UG1 LONGWALLS 101 TO 105 SUBSIDENCE MONITORING PROGRAM

Version	Issue Date	Approval Date	Description	Author(s)	Review Team
1	September 2017	September 2017	Approved	MCO	MCO
2	March 2019	March 2019	Amended 103 Layout	AM	MCO
3	June 2020	June 2020	Inclusion of LWs 104-105	MCO	MCO

Approved: S Archinal Date: 11/06/2020

Document	Version	Issue	Effective	Review	Author	Approved
MCO_UG1_LW101-105_SMP	3	Jun 20	Jun 20	Jun 21	MCO	S. Archinal

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ATTACHMENTS

1.0 INTRODUCTION

The Moolarben Coal Complex is an open cut and underground coal mining operation located approximately 40 kilometres (km) north of Mudgee in the Western Coalfield of New South Wales (NSW) (Figure 1).

Moolarben Coal Operations Pty Ltd (MCO) is the operator of the Moolarben Coal Complex on behalf of the Moolarben Joint Venture (Moolarben Coal Mines Pty Ltd [MCM], Sojitz Moolarben Resources Pty Ltd and a consortium of Korean power companies). MCO and MCM are wholly owned subsidiaries of Yancoal Australia Limited.

The Moolarben Coal Complex comprises four approved open cut mining areas (OC1 to OC4), three approved underground mining areas (UG1, UG2 and UG4) and other mining related infrastructure (including coal processing and transport facilities) (Figure 2).

Since the commencement of coal mining operations in 2010, mining activities have occurred within OC1, OC2, OC4 and UG1 (Figure 2).

The UG1 Underground Mine is a component of the approved Moolarben Coal Complex (Figure 2). The UG1 Underground Mine commenced first workings in April 2016 and commenced secondary workings (longwall extraction) in October 2017 by longwall mining methods from the Ulan Seam within Mining Lease (ML) 1605, ML 1606, ML 1628, ML 1691 and ML 1715 (Figure 3).

Mining operations at the Moolarben Coal Complex are currently approved until 31 December 2038 in accordance with Project Approval (05_0117) (Moolarben Coal Project Stage 1) (as modified) and Project Approval (08_0135) (Moolarben Coal Project Stage 2) (as modified).

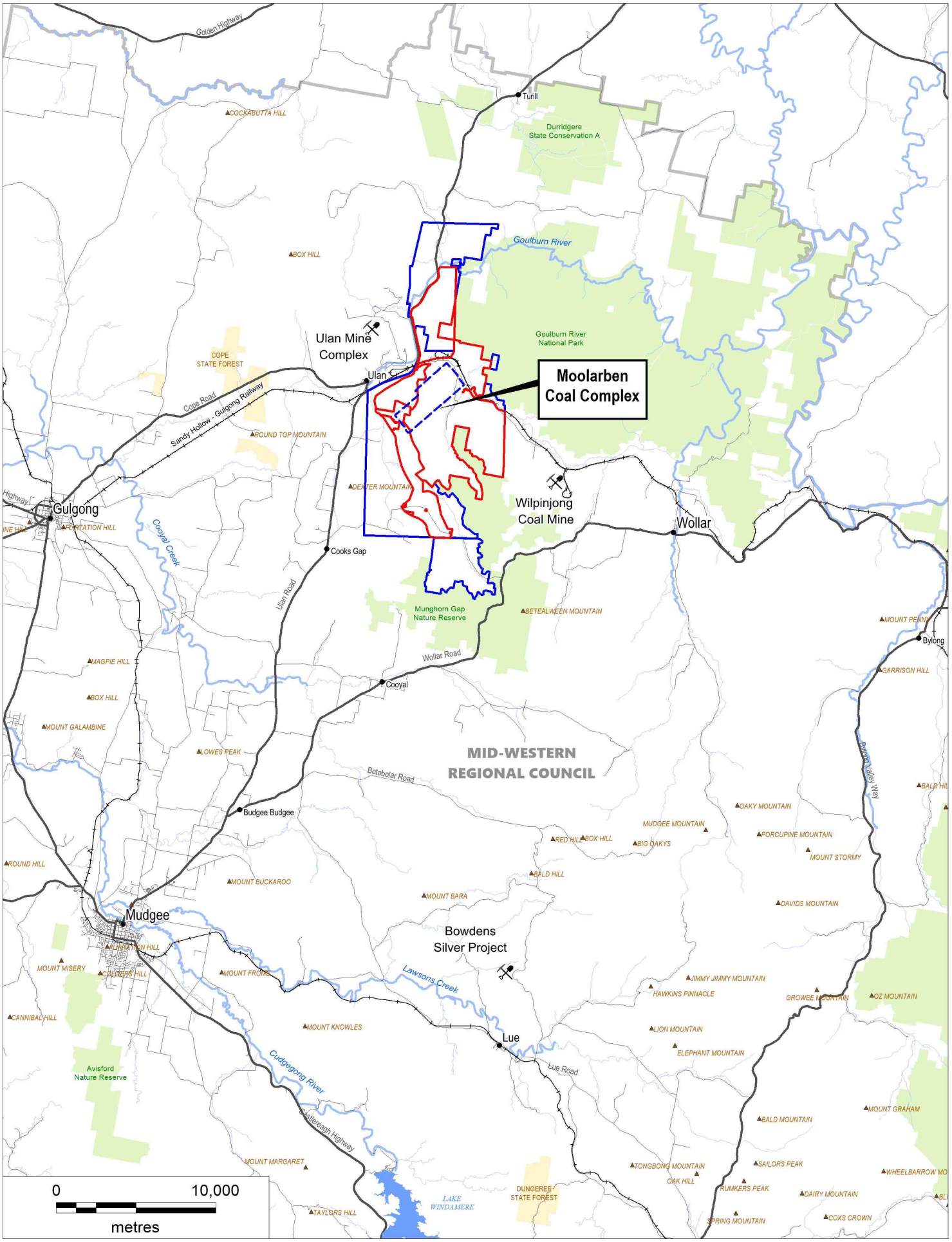


Figure 1
Regional Location

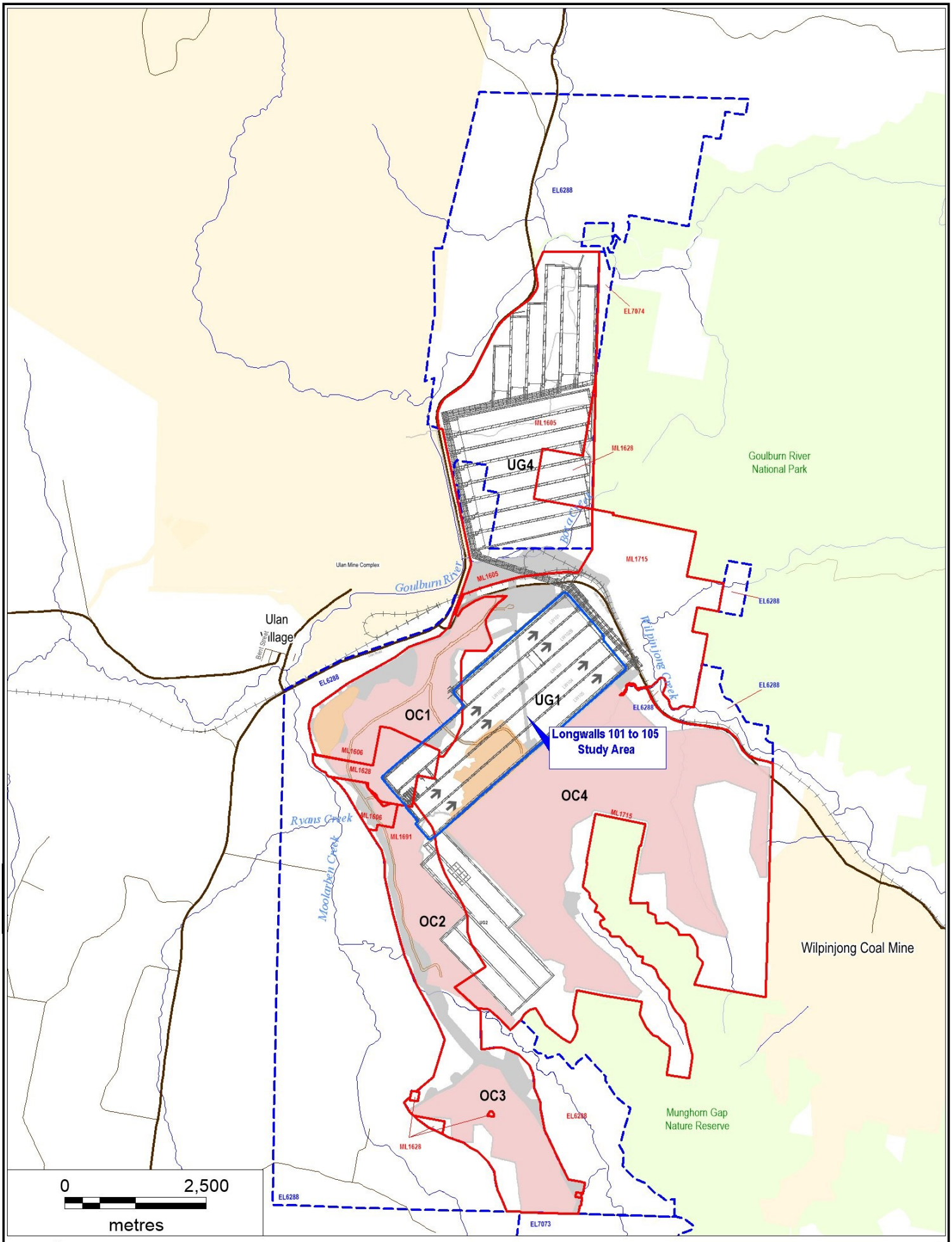


Figure 2
Moolarben Coal Complex Layout

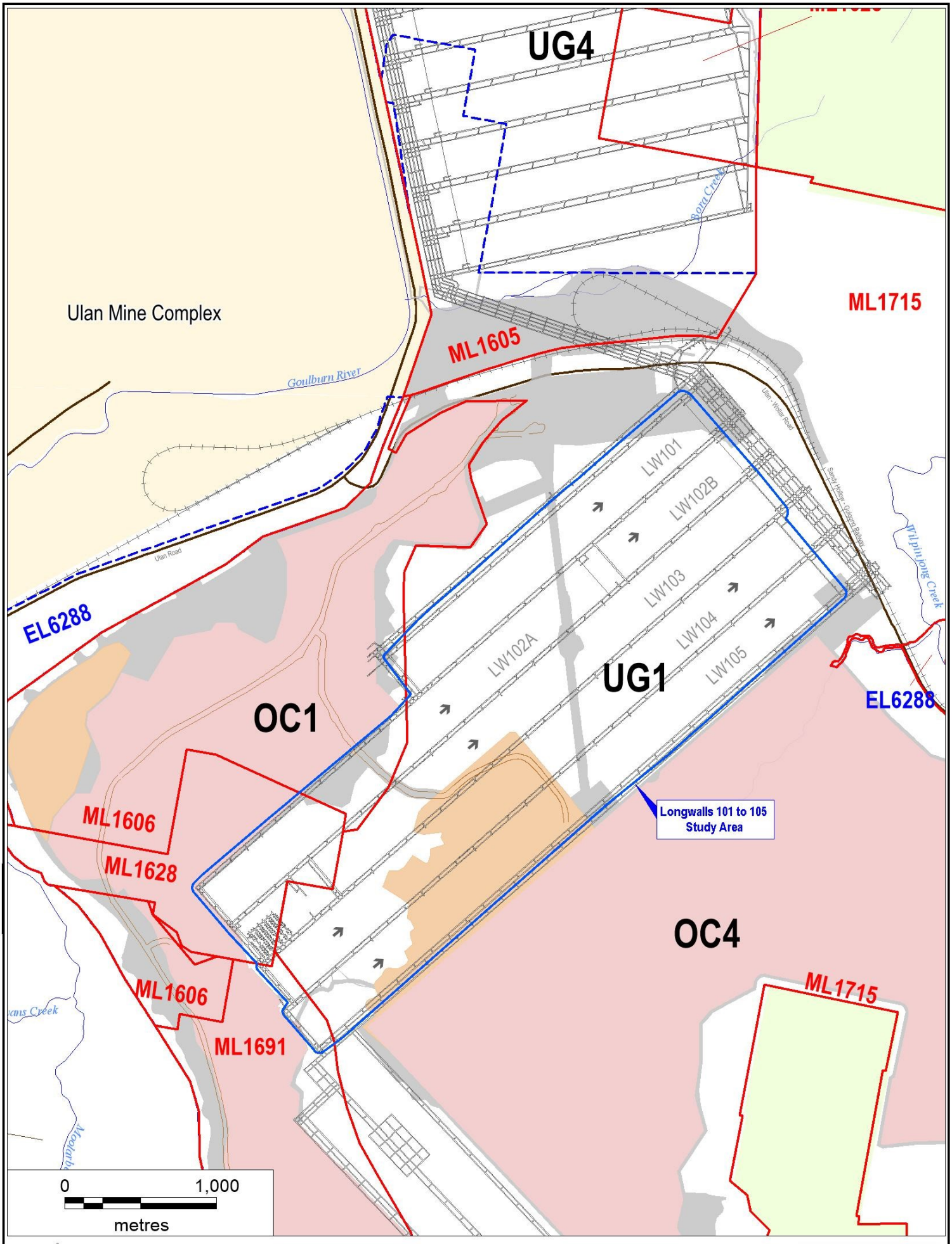


Figure 3
UG1 Longwalls 101-105 Layout

1.1 PURPOSE AND SCOPE

This UG1 Longwalls 101 to 105 Subsidence Monitoring Program (LW101-105 SMP) forms a part of the Extraction Plan for Longwalls 101 to 105 (herein referred to as Longwalls 101-105) of the approved UG1 Underground Mine. This LW101-105 SMP has been prepared by MCO, with input from Mine Subsidence Engineering Consultants [MSEC], to satisfy the requirements of Project Approval (08_0135) as modified and the NSW Department of Planning and Environment (DP&E) and NSW Division of Resources and Energy (DRE) (2015) draft *Guidelines for the Preparation of Extraction Plans*. The appointment of the team of suitably qualified and experienced persons (which includes representatives of MCO and MSEC) was endorsed by the Secretary of the Department of Planning, Industry and Environment (DPIE).

Purpose: This LW101-105 SMP describes the subsidence monitoring program (subsidence impacts and subsidence effects) that forms part of the overall management of the consequential environmental impacts associated with the extraction of Longwalls 101-105.

Scope: This LW101-105 SMP covers areas within and proximal to the Longwalls 101-105 Study Area[1] (Figure 3).

Longwalls 101-105 form the UG1 Underground Mine at the Moolarben Coal Complex.

This amendment has been prepared to incorporate the final two longwall panels 104 and 105 of the UG1 mining area into the Extraction Plan. The only mine plan alteration from that approved under the Stage 2 Project Approval (08_0135) is the shortening of the commencing end of LW104 by 70m, which was conducted to facilitate the installation of a rear panel ventilation shaft and associated roadway.

1.2 STRUCTURE OF THE LONGWALLS 101 TO 105 SUBSIDENCE MONITORING PROGRAM

The remainder of the LW101-105 SMP is structured as follows:

Section 2 Describes the LW101-105 SMP revision status.

Section 3 Outlines the statutory requirements applicable to the LW101-105 SMP.

Section 4 Describes the Longwalls 101-105 extraction layout.

Section 5 Describes the natural and built features at the surface.

Section 6 Summarises the predicted subsidence parameters and impacts for the longwalls.

Section 7 Describes the monitoring program.

Section 8 Describes the program to analyse subsidence effects, subsidence impacts, and environmental consequences.

[1] Longwalls 101-105 and the area of land within the furthest extent of the 26.5 degree (°) angle of draw and 20 millimetres (mm) predicted subsidence contour.

Section 9 Describes the roles and responsibilities for MCO personnel and key contacts.

Section 10 Lists the references cited in this LW101-105 SMP.

2.0 SUBSIDENCE MONITORING PROGRAM REVIEW AND UPDATE

In accordance with Condition 5, Schedule 6 of Project Approval (08_0135), this LW101-105 SMP will be reviewed as follows:

> *5. Within 3 months of the submission of:*
> *(a) the submission of annual review under condition 4 above;*
> *(b) the submission of an incident report under condition 7 below;*
> *(c) the submission of an audit under condition 9 below; or*
> *(d) any modification to the conditions of this approval or MP 05_0117 (unless the conditions require otherwise),*
> *the Proponent shall review and, if necessary, revise the strategies, plans, and programs required under this approval to the satisfaction of the Secretary. Where this review leads to revisions in any such document, then within 4 weeks of the review the revised document must be submitted to the Secretary for approval.*

2.1 ACCESS TO INFORMATION

In accordance with Condition 11, Schedule 6 of Project Approval (058_0135) MCO will make the approved LW101-105 SMP publicly available on the MCO website.

3.0 STATUTORY REQUIREMENTS

MCO's statutory obligations are contained in:

- the conditions of the NSW Project Approval (05_0117) (as modified) and NSW Project Approval (08_0135) (as modified);
- the conditions of Commonwealth Approvals (EPBC 2007/3297, EPBC 2013/6926, EPBC 2008/4444 and EPBC 2017/7974);
- relevant licences and permits, including conditions attached to the Environment Protection Licence (EPL No. 12932) and MLs (i.e. ML 1605, ML 1606, ML 1628, ML 1691 and ML 1715); and
- other relevant legislation.

Obligations relevant to this LW101-105 SMP are described below.

3.1 EP&A ACT PROJECT APPROVAL

Condition 5(m), Schedule 4 of Project Approval (08_0135) requires the preparation of a Subsidence Monitoring Program (i.e. this LW101-105 SMP) as a component of the Extraction Plan. Condition 5(m), Schedule 4 of Project Approval (08_0135) states:

> ***SUBSIDENCE***
> ***…***
> ***Extraction Plan***
>
> *5. The Proponent shall prepare and implement an Extraction Plan for all second workings on site to the satisfaction of the Secretary. Each extraction plan must:*
>
> *…*
>
> *(m)include a Subsidence Monitoring Program, which has been prepared in consultation with DRE, to:*
>
> - *describe the on-going subsidence monitoring program;*
> - *provide data to assist with the management of the risks associated with subsidence;*
> - *validate the subsidence predictions;*
> - *analyse the relationship between the predicted and resulting subsidence effects and predicted and resulting impacts under the plan and any ensuing environmental consequences; and*
> - *inform the contingency plan and adaptive management process;*

The following graphical plans have been prepared in accordance with the DP&E and DRE (2015) draft *Guidelines for the Preparation of Extraction Plans* and are provided in Attachment 1:

- Plan 1: Extraction Plan Area and Mining Layout.
- Plan 2: Surface Features.
- Plan 3: Seam Geology.
- Plan 4: Seam Geology and Future Workings.
- Plan 5: Mining Titles and Land Ownership.
- Plan 6: Geological Sections.
- Plan 7: Subsidence Monitoring.

The documents MSEC (2017; 2020) include predictions of the conventional and non-conventional subsidence impacts and subsidence effects of the Extraction Plan, incorporating any relevant information that has been obtained since Project Approval.

This LW101-105 SMP outlines the subsidence monitoring program prepared to satisfy that component of Condition 5(m), Schedule 4 of Project Approval (08_0135) relating to subsidence monitoring. The LW101-105 SMP is, among other things, designed to compare and validate the subsidence predictions outlined in MSEC (2017; 2020).

3.2 OTHER LEGISLATION

MCO will operate the Moolarben Coal Complex consistent with Project Approval (08_0135) and any other legislation that is applicable to an approved Part 3A Project under the *Environmental Planning and Assessment (EP&A) Act 1979*.

The Acts which may be applicable to the conduct of the Moolarben Coal Complex include, but are not limited to,:

- *Crown Lands Act, 1989;*
- *Fisheries Management Act, 1994;*
- *Heritage Act, 1977;*
- *Coal Mine Subsidence Compensation Act, 2017;*
- *Mining Act, 1992;*
- *National Parks and Wildlife Act, 1974;*
- *Biodiversity Conservation Act, 2016;*

- *Protection of the Environment Operations Act, 1997;*
- *Roads Act, 1993;*
- *Water Act, 1912;*
- *Water Management Act, 2000;*
- *Work Health and Safety Act, 2011*; and
- *Work Health and Safety (Mines and Petroleum Sites) Act, 2013.*

Relevant licences or approvals required under these Acts will be obtained as required.

4.0 LONGWALLS 101-105 EXTRACTION LAYOUT AND SCHEDULE

Longwalls 101-105, 103 Plunge Panel and the area of land within the furthest extent of the 26.5° angle of draw and 20 mm predicted subsidence contour (i.e. the Longwalls 101-105 Study Area) are shown on Figures 2 and 3. Longwall extraction will occur from the west to the east. The longwall layout includes approximately 311 metre (m) panel widths (void) with 20 m pillars (solid).

The geometry of Longwalls 101-105 is summarised in Table 1.

Table 1: Geometry of Longwalls 101-105 Layout

Longwall		Overall Void Length (including Installation Heading) (m)	Overall Void Width (including First Workings) (m)	Overall Tailgate Chain Pillar Width (m)
101		2,561	311	20
102	A	3,292	311	20
	B	1,060	311	20
103 plunge		15	>10.5	NA
103		3,831	311	20
104		4,469	311	20
105		4,544	311	20

The dimensions of the headings are nominally 5.4 m wide and 3.4 m in height. The headings are connected approximately every 150 m by driving a cut-through from one heading to another which forms pillars of coal along the length of the gate road.

Following approval of the UG1 Optimisation Modification in April 2016, MCO has delineated geological features in Longwall 102 and 103 that prevented economic mining of these sections, and has subsequently revised the longwall layout to avoids these features. The subsequent barrier pillar separating Longwalls 102A and 102B is approximately 140 m in length and the Longwall 103 commencing end was shortened by 660 m and replaced by a first workings only production panel. Longwall 104 was also shorted by 70m at the commencing end to allow for a rear of panel shaft. In addition, following further detailed design, Longwalls 101-103 have been shortened by approximately 70 m to provide safe operational conveyor distance between the end of the longwalls and main headings.

With the exception of these changes, the longwall geometry is the same as that for the approved UG1 Optimisation Modification, and MSEC (2017; 2019 and 2020) conclude that the overall impact assessments for the natural and built features are unchanged. The revised longwall layout is herein referred to as the Extraction Plan Layout.

The depth of cover to the Ulan Seam above Longwalls 101-105 varies between a minimum of approximately 47 m over Longwall 102A, and a maximum of 165 m over Longwall 102B. The seam floor generally dips from the south-west down to the north-east over the entire mining area.

Further description of the geology, seam structure and thickness, and depth of cover is provided in MSEC (2017; 2020).

The provisional extraction schedule for Longwalls 101-105 is provided in Table 2.

Table 2: Provisional Extraction Schedule

Longwall	Estimated Start Date	Estimated Duration	Estimated Completion Date
101	-	-	Complete
102 (A+B)	-	-	Complete
103	September 2019	9 months	June 2020
103 Plunge	-	-	Complete
104	July 2020	12 months	June 2021
105	July 2021	11 months	May 2022

Open cut operations (OC1 and OC2) are located in the vicinity of the Longwall 102A tailgate and Longwalls 102A and Longwalls 103-105 commencing ends. OC4 open cut is adjacent Longwall 105 with out of pit emplacement over longwalls 104 and 105. This emplacement has been considered in the pillar loading and subsidence assessments.

5.0 SURFACE FEATURES INCLUDED IN THE MONITORING PROGRAM

5.1 THE LONGWALLS 101-105 STUDY AREA

The Longwalls 101-105 Study Area in MSEC (2017; 2020) is defined as the surface area that is likely to be affected by the proposed mining of Longwalls 101-105 in the Ulan Seam by MCO. The extent of the Study Area has been calculated by combining the areas bounded by the following limits:

- a 26.5° angle of draw line from the extents of Longwalls 101-105; and
- the predicted vertical limit of subsidence, taken as the 20 mm subsidence contour resulting from the extraction of Longwalls 101-105 and 103 Plunge Panel.

As the depth of cover above the longwalls varies between 47 and 165 m, the 26.5° angle of draw line has been conservatively determined by drawing a line around the outer edge of the longwall voids at a horizontal distance that varies between 24 and 88 m.

There are features that lie outside the defined Longwalls 101-105 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 also been included in the assessments provided in MSEC (2017; 2020).

Natural features identified within the Longwalls 101-105 Study Area include:

- drainage lines (DL6 and DL7);
- cliffs (C5 and C6);
- minor cliffs and rock face features;
- steep slopes and land in general; and
- natural vegetation.

Aboriginal and Historic heritage sites have also been identified within the Longwalls 101-105 Study Area and surrounds.

The built features identified within the Longwalls 101-105 Study Area include:

- MCO assets (e.g. overland conveyor, OC4 South-West Haul Road, OC4 ROM facilities, out of pit emplacement area, communications tower and fibre cable, access roads, fences, groundwater piezometers and surface dams);

- Ulan-Wollar Road (closed and inaccessible to the public) (Mid-Western Regional Council [MWRC]); and
- Murragamba Road and Carrs Gap Road (closed and inaccessible to the public) (MWRC).

MSEC (2017; 2020) also considered built features that lay outside the Study Area that were expected to experience far-field movements. The built features included within the assessment beyond the extent of the Study Area included:

- 330 kV electricity transmission lines (ETL) and transmission structures (TransGrid);
- 66 kV/22 kV dual circuit powerline and substation (located at the Remote Services Facilities) (Essential Energy);
- telecommunication (optical fibre and copper) cables (Telstra);
- Sandy Hollow Gulgong Railway (Australian Rail Track Corporation [ARTC]);
- Ulan-Wollar Road including road pavement, embankments, tunnels and culverts (MWRC);
- Ulan Road and bridge over the Sandy Hollow Gulgong Railway (MWRC); and
- survey control marks (e.g. Murragamba Trig Station).

The highwalls of the MCO open cut mining operations (e.g. OC1) and the underground mine entries from OC1 have also been included as part of the assessment.

The above natural and built features are discussed in detail in MSEC (2017; 2020) and summarised below.

The surface features are shown on Plan 2 (Attachment 1).

5.1.1 Drainage Lines

Four minor ephemeral drainage lines were identified by MSEC (2015) within the UG1 Study Area (i.e. associated with Longwalls 101-105) as part of the Subsidence Assessment for the *UG1 Optimisation Modification Environmental Assessment* (UG1 Optimisation Modification). All drainage lines identified in the vicinity of the Longwalls 101-105 Study Area are ephemeral as water only flows during, and for short periods after, each rain event (MSEC, 2015).

Of the drainage lines identified within the UG1 Study Area, only DL6 and DL7 will be impacted by Longwalls 101-105. DL6 and DL7 are tributaries of Murragamba Creek, which flows into Wilpinjong Creek.

DL4 and DL5 are located within the approved out-of-pit emplacement and no longer exist. These drainage lines have not been considered further in this Extraction Plan.

5.1.2 Cliffs and Overhangs

Project Approval (08_0135) includes the following definition:

> *Cliff:*
>
> > *A continuous rock face, including overhangs, having a minimum length of 20 metres, a minimum height of 10 metres and a minimum slope of 2 in 1 (>63.4°).*

Consistent with this definition, for the purposes of subsidence assessments, MSEC (2015; 2017 and 2020) assessed cliffs as a continuous rock face having a minimum length of 20 m, height of 10 m and a minimum slope of 2 to 1 (i.e. having a minimum angle to the horizontal of 63.4°).

Six cliffs (cliffs C1 to C6) were identified by MSEC (2015) within the UG1 Study Area (i.e. associated with Longwalls 101-105) as part of the Subsidence Assessment for the *UG1 Optimisation Modification Environmental Assessment* (UG1 Optimisation Modification).

Of the cliffs identified within the UG1 Study Area, only cliffs C5 and C6 lie within the Longwalls 101-105 Study Area. Cliffs C1 was located within the overland conveyor trace and no longer exists. C2, C3 and C4 were located within the approved out-of-pit emplacement area and no longer exist.

Both cliffs C5 and C6 are approximately 20 m in length, with a height of approximately 15 m and 10 m, respectively.

5.1.3 Minor Cliffs and Rock Face Features

Project Approval (08_0135) includes the following definitions:

> *Minor cliff:*
>
> > *A continuous rock face, including overhangs, which has a:*
> >
> > - *minimum length of 20 metres and a height between 5 metres and 10 metres, or maximum length of 20 metres and a minimum height of 10 metres; and*
> > - *minimum slope of 2 to 1 (>63.4°).*
>
> *Rock face feature:*
>
> > *A continuous rock face, including overhangs, which has a:*
> >
> > - *minimum length of 20 metres and a height between 3 metres and 5 metres, or maximum length of 20 metres and a minimum height of 5 metres; and*

- *minimum slope of 2 to 1 (>63.4°).*

MSEC (2015; 2017 and 2020) identified a number of overhangs and smaller cliffs (i.e. minor cliffs and rock face features) within the UG1 Study Area, which are referred to as rock ledges.

5.1.4 Steep Slopes and Land in General

Project Approval (08_0135) includes the following definition:

Steep slope:

An area of land having a gradient between 1 in 3 (33% or 18.3°) and 2 in 1 (200% or 63.4°).

MSEC (2015; 2017 and 2020) identified a number of steep slopes within the UG1 Study Area. Steep slopes were identified by MSEC as having a gradient of between 1 in 3 (i.e. having an angle to the horizontal of 18°) and 2 in 1 (i.e. having an angle to the horizontal of 63°) and were determined using 2 m contours of the UG1 Study Area (i.e. Longwalls 101-105).

Steep slopes have been identified to highlight areas where the existing ground slopes may be marginally stable. However, no significant slope failures have been observed in the Western or Southern Coalfields as a result of longwall mining (MSEC, 2017; 2020).

Land in general refers to the general landscape other than cliffs, minor cliffs, rock face features and steep slopes. Land in general includes other land features such as fire trails and vehicular tracks, however excludes surface features such as drains, diversions, and other MCO assets including the conveyor trace, open cut highwalls and out-of-pit emplacements which are addressed elsewhere in the Extraction Plan.

5.1.5 Natural Vegetation

Natural Vegetation

Natural vegetation covers the majority of the Study Area.

Threatened, Protected Species or Critical Habitats

Five threatened flora species have been recorded at the Moolarben Coal Complex, including (Moolarben Biota, 2006; Ecovision Consulting, 2008; EMGA Mitchell McLennan, 2013):

- *Diuris tricolor* (Pine Donkey Orchid) – vulnerable under the BC Act.

- *Eucalyptus cannonii* (Capertee Stringybark) – vulnerable under the BC Act.
- *Eucalyptus scoparia* (Wallangarra White Gum) – endangered under the BC Act and vulnerable under the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act).
- *Leucochrysum albicans* var *tricolor* (Hoary Sunray) – endangered under the EPBC Act.
- *Pomaderris queenslandica* (Scant Pomaderris) – endangered under the BC Act.

Of the above, only Scant Pomaderris was recorded within the Longwalls 101-105 Study Area.

Across the Moolarben Coal Complex, a total of 32 threatened and/or migratory fauna species, consisting of seven mammal species (including six microbat species) and 25 bird species have been recorded by Moolarben Biota (2006), Ecovision Consulting (2008) and EMGA Mitchell McLennan (2013) at the Moolarben Coal Complex. Only a subset of the threatened and migratory species recorded at the Moolarben Coal Complex has been recorded within the Longwalls 101-105 Study Area.

Potential cave-dwelling bat roosting sites have been identified across the UG1 Longwalls 101-105 Study Area, including cliffs C5 and C6 and minor cliffs.

Literature reviews and aquatic ecology studies undertaken at the Moolarben Coal Complex indicate that there are no threatened aquatic plants, fish or macroinvertebrate species or populations (as listed under EPBC Act or under the NSW *Fisheries Management Act, 1994*) listed or found in the upper Goulburn River (Ecovision Consulting, 2008).

No GDEs have been identified in the Longwalls 101-105 Study Area.

Endangered Ecological Communities

Eco Logical Australia Pty Ltd (Eco Logical) (2016; 2020) identified the following endangered ecological communities (EEC) and critically endangered ecological communities (CEEC), listed under either the BC Act and/or under the EPBC Act, in the Longwalls 101-105 Study Area:

- *White Box, Yellow Box, Blakely's Red Gum Grassy Woodland and Derived Native Grassland*, listed as an EEC under the BC Act and CEEC under the EPBC Act.
- *Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions*, listed as an EEC under the BC Act.

In addition to the above, Eco Logical (2016) also identified *Central Hunter Valley Eucalypt Forest and Woodland*, listed as a CEEC under the EPBC Act. This CEEC was listed in May 2015 and does not apply to the approved Stage 1 and Stage 2 mining operations pursuant to section 158A of the EPBC Act.

5.2 PUBLIC UTILITIES

5.2.1 Railways and Culverts

There are no railways in the Longwalls 101-105 Study Area.

The Sandy Hollow Gulgong Railway is located to the north and east of Longwalls 101-105 and the nearest edges vary from approximately 255 m (Longwall 105) to 400 m (Longwall 101) from the rail track.

Drainage culverts are located along the Sandy Hollow Gulgong Railway, the nearest of which is at Murragamba Creek crossing, over 550m from Longwall 105.

At these locations, the rail track and culverts will not be subjected to measurable systematic mine subsidence ground movement; however, they may experience small far-field horizontal movement.
A baseline subsidence monitoring survey of the Sandy Hollow Gulgong Railway infrastructure ('Railway' line) in the area that may be affected by the mining of Longwalls 101-103 will be undertaken prior to mining within 400 m of the Longwall 104. Subsequent monitoring proposed as part of this LW101-105 SMP will reference the FF Line along Ulan-Wollar Road which will trigger any requirement for further railway monitoring.

5.2.2 Roads and Culverts

The locations of roads including Ulan-Wollar Road, Murragamba Road, Carrs Gap Road, Ulan Road, other access roads and four-wheel drive tracks within and adjacent to the Longwalls 101-105 Study Area are shown on Plan 2 (Attachment 1) and are summarised below.

Ulan-Wollar Road

Ulan-Wollar Road runs adjacent to the Sandy Hollow Gulgong Railway at distances of 225 m or more from Longwalls 101-105. Ulan-Wollar Road is a sealed bitumen pavement with no kerb and gutter.

The route of Ulan-Wollar Road from the intersection with Ulan Road and around the northern end of Longwalls 101-105 has recently been realigned by construction of a new road pavement. The former road alignment (located closer to the northern ends of Longwalls 101-105) has been closed to the public at both ends.

The nearest publicly accessible sections of Ulan-Wollar Road to the proposed longwalls are approximately 250 m from Longwall 101 and 225 m from Longwall 105. The nearest closed sections of Ulan-Wollar Road are approximately 100 m from Longwall 103.

Murragamba Road and Carrs Gap Road

Although sections of Murragamba Road and Carrs Gap Road are directly over Longwalls 101-105, as the roads are closed to the public, they will be managed together with other private access roads and tracks as part of the Underground Subsidence Principal Hazard Management Plan to manage Work Health and Safety risks for personnel working at MCO.

Ulan Road

Ulan Road is located to the north-west of Longwalls 101 to 105, more than 1 km from the nearest longwall with an open cut pit between the road and the longwalls, and is not expected to experience measurable conventional ground subsidence movements or far-field horizontal movements (MSEC, 2017; 2020).

Other Access Roads and Tracks

All other roads are unsealed access roads and are inaccessible to the public. A number of four-wheel drive tracks are located throughout the Longwalls 101-105 Study Area.

Road Drainage Culverts

No drainage culverts beneath roads were identified within the Study Area. The nearest drainage culvert on Ulan-Wollar Road is located approximately 550 m to the south-east at Murragamba Creek.

An embankment and twin tunnels have also been constructed beneath the Ulan-Wollar Road along the alignment of the conveyor, approximately 720 m from Longwall 101.

5.2.3 Bridges

A road bridge is located along Ulan Road, over the Sandy Hollow Gulgong Railway line, and is 1.2 km from Longwall 101.

5.2.4 Electrical Services

66 kV/22 kV Dual Circuit Powerline

A 66 kV/22 kV dual circuit powerline owned by Essential Energy runs adjacent to Ulan-Wollar Road and the Sandy Hollow Gulgong Railway Line. The 66 kV/22 kV dual circuit powerline is supported on timber poles with guy wires at changes in the alignment of the powerline for additional lateral restraint.

The nearest sections of the 66 kV/22 kV dual circuit powerline are approximately 90 metres (m) from the northern (finishing) end of Longwall 103 (pole 70548) and 60 m from the finishing end of Longwall 105 (pole 70454), and beyond the Essential Energy substation location within the Remote Services Facilities.

Substation

The Essential Energy substation located at the Remote Services Facilities is outside of the Longwalls 101-105 Study Area.

330 kV Electricity Transmission Line

A 330 kV ETL (Wollar-Wellington 330 kV High Voltage Line) owned by TransGrid runs adjacent to Ulan-Wollar Road and the Sandy Hollow Gulgong Railway Line.

The 330 kV ETL and towers are located to the north-east of Longwalls 101-105 and the longwalls will not pass beneath these electrical services. The nearest tension tower (106) is located 605 m to the north-east of the northern corner of Longwall 101. The nearest suspension tower is located approximately 325 m to the north of the northern corner of Longwall 101.

5.2.5 Telecommunication Infrastructure

Telecommunication infrastructure in the vicinity of the Study Area includes an optical fibre cable and a copper cable (both owned by Telstra). The Telstra telecommunication cables are located along the northern side of Ulan-Wollar Road and adjacent to the Sandy Hollow Gulgong Railway.

The telecommunication cables are located to the north and east of the Study Area and are approximately 160 m from Longwall 105 at their nearest point. To the west, the telecommunication cables are approximately 335 m from Longwall 103.

5.3 FARM LAND AND FACILITIES

With the exception of a portion of land (Lot 7010, DP1025345) owned by The State of NSW (Crown Land) and a number of roads (and associated easements) owned by the MWRC, all other land (including farm land and facilities) within the Longwalls 101-105 Study Area is owned by MCO.

5.3.1 Fences

Fences are located within the Longwalls 101-105 Study Area and are constructed in a variety of ways, generally using either timber or metal materials.

5.3.2 Surface Dam

Several surface dams are located on MCO owned land within the Longwalls 101-105 Study Area.

5.4 MINE INFRASTRUCTURE

5.4.1 Open Cut Highwalls

The tailgate of Longwall 102A is located adjacent to the partially backfilled OC1. Extraction of Longwall 102A has resulted in localised movements on the adjacent highwall face.

The commencing ends of Longwalls 102A - 105 are located adjacent to the approved OC1/OC2 mining area. Open cut mining in OC1/OC2 is scheduled following the completion of mining in the immediate proximity of the adjacent longwall panel.

5.4.2 Out-of-Pit Waste Rock Emplacement

The approved out-of-pit waste rock emplacement area is located within the Longwalls 101-105 Study Area, above the maingate of Longwall 103 and Longwall panels 104 and 105.

The top of the approved out-of-pit waste rock emplacement is proposed to be relatively flat with a top surface level of approximately 530 m to 540 m Australian Height Datum (AHD). The slopes of the batters formed at the sides of the emplacement area are proposed to vary from grades of approximately 1 in 4 to 1 in 6, however because the natural surface levels surrounding the emplacement in the Longwalls 101-105 Study Area are close to the proposed finishing level (530 m to 540 m AHD) there will be minimal to no batters. The maximum depth of fill above Longwall 103 m will be about 10 m to 15 m and above 104 and 105 will be 85m.

The approved out-of-pit waste rock emplacement will be completed prior to the extraction of Longwalls 103-105.

5.4.3 Stage 2 ROM Facilities and Conveyor

The Stage 2 run-of-mine (ROM) Facilities have been constructed adjacent to the maingate of Longwall 105.

The conveyor from the Stage 2 ROM Facilities to the CHPP has been constructed and is aligned diagonally across Longwalls 101-105 and includes an access road adjacent to the conveyor.

5.4.4 Haul Road

A haul road (OC4 South-West Haul Road) is located above Longwalls 102A and 103.

5.5 ITEMS OF ARCHAEOLOGICAL SIGNIFICANCE

5.5.1 Aboriginal Heritage Sites

There are 17 Aboriginal heritage sites identified above Longwalls 101-103 which comprise rock shelters with potential archaeological deposits (PAD), rock shelters with artefacts and PAD, isolated finds or artefact scatters.

There are 22 identified Aboriginal Heritage sites above Longwalls 104-105. Of these sites, 14 have been managed under existing approvals and are no long *in situ.* A total of 8 Aboriginal Heritage sites remain over longwall panels 104-105.

Detailed descriptions of the Aboriginal heritage sites are provided in the reports by Niche Environment and Heritage (2017; 2020).

5.5.2 Historic Heritage Sites

Historic heritage site 18 is located above longwall panel 105.

5.6 SURVEY CONTROL MARKS

The Murragamba Trig Station is located above Longwall 105.

Other survey marks in the vicinity of Longwalls 101-105 are predominantly located along Ulan-Wollar Road and the Sandy Hollow Gulgong Railway.

6.0 SUBSIDENCE PARAMETERS AND SUBSIDENCE IMPACTS DUE TO LONGWALLS 101-105 EXTRACTION

MSEC (2017; 2020) 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 the longwalls. The report includes the maximum predicted conventional subsidence parameters for the longwalls (MSEC 2017; 2020) 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 101-105 is 2,250 mm, with a maximum predicted total conventional subsidence of 2,400mm.

A comparison of the maximum predicted conventional total subsidence parameters, for the Extraction Plan Layout and the Approved Layout for Longwalls 101-105, is provided in MSEC (2020). MSEC (2020) concludes that the maximum predicted total subsidence parameters are the same (e.g. maximum predicted total conventional subsidence of 2,400 mm).

The predictions of conventional subsidence parameters do not include the valley related upsidence and closure movements, nor the effects of faults and other geological structures.

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

MSEC (2017; 2020) provides a comprehensive description of the 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 101-105. Additionally, natural and built features that are located outside the Longwalls 101-105 Study Area, which may be subjected to far-field movements and may be sensitive to the predicted subsidence parameters, were also included in the assessments. Further descriptions are provided in MSEC (2019; 2020) and Mine Advice (2019).

In particular, impact assessments were completed for the following surface features:

- drainage lines (DL6 and DL7);
- cliffs (C5 and C6);

- rock ledges (minor cliffs and rock face features);
- steep slopes and land in general;
- natural vegetation (including threatened, protected species or critical habitats and EECs);
- MCO assets and mine infrastructure (e.g overland conveyor, OC4 South-West Haul Road, OC4 ROM facilities, out of pit emplacement area, communications tower and fibre cable, access roads, fences, groundwater piezometers and surface dams).
- ARTC assets (e.g. Sandy Hollow Gulgong Railway);
- MWRC assets (e.g. Ulan-Wollar Road including road pavement, embankments, tunnels and culverts, Murragamba Road, Carrs Gap Road, Ulan Road and bridge over Sandy Hollow Gulgong Railway, other access roads and four wheel drive tracks);
- TransGrid assets (e.g. 330 kV ETL and transmission structures);
- Essential Energy assets (e.g. 66 kV/22 kV dual circuit powerline supported on timber poles and proposed substation);
- Telstra assets (e.g. optical fibre and copper cables);
- Aboriginal heritage sites;
- Historic heritage sites; and
- survey control marks (Murragamba Trig Station).

The monitoring program described below was developed in consideration of the predicted subsidence parameters and subsidence impacts outlined in MSEC (2017; 2020).

7.0 MONITORING

7.1 OBJECTIVES

The objectives of the subsidence monitoring program are:

- To monitor the subsidence effects associated with Longwalls 101-105 extraction.
- To summarise and consolidate the various monitoring programs presented in each of the key component plans of the UG1 Longwalls 101-105 Extraction Plan. These include:
  - the UG1 Longwalls 101 to 105 Water Management Plan (LW101-105 WMP);
  - the UG1 Longwalls 101 to 105 Land Management Plan (LW101-105 LMP);
  - the UG1 Longwalls 101 to 105 Biodiversity Management Plan (LW101-105 BMP);
  - the UG1 Longwalls 101 to 105 Heritage Management Plan (LW101-105 HMP);
  - the UG1 Longwalls 101 to 105 Built Features Management Plans, including:
    - the UG1 Longwalls 101 to 105 Built Features Management Plan – TransGrid (LW101-105 BFMP-TransGrid);
    - the UG1 Longwalls 101 to 105 Built Features Management Plan – Essential Energy (LW101-105 BFMP-EE);
    - the UG1 Longwalls 101 to 105 Built Features Management Plan – Australian Rail Track Corporation (LW101-105 BMFP-ARTC);
    - the UG1 Longwalls 101 to 105 Built Features Management Plan – Telstra (LW101-105 BFMP-Telstra);
    - the UG1 Longwalls 101 to 105 Built Features Management Plan – Mid-Western Regional Council (LW101-105 BFMP-MWRC); and
  - the UG1 Longwalls 101 to 105 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
"103A" Line	Main monitoring line traversing 103 Plunge Panel first workings	• Prior to commencement of pillar formation and plunging • Within 3 months following completion of plunging	Extraction Plan
"A" Line	Main monitoring line traversing Longwalls 101-103	• Prior to commencement of Longwall 101 extraction. • Within three months following completion of each of Longwalls 101, 102 and 103.	Extraction Plan
"B" Line	Longitudinal monitoring line at Longwall 101 commencing end	• Prior to commencement of Longwall 101 extraction. • At 100 m intervals determined by the longwall chainage marks while the active mining face is within 400 m of the Longwall 101 commencing end. • Within three months following completion of Longwall 101.	Extraction Plan
"C" Line	Longitudinal monitoring line at Longwall 101 finishing end	• Prior to secondary extraction within 400 m of the Longwall 101 take-off point. • At 100 m intervals determined by the longwall chainage marks while the active mining face is within 400 m of the Longwall 101 take-off point. • Within three months following completion of Longwall 101.	Extraction Plan
"D" Line	Longitudinal monitoring line at Longwall 102 finishing end	• Prior to secondary extraction within 400 m of the Longwall 102 take-off point. • At 100 m intervals determined by the longwall chainage marks while the active mining face is within 400 m of the Longwall 102 take-off point. • Within three months following completion of Longwall 102.	Extraction Plan
"E" Line	Longitudinal monitoring line at Longwall 103 finishing end	• Prior to secondary extraction within 400 m of the Longwall 103 take-off point. • At 100 m intervals determined by the longwall chainage marks while the active mining face is within 400 m of the Longwall 103 take-off point. • Within three months following completion of Longwall 103.	Extraction Plan
"G" Line	Main monitoring line traversing Longwalls 104-105	• Prior to commencement of Longwall 104 extraction. • Within three months following completion of each of Longwalls 104 and 105.	Extraction Plan
"H" Line	Monitoring line traversing Longwalls 104-105	• Prior to commencement of Longwall 104 extraction. • Within three months following completion of each of Longwalls 104 and 105.	Extraction Plan

Monitoring Component	Description	Frequency	Relevant Management Plan
"I" Line	Longitudinal monitoring line at Longwall 104 finishing end	• Prior to secondary extraction within 400 m of the Longwall 104 take-off point. • At 100 m intervals determined by the longwall chainage marks while the active mining face is within 400 m of the Longwall 104 take-off point. • Within three months following completion of Longwall 104.	Extraction Plan
"J" Line	Longitudinal monitoring line at Longwall 105 finishing end	• Prior to secondary extraction within 400 m of the Longwall 105 take-off point. • At 100 m intervals determined by the longwall chainage marks while the active mining face is within 400 m of the Longwall 105 take-off point. • Within three months following completion of Longwall 105.	Extraction Plan
"BC" Line	OC1 Highwall / UG1 Entries	• Prior to commencement of Longwall 101 extraction. • When the active longwall face is approximately 500 m from the Longwall 101 commencing end. • When the active longwall face in Longwall 102 retreats past the Longwall 101 commencing end. • When the active longwall face in Longwall 102 retreats approximately 500 m past the Longwall 101 commencing end.	Extraction Plan

Table 3 (Continued): Subsidence Parameter Monitoring Components

Monitoring Component	Description	Frequency	Relevant Management Plan
"Railway" Line	Sandy Hollow Gulgong Railway Line	• Prior to mining within 400 m of the Sandy Hollow Gulgong Railway Line. • At any time in case of fault or emergency and where requested by ARTC. • In the event monitoring detects movements in excess of survey/design tolerances (as advised by ARTC).	BFMP-ARTC
"FF" Line	Along the alignment of Ulan-Wollar Road in the vicinity of Longwalls 101-105	• Prior to commencement of Longwall 101 extraction. • When mining reaches the "A" Line for Longwall 101. • Prior to secondary extraction within 400 m of the Longwall 101 take-off point. • At 100 m intervals determined by the longwall chainage marks while the active mining face is within 400 m of the longwall take-off point. • Within two weeks following completion of longwall recovery from each of the Longwalls. • Within three months following completion of longwall recovery from each of the Longwall. • At any time in case of fault or emergency and where requested by relevant asset owners.	LW101-105 BFMP-MWRC LW101-105 BFMP-ARTC LW101-105 BFMP-TRANSGRID LW101-105 BFMP-TELSTRA
330 kV ETL – Towers 102 to 111	Tower survey – 4 x survey stations at each tower (measuring differential separation) as well as target (bolt) locations on both earth peaks of each tower and ground network monitoring at the base of each tower	• Prior to commencement of Longwall 101 extraction. • When mining reaches the "A" Line for Longwall 101. • At 100 m intervals determined by the longwall chainage marks, commencing when Line FF horizontal movement is >20mm. • Within two weeks following completion of longwall recovery from each of Longwall • Within three months following completion of longwall recovery from each of Longwall • At any time in case of fault or emergency and where requested by TransGrid.	LW101-105 BFMP-TRANSGRID

Table 3 (Continued): Subsidence Parameter Monitoring Components

Monitoring Component	Description	Frequency	Relevant Management Plan
66 kV/22 kV dual circuit powerline – power poles within 300 m of the relevant longwall	Structure survey – 2 x monitoring points at each timber pole	• Prior to commencement of longwall extraction. • Prior to secondary extraction within 400 m of the longwall take-off point. • At 100 m intervals determined by the longwall chainage marks while the active mining face is within 400 m of the longwall take-off point. • Within three months following completion of longwall recovery from each of the Longwalls.	LW101-105 BFMP-EE
Essential Energy substation	Subsidence monitoring at survey points installed around the substation	• Prior to commencement of Longwall 101 extraction. • Prior to secondary extraction within 400 m of the Longwall 101 take-off point. • At 100 m intervals determined by the longwall chainage marks while the active mining face is within 400 m of the longwall take-off point. • Within three months following completion of longwall recovery from each of Longwalls 101, 102 and 103.	LW101-105 BFMP-EE
Survey Station	Murragamba Trig Station	• Prior to commencement of Longwall 101 extraction. • Within three months following completion of active mining at UG1.	Extraction Plan

Table 4: Subsidence Impact and Environmental Consequences Monitoring Components

Extraction Plan Component	Aspect	Sites	Frequency	Purpose/Parameters
LW101-105 LMP	Visual inspection of cliffs	C5 and C6.	• Prior to commencement of Longwall 101 extraction. • Prior to commencement of Longwall 103 extraction. • Within one month of the completion of Longwall 103 extraction.	Evidence of subsidence impacts compared to baseline records by visual inspection of location, physical description (e.g. length and height of cliffs, angle to horizontal) and general condition of cliffs.
	Minor cliffs, rock face features, steep slopes and land in general	Representative sites within the Study Area.	• Prior to commencement of Longwall 101 extraction. • Opportunistic visual observations during mining. • Within one month following completion of Longwall 105 (for previous longwalls).	Evidence of subsidence impacts compared to baseline observations (e.g. photography, rockfalls, cliff instabilities, displacement of or dislodgement of boulders or slabs surface cracking) and total face area to be recorded.
LW101-105 BMP	Flora and fauna habitats	Longwall panel traverses.	• During spring, prior to longwall extraction beneath the transect. • During spring, for two years following longwall extraction beneath the transect.	Evidence of subsidence impacts compared to baseline condition (e.g. surface cracking, ponding, deterioration in tree health outside natural variations, weed incursion and/or infestation). Nature and extent of any impacts on flora and fauna habitats and observations of terrestrial fauna. The extent and condition of identified threatened flora species or EECs.
		Floristic monitoring sites.	• During spring, prior to longwall extraction beneath the monitoring site. • During spring, for two years following longwall extraction beneath the monitoring site.	Collection of data at each site for comparison to baseline condition, including: • Canopy health and defoliation. • Vegetation structure. • Nature and extent of any impacts on flora and fauna habitats. • Evidence of any impacts on terrestrial fauna. • Condition and extent of threatened species or EECs (if present).

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

Extraction Plan Component	Aspect	Sites	Frequency	Purpose/Parameters
LW101-105 BMP (continued)	Flora and fauna habitats (continued)	Targeted cliff line monitoring	• Prior to commencement of longwall extraction beneath the potential roosting site. • Between October and February after completion of longwall extraction.	Evidence of subsidence impacts to features that provide potential bat roosting sites compared to baseline condition (e.g. rockfalls, displacement of or dislodgement of boulders or slabs, or fracturing).
LW101-105 WMP	Drainage line	DL6 and DL7.	• Prior to undermining of drainage line DL6 & DL7. • Within three months of undermining of drainage lines DL6 & DL7. • An inspection every six months for one year after a longwall undermines drainage lines DL6 and DL7.	Evidence of subsidence impacts compared to baseline records by visual inspection and photographic record (noting any areas of active erosion, sediment deposition, water ponding or streambed cracking).
	Surface Water Flow and Quality	SW04 and SW16 (Murragamba & Wilpinjong Creek).	In accordance with the approved complex-wide Surface Water Management Plan.	In accordance with the approved complex-wide Surface Water Management Plan.
	Groundwater extraction, groundwater levels, groundwater quality and leachate/seepage losses from water and water storages	Bores PZ127, PZ130, PZ186,PZ186a, PZ188, PZ189, PZ179, PZ211, PZ213 and PZ214.	In accordance with the approved complex-wide Groundwater Management Plan, whilst serviceable.	In accordance with the approved complex-wide Groundwater Management Plan.
	Mine Water Make	UG1 Inflows and Outflows.	Weekly.	Pumping records/flow meters. Groundwater inflow.
		Major Surface Water Dams.	In accordance with the approved complex-wide Surface Water Management Plan.	Water levels.
LW101-105 HMP	Aboriginal Heritage	PAD 3 Moolarben Coal.	• Baseline recording where not sufficiently recorded. • Within three to six months of undermining.	To identify and document whether any subsidence impacts have arisen from mining activities at PAD 3 Moolarben Coal, the monitoring requirements described in section 5.9.1 of the approved complex-wide Heritage Management Plan will be implemented for this site.

Extraction Plan Component	Aspect	Sites	Frequency	Purpose/Parameters
		Rock Shelters S2MC434 and S2MC435	• Within three to six months of undermining (unless salvaged).	Monitoring and/or salvage and/or excavation would only occur where safe to do so, as determined in consultation with relevant MCO safety personnel and in accordance with sections 5.6.1 and 5.6.2 of the complex-wide HMP.
	Historic Heritage	Heritage Site 18	• Historic Heritage Site 18 (Carrs Gap Road Stone Wall) has been subject to historical research and archival recording. No further monitoring is required.	

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

Extraction Plan Component	Aspect	Sites	Frequency	Purpose/Parameters
LW101-105 BFMP-EE	Condition of 66 kV/22 kV dual circuit powerline	Timber poles.	• Prior to commencement of Longwall 104 extraction. • Prior to secondary extraction within 400 m of the Longwall 104 take-off positions. • In the event monitoring detects movements in excess of survey/design tolerances. • At any time in case of fault or emergency and where requested by Essential Energy. • Routinely as per Essential Energy inspections. • Within three months of longwall completion (e.g. longwall has been relocated from the final end of block mining position).	Evidence of subsidence impacts compared to baseline record (photographic record) and targeting the identification of: • surface cracking (particularly in areas around power pole foundations); • surface humps (particularly in areas around power pole foundations); • damage to poles, conductors and/or powerlines; • reduced ground clearance (vegetation management to be completed by Essential Energy); • tilting of power poles [using 2 x reflectors] (resulting in increased/decreased tension in conductors); and • bent cross-arms or insulators.
	Condition of substation	Essential Energy substation.	• Prior to secondary extraction within 400 m of the Longwall 104 take-off positions. • In the event monitoring detects movements in excess of survey/design tolerances. • Additional opportunistic observations of subsidence impacts will be conducted during routine works by MCO and its contractors. • Within three months of longwall 101 completion (e.g. longwall has been relocated from the final end of block mining position).	Evidence of subsidence impacts compared to design/baseline records by visual inspection of location (e.g. surface cracking; surface humps; and tilting of foundations).

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

Extraction Plan Component	Aspect	Sites	Frequency	Purpose/Parameters
LW101-105 BFMP-TRANSGRID	Condition of 330 kV ETL	Towers 102 to 111.	• Prior to commencement of Longwall 104. *[Unless a suitable inspection has been, or will be, completed by TransGrid prior to commencement of Longwall 101 extraction].* • Routinely as per TransGrid inspections. • In the event monitoring detects movements in excess of survey/design tolerances (as advised by TransGrid).	Evidence of subsidence impacts compared to baseline record (photographic record) (e.g. land clearance, vegetation clearance, road clearance, integrity and function of support clamps or other items).
LW101-105 BFMP-MWRC	Subsidence impact inspection of Ulan-Wollar Road	Road pavements, culverts and other furniture.	• Prior to commencement of Longwall 104 extraction. • If/when ground movement (in excess of survey accuracy) is detected during monitoring of the FF Line. • At any time in case of an emergency and requested by MWRC. • Routinely as per MWRC inspections. • Following completion of active mining at UG1.	Evidence of subsidence impacts compared to baseline record (photographic record) and targeting the identification of: • impacts to the pavement surface including cracks, buckling and stepping; • impacts to the visible surfaces of pipes/culverts including cracking, buckling, shearing, and collapse; and • visible impacts to furniture.

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

Extraction Plan Component	Aspect	Sites	Frequency	Purpose/Parameters
LW101-105 BFMP-TELSTRA	Optical Fibre Cable	Signal integrity testing using a Remote Fibre Monitoring System (RFMS).	• Prior to secondary extraction within 400 m of the Longwall 104 take-off point. • Continuous following identification of ground movements >20mm along FF Line	Establish pre-mining condition by taking a baseline RFMS measurement. Monitor for loss in signal using Optical Time Domain Reflectometry.
		Subsidence impact inspection.	If RFMS records a change that exceeds ± 3.0 decibels (dB) (compared to baseline).	Evidence of subsidence impacts and targeting the identification of: • movement of the cable; and • ground compression / tension.
	Copper Cable	Signal integrity testing using a resistance test.	• Prior to secondary extraction within 400 m of the Longwall 104 take-off point. • Following identification of ground movements along FF Line (in excess of survey accuracy >20mm).	Establish pre-mining condition by taking a baseline resistance measurement. In the event monitoring identifies ground movements along FF Line (in excess of survey accuracy), monitor for a significant variation from the baseline reading.
		Subsidence impact inspection.	In the event resistance testing indicates a significant variation from the baseline reading.	Evidence of subsidence impacts and targeting the identification of: • movement of the cable; and • ground compression / tension.
LW101-103 BFMP-ARTC	Sandy Hollow Gulgong Railway	Subsidence impact inspection.	• Prior to secondary extraction within 400 m of the Longwall 104 take-off position. • If/when ground movement (in excess of survey accuracy >20mm) is detected during monitoring of the FF Line. • Routinely as per ARTC inspections. • At any time in case of fault or emergency and where requested by ARTC.	Evidence of subsidence impacts and targeting the identification of: • any defects or deformation of the rail line and associated infrastructure; and • changes to the visible surfaces of the culverts including cracking, buckling, shearing, and collapse.

7.2 SUBSIDENCE PARAMETER MONITORING COMPONENTS

The components of the program to monitor subsidence parameters are illustrated in Plan 7 (Subsidence Monitoring) prepared in accordance with the DP&E and (2015) Draft *Guidelines for the Preparation of Extraction Plans*) provided in Attachment 1 and described below.

7.2.1 "103A" Line

The location of the "103A" Line is shown on Plan 7 in Attachment 1. The line is located across and perpendicular to 103 Plunge Panel.

The "103A" Line will be composed of survey marks established at a spacing of approximately 15 m to 20 m. Survey marks will be comprised of either:

- concrete nails set in rock; or
- star pickets.

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

Prior to installation of the 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 "103A" Line is to measure the vertical subsidence associated with extraction and the total vertical subsidence associated with overall extraction.

The frequency of monitoring the "103A" Line will be:

- prior to commencement of pillar formation and plunging;
- within three months following completion of each plunging;
- more frequently if directed by the Principal Subsidence Engineer NSW Resource Regulator.

Monitoring of the "103A" Line will provide information of relevance to some of the management plans listed in Section 7.1.

7.2.2 "A" Line

The location of the "A" Line is shown on Plan 7 in Attachment 1. The line is located across and perpendicular to Longwalls 101-103.

The "A" Line will be composed of survey marks established at a spacing of approximately 10 m to 20 m. Survey marks will be comprised of either:

- stations set in rock; or
- star pickets.

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

Prior to installation of the 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 "A" Line is to measure the subsidence parameters (e.g. subsidence, tilt, strain) associated with extraction of each longwall panel and the total subsidence parameters associated with overall extraction.

The frequency of monitoring the "A" Line will be:

- prior to commencement of Longwall 101 extraction;
- within three months following completion of each of Longwalls 101, 102 and 103; and
- more frequently if directed by the Principal Subsidence Engineer NSW Resource Regulator.

Monitoring of the "A" Line will provide information of relevance to each of the management plans listed in Section 7.1.

7.2.3 "B" Line

The location of the "B" Line is shown on Plan 7 in Attachment 1. The line is a longitudinal line approximately 300 m long, extending 100 m to the south-west and 200 m to the north east from the commencing end of Longwall 101.

The "B" Line will be composed of survey marks established at a spacing of approximately 15 m to 20 m. Survey marks will be comprised of either:

- stations set in rock; or
- star pickets.

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

Prior to installation of the 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 "B" Line is to measure the subsidence parameters (e.g. subsidence, tilt, strain) associated with extraction of Longwall 101.

The frequency of monitoring the "B" Line will be:

- prior to commencement of Longwall 101 extraction;
- at 100 m intervals determined by the longwall chainage marks while the active mining face is within 400 m of the Longwall 101 commencing end;
- within three months following completion of Longwall 101; and
- more frequently if directed by the Principal Subsidence Engineer NSW Resource Regulator.

Monitoring of the "B" Line will provide information of relevance to each of the management plans listed in Section 7.1.

7.2.4 "C" Line

The location of the "C" Line is shown on Plan 7 in Attachment 1. The line is a longitudinal line approximately 450 m long, extending 150 m to the north-east and 300 m to the south-west of the finishing end of Longwall 101.

The "C" Line will be composed of survey marks established at a spacing of approximately 15 m to 20 m. Survey marks will be comprised of either:

- stations set in rock; or
- star pickets.

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

Prior to installation of the 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 "C" Line is to measure the subsidence parameters (e.g. subsidence, tilt, strain) associated with extraction of Longwall 101, particularly in the vicinity of the overlying tertiary sediments.

The frequency of monitoring the "C" Line will be:

- prior to secondary extraction within 400 m of the Longwall 101 take-off point;
- at 100 m intervals determined by the longwall chainage marks while the active mining face is within 400 m of the Longwall 101 take-off point;
- within three months following completion of Longwall 101; and
- more frequently if directed by the Principal Subsidence Engineer NSW Resource Regulator.

Monitoring of the "C" Line will provide information of relevance to each of the management plans listed in Section 7.1.

7.2.5 "D" Line

The location of the "D" Line is shown on Plan 7 in Attachment 1. The line is a longitudinal line approximately 400 m long, extending 100 m to the north-east and 300 m to the south-west of the finishing end of Longwall 102. The line has been offset to the east from the centre of the panel to avoid interaction with the adjacent EEC.

The "D" Line will be composed of survey marks established at a spacing of approximately 15 m to 20 m. Survey marks will be comprised of either:

- stations set in rock; or
- star pickets.

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

Prior to installation of the 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 "D" Line is to measure the subsidence parameters (e.g. subsidence, tilt, strain) associated with extraction of Longwall 102, particularly in the vicinity of the overlying tertiary sediments.

The frequency of monitoring the "D" Line will be:

- prior to secondary extraction within 400 m of the Longwall 102 take-off point;
- at 100 m intervals determined by the longwall chainage marks while the active mining face is within 400 m of the Longwall 102 take-off point;
- within three months following completion of Longwall 102; and
- more frequently if directed by the Principal Subsidence Engineer NSW Resource Regulator.

Monitoring of the "D" Line will provide information of relevance to each of the management plans listed in Section 7.1.

7.2.6 "E" Line

The location of the "E" Line is shown on Plan 7 in Attachment 1. The line is a longitudinal line approximately 400 m long, extending 100 m to the north-east and 300 m to the south-west of the finishing end of Longwall 103. The line has been offset to the east from the centre of the panel to avoid interaction with the adjacent EEC.

The "E" Line will be composed of survey marks established at a spacing of approximately 15 m to 20 m. Survey marks will be comprised of either:

- stations set in rock; or
- star pickets.

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

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

The purpose of the "E" Line is to measure the subsidence parameters (e.g. subsidence, tilt, strain) associated with extraction of Longwall 103, particularly in the vicinity of the overlying tertiary sediments.

The frequency of monitoring the "E" Line will be:

- prior to secondary extraction within 400 m of the Longwall 103 take-off point;
- at 100 m intervals determined by the longwall chainage marks while the active mining face is within 400 m of the Longwall 103 take-off point;
- within three months following completion of Longwall 103; and
- more frequently if directed by the Principal Subsidence Engineer NSW Resource Regulator.

Monitoring of the "E" Line will provide information of relevance to each of the management plans listed in Section 7.1.

7.2.7 "G" Line

The location of the "G" Line is shown on Plan 7 in Attachment 1. The line is located across and perpendicular to Longwalls 104-105.

The "G" Line will be composed of survey marks established at a spacing of approximately 10 m to 20 m. Survey marks will be comprised of either:

- stations set in rock; or
- star pickets.

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

Prior to installation of the 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 "G" Line is to measure the subsidence parameters (e.g. subsidence, tilt, strain) associated with extraction of each longwall panel and the total subsidence parameters associated with overall extraction.

The frequency of monitoring the "G" Line will be:

- prior to commencement of Longwall 104 extraction;
- within three months following completion of each of Longwalls 104 and 105; and
- more frequently if directed by the Principal Subsidence Engineer NSW Resource Regulator.

Monitoring of the "G" Line will provide information of relevance to each of the management plans listed in Section 7.1.

7.2.8 "H" Line

The location of the "H" Line is shown on Plan 7 in Attachment 1. The line is located across and perpendicular to Longwalls 104-105.

The "H" Line will be composed of survey marks established at a spacing of approximately 10 m to 20 m. Survey marks will be comprised of either:

- stations set in rock; or
- star pickets.

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

Prior to installation of the 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 "H" Line is to measure the subsidence parameters (e.g. subsidence, tilt, strain) associated with extraction of each longwall panel and the total subsidence parameters associated with overall extraction particularly in the vicinity of the overlying tertiary sediments.

The frequency of monitoring the "H" Line will be:

- prior to commencement of Longwall 104 extraction;
- within three months following completion of each of Longwalls 104 and 105; and
- more frequently if directed by the Principal Subsidence Engineer NSW Resource Regulator.

Monitoring of the "G" Line will provide information of relevance to each of the management plans listed in Section 7.1.

7.2.9 "I" Line

The location of the "I" Line is shown on Plan 7 in Attachment 1. The line is a longitudinal line approximately 450 m long, extending 150 m to the north-east and 300 m to the south-west of the finishing end of Longwall 104.

The "I" Line will be composed of survey marks established at a spacing of approximately 15 m to 20 m. Survey marks will be comprised of either:

- stations set in rock; or
- star pickets.

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

Prior to installation of the 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 "I" Line is to measure the subsidence parameters (e.g. subsidence, tilt, strain) associated with extraction of Longwall 104, particularly in the vicinity of the overlying tertiary sediments.

The frequency of monitoring the "I" Line will be:

- prior to secondary extraction within 400 m of the Longwall 104 take-off point;
- at 100 m intervals determined by the longwall chainage marks while the active mining face is within 400 m of the Longwall 104 take-off point;
- within three months following completion of Longwall 105; and
- more frequently if directed by the Principal Subsidence Engineer NSW Resource Regulator.

Monitoring of the "I" Line will provide information of relevance to each of the management plans listed in Section 7.1.

7.2.10 "J" Line

The location of the "J" Line is shown on Plan 7 in Attachment 1. The line is a longitudinal line approximately 450 m long, extending 150 m to the north-east and 300 m to the south-west of the finishing end of Longwall 105.

The "J" Line will be composed of survey marks established at a spacing of approximately 15 m to 20 m. Survey marks will be comprised of either:

- stations set in rock; or

- star pickets.

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

Prior to installation of the 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 "J" Line is to measure the subsidence parameters (e.g. subsidence, tilt, strain) associated with extraction of Longwall 105, particularly in the vicinity of the overlying tertiary sediments.

The frequency of monitoring the "J" Line will be:

- prior to secondary extraction within 400 m of the Longwall 105 take-off point;
- at 100 m intervals determined by the longwall chainage marks while the active mining face is within 400 m of the Longwall 105 take-off point;
- within three months following completion of Longwall 105; and
- more frequently if directed by the Principal Subsidence Engineer NSW Resource Regulator.

Monitoring of the "J" Line will provide information of relevance to each of the management plans listed in Section 7.1.

7.2.11 "BC" Line

The location of the "BC" Line is shown on Plan 7 in Attachment 1. The line is located across the top of the OC1 highwall/UG1 entries.

The "BC" line (i.e. OC1 highwall) will be scanned by the open cut surveyors.

The purpose of the "BC" Line is to measure the subsidence parameters (e.g. subsidence, tilt, strain) associated with extraction of each longwall panel and the total subsidence parameters associated with overall extraction.

The frequency of monitoring the "BC" Line will be:

- prior to commencement of Longwall 101 extraction;
- when the active longwall face is approximately 500 m from the Longwall 101 commencing end;
- when the active longwall face in Longwall 102 retreats past the Longwall 101 commencing end;
- when the active longwall face in Longwall 102 retreats approximately 500 m past the Longwall 101 commencing end; and
- more frequently if directed by the Principal Subsidence Engineer NSW Resource Regulator.

Monitoring of the "BC" Line will provide information of relevance for the management of MCO assets and highwall stability.

7.2.12 "FF" Line

The location of "FF" Line is shown on Plan 7 in Attachment 1. The "FF" Line follows the alignment of the Ulan-Wollar Road in the vicinity of Longwalls 101-105 and is constructed for the purpose of monitoring far field effects.

The "FF" Line will be composed of survey marks established at a spacing of approximately 15 m to 20 m, which will be comprised of either:

- stations set in rock or bitumen; or
- star pickets.

Due to the practicalities of following the road, bends in the survey line will have to be incorporated.

The purpose of "FF" Line is to:

- provide monitoring of ground movements about the Ulan-Wollar Road (and adjacent telecommunication cables, Sandy Hollow Gulgong Railway and 330 kV ETL); and
- obtain subsidence information ahead of longwall panels to validate, and if necessary better calibrate, the MSEC subsidence prediction methods.

The frequency of monitoring "FF" Line will be:

- prior to commencement of Longwall 101 extraction;
- when mining reaches the "A" Line for Longwall 101;

- prior to secondary extraction within 400 m of the Longwall 101 take-off point;
- at 100 m intervals determined by the longwall chainage marks while the active mining face is within 400 m of the longwall take-off point;
- within two weeks following completion of longwall recovery from each of Longwall;
- within three months following completion of longwall recovery from each of Longwall
- at any time in case of fault or emergency and where requested by relevant asset owners; and
- more frequently if directed by the Principal Subsidence Engineer NSW Resource Regulator.

The "FF" Line is a monitoring component of the LW101-105 BFMP-MWRC, LW101-105 BFMP-ARTC, LW101-105 BFMP-TELSTRA and LW101-105 BFMP-TRANSGRID.

7.2.13 Transmission Towers

The locations of the "Transmission Towers" monitoring are shown on Plan 7 in Attachment 1.

Monitoring for Longwalls 101-105 will include Transmission Towers 102 to 111 of TransGrid's 330 kV ETL.

The "Transmission Towers" monitoring will be composed of:

- survey stations established at each of the four tower legs;
- target (bolt) locations on both earth peaks of each tower; and
- ground survey marks located at the base of each Transmission Tower (Towers 102 to 111).

Due to the practicalities of survey mark installation, prisms cannot be used at the tops of the towers.

The purpose of the "Transmission Towers" monitoring is to:

- provide monitoring of tower movements for the 330 kV transmission towers; and
- obtain subsidence information ahead of longwall panels to validate, and if necessary better calibrate the MSEC subsidence prediction methods.

The frequency of "Transmission Towers" monitoring will be:

- prior to commencement of Longwall 101 extraction;
- when mining reaches the "A" Line for Longwall 101;
- at 100 m intervals determined by the longwall chainage marks, commencing when Line FF horizontal movement is >20mm
- within two weeks following completion of longwall recovery from each of Longwall;
- within three months following completion of longwall recovery from each of Longwall;
- at any time in case of fault or emergency and where requested by TransGrid; and
- more frequently if directed by the asset owner or the Principal Subsidence Engineer NSW Resource Regulator.

The "Transmission Towers" monitoring is a component of the LW101-105 BFMP-TransGrid.

7.2.14 66 kV/22 kV Dual Circuit Powerline Poles

The location of the 66 kV/22 kV dual circuit powerline (supported on timber poles) is shown on Plan 7 in Attachment 1. Monitoring of timber poles within will include two targets (an upper and lower survey mark) for measuring tilt.

The frequency of monitoring for potentially impacted poles within 300 m of the relevant longwall will be:

- prior to commencement of longwall extraction;
- prior to secondary extraction within 400 m of the longwall take-off point;
- at 100 m intervals determined by the longwall chainage marks while the active mining face is within 400 m of the longwall take-off point;
- within three months following completion of longwall recovery from each of Longwalland
- more frequently if directed by the Principal Subsidence Engineer NSW Resource Regulator.

Monitoring of the 66 kV/22 kV dual circuit powerline poles is a component of the LW101-105 BFMP-EE.

7.2.15 Substation

The location of the Essential Energy substation (in the Remote Services Facilities) is shown on Plan 7 in Attachment 1.

The substation monitoring will be composed of survey marks established at a spacing of approximately 15 m to 20 m around the substation. Survey marks will be comprised of either:

- survey stations set in rock; or
- star pickets.

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

The purpose of the substation monitoring is to measure the subsidence parameters (e.g. subsidence, tilt, strain) around the Essential Energy substation.

The frequency of monitoring will be:

- prior to commencement of Longwall 101 extraction;
- prior to secondary extraction within 400 m of the Longwall 101 take-off point;
- at 100 m intervals determined by the longwall chainage marks while the active mining face is within 400 m of the longwall take-off point;
- within three months following completion of longwall recovery from each of Longwalls 101, 102 and 103; and
- more frequently if directed by the Principal Subsidence Engineer NSW Resource Regulator.

Monitoring of the substation is a component of the LW101-105 BFMP-EE.

7.2.16 Survey Station

The location of the "Murragamba Trig Station" Line is shown on Plan 7 in Attachment 1.

The frequency of monitoring the "Murragamba Trig Station" will be:

- prior to extraction of Longwall 101;
- within three months following completion of UG1; and
- more frequently if directed by the Principal Subsidence Engineer NSW Resource Regulator.

Monitoring of the "Murragamba Trig Station" will provide information of relevance for its re-establishment and/or replacement as necessary, on completion of subsidence.

7.2.17 Parameters to be Measured

Surveys will measure subsidence movements in three dimensions for the 330 kV transmission towers, 66 kV/22 kV dual circuit powerline poles and Ulan-Wollar Road. Surveys of railway and subsidence line marks will measure subsidence movements in two dimensions.

The OC1 highwall will be scanned.

7.2.18 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 Mine Surveyors 2015 (NSW – Mines)*; and
- *Inter-government 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 2015 (NSW – Mines) 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 central areas of Longwalls 101-103 to be surveyed to Class "D" using prescribed methods as described in ICSM SP1.

7.3 SUBSIDENCE IMPACTS AND ENVIRONMENTAL CONSEQUENCES MONITORING COMPONENTS

The subsidence impact and environmental consequences monitoring components are summarised in Table 4. All subsidence impact and environmental consequence monitoring is included in a relevant management plan within the UG1 Longwalls 101-105 Extraction Plan as summarised in Table 4.

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

7.4 LONGWALLS 101 TO 105 LAND MANAGEMENT PLAN

The LW101-105 LMP has been prepared to manage the potential environmental consequences of the Longwalls 101-105 Extraction Plan on cliffs, minor cliffs and rock face features, steep slopes and land in general.

7.4.1 Cliffs

Visual inspections of cliffs C5 and C6 will be conducted prior to commencement of secondary extraction of Longwalls 101 and 103, and following the completion of Longwall 103. Opportunistic observations of subsidence impacts to these cliffs will also be conducted during routine works by MCO and its contractors.

If additional subsidence impact(s) (i.e. cliff instabilities) are observed during an inspection, 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) relative to the cliff face;
- 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 (e.g. implementation of management measures, initiation of the Contingency Plan, incident notification, implementation of appropriate safety controls, review of public safety etc); and
- any other relevant information.

7.4.2 Minor Cliffs, Rock Face Features, Steep Slopes and Land in General

A visual inspection of representative land features (i.e. minor cliffs, rock face features, steep slopes and land in general) within the Longwalls 101-105 Study Area will be conducted prior to the commencement of Longwall 101 to establish a baseline record.

Opportunistic observations of subsidence impacts to such land features will be conducted during routine works by MCO and its contractors. Where relevant, inspections of subsidence impacts will include detailed measurement and photographic record of the impact for comparison with baseline records.

If additional subsidence impact(s) are observed during an inspection, the location of any minor cliffs, rock face features and steep slopes that experience minor environmental consequences (i.e. rockfalls, displacement of or dislodgement of boulders or slabs, or fracturing) will be recorded and the area photographed.

7.5 LONGWALLS 101 TO 105 BIODIVERSITY MANAGEMENT PLAN

The LW101-105 BMP has been prepared to manage the potential environmental consequences of the Longwalls 101-105 Extraction Plan on aquatic and terrestrial flora and fauna.

7.5.1 Flora and Fauna Habitats

Longwall Panel Traverses

A series of transects will be established across the width of each longwall and have been indicatively positioned to intersect with the identified EECs. Each transect will be traversed to identify any subsidence related impacts. Key triggers to undertake more detailed monitoring include:

- areas of cracking or ponding that exceed predictions in the subsidence predictions and assessments of the impacts relating to the predicted subsidence above Longwalls 101-105;
- declining trend in canopy health or vegetation structure inconsistent with seasonal trends at analogue sites;
- deterioration in tree health outside natural variations (analogue sites to be used as a guide);
- areas of weed incursion and/or infestation; and
- mortality of more than a small number of threatened flora or fauna species attributed to subsidence impacts.

Opportunistic observations of subsidence impacts (e.g. surface cracking and ponding, deterioration of tree health and weed incursion and/or infestation) will be recorded during routine works conducted by MCO and its contractors. Where relevant, observations of subsidence impacts will include detailed measurement and photographic record of the impact for comparison with baseline records (ELA, 2017; 2020).

Floristic Monitoring Sites

Nine floristic monitoring sites (i.e. total, not per transect) will be established at random locations along the longwall transects, with a minimum distance of 50 m between each site, and, where relevant, will be positioned proximal to any observed threatened species (e.g. Scant Pomaderris) and/or within the EECs (i.e. *White Box, Yellow Box, Blakely's Red Gum Grassy Woodland and Derived Native Grassland*

and *Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions*). Notwithstanding, in the event Scant Pomaderris is not identified along the longwall transects, visual monitoring of representative Scant Pomaderris individuals would be undertaken following completion of each longwall. Each site will be marked with a metal star picket (ELA, 2017; 2020).

Data collected at each floristic monitoring site will include:

- Canopy health and defoliation (all in 5% increments):
  - percentage of epicormic foliage in relation to total tree foliage;
  - proportion of primary branches within canopy that have died back;
  - percentage of current canopy foliage as a proportion of the estimated canopy foliage volume/potential canopy; and
  - percentage of canopy foliage discoloured.
- Plot vegetation:
  - projected foliage cover (PFC) (PFC – 1 to 5%, then 5% increments) of native grass/ground cover; native shrubs less than 1 m height, native shrubs/small trees greater than 1 m height;
  - PFC (5% increments) of upper canopy (assessed at each quadrat corner and averaged);
  - Dominant species at the upper, mid and ground strata, and PFC of each species.
- Vegetation structure:
  - exotic species;
  - number of stags, estimated time since cause of death;
  - lower, estimated median and upper height of canopy (m);
  - lower, estimated median and upper diameter at breast height (DBH) over bark of canopy stems (centimetres);
  - abundance of each canopy species (identified to species level); and calculated, total stems per hectare (ha).
- Photograph of the canopy (camera placed on top of the star picket, facing up); photograph facing due north, south, east and west from the star picket and a general photograph taken from the plot along each transect.

In the event monitoring identifies subsidence related impacts greater than predicted to threatened flora, fauna or EECs, MCO will investigate the implementation of additional monitoring or appropriate management measures. Potential subsidence related impacts include:

- areas of cracking or ponding that exceed predictions in the subsidence predictions and assessments of the impacts relating to the predicted subsidence above Longwalls 101-105;
- declining trend in canopy health or vegetation structure inconsistent with seasonal trends at analogue sites;
- deterioration in tree health outside natural variations (analogue sites to be used as a guide);
- areas of weed incursion and/or infestation; or
- mortality of more than a small number of threatened flora or fauna species attributed to subsidence impacts.

Terrestrial Fauna and their Habitats

The terrestrial fauna and habitat monitoring will be based on a review of the results of the flora/vegetation monitoring to determine any potential impacts on fauna habitats. Opportunistic recording of fauna species will also be undertaken during the traverses of the longwall transects (ELA 2017; 2020).

If required, terrestrial fauna and habitat monitoring will be used to assess the environmental consequences of subsidence-related impacts, including the nature and extent of impacts on flora and fauna habitats and evidence of impacts on terrestrial fauna.

Review of the cliff line monitoring data will be undertaken in accordance with Table 10, particularly in relation to any potential roosting sites for cave-dwelling bats (including the Large-eared Pied Bat). In the event that impacts are considered likely to occur, or are identified as having occurred, inspection of any potential roosting sites for the Large-eared Pied Bat will be undertaken to document any potential impacts.

7.6 LONGWALLS 101 TO 105 WATER MANAGEMENT PLAN

The LW101-105 WMP has been prepared to manage the potential environmental consequences of the Longwalls 101-105 Extraction Plan on water resources (including drainage lines and groundwater aquifers).

7.6.1 Drainage Lines ((DL6 & DL7)

Visual inspections and photographic records of drainage lines DL6 & DL7 will be conducted prior to and following undermining. This would be undertaken by walking the length of drainage lines DL6 and DL7 over Longwall 103-105 and noting any areas of active erosion, sediment deposition, water ponding or streambed cracking.

An inspection would be conducted within 3 months of undermining DL6 and DL6, then every six months for one year after a longwall undermines drainage lines DL6 and DL7 to identify any evidence of subsidence impacts compared to baseline records.

7.6.2 Surface Water

Surface water monitoring for receiving watercourses is undertaken for flow, water quality, stream health and channel stability as described in the approved complex-wide Surface Water Management Plan.

Water quality sampling of receiving streams will continue to be undertaken in accordance with the approved complex-wide Surface Water Management Plan. Appropriate water quality monitoring locations are downstream of DL6 and DL7, on Murragamba Creek (SW04) and Wilpinjong Creek (SW16).

7.6.3 Groundwater

Groundwater monitoring is undertaken for groundwater extraction, groundwater levels, groundwater quality and leachate/seepage losses from water and water storages as described in section 6.0 of the approved complex-wide Groundwater Management Plan. Groundwater monitoring bores considered by SLR (2020) to be relevant to Longwalls 101-105 are detailed in the LW101-105 WMP.

7.6.4 Groundwater Inflows

Groundwater inflows are determined by monitoring of dewatering (with flow meters), less metered supply inflows, estimated water stored underground, water loss in workings, and calculated recirculation from adjacent Open Cut workings. Groundwater take will be partitioned into the various water sharing plan sources using the relative proportions predicted in the groundwater model. Partitioning may be adjusted based on monitoring data, water geochemistry or expert input.

7.7 LONGWALLS 101 TO 105 HERITAGE MANAGEMENT PLAN

The LW101-105 HMP has been prepared to manage the potential environmental consequences of the Longwalls 101-105 Extraction Plan on Aboriginal and historic heritage.

7.7.1 Aboriginal Heritage Sites

MCO will undertake subsidence monitoring of site PAD 3, S2MC434 and S2MC435 unless salvaged prior to undermining. In order to identify and document whether any subsidence impacts have arisen from mining activities at these sites, the monitoring requirements described in the approved complex-wide Heritage Management Plan will be implemented for this site. Monitoring will involve the following:

- *MCO will engage an appropriately qualified expert to monitor the Aboriginal archaeological sites described as requiring monitoring. This may include the establishment of a percentage estimate of the likelihood of subsidence occurring in sensitive areas.*
- *Where insufficient pre-existing information is available for any of the specific Aboriginal archaeological sites to permit comparison with the condition post-mining, more detailed recording will occur prior to undermining.*
- *Monitoring will involve inspecting and recording the condition of these specific Aboriginal archaeological sites within three to six months after undermining has occurred. Each inspection will involve recording of data on environmental conditions, pre-existing human and natural impacts, heritage evidence present and any identified changes to these environmental and heritage conditions compared with previous inspections. The potential cause (subsidence or other impacts) of changes to the condition of individual sites will be assessed.*
- *Monitoring will be focussed on the features of the site that make it significant (e.g. grooves, art, artefacts and/or PAD).*
- *A report documenting the results of monitoring will be prepared that details the methodology of the inspections, conditions of the environment and Aboriginal heritage evidence at the relevant sites, comparisons with previously reported conditions at each site, identification of any natural and/or human impacts during the intervening period, identification of any implications for the ongoing management and protection of Aboriginal heritage evidence at the Moolarben Coal Complex, and documentation of the actual impacts of operations on the Aboriginal archaeological sites.*
- *Copies of this report will be distributed to the RAPs, OEH and the DPIE and a summary included in the Annual Review.*

Monitoring for subsidence related impacts will occur at PAD 3, S2MC434 and S2MC435 within three to six months of undermining (unless salvaged). If, during the above monitoring, significant subsidence impacts are identified, then the salvage and excavation procedures outlined in the LW101-103 HMP and complex-wide HMP will be considered.

Monitoring and/or salvage and/or excavation would only occur where safe to do so, as determined in consultation with relevant MCO safety personnel.

For the purpose of determining what constitutes a significant subsidence impact on Aboriginal heritage sites, a site is considered to be "affected by significant subsidence impacts" if it exhibits one or more of the following consequences that cannot be attributed to natural weathering or deterioration:

- overhang collapse;
- cracking of sandstone that coincides with the feature(s) of the site that make it significant; and
- rock fall that damages the feature(s) of the site that make it significant.

7.7.2 Historic Heritage Sites

Historic Heritage Site 18 (Carrs Gap Road Stone Wall) has been subject to historical research and archival recording. No further monitoring is required.

7.8 LONGWALLS 101 TO 105 BUILT FEATURES MANAGEMENT PLANS

A number of component plans have been prepared to manage the potential environmental consequences of the Longwalls 101-105 Extraction Plan on built features including:

- 66 kV/22 kV dual circuit powerline on timber poles and Essential Energy substation (LW101-105 BFMP-EE).
- 330 kV ETL and towers (LW101-105 BFMP-TRANSGRID).
- Ulan-Wollar Road (LW101-105 BFMP-MWRC).
- Telecommunication (optical fibre and copper) cables (LW101-105 BFMP-TELSTRA).
- Sandy Hollow Gulgong Railway (LW101-105 BFMP-ARTC).

Each of the Longwalls 101 to 105 Built Features Management Plans has been developed in consultation with the relevant asset owner in accordance with Condition 5(g), Schedule 4 of Project Approval (08_0135).

Any subsidence impacts will be recorded in the relevant Built Features Management Plan – Subsidence Impact Register.

7.8.1 66 kV/22 kV Dual Circuit Powerline Poles (LW101-105 BFMP-EE)

A visual inspection (including structural assessment) of the 66 kV/22 kV dual circuit powerline will be conducted prior to secondary extraction within 400 m of the Longwall 104 take-off positions. Visual inspections will also be conducted by MCO at the 66 kV/22 kV dual circuit powerline in the event monitoring detects movements in excess of survey/design tolerances. Additional opportunistic

observations of subsidence impacts will be conducted during routine works by MCO and its contractors.

As described in Section 7.2.7, monitoring for the timber poles will include two targets (an upper and lower survey mark) for measuring tilt.

Where relevant, inspections of subsidence impacts will include photographic record of the impacts from nominated photo points for comparison with baseline photographic records.

Unless otherwise agreed with Essential Energy, inspection sheets detailing the outcome of the subsidence impact monitoring program will be provided to Essential Energy.

It is understood that Essential Energy also conducts routine inspections (including fault and emergency patrols) which would be used for monitoring of the impacts of subsidence if conducted during the course of mining Longwalls 101-105.

7.8.2 Essential Energy Substation (LW101-105 BFMP-EE)

The substation foundation has been designed in consultation with Essential Energy.

A visual inspection of the Essential Energy substation will be conducted prior to secondary extraction within 400 m of the Longwall 101 take-off positions. Visual inspections will also be conducted by MCO at the substation in the event monitoring detects movements in excess of survey/design tolerances. Additional opportunistic observations of subsidence impacts will be conducted during routine works by MCO and its contractors.

Where relevant, inspections of subsidence impacts will include photographic record of the impacts from nominated photo points for comparison with baseline photographic records.

Unless otherwise agreed with Essential Energy, inspection sheets detailing the outcome of the subsidence impact monitoring program will be provided to Essential Energy.

7.8.3 330 kV ETL Towers (LW101-105 BFMP-TRANSGRID)

A visual inspection/baseline audit of the 330 kV ETL will be conducted prior to commencement of Longwall 104 unless TransGrid has completed, or will complete, a suitable inspection prior to commencement of Longwall 104. Where relevant, inspections of subsidence impacts will include photographic record of the impacts from nominated photo points for comparison with baseline photographic records.

As described in Section 7.2.6, monitoring will include Transmission Towers 102 to 111 of TransGrid's 330 kV ETL.

Surveys of Towers 102 to 111 will be conducted prior to extraction of Longwall 101, when mining reaches the mid-point of Longwall 101, and at 100 m intervals based on longwall chainage marks when mining is within 400 m of the longwall take-off position (when triggered by Line 'FF' horizontal movement >20mm). Surveys will also be conducted following completion of longwall recovery (the first within two weeks and the second within three months). Additional opportunistic observations of subsidence impacts will be conducted during routine works by MCO and its contractors. Surveys of Towers 102 to 111 will include measurement of differential separation between tower legs and monitoring of both earth peaks.

Inspection sheets detailing the outcomes of the subsidence impact monitoring program will be provided to TransGrid during mining of Longwall 101 (requirement to be reviewed following completion of Longwall 101).

It is understood that TransGrid also conducts routine inspections (including fault and emergency patrols) which would be used for monitoring of the impacts of subsidence if conducted during the course of mining Longwalls 101-105.

7.8.4 Ulan-Wollar Road (LW101-105 BFMP-MWRC)

A visual inspection of Ulan-Wollar Road will be conducted prior to commencement of Longwall 104 to establish the condition of the roadway and pipes/culverts.

The visual inspection will be conducted by MCO and include:

- recording of existing defects using detailed road surface photography (video), i.e. one photograph every 2 m; and
- recording of existing pipe/culvert condition.

A copy of the visual inspection report will be provided to MWRC. Other road pavement baseline records (where available) would be provided to MCO.

In the event monitoring identifies ground movement (in excess of survey accuracy) MCO will undertake an inspection of the road for any impacts caused by subsidence movements. Opportunistic observations of subsidence impacts will be conducted during routine works by MCO (and its contractors) and MWRC's routine road condition inspections.

As described in Section 7.2.5, monitoring will include the "FF Line" which follows the alignment of the Ulan-Wollar Road.

Unless otherwise agreed with MWRC, inspection sheets detailing the outcome of the subsidence impact monitoring program will be provided to MWRC following confirmation of the results.

7.8.5 Telecommunication (Optical Fibre and Copper) Cables (LW101-105 BFMP-TELSTRA)

Prior to the commencement of Longwall 101 and 104 extraction, in conjunction with Telstra, MCO will conduct an investigation to determine the Telstra customers that would be affected if the copper cabling became unserviceable and what service would need to be provided while copper cabling repairs were carried out.

An inspection of the physical location of the telecommunication cables within 400 m of Longwalls 101-105 will also be conducted prior to commencement of Longwall 104 to confirm access.

A baseline resistance test (of the copper cable) and RFMS measurement (of the optical fibre cable) will be completed prior to secondary extraction occurring within 400 m of the Longwall 104 take-off position. Additional resistance tests of the copper cable will be undertaken in the event monitoring of the FF Line identifies ground movements in excess of survey accuracy. RFMS monitoring of the optical fibre cable will occur continuously following identification of ground movements >20 mm along Line FF.

In the event that resistance tests detect a significant variation from the baseline reading, or, in the event RFMS detects a change from the baseline condition that exceeds ± 3.0 dB, Telstra will conduct a subsidence impact inspection targeting the identification of movement of the cable and ground compression/tension.

Visual inspections of the cables will be conducted by Telstra as required, in accordance with Telstra's routine inspection program or if triggered by a signal loss or transmission fault detected by the RFMS.

Unless otherwise agreed with Telstra, inspection sheets detailing the outcome of the subsidence impact inspections will be provided, following confirmation of any observed ground movements.

7.8.6 Sandy Hollow Gulgong Railway (LW101-105 BFMP-ARTC)

A baseline inspection (including visual inspection and dilapidation audit) of the Sandy Hollow Gulgong Railway in the vicinity of Longwalls 101-105 will be conducted prior to mining within 400 m of the Longwall 104 take-off position.

A survey along the FF Line will be undertaken prior to secondary extraction within 400 m of the Longwall 101 take-off point. Additional surveys along the FF Line will be undertaken by MCO while mining is within 400 m of the longwall take-off position (i.e. at 100 m intervals as determined by the longwall chainage marks).

As described in Section 5.2.1, monitoring will include the Railway Line which follows the alignment of the Sandy Hollow to Gulgong Railway in the vicinity of Longwalls 101-105. In the event monitoring identifies ground movement (in excess of survey accuracy) MCO will undertake an inspection of the Railway Line for any impacts caused by subsidence movements. Opportunistic observations of subsidence impacts will be conducted during routine works by MCO and its contractors.

As agreed with ARTC, in the event the subsidence monitoring program identifies ground movements (in excess of survey accuracy), inspection sheets detailing the results of the subsidence monitoring program will be provided to ARTC, following confirmation of the results.

It is understood that ARTC also conducts routine inspections (including fault and emergency patrols) which would be used for monitoring of the impacts of subsidence if conducted during the course of mining Longwalls 101-105.

7.9 FENCES, SURFACE DAM AND ACCESS ROADS/TRACKS

Visual inspections of fences, access roads/tracks and the surface will be conducted opportunistically by MCO.

7.10 MINE INFRASTRUCTURE

Visual inspections of mine infrastructure (e.g. conveyor, haul road, out-of-pit emplacement, ROM facilities, communications tower, open cut highwalls, etc.) will be conducted through routine (e.g. each shift) statutory inspections with additional inspection frequencies as determined by the Subsidence Principal Hazard Management Plan.

7.11 SURVEY CONTROL MARKS

As described in Section 7.2.9, monitoring of the "Murragamba Trig Station" will be conducted to provide information of relevance for its re-establishment and/or replacement as necessary, on completion of subsidence.

8.0 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; and
- 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.

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 component management plan (e.g. LW101-105 LMP, LW101-105 WMP, LW101-105 BMP, LW101-105 HMP and LW101-105 BFMPs).

9.0 ROLES AND RESPONSIBILITIES

Key responsibilities of MCO personnel in relation to this LW101-105 SMP are summarised in Table 5. Responsibilities may be delegated as required.

Table 5: Longwalls 101 to 105 Subsidence Monitoring Program Responsibility Summary

Responsibility	Task
General Manager	• Ensure resources are available to MCO personnel to facilitate the completion of responsibilities under this LW101-105 SMP.
Underground Technical Manager	• Ensure the LW101-105 SMP is implemented. • Ensure monitoring required under this LW101-105 SMP is carried out within specified timeframes, adequately checked and processed and prepared to the required standard. • Undertake relevant monitoring summarised in Section 7.
Environmental and Community Manager	• Ensure the LW101-105 SMP is implemented. • Liaise with relevant stakeholders regarding subsidence impact management and related environmental consequences.
Registered Mine Surveyor	• Undertake all subsidence monitoring to the required standard within the specified timeframes and ensure data are adequately checked, processed and recorded.

9.1 KEY CONTACTS

The details of key contacts and phone numbers in relation to this LW101-105 SMP are summarised in Table 6.

Table 6: Longwalls 101 to 105 Subsidence Monitoring Program Key Personnel Contact Details

Organisation	Position	Contact Name	Phone Number
MCO	Underground Technical Manager	Mr Liam Mildon	02 6376 1614
	Environmental and Community Manager	Mr Graham Chase	02 6376 1407
	Registered Mine Surveyor	Mr Zac Burley	02 6376 1613
	Moolarben Coal Hotline		1800 556 484
Resource Regulator	Principal Subsidence Engineer	Dr Gang Li	02 4931 6644

10.0 REFERENCES

Department of Planning & Environment and Division of Resources and Energy (2015) *Guidelines for the Preparation of Extraction Plans*.

Eco Logical Australia Pty Ltd (2016) *Moolarben Coal UG1 Vegetation Validation.*

Eco Logical Australia Pty Ltd (2017) *Biodiversity Technical Report – UG1 Extraction Plan*. Prepared for Moolarben Coal Operations.

Eco Logical Australia Pty Ltd (2020) *MCO UG1 Extraction Plan Amendment Biodiversity Technical Report. Prepared for Moolarben Coal Operations.*

Ecovision Consulting (2008) *Ecological Impact Assessment*, Appendix 7 in Moolarben Coal Mines Pty Limited (2009) *Moolarben Coal Project Stage 2 Environmental Assessment Report*.

EMGA Mitchell McLennan (2013) *Ecology Assessment*, Appendix E in EMGA Mitchell McLennan (2013) *Moolarben Coal Project – Stage 1 Optimisation Modification*.

HydroSimulations (2017) *Moolarben Extraction Plan Longwalls 101 to 103 – Groundwater Assessment Review.*

Mine Advice (2019), *Geotechnical Evaluation of Proposed Taking of Unsupported Plunges in LW103A Block*

Mine Subsidence Engineering Consultants (2015) *Subsidence Assessment (MSEC Report MSEC731 Revision A, June 2015),* Appendix A in Moolarben Coal Operations Pty Ltd (2015) *Moolarben Coal Complex UG1 Optimisation Modification Environmental Assessment.*

Mine Subsidence Engineering Consultants (MSEC) (2017) *Moolarben Coal Complex - Moolarben Project Stage 2 – Longwalls 101 to 103 Subsidence Predictions and Impact Assessments for the Natural and Built Features in Support of the Extraction Plan*.

Mine Subsidence Engineering Consultants (2019) *Modified Commencing End of LW103 and Proposed 103A Workings* Report number MSEC103.

Mine Subsidence Engineering Consultants (2020) *Moolarben Coal Complex - Moolarben Project Stage 2 – Longwalls 101 to 105, Subsidence Predictions and Impact Assessments for the Natural and Built Features in Support of the Extraction Plan.* Report Number 1084.

Moolarben Biota (2006) *Flora, Fauna and Aquatic Ecology Assessment*, Appendix 11 in Wells Environmental Services (2006) *Moolarben Coal Project Environmental Assessment Report*. Prepared for Moolarben Coal Mines Pty Limited.

Niche Environment and Heritage (2017) *Moolarben Coal UG1 Longwalls 101-103 Extraction Plan – Aboriginal Cultural Heritage Technical Report*.

Niche Environment and Heritage (2020) *Moolarben Coal UG1 Longwalls 104-105 Extraction Plan Aboriginal Cultural Heritage Technical Report.*

SLR (2020), *Moolarben Coal Complex Extraction Plan Longwalls 104 to 105 Groundwater Technical Report.*

WRM Water and Environment (2020) *UG1 Longwalls 104 to 105 Extraction Plan Surface Water Technical Report.*

ATTACHMENT 1

PLANS 1 TO 7
(IN ACCORDANCE WITH THE DEPARTMENT OF PLANNING AND ENVIRONMENT AND DIVISION OF RESOURCES AND ENERGY [2015] DRAFT *GUIDELINES FOR THE PREPARATION OF EXTRACTION PLANS*)

763000E
763500E
764000E
764500E
765000E
765500E
762500E
762000E
761500E
761000E
760500E
760000E
759500E
6427000N
6426500N
6426000N
6425500N
6425000N
6424500N
6424000N
ML 1605 Surface Case
ML1715
ML1606
ML1628
UG4 HIGHWAY
SE MAINS
SOUTH MAINS
No.2 Sump
Sump Drivage
Backroads Drivage
MHT01
TG101
MG101
MG102
MG103
MG104
MG105
LW101
LW102A
LW102B
LW103
LW104
LW105
Open Cut 1
Open Cut 2
Open Cut 4
BLASTED GROUND
A
B
C
D

Scale

0m 100m 250m 500m

Legend

- Extraction Plan Area
- Mining Lease
- Moolarben Open Cut Extents

Notes

1. Proposed workings are in the Ulan Seam.
   Development - 3.4m Basal Section
   103A Project - Up to 3.4m
   Longwall - Up to 3.5m
2. Pillar dimensions may be modified to suit geological or safety conditions where appropriate
3. Open Cut Extraction Areas are provided by the Moolarben Coal Operations Open Cut Mine Nominated Mining Surveyor and are charted to the 31/12/2019

Longwall Void Dimensions:

LW101 - 2560.9m x 310.8m
LW102A - 3292.0m x 310.8m
LW102B - 1061.0m x 310.8m
LW103 - 3830.6m x 310.8m
LW104 - 4469m x 310.8m
LW105 - 4544m x 310.8m

Endorsement

The following information has been provided by others an is indicative only. The Registered Mining Surveyor does not certify the accuracy of this information.

- Land Ownership Boundaries
- Cadastral Boundaries
- Rivers, Creeks and Drainage Lines
- Roads and Railway Lines
- Surface Features
- Powerlines and Telecommunications
- Archaeological Sites
- Vegetation Communities
- Contours
- Natural Features
- Infrastructure Items
- Geological Information
- Open Cut Limits - Provided by Nominated Open Cut Surveyor

Certification

I, SHANE PEGG, Holder of Mining Engineering Manager Practicing Certificate, certify that the information on this plan is a true indication of the proposed development.

Mining Engineering Manager

I, ZACHARY BURLEY, Registered Mining Surveyor (under the Surveying and Spatial Information Act 2002), certify that to the best of my knowledge and belief this plan confirms to the accuracy standards required by the Extraction Plan Guidelines.

Nominated Mining Surveyor

YANCOAL
兖煤澳大利亚有限公司
MOOLARBEN COAL
ABN 59 077 939 569

12 Ulan-Wollar Road
Ulan NSW 2850

Phone: 02 6376 1500
Fax: 02 6376 1599

Moolarben Coal Operations Underground Mine
Extraction Plan LW101 to LW105
Plan 1 - Extraction Plan Area And Mining Layout

Drawing No.	Revision No.
MCUG02424\1	0

Date	Scale:	Drawn	Checked	Approved	Sheet Size
06/03/2020	1:5000	ZB	AM	SP	A0

RSIA Area - Shafts and Service Borehole Facility

106 (Tension)

105

104

103

102

101

100

99

330kV POWER LINE

330kV TRANSMISSION LINE

Gulgong - Sandy Hollow Railway

Ulan - Wollar Road

Willpinjong Creek

CULVERT

107

Old Ulan - Wollar Road

SE MAINS

108

Moolarben Rail Loop

Essential Energy Substation

109

ROAD & RAIL CONVEYOR TUNNELS

110 (Tension)

111

112 (Tension)

113

LW102B

DRAINAGE LINE 7

Drainage Line 7

DRAINAGE LINE 6

Drainage Line 6

Murragamba Road

Murragamba Creek

MHT01

TG101

OMG101

OC4 Overland Conveyor

MG102

MG103

MG104

MG105

LW101

LW102A

LW103

LW104

LW105

SOUTH MAINS

DRAINAGE LINE 5

Communications Tower

DRAINAGE LINE 4

Southwest Haul Road

C5

C6

CARR'S GAP ROAD

MURRAGAMBA TRIG STATION

Backroads Drivage

763000E 763500E 764000E 764500E 765000E 765500E

6427000N 6426500N 6426000N 6425500N 6425000N 6424500N

762500E 761000E 761500E 760000E 760500E 759500E

Scale

0m 100m 250m 500m

Legend

- Extraction Plan Area
- Subsidence Zone (AoD)
- Road
- Surface Contour - 1m
- Drainage Line/Creek
- Steep Slope
- Cliffline
- Railway
- Electrical Infrastructure
- Heritage Site
- Endangered Ecological Community
- Survey Station
- Telstra Copper Cable
- Telstra Fibre Optics
- Dam
- Moolarben O/C
- Telstra Comms
- Moolarben O/C Design Limits
- Buildings
- Haul Road

Notes

1. Proposed workings are in the Ulan Seam.
   Development - 3.4m Basal Section
   103A Project - Up to 3.4m
   Longwall - Up to 3.5m
2. Pillar dimensions may be modified to suit geological or safety conditions where appropriate
3. Open Cut Extraction Areas are provided by the Moolarben Coal Operations Open Cut Mine Nominated Mining Surveyor and are charted to the 31/12/2019

Longwall Void Dimensions:

LW101 - 2560.9m x 310.8m
LW102A - 3292.0m x 310.8m
LW102B - 1061.0m x 310.8m
LW103 - 3830.6m x 310.8m
LW104 - 4469m x 310.8m
LW105 - 4544m x 310.8m

Endorsement

The following information has been provided by others and is indicative only. The Registered Mining Surveyor does not certify the accuracy of this information.

- Land Ownership Boundaries
- Cadastral Boundaries
- Rivers, Creeks and Drainage Lines
- Roads and Railway Lines
- Surface Features
- Powerlines and Telecommunications
- Archaeological Sites
- Vegetation Communities
- Contours
- Natural Features
- Infrastructure Items
- Geological Information
- Open Cut Limits - Provided by Nominated Open Cut Surveyor

Certification

I, SHANE PEGG, Holder of Mining Engineering Manager Practicing Certificate, certify that the information on this plan is a true indication of the proposed development.

Mining Engineering Manager

I, ZACHARY BURLEY, registered mining surveyor (under the Surveying and Spatial Information Act 2002), certify that to the best of my knowledge and belief this plan confirms to the accuracy standards required by the Extraction Plan Guidelines.

Nominated Mining Surveyor

YANCOAL 兖煤澳大利亚有限公司
MOOLARBEN COAL
ABN 59 077 939 569

12 Ulan-Wollar Road
Ulan NSW 2850

Phone: 02 6376 1500
Fax: 02 6376 1599

Moolarben Coal Operations Underground Mine
Extraction Plan LW101 to LW105
Plan 2 - Surface Features

Drawing No.	Revision No.	Date	Scale:	Drawn	Checked	Approved	Sheet Size
MCUG02424\2	0	06/03/2020	1:5000	ZB	AM	SP	A0

SE MAINS

SOUTH MAINS

UG4 HIGHWAY

No.2 Sump

Sump Drivage

LW101

LW102A

LW102B

LW103

LW104

LW105

MHT01

TG101

MG101

MG102

MG103

MG104

MG105

Plug

Backroads Drivage

763000E 763500E 764000E 764500E 765000E 765500E

6427000N 762500E

6426500N 762000E

6426000N 761500E

761000E 6425500N

6425000N 760500E

760000E 6424500N

6424000N

Scale

0m 100m 250m 500m

Longwall Void Dimensions:

LW101 - 2560.9m x 310.8m
LW102A - 3292.0m x 310.8m
LW102B - 1061.0m x 310.8m
LW103 - 3830.6m x 310.8m
LW104 - 4469m x 310.8m
LW105 - 4544m x 310.8m

Endorsement

The following information has been provided by others and is indicative only. The Registered Mining Surveyor does not certify the accuracy of this information.

- Land Ownership Boundaries
- Cadastral Boundaries
- Rivers, Creeks and Drainage Lines
- Roads and Railway Lines
- Surface Features
- Powerlines and Telecommunications
- Archaeological Sites
- Vegetation Communities
- Contours
- Natural Features
- Infrastructure Items
- Geological Information
- Open Cut Limits - Provided by Nominated Open Cut Surveyor

Certification

I, SHANE PEGG, Holder of Mining Engineering Manager Practicing Certificate, certify that the information on this plan is a true indication of the proposed development.

Mining Engineering Manager

I, ZACHARY BURLEY, Registered Mining Surveyor (under the Surveying and Spatial Information Act 2002), certify that to the best of my knowledge and belief this plan confirms to the accuracy standards required by the Extraction Plan Guidelines.

Nominated Mining Surveyor

Legend

- Extraction Plan Area
- Fault
- Depth Of Cover Isopach
- "D" Working SectionThickness Isopach
- Dyke
- Dyke Inferred
- Borehole Hazard
- Diatreme/Plug
- Moolarben Open Cut
- Sill

Notes

1. Proposed workings are in the Ulan Seam.
   Development - 3.4m Basal Section
   103A Project - Up to 3.4m
   Longwall - Up to 3.5m
2. Pillar dimensions may be modified to suit geological or safety conditions where appropriate
3. Open Cut Extraction Areas are provided by the Moolarben Coal Operations Open Cut Mine Nominated Mining Surveyor and are charted to the 31/12/2019

YANCOAL 兖煤澳大利亚有限公司 MOOLARBEN COAL

ABN 59 077 939 569

12 Ulan-Wollar Road
Ulan NSW 2850

Phone: 02 6376 1500
Fax: 02 6376 1599

Moolarben Coal Operations Underground Mine
Extraction Plan LW101 to LW105
Plan 3 - Seam Geology

Drawing No.	Revision No.	Date	Scale:	Drawn	Checked	Approved	Sheet Size
MCUG02424\3	0	06/03/2020	1:5000	ZB	AM	SP	A0

SE MAINS

SOUTH MAINS

UG4 HIGHWAY

No.2 Sump

Sump Drivage

LW101

LW102A

LW102B

LW103

LW104

LW105

MHT01

TG101

MG101

MG102

MG103

MG104

MG105

Plug

Backroads Drivage

763000E 763500E 764000E 764500E 765000E 765500E

6427000N 762500E

6426500N 762000E

6426000N 761500E

6425500N 761000E

6425000N 760500E

6424500N 760000E

Scale

0m 100m 250m 500m

Legend

- Extraction Plan Area
- Fault
- Depth Of Cover Isopach
- "D" Working SectionThickness Isopach
- Dyke
- Dyke Inferred
- Borehole Hazard
- Diatreme/Plug
- Moolarben Open Cut
- Sill

Notes

1. Proposed workings are in the Ulan Seam.
   Development - 3.4m Basal Section
   103A Project - Up to 3.4m
   Longwall - Up to 3.5m
2. Pillar dimensions may be modified to suit geological or safety conditions where appropriate
3. Open Cut Extraction Areas are provided by the Moolarben Coal Operations Open Cut Mine Nominated Mining Surveyor and are charted to the 31/12/2019

Endorsement

The following information has been provided by others and is indicative only. The Registered Mining Surveyor does not certify the accuracy of this information.

- Land Ownership Boundaries
- Cadastral Boundaries
- Rivers, Creeks and Drainage Lines
- Roads and Railway Lines
- Surface Features
- Powerlines and Telecommunications
- Archaeological Sites
- Vegetation Communities
- Contours
- Natural Features
- Infrastructure Items
- Geological Information
- Open Cut Limits - Provided by Nominated Open Cut Surveyor

Certification

I, SHANE PEGG, Holder of Mining Engineering Manager Practicing Certificate, certify that the information on this plan is a true indication of the proposed development.

Mining Engineering Manager

I, ZACHARY BURLEY, Registered Mining Surveyor (under the Surveying and Spatial Information Act 2002), certify that to the best of my knowledge and belief this plan confirms to the accuracy standards required by the Extraction Plan Guidelines.

Nominated Mining Surveyor

Longwall Void Dimensions:

LW101 - 2560.9m x 310.8m
LW102A - 3292.0m x 310.8m
LW102B - 1061.0m x 310.8m
LW103 - 3830.6m x 310.8m
LW104 - 4469m x 310.8m
LW105 - 4544m x 310.8m

YANCOAL 兖煤澳大利亚有限公司 MOOLARBEN COAL
ABN 59 077 939 569

12 Ulan-Wollar Road
Ulan NSW 2850

Phone: 02 6376 1500
Fax: 02 6376 1599

Moolarben Coal Operations Underground Mine
Extraction Plan LW101 to LW105
Plan 4 - Seam Geology And Future Workings

Drawing No.	Revision No.	Date	Scale:	Drawn	Checked	Approved	Sheet Size
MCUG02424/4	0	06/03/2020	1:5000	ZB	AM	SP	A0

763000E
764000E
764500E
765000E
765500E
762500E
761500E
760000E
6427000N
6426500N
6426000N
6425500N
6425000N
6424500N
6424000N
ML1605 Surface Lease
ML1715
UG4 HIGHWAY
No.2 Pump
Sump Drivage
SE MAINS
SOUTH MAINS
Backroads Drivage
MHT01
TG101
MG101
MG102
MG103
MG104
MG105
LW101
LW102A
LW102B
LW103
LW104
LW105
ML1606
ML1628
ML1715
A
B
C
D

Scale

0m 100m 250m 500m

Longwall Void Dimensions:

LW101 - 2560.9m x 310.8m
LW102A - 3292.0m x 310.8m
LW102B - 1061.0m x 310.8m
LW103 - 3830.6m x 310.8m
LW104 - 4469m x 310.8m
LW105 - 4544m x 310.8m

Endorsement

The following information has been provided by others and is indicative only. The Registered Mining Surveyor does not certify the accuracy of this information.

- Land Ownership Boundaries
- Cadastral Boundaries
- Rivers, Creeks and Drainage Lines
- Roads and Railway Lines
- Surface Features
- Powerlines and Telecommunications
- Archaeological Sites
- Vegetation Communities
- Contours
- Natural Features
- Infrastructure Items
- Geological Information
- Open Cut Limits - Provided by Nominated Open Cut Surveyor

Certification

I, SHANE PEGG, Holder of Mining Engineering Manager Practicing Certificate, certify that the information on this plan is a true indication of the proposed development.

Mining Engineering Manager

I, ZACHARY BURLEY, Registered Mining Surveyor (under the Surveying and Spatial Information Act 2002), certify that to the best of my knowledge and belief this plan confirms to the accuracy standards required by the Extraction Plan Guidelines.

Nominated Mining Surveyor

Legend

- Extraction Plan Area
- Cadastral Boundary
- Mining Lease Boundary
- Moolarben Coal Operations
- Crown Land

Schedule Of Leases

Lease	Approval	Expiry
ML1605	20-Dec-2007	20-Dec-2028
ML1606	20-Dec-2007	20-Dec-2028
ML1628	24-Feb-2009	24-Feb-2030
ML1691	23-Sep-2013	23-Sep-2034
ML1715	31-Aug-2015	31-Aug-2036

Notes

1. Proposed workings are in the Ulan Seam.
   Development - 3.4m Basal Section
   103A Project - Up to 3.4m
   Longwall - Up to 3.5m
2. Pillar dimensions may be modified to suit geological or safety conditions where appropriate
3. Cadastral information is taken from the D.C.D.B provided by the Land Property and Information NSW
4. Mining Lease Boundaries based on survey information

YANCOAL 兖煤澳大利亚有限公司
MOOLARBEN COAL
ABN 59 077 939 569

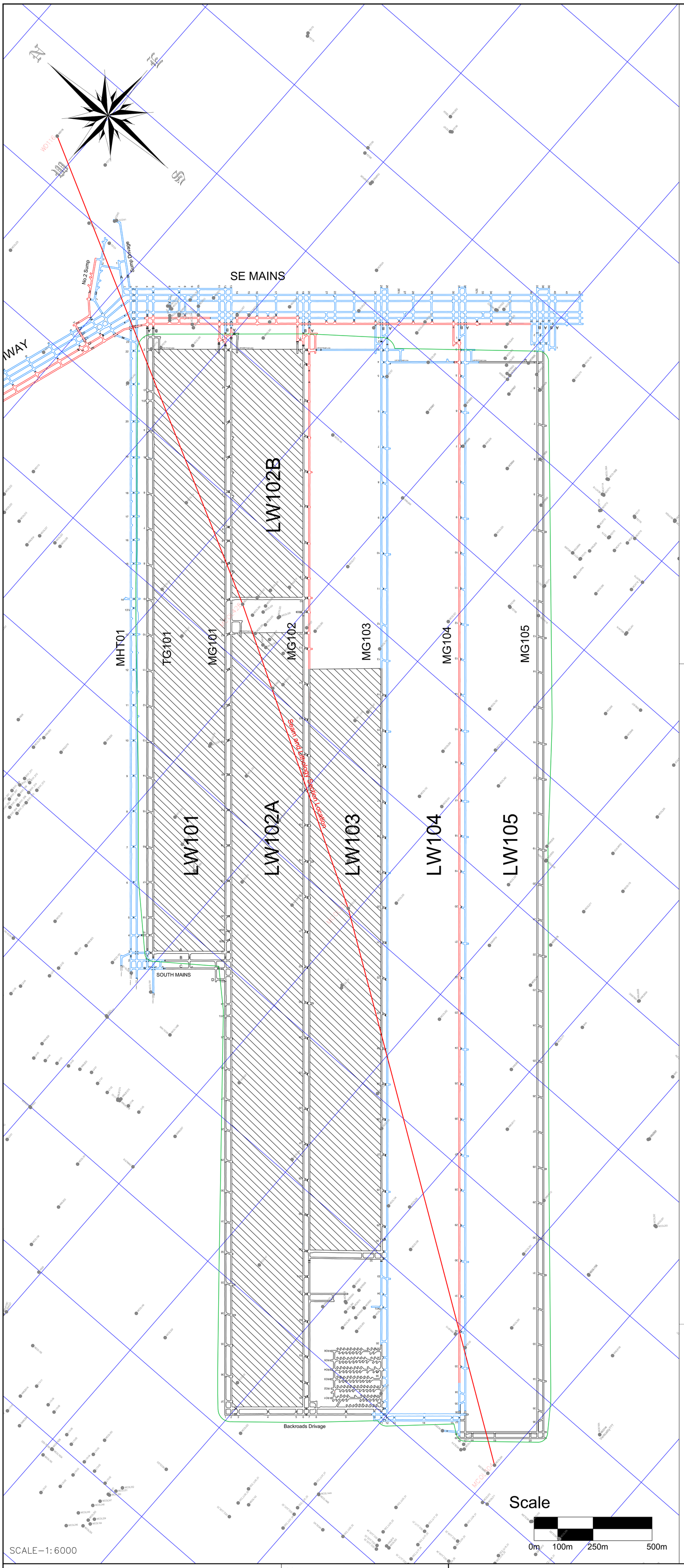
12 Ulan-Wollar Road
Ulan NSW 2850

Phone: 02 6376 1500
Fax: 02 6376 1599

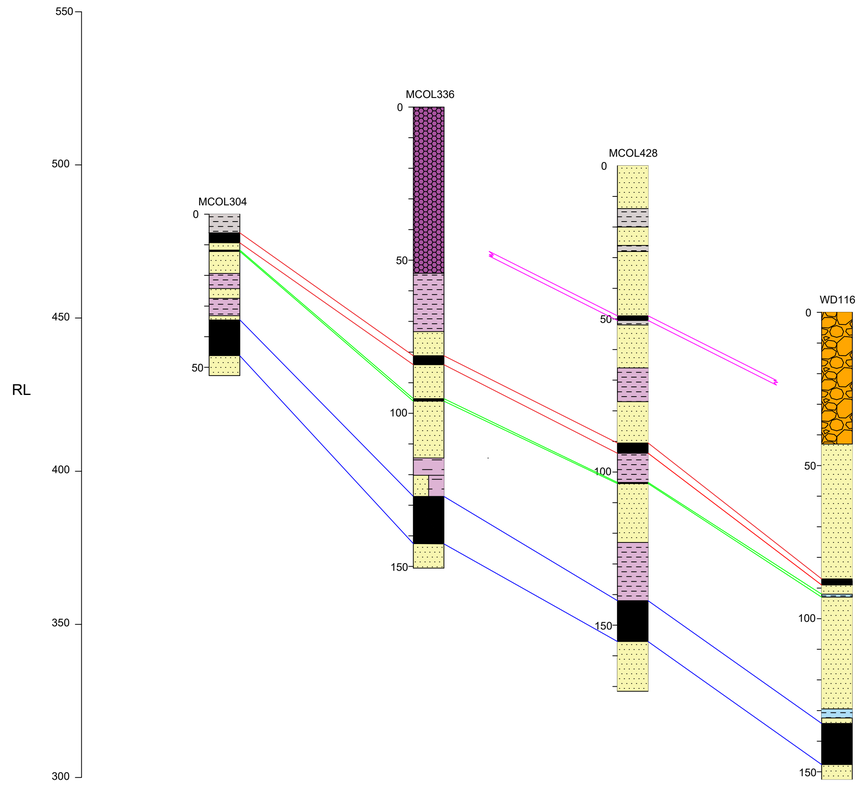
Moolarben Coal Operations Underground Mine
Extraction Plan LW101 to LW105
Plan 5 - Mining Titles and Land Ownership

Drawing No.	Revision No.
MCUG02424\5	0

Date	Scale:	Drawn	Checked	Approved	Sheet Size
06/03/2020	1:5000	ZB	AM	SP	A0



Surface to Seam Lithology



Lithology Key

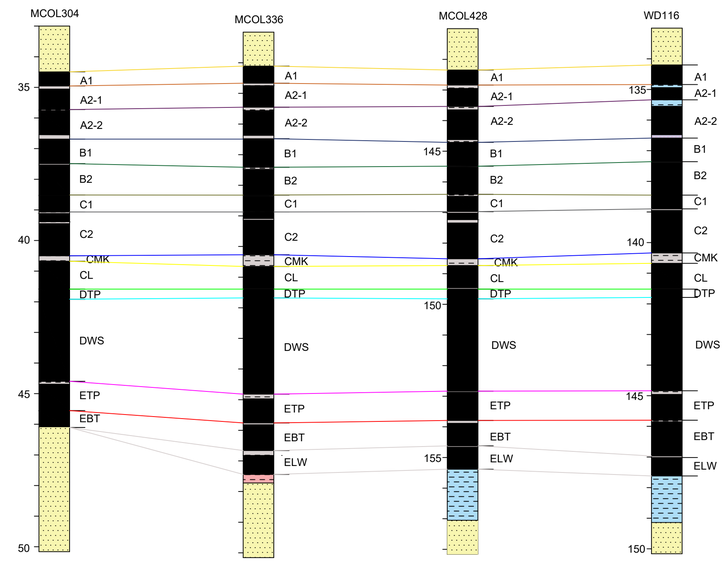
- Conglomerate
- Sandstone
- Siltstone
- Claystone
- Alluvium Gravel
- Carbonaceous Claystone
- Coal

Seam Expansion Key

- Moolarben Seam
- Glen Davis Seam
- Irondale Seam
- Ulan Seam

SCALE–1:1000

Ulan Seam Section



Lithology Key

- Sandstone
- Siltstone
- Claystone
- Carbonaceous Claystone
- Coal

Seam Expansion Key

- Ulan A1 Ply
- Ulan A2-1 Ply
- Ulan A2-2 Ply
- Ulan B1 Ply
- Ulan B2 Ply
- Ulan C1 Ply
- Ulan C2 Ply
- CMK
- Ulan CL Ply
- Ulan DTP Ply
- Ulan DWS Ply
- Ulan ETP Ply
- Ulan EBT Ply
- Ulan ELW Ply

SCALE–1:100

Legend

- Extraction Plan Area
- Seam and Lithology Section Location

Notes

1. Proposed workings are in the Ulan Seam.
   Development - 3.4m Basal Section
   103A Project - Up to 3.4m
   Longwall - Up to 3.5m
2. Pillar dimensions may be modified to suit geological or safety conditions where appropriate
3. Open Cut Extraction Areas are provided by the Moolarben Coal Operations Open Cut Mine Nominated Mining Surveyor and are charted to the 31/12/2019

Endorsement

The following information has been provided by others and is indicative only. The Registered Mining Surveyor does not certify the accuracy of this information.

- Land Ownership Boundaries
- Cadastral Boundaries
- Rivers, Creeks and Drainage Lines
- Roads and Railway Lines
- Surface Features
- Powerlines and Telecommunications
- Archaeological Sites
- Vegetation Communities
- Contours
- Natural Features
- Infrastructure Items
- Geological Information
- Open Cut Limits - Provided by Nominated Open Cut Surveyor

Certification

I, SHANE PEGG, Holder of Mining Engineering Manager Practicing Certificate, certify that the information on this plan is a true indication of the proposed development.

Mining Engineering Manager

I, ZACHARY BURLEY, Registered Mining Surveyor (under the Surveying and Spatial Information Act 2002), certify that to the best of my knowledge and belief this plan confirms to the accuracy standards required by the Extraction Plan Guidelines.

Nominated Mining Surveyor

Longwall Void Dimensions:
LW101 - 2560.9m x 310.8m
LW102A - 3292.0m x 310.8m
LW102B - 1061.0m x 310.8m
LW103 - 3830.6m x 310.8m
LW104 - 4469m x 310.8m
LW105 - 4544m x 310.8m

Scale
0m 100m 250m 500m

YANCOAL 兖煤澳大利亚有限公司
MOOLARBEN COAL
ABN 59 077 939 569

12 Ulan-Wollar Road
Ulan NSW 2850

Phone: 02 6376 1500
Fax: 02 6376 1599

Moolarben Coal Operations Underground Mine
Extraction Plan LW101 to LW105
Plan 6 - Geological Sections

Drawing No.	Revision No.
MCUG02424\6	0

Date	Scale:	Drawn	Checked	Approved	Sheet Size
06/03/2020	SHOWN	ZB	AM	SP	A0

RSIA Area - Shafts and Service Borehole Facility

106 (Tension) 105 104 103 102 101 100 99

330kV POWER LINE

330kV TRANSMISSION LINE

Gulgong - Sandy Hollow Railway

Ulan - Wollar Road

Willpinjong Creek

SE MAINS

Old Ulan Wollar Road

107

106

109

Moolarben Rail Loop

Essential Energy Substation

"FF" Line

CULVERT

66kV/22kV POWER LINE

"C" Line

"D" Line

"E" Line

"I" Line

"J" Line

"H" Line

DRAINAGE LINE 7

Drainage Line 7

DRAINAGE LINE 6

Drainage Line 6

330kV TRANSMISSION LINE

ROAD & RAIL CONVEYOR TUNNELS

110 (Tension)

111

112 (Tension)

113

Ulan -Wollar Road

LW101

LW102A

LW102B

LW103

LW104

LW105

MHT01

TG101

MG101

MG102

MG103

MG104

MG105

OC4 Overland Conveyor

"G" Line

"A" Line

"B" Line

"BC" Highwall Scan

SOUTH MAINS

Southwest Haul Road

Communications Tower

DRAINAGE LINE 5

DRAINAGE LINE 4

OC1 Highwall Scan

"103A" Line

MURRAGAMBA TRIG STATION

CARR'S GAP ROAD

Backroads Drivage

Murragamba Road

Murragamba Creek

BLASTED GROUND

Longwall Void Dimensions:

LW101 - 2560.9m x 310.8m
LW102A - 3292.0m x 310.8m
LW102B - 1061.0m x 310.8m
LW103 - 3830.6m x 310.8m
LW104 - 4469m x 310.8m
LW105 - 4544m x 310.8m

Endorsement

The following information has been provided by others and is indicative only. The Registered Mining Surveyor does not certify the accuracy of this information.

- Land Ownership Boundaries
- Cadastral Boundaries
- Rivers, Creeks and Drainage Lines
- Roads and Railway Lines
- Surface Features
- Powerlines and Telecommunications
- Archaeological Sites
- Vegetation Communities
- Contours
- Natural Features
- Infrastructure Items
- Geological Information
- Open Cut Limits - Provided by Nominated Open Cut Surveyor

Certification

I, SHANE PEGG, Holder of Mining Engineering Manager Practicing Certificate, certify that the information on this plan is a true indication of the proposed development.

Mining Engineering Manager

I, ZACHARY BURLEY, registered mining surveyor (under the Surveying and Spatial Information Act 2002), certify that to the best of my knowledge and belief this plan confirms to the accuracy standards required by the Extraction Plan Guidelines.

Nominated Mining Surveyor

Scale

0m 100m 250m 500m

Legend

- Extraction Plan Area
- Subsidence Zone (AoD)
- Road
- Surface Contour - 1m
- Drainage Line/Creek
- Steep Slope
- Cliffline
- Telstra Fibre Optics
- Essential Energy Monitoring
- Railway
- Electrical Infrastructure
- Heritage Site
- Endangered Ecological Community
- Survey Station
- Buildings
- Telstra Copper Cable
- Proposed/Existing Subsidence Line
- Dam
- Moolarben O/C Transgrid Monitoring
- Moolarben O/C Design Limits
- Haul Road

Notes

1. Proposed workings are in the Ulan Seam.
   Development - 3.4m Basal Section
   103A Project - Up to 3.4m
   Longwall - Up to 3.5m
2. Pillar dimensions may be modified to suit geological or safety conditions where appropriate
3. Open Cut Extraction Areas are provided by the Moolarben Coal Operations Open Cut Mine Nominated Mining Surveyor and are charted to the 31/12/2019

YANCOAL 兖煤澳大利亚有限公司
MOOLARBEN COAL
ABN 59 077 939 569

12 Ulan-Wollar Road
Ulan NSW 2850

Phone: 02 6376 1500
Fax: 02 6376 1599

Moolarben Coal Operations Underground Mine
Extraction Plan LW101 to LW105
Plan 7 - Subsidence Monitoring

Drawing No.	Revision No.
MCUG02424\7	0

Date	Scale:	Drawn	Checked	Approved	Sheet Size
06/03/2020	1: 5000	ZB	AM	SP	A0