

The closest dam to Longwalls 311-316 is the Woronora Dam. The Woronora Dam wall is located approximately 4.9 km from the commencing end of Longwall 316. The distance from the labyrinth spillway (south of the dam wall) is approximately 4.5 km from the nearest point of Longwall 316. Monitoring of the Woronora Dam wall is not included in this SMP due to the large distance of the dam wall from the extraction of Longwalls 311-316.

The extraction of Longwalls 311-316 will occur outside the Woronora Notification Area² and Longwalls 311, 312 and 313 will pass beneath the full supply level of the Woronora Reservoir.

The extraction geometries of Longwall's 311, 312, 313, 314, 315 and 316 are in accordance with the Project Approval (08_0149).

Further considerations of the Woronora Reservoir is provided in the Metropolitan Coal Longwalls 311-316 Extraction Plan Main Text and the Longwalls 311-316 Water Management Plan (WMP) (Appendix A).

² The Woronora Notification area was amended on 1 July 2022 to an area 1.5 km around the Woronora Dam wall which is outside or beyond the mining lease.

4.3 MINE INFRASTRUCTURE

There are seven surface to seam drill holes (exploration or groundwater monitoring boreholes) located within the Study Area. Three boreholes are located directly above Longwalls 311-316, namely S288, PM01 and PM02. Boreholes S288, PM01 and PM02 are recorded as being fully grouted for the entirety of their lengths. The location of the borehole is shown on Plan 2 in the Longwalls 311-316 CRRP and on Drawing No. MSEC1340-09.

4.4 ITEMS OF ARCHAEOLOGICAL SIGNIFICANCE

4.4.1 Aboriginal Heritage Sites

The locations of known Aboriginal heritage sites within the Study Area are shown in Drawing No. MSEC1340-09 in MSEC (2024). Nine Aboriginal heritage sites of high archaeological significance and/or particular cultural significance are located within the Longwalls 311-316 Study Area.

Detailed baseline recordings of Aboriginal heritage sites and a geotechnical risk assessment for Aboriginal Cultural Heritage sites of high archaeological significance and/or particular cultural significance relevant to the Longwalls 311-316 Extraction Plan are provided in baseline reports prepared by Niche Environment and Heritage and MSEC and are described in the Metropolitan Coal Longwalls 311-316 Heritage Management Plan (HMP).

4.4.2 Local Heritage Sites

The *Wollongong Local Environmental Plan 2009* lists items of heritage significance at the Garrawarra Centre Complex including the Garrawarra Hospital Heritage Conservation Area, Gates and Gatehouse, Administration, Kitchen and Store Block, Staff Cafeteria, Nurses Hostel and Residential Houses. Howard Tanner and Associates (1993) also lists additional items of varying significance at the Garrawarra Centre Complex. NSW Health manages the Garrawarra Centre Complex. The Garrawarra Centre Complex is located greater than 1.4 km to the east of Longwall 311, outside the Study Area.

The Waterfall General [Garrawarra] Cemetery, also referred to as the Garrawarra Hospital Cemetery or Waterfall Cemetery, is currently listed as an item of local significance under the *Wollongong Local Environmental Plan 2009* (Item 61028). The Waterfall Cemetery site is under the management of the Wollongong City Council. The Waterfall Cemetery is located outside of the Study Area to the east of Longwall 311.

4.5 PERMANENT SURVEY CONTROL MARKS

The locations of survey control marks are shown on Plan 2 in the Longwalls 311-316 CRRP and on Drawing No. MSEC1340-09 in MSEC (2024). No survey control marks are located within the Study Area.

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5 REVISED SUBSIDENCE PARAMETERS AND SUBSIDENCE IMPACTS DUE TO LONGWALLS 311-316 EXTRACTION

MSEC (2024) provides a detailed description of the development of mine subsidence and the method used to predict the mine subsidence movements resulting from the extraction of Longwalls 311-316. The report includes the maximum predicted conventional subsidence parameters for Longwalls 311-316 (Chapter 4 of MSEC [2024]) including:

- Incremental Subsidence Parameters, which are the predicted subsidence parameters due to the extraction of a single Longwall.
- Total Subsidence Parameters, which include the accumulated subsidence parameters after the completion of each longwall within a series of longwalls.

The maximum predicted incremental conventional subsidence from the extraction of Longwalls 311-316 is 600 mm, and the maximum predicted total conventional subsidence from the extraction of Longwalls 311-316 is 1500 mm within the Study Area, which represents approximately 54 percent (%) of the minimum extraction height of 2.8 m.

A comparison of the maximum predicted conventional total subsidence parameters, for the Extraction Plan Layout and the Preferred Project Layout for Longwalls 311-316, is provided in Table 4.3 of MSEC (2024). The Extraction Plan Layout maximum predicted total subsidence, tilt and curvature for the extraction of Longwalls 311-316 are greater than the maxima predicted values based on the Preferred Project Layout.

5.1 PREDICTED SUBSIDENCE PARAMETERS AND IMPACTS FOR THE NATURAL AND BUILT FEATURES WITHIN THE STUDY AREA

MSEC (2024) provides a comprehensive description of revised (since the Project Environmental Assessment [Helensburgh Coal Pty Ltd, 2008] and Preferred Project Report [Helensburgh Coal Pty Ltd, 2009]) site specific predicted subsidence parameters and impact assessments for each of the natural and built features that are located within the Study Area, due to the extraction of Longwalls 311-316. Additionally, natural and built features that are 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.

In particular, the following surface features were assessed:

- Waratah Rivulet.
- Eastern Tributary.
- Other Streams.
- Woronora Reservoir and Woronora Dam (*situated more than 2.0 km from the Study Area*).
- Cliffs and Associated Overhangs.
- Steep Slopes and Land in General.
- Upland Swamps and other Natural Vegetation.
- Old Princes Highway.
- Fire Trails and Four Wheel Drive Tracks.
- M1 Princes Motorway Bridges (Bridge 2 [*located approximately 2.2 km away*]).and Cawley Road Overbridge [*located approximately 2.5 km away*]).

- Woronora Dam Road.
- Sydney Water Infrastructure (water mains).
- Archaeological Sites (Aboriginal heritage and local heritage).
- Exploration Holes.
- Survey Control Marks.

The monitoring program described below was developed in consideration of the predicted subsidence parameters and subsidence impacts outlined in MSEC (2024).

6 MONITORING

6.1 INTRODUCTION

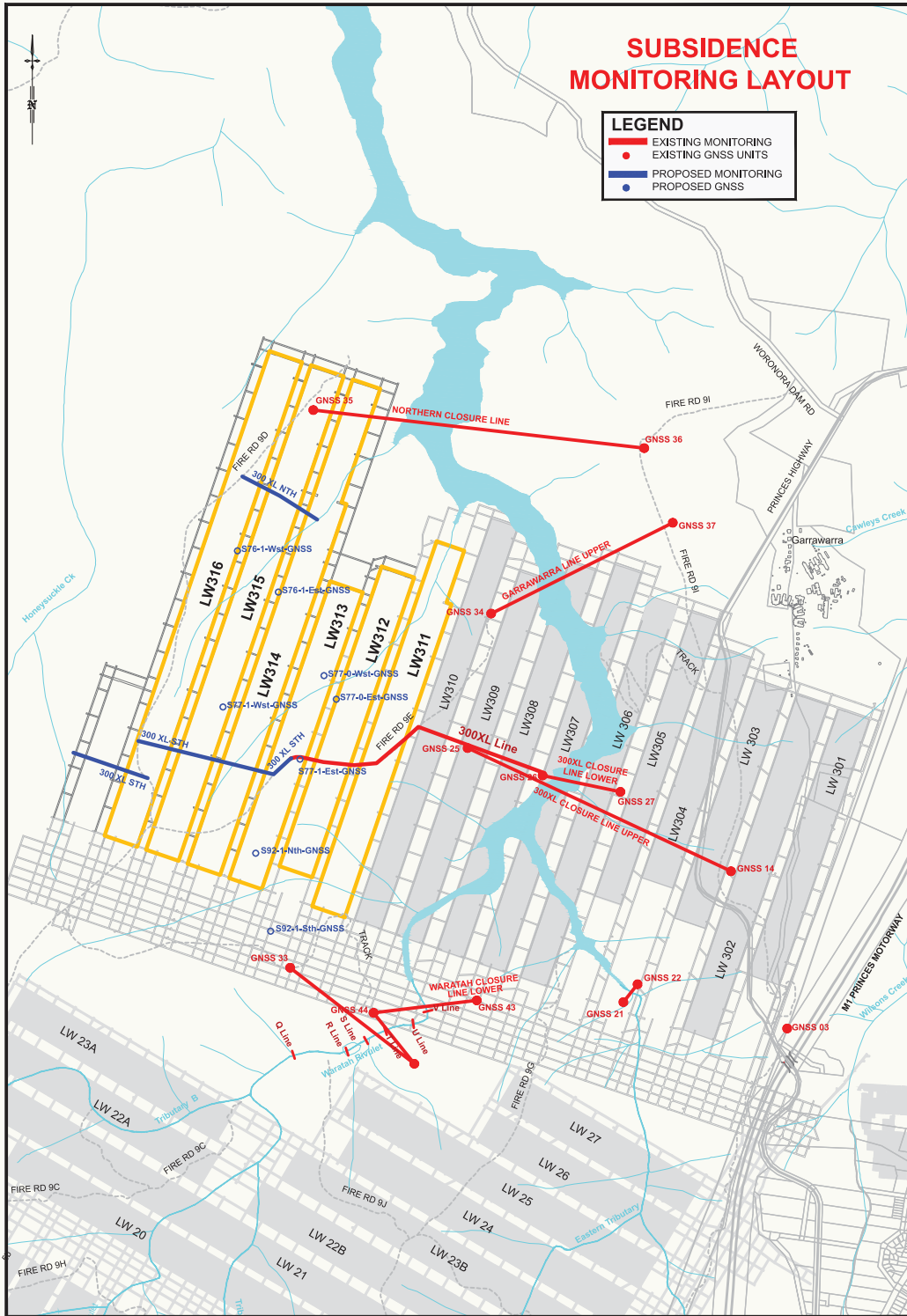
The objectives of the monitoring program are:

- To monitor the subsidence effects associated with Longwalls 311-316 extraction and where relevant, previous Longwalls 308-310, Longwalls 301-307 and Longwalls 20-27.
- To summarise and consolidate the various environmental monitoring programs presented in each of the key component plans of the Longwalls 311-316 Extraction Plan which focus on the monitoring of subsidence impacts and environmental consequences of mine subsidence. These include:
 - the WMP;
 - the BMP;
 - the LMP;
 - the HMP; and
 - the Public Safety Management Plan.
- To analyse the relationship between the subsidence effects and subsidence impacts of the Extraction Plan and any ensuing environmental consequences.
- To validate subsidence predictions.
- To provide subsidence data to improve the predictive methods and provide a better understanding of the underlying factors contributing to ground movement.

The subsidence monitoring program is composed of subsidence parameter monitoring that is summarised in Table 3 and subsidence impact/environmental consequence monitoring as summarised in Table 4.

**Table 3
Subsidence Parameter Monitoring Components**

Monitoring Component	Description	Frequency	Relevant Management Plan
300 XL Line	Monitoring line traversing approximately perpendicular across 300 series longwalls.	<ul style="list-style-type: none"> • Prior to Longwall 311. • Within 3 months following completion of each longwall. 	General – all plans
Waratah Rivulet	Cross Line Q (WaterNSW gauging station). Cross Line at rock bars R, S, T, U and V. Real-time absolute monitoring sites 43 and 44.	<ul style="list-style-type: none"> • Prior to Longwall 311. • Following the completion of Longwall 311. 	WMP Rock Bars Q, R, S, T, U, V
Valley Closure monitoring	Real-time absolute three-dimensional (3D) monitoring sites as per subsidence monitoring figure (Figure 5).	<ul style="list-style-type: none"> • Prior to Longwall 311. • Real-time (continuous) absolute 3D monitoring. • Following the completion of each longwall. 	General
Large Swamps (76, 77 and 92) valley closure monitoring.	Real-time absolute 3D monitoring sites as per subsidence monitoring figure (Figure 5).	<ul style="list-style-type: none"> • Prior to Longwall 311. • Real-time (continuous) absolute 3D monitoring. • Following the completion of each longwall. 	WMP BMP Large Swamps 76, 77 and 92



MEF-23-33 LW311-316 EP SMP_002A



Source: MSEC (2024)

Figure 5

Table 4
Subsidence Impact and Environmental Consequences Monitoring Components

Extraction Plan Component	Aspect	Sites	Frequency	Parameters / Purpose
LMP	Cliffs and overhangs	<ul style="list-style-type: none"> Cliff sites COH10, COH11, COH12, COH13, COH18 and COH19. 	<ul style="list-style-type: none"> Visual inspection prior to Longwall 311 extraction. Monthly when longwall extraction is within 400 m of each site. Following completion of Longwall 311, Longwall 312 and Longwall 313 at all identified sites (i.e. sites COH10, COH11, COH12, COH13, COH18 and COH19) and following completion of Longwall 314, Longwall 315 and Longwall 316 at sites COH18 and COH19. 	<ul style="list-style-type: none"> Cliff instabilities – length of cliff/overhang that experiences mining-induced rock fall (i.e. the exposure of a fresh face of rock and debris scattered around the base of the cliff or overhang), compared against the land subsidence impact performance indicator and subsidence impact performance measure.
	Steep slopes and land in general	<ul style="list-style-type: none"> Steep slopes and other land within 600 m of Longwalls 20-27 and Longwalls 301-316 secondary extraction. 	<ul style="list-style-type: none"> Visual observations during catchment visits. 	<ul style="list-style-type: none"> Sandstone fracturing and rock falls (nature and extent of surface tension cracks and rock ledge collapse, compared against the land subsidence impact performance indicator).
BMP	Upland Swamps – Vegetation	<ul style="list-style-type: none"> Swamps 16, 17, 18, 19, 20, 24, 25, 28, 30, 31, 32, 33, 34, 35, 36 and 94 (overlying or adjacent to Longwalls 20-27). Swamps 40, 41, 46, 47, 48, 49, 50, 51/52, 53 and 58 (overlying or adjacent to Longwalls 301-304). Swamps 69, 70, 71a, 71b, 72 and 73 (overlying or adjacent to Longwalls 305-307). Swamps 61, 62, 63, 64, 78, 79, 80, 81, 82, 83, 88, 89, 90 and 92 within the Longwalls 308-310 35° angle of draw and/or predicted 20 mm subsidence contour. Swamps 74, 75, 76, 77, 92, 106, 119, 128 and 139 within Longwalls 311-316 35° angle of draw and/or predicted 20 mm subsidence contour¹. Control Swamps 101, 111a, 125, 135, 136, 137a, 137b, 138, Bee Creek Swamp, Woronora River 1, Woronora River south arm and Dahlia Swamp. 	<ul style="list-style-type: none"> Visual inspections bi-annually in spring and autumn for swamps overlying or adjacent to Longwalls 301-316. Every third year, in autumn and spring for swamps overlying or adjacent to Longwalls 20-27. 	<ul style="list-style-type: none"> Cracking of exposed bedrock areas and/or swamp substrate. Areas of increased erosion, particularly along any existing drainage line. Any changes in water colour, particularly evidence of iron precipitation. Changes in vegetation condition, including areas of stressed vegetation (i.e. plants that demonstrate symptoms of stress) and dead/dying plants that appear unusual. Whether the amount of seepage (at the terminal step/over exposed surfaces of the swamp) at the time of inspection appears unusual (relative to recent rainfall).
		<ul style="list-style-type: none"> Swamps 28, 30, 33, 35 and 94 (Longwalls 23-27). Swamps 40, 41, 46, 48, 50 51/52 and 53 (Longwalls 301-304). Swamp 71a (Longwalls 305-307). Swamps 62, 64, 78, 79, 80, 81, 82, 83, 89, 90 and 92 within the Longwalls 308-310 35° angle of draw and/or predicted 20 mm subsidence contour. Swamps 76 and 77 within the Longwalls 311-316 35° angle of draw and/or predicted 20 mm subsidence contour. Control Swamps 101, 111a, 125, 135, 136, 137a, 137b, 138, Bee Creek Swamp, Woronora River 1, Woronora River south arm and Dahlia Swamp. 	<ul style="list-style-type: none"> Transect and quadrat monitoring bi-annually in spring and autumn for swamps overlying or adjacent to Longwalls 301-316. Every third year, in autumn and spring for swamps overlying or adjacent to Longwalls 20-27. 	<ul style="list-style-type: none"> Vegetation structure. Dominant species. Estimated cover and height for each stratum. Full floristics. Estimated cover abundance for each species using seven point Braun-Blanquet scale. Condition/health rating for each species in the quadrat.
		<ul style="list-style-type: none"> Twenty tagged individuals (<i>Epacris obtusifolia</i>) in each of Swamps 18 and 24 (Longwalls 20-22) and Control Swamps 101, 111a and 125. Twenty tagged individuals (<i>Epacris obtusifolia</i>) in each of Swamps 35 and 94 (Longwalls 23-27) and Control Swamps 137a, 137b and 138. Twenty tagged individuals (<i>Epacris obtusifolia</i>) in each of Swamps 40 and 53 (Longwalls 301-304) and Control Swamps 101, 136 and 137a. Twenty tagged individuals (<i>Pultenaea aristata</i>) in each of Swamps 19, 30, 33, 35 and 94 (Longwalls 23-27) and Control Swamps 135, 136, 137a and 138. Twenty tagged individuals (<i>Banksia robur</i>, <i>Callistemon citrinus</i> and <i>Leptospermum juniperinum</i>) in each of Swamps 20 (Longwalls 20-22) and Control Swamps Woronora River 1, Woronora River south arm and Dahlia Swamp. Twenty tagged individuals (<i>Callistemon citrinus</i>) in each of Swamps 28 (Longwalls 23-27) and Control Swamps Woronora River 1, Woronora River south arm and Dahlia Swamp. 	<ul style="list-style-type: none"> Indicator species monitoring bi-annually in spring and autumn for swamps overlying or adjacent to Longwalls 301-316. Every third year, in autumn and spring for swamps overlying or adjacent to Longwalls 20-27. 	<ul style="list-style-type: none"> Population monitoring data including condition/health rating for each plant and reproductive rating.

Table 4 (Continued)
Subsidence Impact and Environmental Consequences Monitoring Components

Extraction Plan Component	Aspect	Sites	Frequency	Parameters / Purpose
BMP (Cont.)	Upland Swamps - Groundwater	Includes paired piezometers (i.e. one swamp substrate piezometer to a depth of approximately 1 m and one sandstone piezometer to a depth of approximately 10 m). <ul style="list-style-type: none"> Swamps 20 and 25 (Longwalls 20-22). Swamps 28, 30, 33 and 35 (Longwalls 23-27). Swamps 40, 41, 46, 51, 52 and 53 (Longwalls 301-303). Swamp 50 (Longwall 304). Swamps 71a and 72 (Longwalls 305-307). Swamps 62 and 82 (Longwalls 308-310). Swamps 74, 75, 76², 77, 81, 89, 92, 106², 113, 115 and 119 (Longwalls 311-316). Control Swamps 101, 137a, 137b, Bee Creek Swamp and Woronora River 1. 	<ul style="list-style-type: none"> Datalogger (continuous). 	<ul style="list-style-type: none"> Groundwater levels.
	Riparian Vegetation	<ul style="list-style-type: none"> Sites MRIP01, MRIP02, MRIP05, MRIP06 and MRIP09 (Longwalls 20-22). Sites MRIP11 and MRIP12 overlying (Longwalls 23-27). Sites MRIP07 and MRIP08 (Longwalls 23-27). Control sites MRIP03, MRIP04 and MRIP10 (Longwall 23A). 	<ul style="list-style-type: none"> Visual inspections bi-annually in spring and autumn. 	<ul style="list-style-type: none"> Areas of new water ponding. Any cracking or rock displacement. Changes in vegetation condition, including areas of stressed vegetation that appear unusual.
		<ul style="list-style-type: none"> Sites MRIP01, MRIP05, MRIP06 and MRIP09 (Longwalls 20-22). Sites MRIP11 and MRIP12 (Longwalls 23-27) Sites MRIP03 and MRIP10 (Longwall 23A) Sites MRIP07 and MRIP08 (Longwalls 23-27). 	<ul style="list-style-type: none"> Permanent quadrat (20 m x 2 m) monitoring bi-annually in spring and autumn. 	<ul style="list-style-type: none"> Vegetation structure. Dominant species. Estimated cover and height for each stratum. Full floristics. Estimated cover abundance for each species using seven point Braun-Blanquet scale. Condition/health rating for each species in the quadrat.
		<ul style="list-style-type: none"> Existing tagged individuals (<i>Prostanthera linearis</i>, <i>Schoenus melanostachys</i> and <i>Lomatia myricoides</i>) at sites MRIP01, MRIP03, MRIP05, MRIP06, MRIP07, MRIP08, MRIP09, MRIP10, MRIP11, MRIP12. Existing tagged individuals (<i>Lomatia myricoides</i>) at site MRIP02. Existing tagged individuals (<i>Schoenus melanostachys</i> and <i>Lomatia myricoides</i>) at site MRIP04. 	<ul style="list-style-type: none"> Indicator species monitoring bi-annually in spring and autumn. 	<ul style="list-style-type: none"> Population monitoring data including condition/health rating for each plant and reproductive rating.
	Aquatic Biota and their Habitats	<ul style="list-style-type: none"> Surface water resources and watercourses in accordance with the WMP. 	<ul style="list-style-type: none"> In accordance with the WMP. 	<ul style="list-style-type: none"> Monitoring of aquatic habitats in accordance with the WMP.
		Stream monitoring at following locations (if sufficient aquatic habitat is available for sampling): <ul style="list-style-type: none"> WT3, WT4, WT5, ET1, ET2, ET3 and ET4. Control Locations WR1 and OC. 	<ul style="list-style-type: none"> Bi-annually in spring (15 September to 15 December) and autumn (15 March to 15 June). 	Impacts on aquatic ecology: <ul style="list-style-type: none"> Habitat Characteristics. Water Quality. Aquatic Macroinvertebrates. Aquatic Macrophytes.
		<ul style="list-style-type: none"> Larger pools ETAH on the Eastern Tributary and control Pool WP on the Woronora River and Pool OC on O'Hares Creek. Smaller pools ETAG, ETAI and ETAK on the Eastern Tributary and control Pools WP-A, WP-B and WP-C on the Woronora River and Pools OC-A, OC-B and OC-C on O'Hares Creek. 	<ul style="list-style-type: none"> Monitoring of Pools ETAG and ETAH will recommence subsequent to the conduct of stream remediation activities at Pool ETAH and will be conducted bi-annually in spring (15 September to 15 December) and autumn (15 March to 15 June). Monitoring of Pools ETAI and ETAK will recommence subsequent to the conduct of stream remediation activities at Pool ETAK and will be conducted bi-annually in spring (15 September to 15 December) and autumn (15 March to 15 June). 	The response of aquatic ecosystems to the implementation of stream remediation works: <ul style="list-style-type: none"> Habitat Characteristics. Water Quality. Aquatic Macroinvertebrates. Aquatic Macrophytes.
	Amphibian Monitoring	<ul style="list-style-type: none"> Sites 25-28 (Longwalls 301-303). Sites 29 and 30 (Longwalls 305-307). Sites 33, 34, and 39 (Longwalls 308-310). Transects Sites S76, S77 and S92 (Longwalls 311-316). Control Sites 7 to 12 and 18 to 22. Control Transect Sites S14, S106², Bee Creek Swamp and S76². 	<ul style="list-style-type: none"> Survey biannually in spring/summer (i.e. October to February) during suitable weather conditions. 	<ul style="list-style-type: none"> Multivariate analysis of threatened amphibian species relative abundance. Non-threatened amphibian species relative abundance. Species richness (diversity) to be monitored.

Table 4 (Continued)
Subsidence Impact and Environmental Consequences Monitoring Components

Extraction Plan Component	Aspect	Sites	Frequency	Parameters / Purpose
WMP	Stream Features	<ul style="list-style-type: none"> The Waratah Rivulet from Pool P to the full supply level of the Woronora Reservoir. 	<ul style="list-style-type: none"> Visual inspection and photographic survey of Waratah Rivulet at annual intervals. Weekly monitoring at pools observed with gas releases until no gas releases have been observed at the pool for three consecutive weeks. 	<ul style="list-style-type: none"> Location, approximate dimensions (length, width and depth), and orientation of surface cracks (specifically whether cracks are developed perpendicular to the stream flow or are controlled by rock joints or other factors, etc.). Nature of iron staining (e.g. whether isolated or across the entire streambed). Extent of iron staining (e.g. the length of stream affected). Description of gas release (e.g. isolated bubbles or continuous stream, and type of gas [methane or carbon dioxide]). Nature of scouring, for example the depth of scouring, type of soil exposed, any obvious vegetation impact, potential for severe erosion, etc. Water discoloration or opacity if present. Rock bar characteristics such as extent of cracking, seepage and underflow.
	Surface Water Flow	<ul style="list-style-type: none"> Eastern Tributary (GS 300078). Waratah Rivulet (GS 2132102). Swamp 92 Flume (GS 300143). Swamp 76 Flume (GS 300142). Woronora River (GS 2132101). Honeysuckle Creek (GS 300077). O'Hares Creek (GS 213200). 	<ul style="list-style-type: none"> Continuous (downloaded monthly). 	<ul style="list-style-type: none"> Stream flow data.
	Pool Water Levels and Drainage Behaviour	<ul style="list-style-type: none"> Eastern Tributary Pools ETG, ETJ, ETM, ETO, ETU, ETW, ETAF, ETAG, ETAH, ETAJ/ETAJ/ETAK, ETAL, ETAM, ETAN, ETAO, ETAP, ETAQ, ETAR, ETAS/ETAT³ and ETAU. Waratah Rivulet Pools A, F, J, K, L, M, N, O, P, Q, R, S, T, U, V and W. Pools SR1, SR2 and SP1 on tributaries of the Woronora Reservoir. Woronora River Control Pools WRP1, WRP2, WRP3 and WRP4. 	<ul style="list-style-type: none"> Continuous water level sensor and logger (downloaded monthly at all sites). 	<ul style="list-style-type: none"> Pool water levels.
		<ul style="list-style-type: none"> Waratah Rivulet Pools B, C, E, G, G1, H and I. 	<ul style="list-style-type: none"> Manually monitored daily, until such time that continuous sensors are installed. 	<ul style="list-style-type: none"> Pool water levels.
		<ul style="list-style-type: none"> Pools on the Waratah Rivulet from Pool P to the full supply level of the Woronora Reservoir. 	<ul style="list-style-type: none"> Visual inspections conducted at the completion of each longwall. 	<ul style="list-style-type: none"> Evidence of new cracking within the stream bed or rock bar. Whether the pools continue to flow over, through and/or below the rock bars (where relevant). Whether surface flow is evident along the length of the pools prior to flowing over/through/below the rock bars or boulder fields.
	Stream Water Quality	<ul style="list-style-type: none"> Eastern Tributary sites ETWQ F, ETWQ J, ETWQ N, ETWQ U, ETWQ W, ETWQ AF, ETWQ AH, ETWQ AQ and ETWQ AU. Waratah Rivulet sites WRWQ 2, WRWQ 6, WRWQ 8, WRWQ 9, WRWQ M, WRWQ N, WRWQ P, WRWQ R, WRWQ T, WRWQ U, WRWQ V, and WRWQ W. Woronora Reservoir tributaries at sites SR1, SR2 and SP1. Tributary B site RTWQ1. Far Eastern Tributary site FEWQ 1. Honeysuckle Creek site HCWQ 1. Bee Creek site BCWQ1. Woronora River sites WOWQ1 and WOWQ 2. 	<ul style="list-style-type: none"> Monthly. 	<ul style="list-style-type: none"> Water quality parameters as described in the WMP (samples collected for metal analysis to be field filtered).
		<ul style="list-style-type: none"> Eastern Tributary sites ETWQ F, ETWQ J, ETWQ N, ETWQ AF and ETWQ AQ. Waratah Rivulet sites WRWQ 2, WRWQ 6, WRWQ 8, WRWQ 9, WRWQ M, WRWQ N and WRWQ P. Woronora River site WOWQ 2. Honeysuckle Creek site HCWQ 1. Bee Creek site BCWQ1. Sites SR1, SR2, S92-GS and SP1 on tributaries of the Woronora Reservoir. 	<ul style="list-style-type: none"> Monthly. 	<ul style="list-style-type: none"> Unfiltered water quality samples analysed for total iron, total aluminium and total manganese.

Table 4 (Continued)
Subsidence Impact and Environmental Consequences Monitoring Components

Extraction Plan Component	Aspect	Sites	Frequency	Parameters / Purpose
WMP (Cont.)	Stream Water Quality (Cont.)	<ul style="list-style-type: none"> Site ETAU, and at a minimum of three downstream sites (site ETFSL 0, site ETFSL 100, site ETFSL 200, site ETFSL 300, site ETFSL 400, site ETFSL 500, site CONFLU1, site WDFS1 and/or site WDFS1+100). Site WARARM5. 	<ul style="list-style-type: none"> Site ETAU, and at a minimum of three downstream sites - weekly (until the site ETWQ AU monitoring results are at Level 1 or Level 2 of the WMP Trigger Action Response Plan (TARP) for the quality of water resources reaching the Woronora Reservoir for four consecutive assessment periods. Site ETAU, and at a minimum of three downstream sites - fortnightly (once the site ETWQ AU monitoring results have returned to Level 1 or Level 2 TARP levels for four consecutive assessment periods, unless the TARP level returns to Level 3). Site WARARM5 - at the same frequency described above when the sites downstream of site CONFLU can be accessed for sampling (i.e. when the Woronora Reservoir water levels are suitably low). 	<ul style="list-style-type: none"> Water quality parameters as described in the WMP (samples collected for metal analysis to be field filtered). Unfiltered water quality samples analysed for total iron and total manganese.
	Woronora, Nepean and Cataract Reservoir Water Quality	<ul style="list-style-type: none"> Woronora Reservoir (site DW01). Nepean Reservoir. Cataract Reservoir. 	<ul style="list-style-type: none"> As made available by Water NSW. 	<ul style="list-style-type: none"> Total iron, total manganese and total aluminium.
	Shallow Groundwater Levels Near Streams	<ul style="list-style-type: none"> Site ETO1, ETO2, ETO3 and ETO4 (adjacent to Pool ETO). Eastern Tributary site ETGW1. Waratah Rivulet sites WRGW1, WRGW2, WRGW3, WRGW5, WRGW6 and WRGW7. 	<ul style="list-style-type: none"> Data downloaded monthly at all sites; analysis on a six-monthly basis. 	<ul style="list-style-type: none"> Groundwater levels.
	Groundwater Levels/Pressures	<ul style="list-style-type: none"> Transect sites T1, T2, T3-R, T5 and T6. Groundwater standpipes TBS02-90 and TBS02-190. Site 9HGW0 (Longwall 10 post-mining). Site 9EGW1B. Site 9FGW1A. Site 9GGW2B. Site 9HGW1B. Site PM02. Site 9GGW1-3. Site 9GGW1-80. Site PM01 (9DGW1B). Site 9EGW2A and Site 9EGW2-4 (redrill). Site PM03. Site PHGW1B. Site PHGW2A. Site F6GW3A. Site F6GW4A. site TBS02-90. site TBS02-190. Site TBS02-250R. Site LW305GW (Longwall 305 post-mining). 	<ul style="list-style-type: none"> Data downloaded/reading monthly. Analysis at the frequency described in the WMP. 	<ul style="list-style-type: none"> Groundwater levels.
	Groundwater Quality	<ul style="list-style-type: none"> Waratah Rivulet sites WRGW1, WRGW2 and WRGW7. 	<ul style="list-style-type: none"> Monthly. 	<ul style="list-style-type: none"> Water quality parameters as described in the WMP.
Mine Water Make	Underground.	<ul style="list-style-type: none"> Mine water balance inputs (as described in the WMP). Weekly statutory inspections. Data downloaded monthly/analysis monthly. 	<ul style="list-style-type: none"> Groundwater inflow to the mine (20-day average). 	

Table 4 (Continued)
Subsidence Impact and Environmental Consequences Monitoring Components

Extraction Plan Component	Aspect	Sites	Frequency	Parameters / Purpose
HMP	Aboriginal Heritage	<ul style="list-style-type: none"> All sites within the Longwall 311 35° angle of draw and/or predicted 20 mm subsidence contour, namely sites NT 11, NT 33, NT 34, NT 35, NT 78, NT 79, FRC 97, FRC 185, FRC 186, FRC 187, FRC 189, FRC 191, FRC 193, FRC 194, FRC 196, FRC 198, FRC 199, FRC 340, FRC 344 and FRC 345. 	<ul style="list-style-type: none"> Within three months following the completion of Longwall 311. 	<ul style="list-style-type: none"> Inspections of rock surfaces for cracking and/or exfoliation and/or blockfall. Inspection of art motifs for damage or deterioration. Identification of any natural weathering processes that may result in deterioration (e.g. fire, vegetation growth and water seepage). Comparison of the physical characteristics of the site at the time of monitoring against the previous monitoring and the baseline record.
		<ul style="list-style-type: none"> All sites within the Longwalls 312 35° angle of draw and/or predicted 20 mm subsidence contour, namely sites NT 11, NT 33, NT 34, NT 35, NT 78, NT 79, FRC 97, FRC 185, FRC 186, FRC 187, FRC 189, FRC 191, FRC 193, FRC 194, FRC 196, FRC 198, FRC 199, FRC 340, FRC 344 and FRC 345. 	<ul style="list-style-type: none"> Within three months following the completion of Longwall 312. 	
		<ul style="list-style-type: none"> All sites within the Longwalls 313 35° angle of draw and/or predicted 20 mm subsidence contour, namely sites NT 3, NT 7, NT 8, NT 9, NT 11, NT 18, NT 33, NT 34, NT 35, NT 78, NT 79, FRC 61, FRC 62, FRC 97, FRC 185, FRC 186, FRC 187, FRC 189, FRC 191, FRC 193, FRC 194, FRC 195, FRC 196, FRC 198, FRC 199, FRC 340, FRC 344 and FRC 345. 	<ul style="list-style-type: none"> Within three months following the completion of Longwall 313. 	
		<ul style="list-style-type: none"> All sites within the Longwalls 314 35° angle of draw and/or predicted 20 mm subsidence contour, namely sites NT 3, NT 5, NT 6, NT 7, NT 8, NT 9, NT 11, NT 18, NT 21, NT 33, NT 34, NT 35, NT 46, NT 78, NT 79, FRC 61, FRC 62, FRC 97, FRC 185, FRC 186, FRC 187, FRC 189, FRC 191, FRC 193, FRC 194, FRC 195, FRC 196, FRC 198, FRC 199, FRC 340, FRC 344 and FRC 345. 	<ul style="list-style-type: none"> Within three months following the completion of Longwall 314. 	
		<ul style="list-style-type: none"> All sites within the Longwalls 315 35° angle of draw and/or predicted 20 mm subsidence contour, namely sites NT 3, NT 4, NT 5, NT 6, NT 7, NT 8, NT 9, NT 11, NT 18, NT 21, NT 33, NT 34, NT 35, NT 46, NT 78, NT 79, FRC 61, FRC 62, FRC 97, FRC 185, FRC 186, FRC 187, FRC 189, FRC 191, FRC 193, FRC 194, FRC 195, FRC 196, FRC 198, FRC 199, FRC 340, FRC 344 and FRC 345. 	<ul style="list-style-type: none"> Within three months following the completion of Longwall 315. 	
		<ul style="list-style-type: none"> All sites within the Longwalls 316 35° angle of draw and/or predicted 20 mm subsidence contour, namely sites NT 3, NT 4, NT 5, NT 6, NT 7, NT 8, NT 9, NT 10, NT 11, NT 12, NT 17, NT 18, NT 29/30, NT 33, NT 34, NT 35, NT 46, NT 78, NT 79, FRC 61, FRC 62, FRC 97, FRC 185, FRC 186, FRC 187, FRC 189, FRC 191, FRC 193, FRC 194, FRC 195, FRC 196, FRC 198, FRC 199, FRC 340, FRC 344 and FRC 345. 	<ul style="list-style-type: none"> Within three months following the completion of Longwall 316. 	

¹ Metropolitan Coal will assess the logistics/access and suitability of Swamps 74, 75, 128, 119, 139 as part of Longwalls 311-316 transect and quadrat vegetation monitoring program.

² Swamp 76 and 106 would be used as a control swamp until such time that subsidence effects are greater than negligible (to be determined by MSEC), at which time, it would become a test (impact) site.

³ Due to the nature of rock bar ETAS, Pool ETAS and Pool ETAT typically sit at the same level.

6.2 SUBSIDENCE PARAMETER MONITORING COMPONENTS

The components of the program to monitor subsidence parameters are illustrated in the Subsidence Monitoring Locations (Plan 7 prepared in accordance with the DPE [2022] *Extraction Plan Guideline*) provided in Attachment 1 and described below.

6.2.1 '300 XL Line'

The location of '300 XL Line' is shown in Attachment 1. The line is located across and perpendicular to Longwalls 301 to 317 extending from the M1 Princes Motorway to the Woronora Reservoir full supply level, and westward to fire trail 9D.

The '300 XL Line' is composed of survey marks established at a spacing of approximately 20 m (being less than 1/20th the mining depth). Survey marks are comprised of either:

- concrete nails set in rock; or
- galvanised iron pipes capped and punched.

Due to the practicalities of following existing tracks and steep terrain, bends in the survey line are incorporated.

Prior to installation of new survey marks, consideration will be given to the presence of Aboriginal heritage sites and, if detected, the survey marks will be located so as to avoid these heritage sites.

The purpose of the '300 XL Line' is to measure the subsidence parameters (subsidence, tilt, strain) associated with extraction of each longwall panel and the cumulative subsidence parameters associated with overall extraction.

The frequency of monitoring the '300 XL Line' will be:

- between Firetrail D and the western rib line of Longwall 309 void within 3 months of the completion of each longwall; and
- more frequently if directed by the Principal Subsidence Engineer NSW Resources Regulator.

Monitoring of the '300 XL Line' will provide information of relevance to each of the management plans listed in Section 6.1.

Metropolitan Coal has commenced investigations to install an additional subsidence monitoring line ('300 XL NTH') overlaying Longwalls 314-316. The location and length of the monitoring line is significantly constrained by the natural topography and vegetation in the northern parts of Longwalls 311-316. Notwithstanding, a preliminary location of the subsidence monitoring lines is shown in Figure 5.

6.2.2 Waratah Rivulet Cross Line

Cross lines established downstream of the maingate of Longwall 23 at Pool Q (WaterNSW Gauging Station) and Pools R, S, T, U, V will be monitored for relative subsidence movement. Absolute valley closure monitoring at WRV is comprised of two real-time (continuous) absolute 3D monitors Global Navigation Satellite System (GNSS) #43 and GNSS #44.

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The frequency of monitoring of the cross lines will be:

- prior to Longwall 311;
- real-time (continuous) absolute 3D monitoring at two sites recorded daily around WRV; and
- following the completion of extraction of Longwall 311.

6.2.3 Ridge Top Survey Stations

Real-time (continuous) absolute 3D monitoring sites are established at ridge top locations across the valleys that contain Woronora Reservoir, Eastern Tributary and Waratah Rivulet.

The purpose of the ridge to ridge survey points is to observe the subsidence related movements at the tops of valley sides and relative movements between the locations across the Woronora Reservoir, Waratah Rivulet and Eastern Tributary Valleys.

Reporting of the ridge top survey points will occur during each Annual Review.

6.2.4 Full Supply Level Valley Closure Stations

Real-time (continuous) absolute 3D monitors are located along both sides of the Waratah Rivulet and Eastern Tributary valleys proximal to the Full Supply Level of Woronora Reservoir.

The purpose of the lower valley survey points is to measure valley closure in closer proximity to the base of the valley. The observed data will be compared with predicted values to assist in providing a better understanding of the mechanism of valley closure and/or better inform the prediction methods.

Reporting of the lower valley survey points will occur during each Annual Review.

6.2.5 Large Swamps Valley Closure Stations

Real-time (continuous) absolute 3D monitors will be installed on both sides of Swamps 76, 77, and 92 proximal to the downstream end of each swamp. The GNSS valley closure monitoring pairs to be established at the downstream groundwater monitoring sites with in the Large swamps include:

- S92-1-STH-GNSS.
- S92-1-NTH-GNSS.
- S77-1-EST-GNSS.
- S77-1-WST-GNSS.
- S76-1-EST-GNSS.
- S76-1-WST-GNSS.

The purpose of the Large Swamp valley survey points is to measure valley closure in close proximity to each Large Swamp. The observed data will be compared with predicted values for the swamps to assist in providing a better understanding of the mechanism of valley closure and/or better inform the prediction methods.

In response to the Independent Expert Advisory Panel for Mining’s recommendation (Independent Expert Advisory Panel for Mining, 2024) of a new groundwater monitoring site at the lower end of Swamp 77 (S77-0), Metropolitan Coal has paired a set of GNSS valley closure monitoring units across the groundwater site, designated as follows:

- S77-0-EST-GNSS.
- S77-0-WST-GNSS.

Reporting of the Large Swamp valley survey points will occur during each Annual Review.

6.2.6 Parameters to be Measured

Surveys will measure subsidence movements in three dimensional using a total station survey instrument.

Real-time (continuous) absolute 3D monitors will measure subsidence movements in three dimensional using GNSS survey methods.

6.2.7 Monitoring Methods and Accuracy

Longwall subsidence measurements will be surveyed in accordance with the relevant specifications and legislation as applied in NSW. These include:

- *Survey and Drafting Directions for Mining Surveyors 2020 (NSW Mines)* (Department of Customer Service – Spatial Service); and
- *Inter-governmental Committee on Surveying and Mapping Standards and Practices for Control Surveys (SP1) Version 1.7 Sept 2007* ICSM Publication No.1 (ICSM SP1).

The *Survey and Drafting Directions for Mine Surveyors 2020* Section 3.4 *Correlation of Surface and Underground Surveys* will be consistent with Class ‘D’ survey as prescribed in ICSM SP1. It is intended that all Control Surveys for mine subsidence of the Longwalls 311-316 to be surveyed to Class ‘D’ using prescribed methods as described in ICSM SP1. In 2000, ICSM adopted POSITIONAL UNCERTAINTY and LOCAL UNCERTAINTY as new, easily understood methods of classifying the accuracy of coordinates.

POSITIONAL UNCERTAINTY is a new concept which caters for positions obtained independent of the survey network (e.g. Global Positioning System [GPS] results from Wide Area Differential GPS [WADGPS] or Geoscience Australia’s online positioning service). POSITIONAL UNCERTAINTY is the uncertainty of the coordinates or height of a point, in metres at the 95% confidence level, with respect to the defined reference frame. LOCAL UNCERTAINTY is the average measure, in metres at the 95% confidence level, of the relative uncertainty of the coordinates, or height, of a point(s), with respect to the survey connections to adjacent points in the defined frame.

CLASS is a function of the precision of a survey network, reflecting the precision of observations as well as suitability of network design, survey methods, instruments and reduction techniques used in that survey. Preferably, the CLASS is verified by an analysis of the minimally constrained least squares adjustment of the network.

Survey Accuracy

Each control survey and subsidiary survey must be planned and surveyed to satisfy the conditions to achieve a standard of accuracy of Class 'D' or better as prescribed in ICSM SP1. The allocation of CLASS to a survey on the basis of the results of a successful minimally constrained least squares adjustment may generally be achieved by assessing whether the semi-major axis of each relative standard error ellipse or ellipsoid (i.e. one sigma), is less than or equal to the length of the maximum allowable semi-major axis (r) using the following formula:

$$r = c (d + 0.2)$$

Where;

- r = length of maximum allowable semi-major axis in mm.
- c = an empirically derived factor represented by historically accepted precision for a particular standard of survey.
- d = distance to any station in km.

The values of 'c' assigned to various CLASSES of survey are shown in Table 5.

Table 5
Classification of Horizontal Control Survey

Class	C (for one sigma)	Typical Applications
3A	1	Special high precision surveys
2A	3	High precision National geodetic surveys
A	7.5	National and State geodetic surveys
B	15	Densification of geodetic surveys
C	30	Survey coordination projects
D	50	Lower CLASS projects
E	100	Lower CLASS projects

The radius of a 95% circle of uncertainty is readily calculated from the standard (1 σ) error ellipse produced by most least squares adjustment software. However, as the Positional Uncertainty is in terms of the national geodetic datum (not just the local control for a particular survey) the error ellipse used also must be in terms of the national geodetic datum. In Australia the national geodetic datum is the Geocentric Datum of Australia 2020 (GDA20) and is adopted by the company for surveys.

In Australia, this means that the Positional Uncertainty must be calculated from a standard error ellipse that refers to the Australian Fiducial Network (AFN) or the Australian National Network (ANN) that were held fixed in the original national GDA20 adjustment.

In essence the subsidence accuracy for POSITIONAL UNCERTAINTY is related to the Positional uncertainty of the controlling survey stations used to co-ordinate the subsidence survey. Controlling survey stations used to co-ordinate the subsidence survey will be of a higher class and survey techniques used will reflect recommended methods of achieving higher class survey.

LOCAL UNCERTAINTY is basically the relationship of the accuracy between the survey subsidence monitoring points. It is expected that the results will be far superior to Class 'D', with monitoring points having a 95% confidence major error ellipse in order of 17 mm.

Real-time (continuous) absolute 3D monitors will be used to achieve an absolute survey accuracy of ± 5 mm horizontal ± 20 mm vertical and relative to external survey reference.

A total station survey instrument will be used to achieve a survey target accuracy of ± 5 mm between marks and ± 20 mm relative to external survey reference. Total station survey instrument accuracy relative to external survey reference is influenced by available access to the sky through vegetation or terrain and may be greater than ± 20 mm.

6.3 SUBSIDENCE IMPACTS/ENVIRONMENTAL CONSEQUENCES MONITORING COMPONENTS

The subsidence impact/environmental consequences monitoring components are summarised in Table 4. All subsidence impact/environmental consequence monitoring is included in a relevant management plan within the Longwalls 311-316 Extraction Plan as summarised in Table 4. Each management plan within the Extraction Plan includes:

- detailed baseline data;
- a description of:
 - the relevant statutory requirements (including any relevant approval, licence or lease conditions);
 - any relevant limits or performance measures/criteria; and
 - the specific performance indicators that are to be used to judge the performance of, or guide the implementation of, the Project or any management measures;
- a description of the measures that would be implemented to comply with the relevant statutory requirements, limits, or performance measures/criteria;
- a program to monitor and report on the:
 - impacts and environmental performance of the project; and
 - effectiveness of any management measures;
- a contingency plan to manage any unpredicted impacts and their consequences;
- a program to investigate and implement ways to improve the environmental performance of the Project over time;
- a protocol for managing and reporting any:
 - incidents;
 - complaints;
 - non-compliances with statutory requirements;
 - exceedances of the impact assessment criteria and/or performance criteria; and
- a protocol for periodic review of the plan.

The subsidence impacts/environmental consequences monitored as part of each management plan are summarised in the following sections.

6.4 LAND MANAGEMENT PLAN

The Longwalls 311-316 LMP has been prepared to manage the potential environmental consequences of the Longwalls 311-316 Extraction Plan on cliffs and overhangs, steep slopes and land in general.

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6.4.1 Cliffs and Overhangs

As outlined in the LMP, detailed baseline recording of the four cliff and overhang sites located within the Longwalls 311-316 35° angle of draw and/or predicted 20 mm subsidence contour (sites COH10, COH11 COH12, COH13, COH18 and COH19) has been undertaken. Baseline recording of the remaining two cliffs, COH18 and COH19, within the 35° angle of draw and/or predicted 20 mm subsidence contour will be carried out prior to the commencement of Longwall 311. Additionally, four cliff overhangs (namely, sites COH5, COH7, COH8 and COH9) are located outside of the Study Area but within 600 m of Longwalls 311-316.

Visual inspections for subsidence impacts on cliff sites will be conducted to record subsidence impacts prior to the commencement of Longwall 311, on a monthly basis when longwall extraction is within 450 m of each site, and following completion of Longwall 311, Longwall 312, Longwall 313, Longwall 314, Longwall 315 and Longwall 316.

In the event subsidence impacts are identified on cliff and overhang sites, the following details will be noted and/or photographed:

- the date of the inspection;
- the location of longwall extraction (i.e. the longwall chainage);
- the location of the cliff instability (i.e. freshly exposed rock face and debris scattered around the base of the cliff or overhang) relative to the cliff face or overhang;
- the nature and extent of the cliff instability (including an estimate of volume);
- the length of the cliff instability;
- other relevant aspects such as water seepage (which can indicate weaknesses in the rock);
- whether any actions are required (for example – implementation of appropriate safety controls, review of public safety etc.); and
- any other relevant information.

6.4.2 Steep Slopes and Land in General

Visual inspections for subsidence impacts on steep slopes and land in general within 600 m of Longwalls 20-27 and Longwalls 301-310 extraction will be conducted by Metropolitan Coal and its contractors during catchment visits, sampling and routine works conducted in the catchment.

In the event subsidence impacts are identified within 600 m of Longwalls 20-27 and Longwalls 301-310 (that were not previously recorded during the mining of Longwalls 20-27 or Longwalls 301-307), or within 600 m of Longwalls 311-316, the following details will be noted and/or photographed:

- the location, approximate dimensions (length, width and depth), and orientation of surface tension cracks;
- the location of the surface tension crack in relation to fire trails or vehicular tracks;
- the location and approximate dimensions of rock falls (e.g. rock ledges);
- whether any actions are required (for example – implementation of appropriate safety controls, review of public safety etc.); and
- any other relevant information.

6.5 BIODIVERSITY MANAGEMENT PLAN

The Longwalls 311-316 BMP has been prepared to manage the potential environmental consequences of the Longwalls 311-316 Extraction Plan on aquatic and terrestrial flora and fauna, with a specific focus on swamps.

6.5.1 Upland Swamps - Vegetation

Longwalls 311-316

Upland swamp vegetation monitoring for Longwalls 311-316 will include visual and quadrat/transect monitoring consistent with the methods used for the monitoring of Longwalls 20-22, Longwalls 23-27, Longwalls 301-303, Longwall 304, Longwalls 305-307 and Longwalls 308-310 upland swamp vegetation.

Visual inspections will be conducted of Swamps 76 and 77 located within the Longwalls 311-316 35° angle of draw and/or predicted 20 mm subsidence contour.

Transect and quadrat monitoring will be conducted in Swamps 76 and 77 located within the Longwalls 311-316 35° angle of draw and/or predicted 20 mm subsidence contour.

Metropolitan Coal will assess the logistics/access and suitability of Swamps 74, 75, 128, 119, 139 as part of Longwalls 311-316 transect and quadrat vegetation monitoring program.

The data collected for each quadrat will be consistent with the data collected for the Longwalls 20-22, Longwalls 23-27, Longwalls 301-303, Longwall 304, Longwalls 305-307 and Longwalls 308-310 upland swamp monitoring programs described in the Longwalls 311-316 BMP.

Monitoring of the swamps will be conducted bi-annually in autumn and spring.

Previous Longwalls 20-22, Longwalls 23-27, Longwalls 301-303, Longwall 304, Longwalls 305-307 and Longwalls 308-310

Visual inspections will continue to be conducted of Swamps 16, 17, 18, 19, 20, 24, 25, 28, 30, 31, 32, 33, 34, 35, 36 and 94 overlying or adjacent to Longwalls 20-27 during the extraction of Longwalls 311-316.

Visual inspections will also continue to be conducted of Swamps 40, 41, 46, 47, 48, 49, 50, 51/52, 53 and 58 overlying or adjacent to Longwalls 301-304, Swamps 69, 70, 71a, 71b, 72 and 73 overlying or adjacent to Longwalls 305-307 and Swamps 61, 62, 63, 64, 78, 79, 80, 81, 82, 83, 88, 89, 90 and 92 overlying or adjacent to Longwalls 308-310 during the extraction of Longwalls 311-316.

Transect and quadrat monitoring will continue to be conducted bi-annually in Swamps 16, 17, 18, 20, 24 and 25 overlying Longwalls 20-22, Swamps 28, 30, 33, 35 and 94 overlying or adjacent to Longwalls 23-27, Swamps 40, 41, 46, 48, 50, 51/52 and 53 overlying or adjacent Longwalls 301-304, Swamp 71a adjacent to Longwalls 305-307 and in control Swamps 101, 111a, 125, 135, 136, 137a, 137b, 138, Bee Creek Swamp, Woronora River 1, Woronora River south arm and Dahlia Swamp.

Population monitoring will continue to be conducted for Longwalls 20-22, Longwalls 23-27 and Longwalls 301-304 during the extraction of Longwalls 311-316 as described in Table 4. Indicator species monitored include *Epacris obtusifolia*, *Pultenaea aristata*, *Callistemon citrinus*, *Leptospermum juniperinum* and *Banksia robur*.

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Monitoring of the swamps will be conducted bi-annually in autumn and spring for swamps overlying or adjacent to Longwalls 301-310 and every third year in autumn and spring for swamps overlying or adjacent to Longwalls 20-27.

6.5.2 Upland Swamps - Groundwater

Groundwater monitoring of upland swamps includes the monitoring of paired piezometers (i.e. one swamp substrate piezometer to a depth of approximately 1 m and one sandstone piezometer to a depth of approximately 10 m). Each piezometer has been equipped with a data logger for continuous water level monitoring.

Upland swamp groundwater monitoring will continue to be conducted in Swamps 20 and 25 for Longwalls 20-22, Swamps 28, 30, 33 and 35 for Longwalls 23-27, Swamps 40, 41, 46, 51, 52 and 53 for Longwalls 301-303, Swamp 50 for Longwall 304, Swamps 71a and 72 for Longwalls 305-307, Swamps 62 and 64 for Longwalls 308-310 and in control Swamps 101, 137a, 137b, Bee Creek Swamp and Woronora River 1 (WRSWAMP 1) during the extraction of Longwalls 311-316.

Upland swamp groundwater monitoring will be conducted in Swamps 76, 77 and 92 for Longwalls 311-316.

Paired piezometers in Swamps 60, 133 and 134 can also be used as potential reference sites during the mining of Longwalls 311-316.

In early 2024, Metropolitan Coal installed additional 10 m piezometers in Swamps 77-1 and 77-3 where monitoring previously housed a substrate piezometer only. Prior to commencing Longwall 311 (and where access, weather and ground conditions permit), Metropolitan Coal has installed additional 10 m piezometers in Swamps 76 and 92 at the locations currently housing a substrate piezometer only (i.e. at sites 76-1, 76-3, and 92-3). The piezometer at Swamp 92 (92-1) will be installed as soon as practicable subject to suitable weather and access.

6.5.3 Riparian Vegetation

No additional riparian vegetation monitoring sites have been established for Longwalls 311-316. Riparian areas along Waratah Rivulet and the Eastern Tributary monitored for Longwalls 20-22 and Longwalls 23-27 will continue to be monitored at sites MRIP01 to MRIP12 during the mining of Longwalls 311-316.

Riparian vegetation monitoring will include visual and quadrat monitoring consistent with the methods detailed in the Longwalls 311-316 BMP.

Visual inspections of riparian areas will continue to be conducted in locations adjacent to riparian vegetation monitoring sites (sites MRIP01 to MRIP12), and areas traversed whilst accessing the monitoring sites during the extraction of Longwalls 311-316 to record evidence of subsidence impacts.

The existing permanent quadrat (20 m x 2 m) will continue to be used to monitor riparian vegetation at sites MRIP01 to MRIP08 and sites MRIP11 and MRIP12.

The three indicator species will continue to be monitored within the riparian vegetation of the Eastern Tributary and Waratah Rivulet, namely, *Prostanthera linearis*, *Schoenus melanostachys* and *Lomatia myricoides* at sites MRIP01, MRIP03, MRIP05, MRIP06, MRIP07, MRIP08, MRIP09, MRIP10, MRIP11 and MRIP12.

The indicator species, *Lomatia myricoides*, will continue to be monitored at the site MRIP02. The indicator species *Schoenus melanostachys* and *Lomatia myricoides* will continue to be monitored at the site MRIP04.

6.5.4 Aquatic Biota and Habitat

Metropolitan Coal will assess the subsidence impacts and environmental consequences on surface water resources and watercourses (aquatic habitats) in accordance with the Metropolitan Coal Longwalls 311-316 WMP.

The aquatic ecology monitoring programs include the monitoring of aquatic habitat characteristics, water quality, macroinvertebrates and aquatic macrophytes. Observations of surface cracking, iron staining and gas releases will also be made during the conduct of the aquatic ecology surveys.

Stream Monitoring

Monitoring of aquatic biota (macroinvertebrates and macrophytes) will continue to be conducted (if sufficient habitat is available for sampling) at two sampling sites (approximately 100 m long) at stream sampling locations WT3, WT4 and WT5 on the Waratah Rivulet, locations ET1, ET2, ET3 and ET4 on the Eastern Tributary and at control location WR1 on the Woronora River and control location OC on O'Hares Creek.

Monitoring of the stream sampling sites on the Waratah Rivulet, Eastern Tributary, Woronora River and O'Hares Creek will be conducted bi-annually in spring (15 September to 15 December) and autumn (15 March to 15 June), consistent with the timing required by the Australian River Assessment System (AUSRIVAS) protocol.

Pool Monitoring

A number of pools will be monitored to assess the response of aquatic ecosystems to the implementation of stream remediation works, namely:

- Larger pools (i.e. >40 m in length) ETAH on the Eastern Tributary, control Pool WP on Woronora River and control Pool OC on O'Hares Creek.
- Smaller pools (i.e. <40 m in length) ETAG, ETAI and ETAK on the Eastern Tributary and control Pools WP-A, WP-B and WP-C on Woronora River and three control Pools OC-A, OC-B and OC-C on O'Hares Creek.

Monitoring of Pools ETAG and ETAH will recommence subsequent to the conduct of stream remediation activities at Pool ETAH and will be conducted bi-annually in spring (15 September to 15 December) and autumn (15 March to 15 June).

Monitoring of Pools ETAI and ETAK will recommence subsequent to the conduct of stream remediation activities at Pool ETAK and will be conducted bi-annually in spring (15 September to 15 December) and autumn (15 March to 15 June).

During the further baseline amphibian surveys to be conducted in late 2024/early 2025 for threatened amphibian species along Tributary P, Tributary R and Tributary S, searches would be conditioned to identify potential breeding pools for threatened amphibian species. If a breeding pool is identified, pool water level monitoring equipment will be installed in the relevant pool.

6.5.5 Terrestrial Fauna and their Habitats

Terrestrial fauna habitats (upland swamps, riparian vegetation, slopes and ridgetops, and aquatic habitats) will be monitored as described in the Longwalls 311-316 BMP. Observations of any surface cracking and loss of flow in streams will also be noted at amphibian monitoring sites during the conduct of the amphibian surveys.

Amphibians were selected as the appropriate representative of terrestrial vertebrate fauna because they are widespread across the Study Area, include at least two threatened species that are sensitive to changes in surface hydrology, and because this group is represented by 14 species that appear to have viable populations.

The amphibian monitoring programs for Longwalls 20-27 and 301-310 consist of: six test sites (sites 1-6) and six control sites (sites 7-12) for Longwalls 20-22, five test sites (sites 13-17) and five control sites (sites 18-22) for Longwalls 23-27 and six test sites (sites 23-28) for Longwalls 301-303. No additional amphibian monitoring sites were established for Longwall 304. The Longwalls 305-307 amphibian monitoring program includes two test sites (sites 29 and 30). The Longwalls 308-310 amphibian monitoring program includes two test sites (sites 32 and 39) in close proximity to Longwalls 308-310.

The Longwalls 311-316 amphibian monitoring program will monitor three threatened amphibian species, namely Littlejohn's Tree Frog (*Litoria littlejohni*), Giant Burrowing Frog (*Heleioporus australiacus*) and Red-crowned Toadlet (*Pseudophryne australis*) through the use of 500 m transects within the boundaries of Swamps 76, 77 and Swamp 92 in close proximity to Longwalls 311-316. Control transects will be monitored at Bee Creek Swamp and Swamp 14. Swamp 76 and Swamp 106 will also be used as control swamps until such time that subsidence effects are greater than negligible (to be determined by MSEC), at which time, it would become a test (impact) site.

The amphibian monitoring will occur biannually in spring/summer (i.e. October to February) during suitable weather conditions.

Species will be assigned to relative abundance categories for tadpole and adult stages.

6.6 WATER MANAGEMENT PLAN

The Longwalls 311-316 WMP has been prepared to manage the potential environmental consequences of the Longwalls 311-316 Extraction Plan on water resources (including the Woronora Reservoir) and watercourses.

6.6.1 Stream Features

Visual inspections and photographic surveys of the Waratah Rivulet from the full supply level of the Woronora Reservoir to Pool P will be conducted at annual intervals.

The visual and photographic surveys will record:

- the location, approximate dimensions (length, width and depth), and orientation of surface cracks (specifically whether cracks are developed perpendicular to the stream flow or are controlled by rock joints or other factors, etc.);
- the nature of iron staining (e.g. whether isolated or across the entire streambed);
- the extent of iron staining (e.g. the length of stream affected);
- a description of gas release (e.g. isolated bubbles or continuous stream, and type of gas [methane or carbon dioxide]);

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- the nature of scouring, for example the depth of scouring, type of soil exposed, any obvious vegetation impact, potential for severe erosion, etc.;
- water discoloration or opacity if present;
- rock bar characteristics such as extent of cracking, seepage and underflow;
- whether any actions are required (e.g. implementation of management measures, incident notification, implementation of appropriate safety controls, review of public safety, etc.); and
- any other relevant information.

Visual inspections on the Waratah Rivulet will record the above parameters by exception (i.e. where they differ to the baseline visual and photographic record).

Any gas releases identified as occurring on the Waratah Rivulet to the full supply level by the visual inspections during the mining of Longwalls 311-316 (either during the visual and photographic surveys or other catchment monitoring) will be monitored weekly to determine the nature of the gas releases, gas concentration (samples taken for the analysis for carbon dioxide and methane content) and any observable environmental effects (e.g. impacts to riparian vegetation or fish kills). Weekly monitoring will be conducted at pools observed with gas releases, until no gas releases have been observed at the pool for three consecutive weeks.

6.6.2 Surface Water Flow

Surface water flow monitoring will include continuous flow monitoring at:

- the Metropolitan Coal owned gauging station on the Eastern Tributary, close to the inundation limits of the Woronora Reservoir (GS 300078);
- the WaterNSW owned gauging station on the Waratah Rivulet, close to the inundation limits of the Woronora Reservoir (GS 2132102);
- the WaterNSW owned gauging station on the Woronora River, close to the inundation limits of the Woronora Reservoir (GS 2132101) (control site);
- the Metropolitan Coal owned gauging station on Honeysuckle Creek (GS 300077) (control site);
- the WaterNSW owned gauging station on O'Hares Creek at Wedderburn (GS 213200) (control site);
- the Metropolitan Coal owned gauging station on a tributary of the Woronora Reservoir (Swamp 92 Flume [GS 300143]); and
- the Metropolitan Coal owned gauging station on a tributary of the Woronora Reservoir (Swamp 76 Flume [GS 300142]).

6.6.3 Waratah Rivulet Gauging Station

Metropolitan Coal will monitor subsidence movements at the Waratah Rivulet gauging station to assess the functionality of the gauging station.

In the event differential survey data indicates vertical and horizontal movements have occurred at the Waratah Rivulet gauging station, Metropolitan Coal will assess whether the movement has altered the stream flow rating curve.

In the event subsidence movements that alter the stream flow rating curve occur, Metropolitan Coal will update the stream flow rating curve to reflect the changes in surface levels resulting from subsidence. Metropolitan Coal will validate the updated stream flow rating curve and continue to monitor subsidence movements.

6.6.4 Pool Water Levels and Drainage Behaviour

Pool water levels and drainage behaviour will be monitored using a continuous water level sensor and logger in:

- Pools ETG, ETJ, ETM, ETO, ETU, ETW, ETAF, ETAG, ETAH, ETAI/ETAJ/ETAK, ETAL, ETAM, ETAN, ETAO, ETAP, ETAQ, ETAR, ETAS/ETAT and ETAU on the Eastern Tributary;
- Pools A, F, J, K, L, M, N, O, P, Q, R, S, T, U, V and W on Waratah Rivulet;
- Pools SR1, SR2 and SP1 on tributaries of the Woronora Reservoir; and
- control Pools WRP1, WRP2, WRP3 and WRP4 on the Woronora River.

Data from these devices will be downloaded monthly.

Pools situated on the Waratah Rivulet from Pool P to the full supply level of the Woronora Reservoir will be visually inspected at the completion of Longwalls 311, 312, 313, 314, 315 and 316 to observe whether the pool water level has fallen below the cease to flow level or whether any changes to the natural drainage behaviour have occurred.

Pools ETAS, ETAT and ETAU on the Eastern Tributary will be visually inspected at the completion of Longwalls 311, 312, 313, 314, 315 and 316 to observe whether any changes to the natural drainage behaviour have occurred.

Prior to the extraction of Longwall 311 continuous water level sensors will replace manual measurements in Waratah Rivulet Pools B, C, E, G, G1, H and I. Data from these devices once active will be downloaded monthly.

Visual observations will include:

- evidence of new cracking within the stream bed or rock bar;
- whether the pools continue to flow over, through and/or below the rock bars (where relevant); and
- whether surface flow is evident along the length of the pools prior to flowing over/through/below the rock bars or boulder fields.

6.6.5 Surface Water Quality

Surface water quality will be sampled monthly at the following sites:

- sites ETWQ F, ETWQ J, ETWQ N, ETWQ U, ETWQ W, ETWQ AF, ETWQ AH, ETWQ AQ and ETWQ AU on the Eastern Tributary;
- sites WRWQ 2, WRWQ 6, WRWQ 8, WRWQ 9, WRWQ M, WRWQ N, WRWQ P, WRWQ R, WRWQ T, WRWQ U, WRWQ V, and WRWQ W on the Waratah Rivulet;
- site FEWQ 1 on the Far Eastern Tributary;
- site HCWQ 1 on Honeysuckle Creek;
- site BCWQ 1 along Bee Creek;

- sites SR1, SR2 and SP1 on Woronora Reservoir tributaries; and
- control sites WOWQ 1 and WOWQ 2 on the Woronora River.

Water quality parameters will include electrical conductivity (EC), pH, redox potential (Eh), dissolved oxygen (DO), turbidity, calcium (Ca), magnesium (Mg), sodium (Na), potassium (K), chloride (Cl), sulphate (SO₄), bicarbonate (HCO₃), total nitrogen (N_{tot}), total phosphorous (P_{tot}), nitrate (NO₃), barium (Ba), strontium (Sr), manganese (Mn), iron (Fe), zinc (Zn), cobalt (Co) and aluminium (Al). Samples collected for metal analysis will be field filtered.

Unfiltered water quality samples will also be collected monthly at the following sites and analysed for total iron, total aluminium and total manganese, in addition to the filtered concentrations:

- sites ETWQ F, ETWQ J, ETWQ N, ETWQ AF and ETWQ AQ on the Eastern Tributary;
- sites WRWQ 2, WRWQ 6, WRWQ 8, WRWQ 9, WRWQ M, WRWQ N and WRWQ P on the Waratah Rivulet;
- sites SR1 and SR2 downstream of Swamp 77 and sites S92-GS and SP1 downstream of Swamp 92; and
- control site WOWQ 2 on the Woronora River, control site BCWQ1 on Bee Creek and control site HCWQ1 on Honeysuckle Creek.

Metropolitan Coal will also monitor site ETAU and a minimum of three downstream sites (site ETFSL 0, site ETFSL 100, ETFSL 200, site ETFSL 300, site ETFSL 400, site ETFSL 500, site CONFLU1, site WDFS1 and/or site WDFS1+100) weekly until the site ETWQ AU monitoring results are at Level 1 or Level 2 of the Longwalls 311-316 WMP TARP for the quality of water resources reaching the Woronora Reservoir for four consecutive assessment periods. The downstream sites will be selected in consideration of the Woronora Reservoir water level and safe access to the sites.

Sampling of site ETAU and three downstream sites will continue fortnightly once the site ETWQ AU monitoring results have returned to Level 1 or Level 2 Longwalls 311-316 WMP TARP levels for four consecutive assessment periods, unless the TARP level returns to Level 3.

Metropolitan Coal will also monitor WARARM5 at the same frequency described above when the sites downstream of site CONFLU1 can be accessed for sampling (i.e. when the Woronora Reservoir water levels are suitably low).

Water quality samples will be collected from the Swamp 92 Weir (S92-GS) to allow for a comparison of data between S92-GS and the water quality data collected downstream at SP1. If data is comparable, then water quality data collected at SP1 will be used as a proxy for S92-GS.

6.6.6 Woronora, Nepean and Cataract Reservoir Water Quality

Metropolitan Coal will source water quality data for the Woronora Reservoir (site DW01, measurements taken from 0 to 9 m below the water surface level), the Nepean Reservoir and the Cataract Reservoir from WaterNSW in accordance with a data exchange agreement.

6.6.7 Shallow Groundwater Levels near Streams

Continuous water level monitoring of shallow groundwater will be conducted at:

- sites ETO1, ETO2, ETO3 and ETO4 adjacent to Pool ETO on the Eastern Tributary; and
- sites WRGW1, WRGW2 and WRGW7 along Waratah Rivulet.

Data will be downloaded monthly and analysis will be conducted on a six monthly basis.

6.6.8 Groundwater Levels/Pressures

Groundwater level monitoring will be conducted at an approximately east-west transect of bores (sites T1, T2, T3-R, T5 and T6) located to the east of Longwalls 311-316. Data from the divers in the standpipes will be downloaded monthly and the measured water levels at these bores will be compared against the water level at the Woronora Reservoir.

Additional groundwater standpipes have been installed as a component of the Woronora Reservoir Impact Strategy, namely bores TBS02-90 (post-mining Longwall 302) and TBS02-190 (post-mining Longwall 302).

Continuous groundwater level/pressure monitoring will be conducted at:

- site 9HGW0 (Longwall 10 post-mining);
- site 9EGW1B;
- site 9FGW1A;
- site 9GGW2B;
- site 9HGW1B;
- site PM02;
- site 9GGW1-80 (Longwall 22 post-mining);
- site PM01 (9DGW1B);
- site 9EGW2A;
- site 9EGW2-4;
- site PM03;
- site PHGW1B;
- site PHGW2A;
- site F6GW3A;
- site F6GW4A;
- site TBS02-250R (Longwall 302 post-mining); and
- site LW305GW (Longwall 305 post-mining).

The following groundwater level monitoring sites are planned to be installed by early 2025 (subject to approval and suitable weather conditions):

- site S92-GW-02;
- site 9E-GW-77;
- site 9D-GW-76-90; and
- site 9D-GW-76-150.

Data from the piezometers will be downloaded monthly and assessed in accordance with the WMP.

6.6.9 Groundwater Quality

Shallow groundwater quality sampling will be conducted monthly at the following sites:

- sites WRGW1, WRGW2 and WRGW7 along the Waratah Rivulet.

Water quality parameters will include EC, pH, Eh, Ca, Mg, Na, K, Cl, SO₄, HCO₃, Ba, Sr, Mn, Fe, Zn, Co and Al. The samples collected for the analysis of metals will be field filtered.

Unfiltered water quality samples will also be collected monthly at site WRGW7 on the Waratah Rivulet and analysed for total iron.

6.6.10 Mine Water Make

Monitoring of the mine water balance will comprise moisture flows into and out of the mine.

Moisture flows into the mine:

- Clean water reticulated into the mine (recorded continuously and downloaded monthly).
- Backfill water used to assist pumping into the mine (recorded continuously and downloaded monthly).
- Ventilation moisture content entering the mine at the intake points by manual measurement using a digital psychrometer. The frequency of readings will be as follows:
 - every hour over a 9 hour period on two occasions during a 12 month period;
 - daily (week day) except public holidays or other circumstances (access) that prevent readings to be taken; and
 - once per week as a minimum.
- Measurement of the in-situ moisture content of the coal during channel sampling for coal quality.

Moisture flows out of the mine:

- Return water reticulated out of the mine (recorded continuously and downloaded monthly).
- Moisture content of the raw coal conveyed out of the mine at the drift portal using an automated moisture scanner. Recorded continuously and downloaded monthly.
- Moisture content of gas stream reticulated out of the mine to the gas drainage plant (recorded continuously and downloaded monthly).
- Ventilation moisture content exiting the mine at the upcast shaft by manual measurement using a digital psychrometer. The frequency of readings will be as follows:

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- every hour over a 9 hour period on two occasions during a 12 month period;
- daily (week day) except public holidays or other circumstances (access, fan maintenance) that prevent readings to be taken; and
- once per week as a minimum.

The inferred water make (i.e. groundwater that has seeped into the mine through the strata) will be calculated from the difference between total mine inflows (reticulated water into the mine, moisture in the downcast ventilation, and the *in-situ* coal moisture content) and total mine outflows (reticulated water out of the mine, moisture in the exhaust ventilation, and moisture in the run-of-mine coal).

Given the large fluctuations in daily water usage and the cycle period for water entering the mine, being used by machinery, and draining to sumps for return pumping to the surface, a 20 day average will be used to provide a more reliable estimate of water make.

In addition to shift inspections conducted by statutory officials that report on any abnormal conditions at the working face and in outbye areas, Metropolitan Coal conducts statutory weekly inspections of development workings to identify water accumulations.

6.7 HERITAGE MANAGEMENT PLAN

The Longwalls 311-316 HMP has been prepared to manage the potential environmental consequences of the Longwalls 311-316 Extraction Plan on Aboriginal heritage sites or values.

All³ Aboriginal heritage sites located within the Longwalls 311-316 35° angle of draw and/or predicted 20 mm subsidence contour will be monitored for Longwalls 311-316.

Round 1 monitoring will be undertaken within three months following the completion of Longwall 311 and will include all sites within the Longwall 311 35° angle of draw and/or predicted 20 mm subsidence contour (Table 4).

Round 2 monitoring will be undertaken within three months following the completion of Longwall 312 and will include all sites within the Longwalls 312 35° angle of draw and/or predicted 20 mm subsidence contour (Table 4).

Round 3 monitoring will be undertaken within three months following the completion of Longwall 313 and will include all sites within the Longwalls 313 35° angle of draw and/or predicted 20 mm subsidence contour (Table 4).

Round 4 monitoring will be undertaken within three months following the completion of Longwall 314 and will include all sites within the Longwalls 314 35° angle of draw and/or predicted 20 mm subsidence contour (Table 4).

Round 5 monitoring will be undertaken within three months following the completion of Longwall 315 and will include all sites within the Longwalls 315 35° angle of draw and/or predicted 20 mm subsidence contour (Table 4).

Round 6 monitoring will be undertaken within three months following the completion of Longwall 316 and will include all sites within the Longwalls 316 35° angle of draw and/or predicted 20 mm subsidence contour (Table 4).

³ Despite extensive searches, site FRC 180 (which is located within the Longwalls 305-307 35° angle of draw and/or predicted 20 mm subsidence contour) was unable to be relocated during baseline recording, and will not be monitored as part of the Longwalls 305-307 HMP.

The monitoring team will include a suitably qualified archaeologist (with experience in rock art recording and management) and representatives of the Aboriginal stakeholders (where available). Specific details that will be recorded during the monitoring program include (but are not limited to):

- the date of monitoring;
- the location of longwall extraction (i.e. the longwall chainage) at the time of monitoring;
- comparison of the physical characteristics of the site at the time of monitoring against the previous monitoring and the baseline record (detail/quantify any changes observed);
- inspections of rock surfaces for cracking and/or exfoliation and/or blockfall since the previous monitoring and against the baseline record;
- inspection of art motifs for damage or deterioration since the previous monitoring and against the baseline record;
- identification of any natural weathering processes that may result in deterioration (e.g. fire, vegetation growth and water seepage);
- detailed description and quantification of any changes noted during the completion of the above tasks;
- a photographic record of any changes noted during monitoring (taken at the same position and distance as baseline record to allow comparison over time);
- whether any follow-up actions are required to be considered (e.g. implementation of management or initiation of the Contingency Plan, etc.); and
- any other relevant information.

Monitoring of Aboriginal heritage sites located within the Longwalls 311-316 35° angle of draw and/or predicted 20 mm subsidence contour would be subject to suitable weather conditions, access to the Woronora Special Area and Registered Aboriginal Party availability.

6.8 BUILT FEATURES MANAGEMENT PLAN

No built features are located within the Longwalls 311-316 35° angle of draw and/or 20 mm subsidence contour or in the vicinity the Longwalls 311-316 35° angle of draw and/or 20 mm subsidence contour that necessitate a Built Features Management Plan (BFMP). As extraction is moving away from previously considered built features, the number of BFMPs has been reduced over time as monitoring indicates the reduction of subsidence to negligible levels post-mining.

In consideration of the above, there are no BFMPs associated with the LW311 to 316 Extraction Plan.

6.9 ACCESS ROADS/TRACKS

Visual inspection of the access roads/tracks will be conducted prior to the commencement of Longwall 311, and following extraction of each longwall panel.

Visual observations of access roads/tracks would occur as part of routine works and inspections within 600 m of Longwalls 311-316 secondary extraction as described in the Metropolitan Coal LMP.

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Specific details that will be noted and/or photographed that are relevant to the access roads/tracks include:

- the location, approximate dimensions (length, width and depth), and orientation of surface tension cracks;
- the location of the surface tension crack in relation to the access road/track;
- whether any actions are required (e.g. implementation of management measures as outlined in the LMP, initiation of the Contingency Plan as outlined in the LMP, incident notification, implementation of appropriate safety controls, review of public safety, etc.); and
- any other relevant information.

7 ANALYSIS OF SUBSIDENCE EFFECTS, SUBSIDENCE IMPACTS AND ENVIRONMENTAL CONSEQUENCES

Analysis of the relationship between subsidence effects, subsidence impacts and environmental consequences will be reported annually in the Annual Review. The analysis will include:

- comparison of predicted subsidence effects and measured parameters;
- comparison of predicted subsidence impacts and measured impacts;
- analysis of any variations between predicted and measured conventional subsidence effects and impacts (e.g. consideration of underlying parameters such as distance functions, etc. used to determine the predicted subsidence profile);
- analysis of variations between predicted and measured far-field movements and non-conventional subsidence effects (e.g. effects of geological structures and valley closure) and impacts;
- analysis of the 3D movement about longwall extraction with particular reference to the transverse and longitudinal movements versus distance in advance of the longwall panel; and
- a review of, and where necessary updates to, the Large Swamp models in consideration of monitoring data where a subsidence consequence has occurred alongside revised predictions for subsequent longwalls.

The analyses will be used to assess the validity of the subsidence predictions and to refine the predictive methods where appropriate.

The relationship between subsidence effects, impacts and environmental consequences will be determined through review and reporting of each environmental management plan (e.g. LMP, WMP, BMP and HMP) in accordance with Condition 3, Schedule 7 of the Project Approval.

8 REFERENCES

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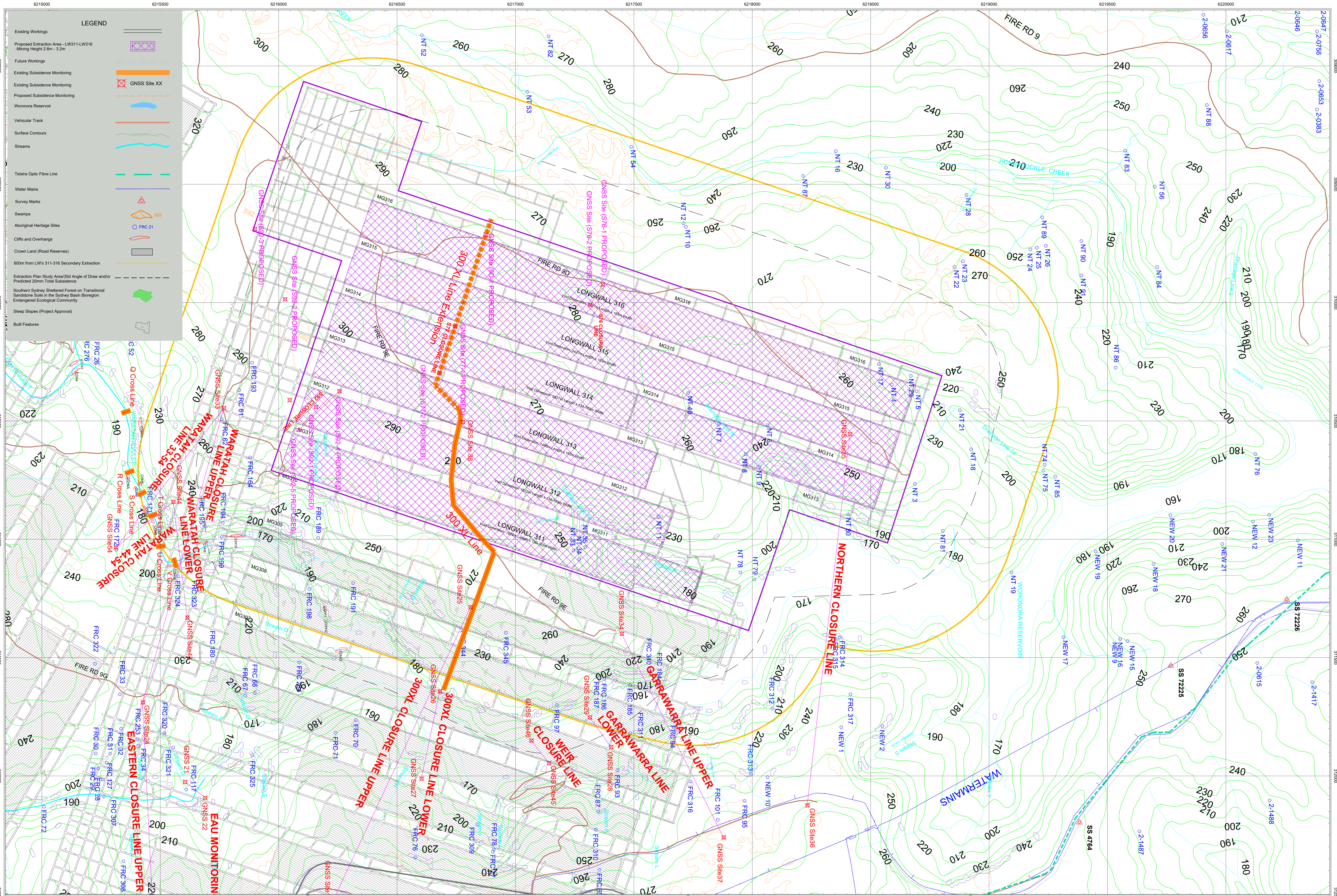
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ATTACHMENT 1

PLAN 7 (SUBSIDENCE MONITORING LOCATIONS)
IN ACCORDANCE WITH THE
DEPARTMENT OF PLANNING AND ENVIRONMENT (2022)
EXTRACTION PLAN GUIDELINE

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	CLIENT/PROJECT Peabody METROPOLITAN COLLIERIES PTY LTD Metropolitan Coal Mine PO BOX 402 HELENSBURGH 2508			
SURV/D/DES/G/D		CHECKED		AUTHORISED

CLIENT/PROJECT Peabody METROPOLITAN COLLIERIES PTY LTD Metropolitan Coal Mine PO BOX 402 HELENSBURGH 2508			
SURV/D/DES/G/D		CHECKED	
AUTHORISED		DATE 24/06/2024	

DRAWING No MET-11-35-Rev 2				
DATE	DRAWN	SHEET	OF	SCALE
24/06/2024	Survey Dept.	1	1	1:5,000

**Longwalls 311-316 Extraction Plan:
 Plan 7 - Subsidence Monitoring**