



UG4 LONGWALLS 401 TO 408 EXTRACTION PLAN

DOCUMENT CONTROL

Applicant	Moolarben Coal Operations Pty Ltd
Mine	Moolarben Coal Complex
Development Consent	Stage 1 Project Approval (05_01175) as modified
Mining Leases	ML 1605 and ML 1628
Title	Moolarben Coal Complex UG4 Extraction Plan Longwalls 401 to 408
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- Attachment 3 Program to Collect Baseline Data for Future Extraction Plans
- Attachment 4 Key Contact Register

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- Appendix A UG4 Longwalls 401 to 408 Water Management Plan
- Appendix B UG4 Longwalls 401 to 408 Land Management Plan
- Appendix C UG4 Longwalls 401 to 408 Biodiversity Management Plan
- Appendix D UG4 Longwalls 401 to 408 Heritage Management Plan
- Appendix E UG4 Longwalls 401 to 408 Built Features Management Plans
- Appendix F UG4 Longwalls 401 to 408 Public Safety Management Plan
- Appendix G UG4 Longwalls 401 to 408 Subsidence Monitoring Program (Plans 1 to 7)
- Appendix H UG4 Longwalls 401 to 408 S1MC280 Subsidence Monitoring and Mitigation Program

LIST OF TECHNICAL REPORTS

- Technical Report 1 Subsidence Report
- Technical Report 2 Groundwater Technical Report
- Technical Report 3 Surface Water Technical Report
- Technical Report 4 Biodiversity Technical Report
- Technical Report 5 Aboriginal Cultural Heritage Technical Report

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1.0 OVERVIEW OF THE EXTRACTION PLAN

1.1 MOOLARBEN COAL COMPLEX OVERVIEW

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

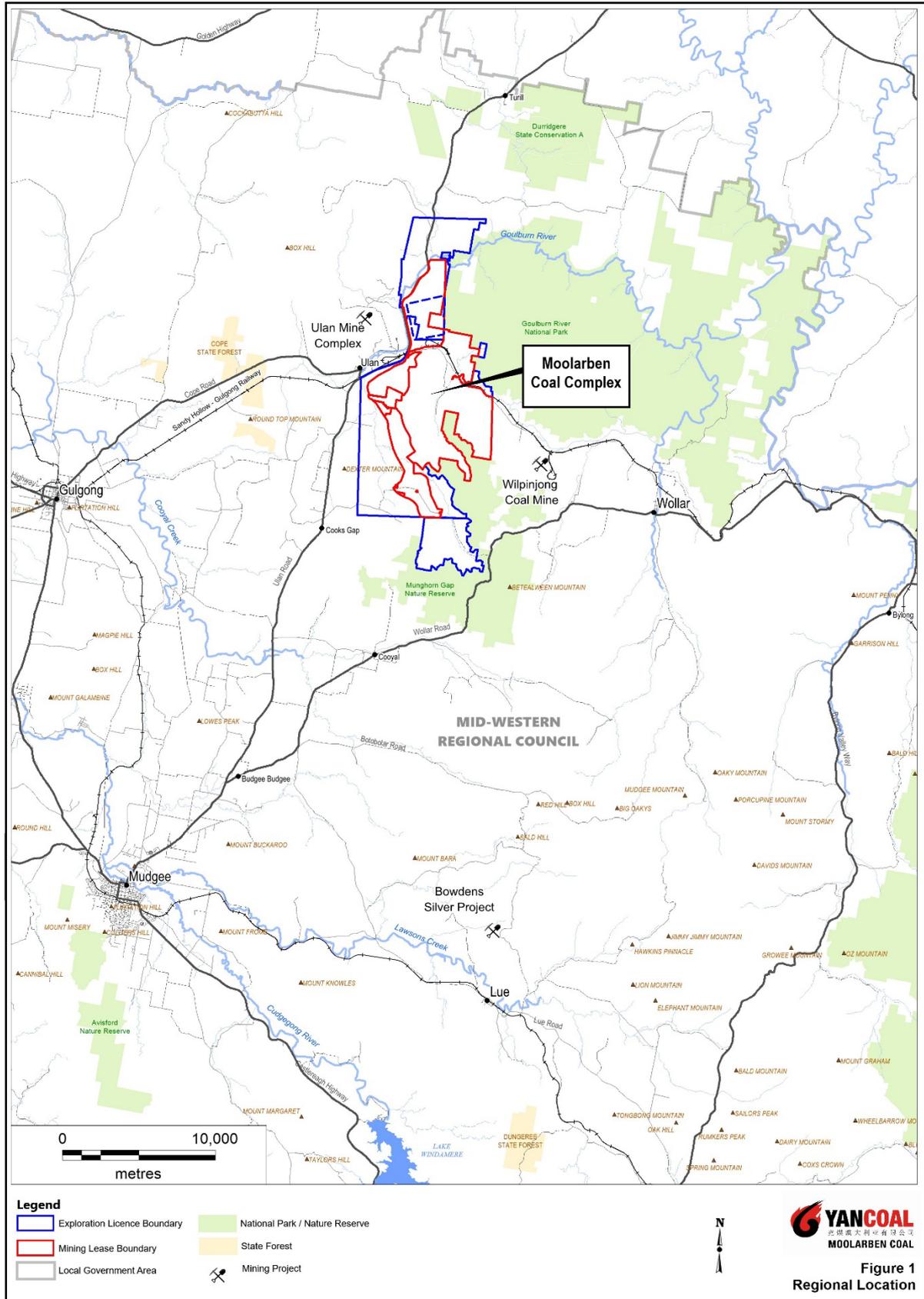
Moolarben Coal Operations Pty Ltd (MCO) is the operator of the Moolarben Coal Complex on behalf of the Moolarben Joint Venture (Moolarben Coal Mines Pty Ltd [MCM], Yancoal Moolarben [YM] Pty Ltd and a consortium of Korean power companies). MCO, MCM and YM are wholly owned subsidiaries of Yancoal Australia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

The UG4 Underground Mine (UG4) is a component of the approved Moolarben Coal Complex (**Figure 2**). First workings for UG4 North Mains commenced in October 2020 (**Figure 3**). Secondary extraction in UG4 of the first Longwall LW401 is scheduled to commence in 2022 (**Table 2**).

Mining operations at the Moolarben Coal Complex are currently approved until 31 December 2038 and continue to be carried out 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).

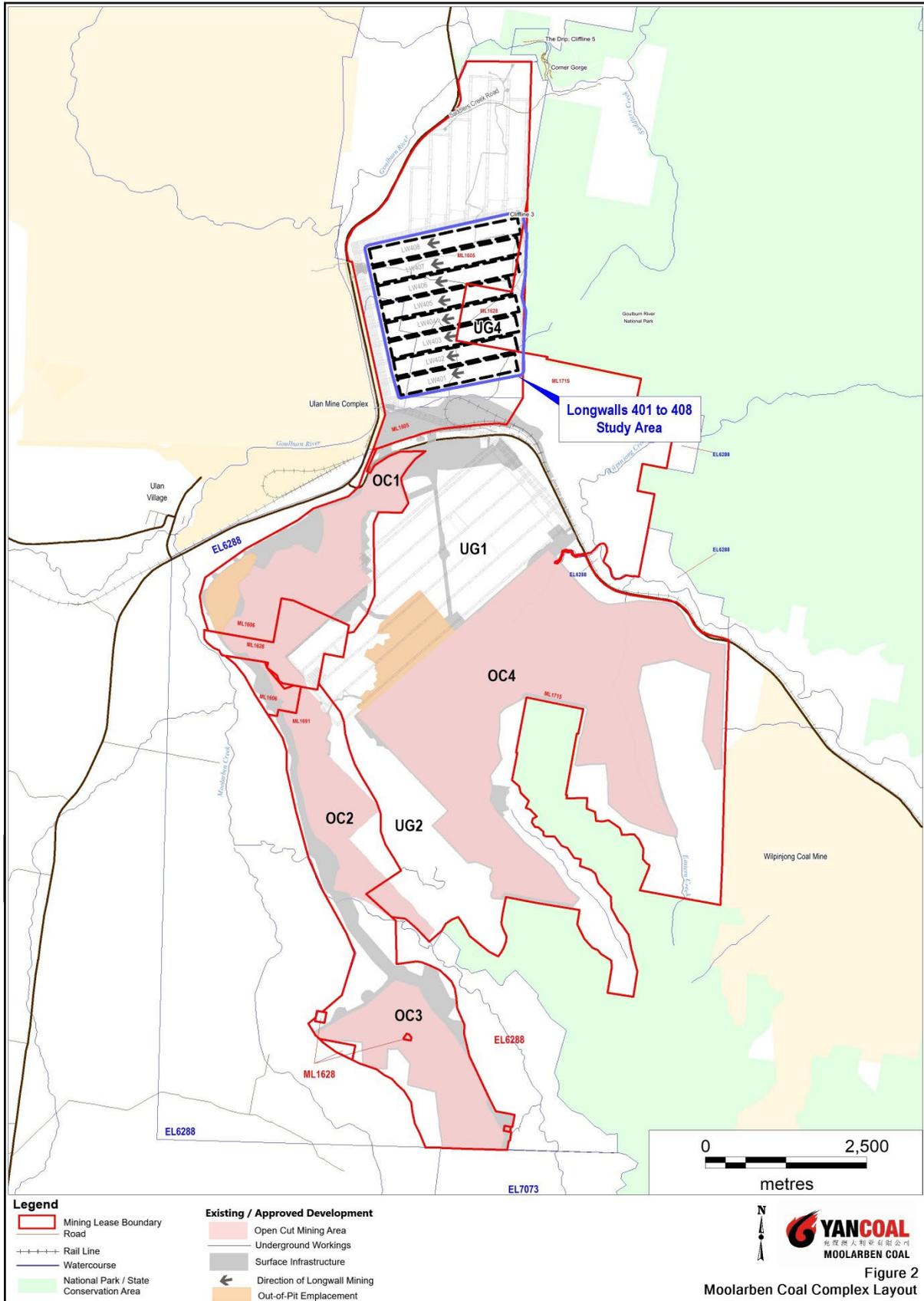
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Figure 1: Regional Location



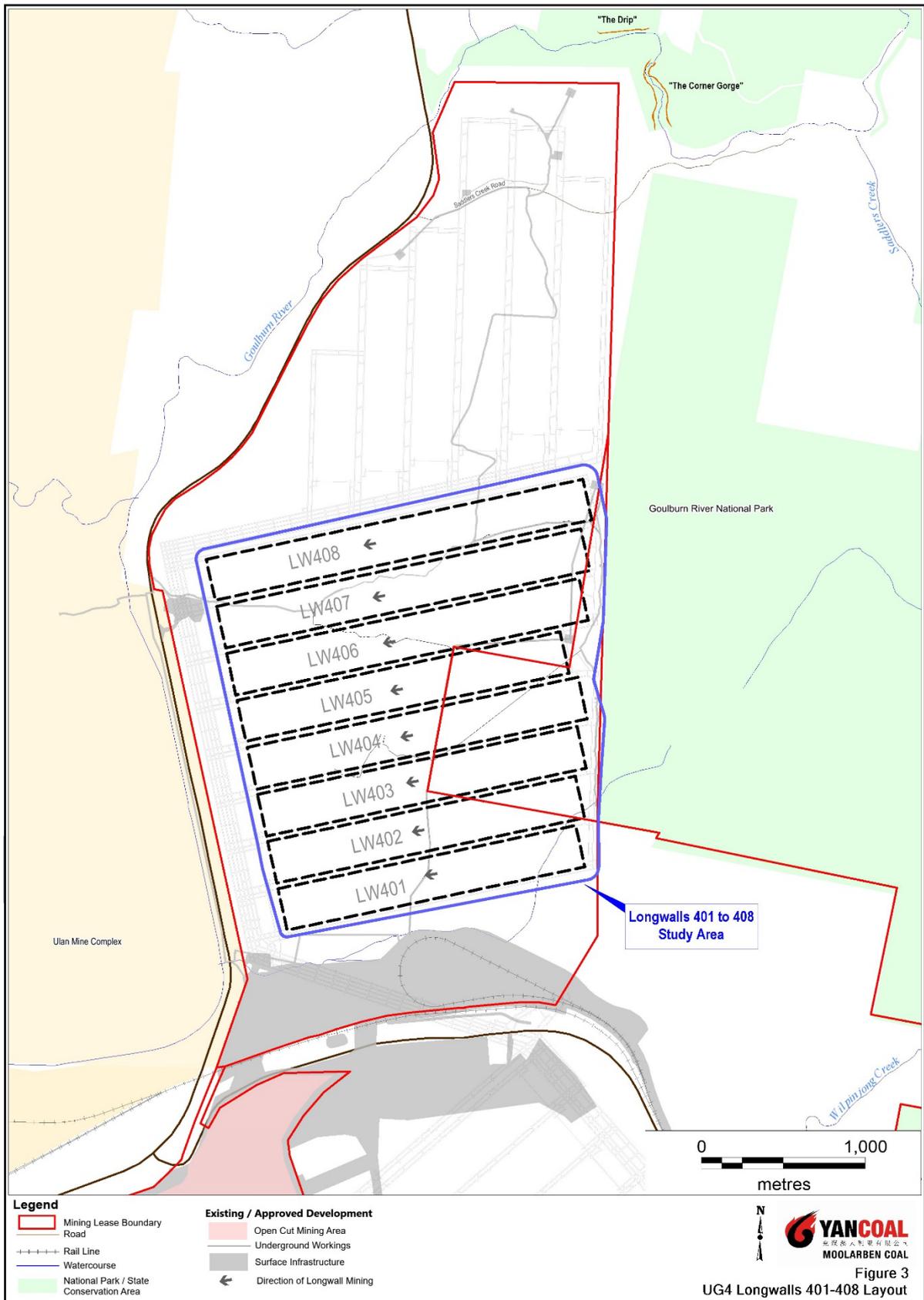
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Figure 2: Moolarben Coal Complex Layout



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Figure 3: Underground 4 Longwalls 401 to 408 Layout



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1.2 EXTRACTION PLAN PURPOSE AND SCOPE

This Extraction Plan outlines the proposed management, mitigation, monitoring and reporting of potential subsidence impacts and environmental consequences in the UG4 mining area during the secondary extraction of Longwalls 401 to 408 (herein referred to as Longwalls 401 - 408).

This Extraction Plan has been prepared in consideration of the NSW Department of Planning and Environment (DPE) and Resource Regulator (RR), formally the NSW Division of Resources and Energy (DRE) (2015) draft *Guidelines for the Preparation of Extraction Plans* (the Guidelines).

The objectives of this Extraction Plan are to:

- provide detailed plans of Longwalls 401 - 408;
- outline potential subsidence effects, subsidence impacts and environmental consequences due to the extraction of Longwalls 401 - 408;
- describe the measures that will be implemented to ensure compliance with the subsidence impact performance measures and investigate, mitigate, manage and remediate potential subsidence impacts and environmental consequences; and
- detail a monitoring and contingency plan for potential subsidence impacts and environmental consequences, including detailed performance indicators for subsidence impact performance measures.

This Extraction Plan has been prepared by MCO with assistance from Mine Subsidence Engineering Consultants (MSEC), Australian Groundwater and Environment (AGE), WRM Water & Environment (WRM) and Niche Environment and Heritage (Niche). The appointment of the suitably qualified and experienced persons has been endorsed by the Secretary of the DPE on the 26 April 2021 (**Attachment 2**).

This Extraction Plan forms part of MCO's Environmental Management Strategy (EMS). The relationship of this Extraction Plan to the MCO's EMS is shown in **Figure 4**.

1.3 THE STUDY AREA

MSEC has prepared a subsidence impact assessment report to support the Extraction Plan for Longwalls 401 to 408 (**Technical Report 1**).

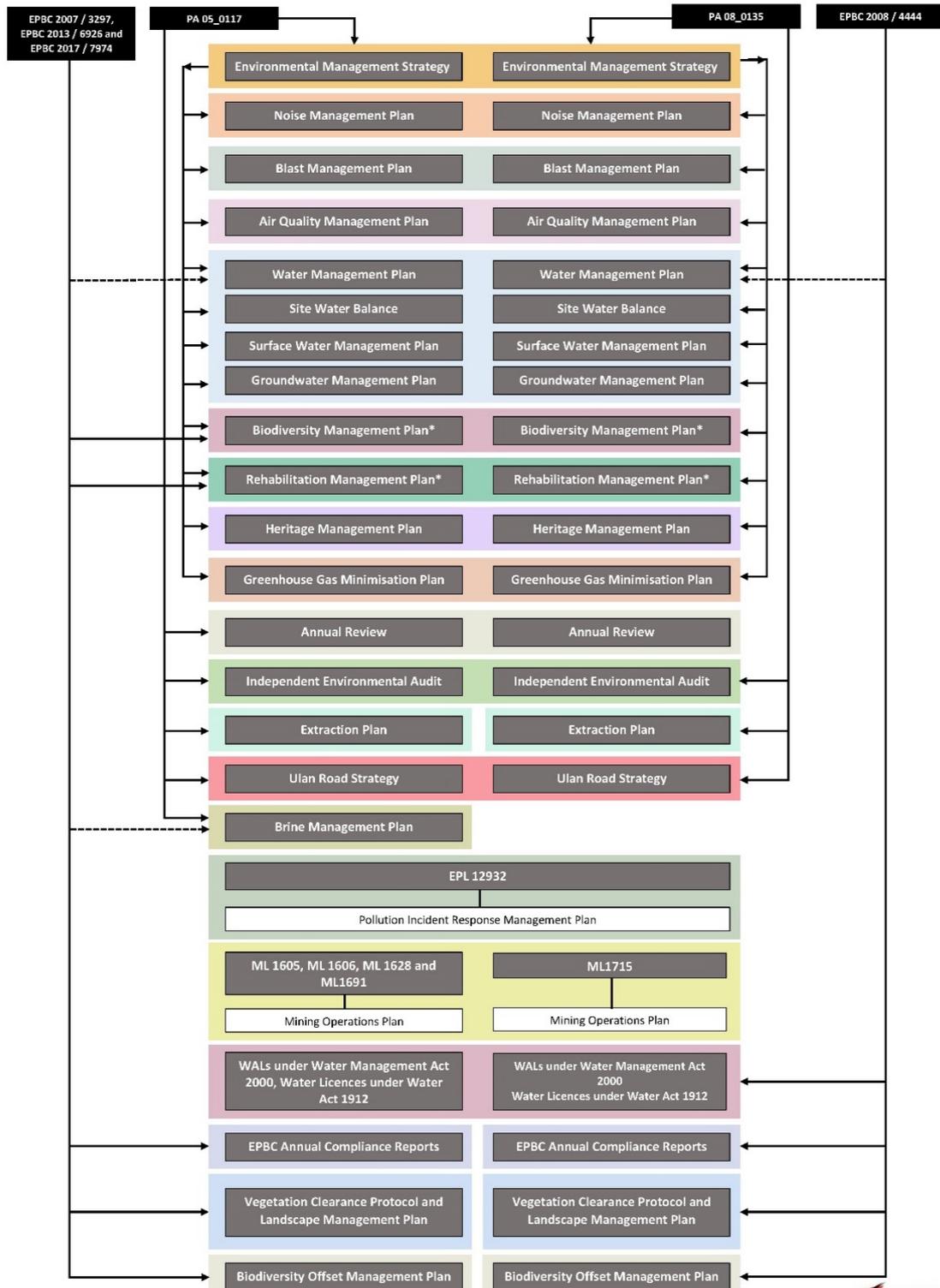
The Study Area (**Figure 3**) for the Extraction Plan is defined as the surface area that is likely to be affected by the proposed mining of Longwalls 401 to 408 (Extraction Plan Layout) in the Ulan Seam. The extent of the Study Area has been calculated by MSEC combining the areas bounded by the following limits:

- The 26.5° angle of draw line;
- The predicted vertical limit of subsidence, taken as the 20 mm subsidence contour; and
- Features sensitive to far-field movements.

As the depth of cover above the longwalls varies between 83 and 205 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 42 and 103 m.

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Figure 4: Environmental Management System Structure Summary



* To replace Landscape Management Plan



MOOLARBEN COAL COMPLEX
Environmental Management System
Structure Summary

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1.3.1 Statutory Requirements

Project Approval (05_0117)

This Extraction Plan has been prepared in accordance with Conditions 77 and 78, Schedule 3 of Project Approval (05_0117) (as modified). These legislative requirements are summarised in **Table 1**, along with the relevant section(s) of this Extraction Plan in which that requirement is addressed. Further detail on the requirements of Project Approval (05_0117) (as modified) is provided in **Attachment 1**.

Mining Leases

Longwalls 401 - 408 are located within ML 1605 and ML 1628 (**Figure 3**). Under the conditions of these mining leases, MCO must not commence or undertake underground mining operations that may cause subsidence other than in accordance with an approved Extraction Plan. The approved Extraction Plan must provide for the effective management of risks associated with any subsidence resulting from mining operations.

The requirements of the conditions of the mining leases are summarised in **Attachment 1**, along with the relevant section of this Extraction Plan where the requirements are addressed.

Licences, Permits and Leases

In addition to the Stage 1 Project Approval (05_0117) (as modified), and the mining leases, all activities at or in association with the Moolarben Coal Complex will be undertaken in accordance with the following licenses, permits and leases:

- The *Moolarben Coal Operations Mining Operations Plan (January 2020 – December 2022)* (MOP¹) approved by the Resource Regulator (RR) as amended from time to time.
- The conditions of Commonwealth Approvals (EPBC 2007/3297, EPBC 2013/6926, EPBC 2008/4444 and EPBC 2017/7974).
- The conditions of Environment Protection Licence (EPL) No. 12932 issued by the NSW Environment Protection Authority (EPA) under the *NSW Protection of the Environment Operation Act, 1997*. Revision of the EPL may be required prior to the commencement of MCO activities that differ from those currently licensed.
- Water Access Licenses issued by the NSW Department of Planning and Environment – Water (DPE-Water) under the *NSW Water Management Act, 2000*.
- Mining and occupational health and safety related approvals granted by the Resources Regulator and SafeWork NSW.

¹ New rehabilitation conditions will replace existing rehabilitation and environmental management conditions on current mining leases in NSW. The main change is to replace the existing MOP with a targeted rehabilitation management plan (RMP) for large mines. The new conditions have been introduced through amendments to the *Mining Regulation 2016* and commenced on the 2 July 2021 with a 12 month implementation period.

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Table 1: Extraction Plan Requirements

Project Approval (05_0117) Condition	Extraction Plan Reference
<p>Condition 77, Schedule 3</p> <p>77. 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:</p> <p>(a) be prepared by suitably qualified and experienced persons whose appointment has been endorsed by the Secretary;</p> <p>(b) be approved by the Secretary before the Proponent carries out any of the second workings covered by the plan;</p> <p>(c) include detailed plans of existing and proposed first and second workings and any associated surface development;</p> <p>(d) include detailed performance indicators for each of the performance measures in Tables 14 and 15;</p> <p>(e) provide revised predictions of the potential subsidence effects, subsidence impacts and environmental consequences of the proposed second workings, incorporating any relevant information obtained since this approval;</p> <p>(f) describe the measures that would be implemented to ensure compliance with the performance measures in Tables 14 and 15, and manage or remediate any impacts and/or environmental consequences;</p> <p>(g) include a Built Features Management Plan, which has been prepared in consultation with Resources Regulator and the owners of affected public infrastructure, to manage the potential subsidence impacts and/or environmental consequences of the proposed second workings, and which:</p> <ul style="list-style-type: none"> • addresses in appropriate detail all items of key public infrastructure and other public infrastructure and all classes of other built features; • has been prepared following appropriate consultation with the owner/s of potentially affected feature/s; • recommends appropriate remedial measures and includes commitments to mitigate, repair, replace or compensate all predicted impacts on potentially affected built features in a timely manner; and • in the case of all key public infrastructure, and other public infrastructure except roads, trails and associated structures, reports external auditing for compliance with ISO 31000 (or alternative standard agreed with the infrastructure owner) and provides for annual auditing of compliance and effectiveness during extraction of longwalls which may impact the infrastructure; <p>(h) include a Water Management Plan, which has been prepared in consultation with EPA and DPIE Water, which provides for the management of the potential impacts and/or environmental consequences of the proposed second workings on watercourses and aquifers, including:</p> <ul style="list-style-type: none"> • surface and groundwater impact assessment criteria, including trigger levels for investigating any potentially adverse impacts on water resources or water quality; • a program to monitor and report stream flows, assess any changes resulting from subsidence impacts and remediate and improve stream stability; • a program to monitor and report groundwater inflows to underground workings; • a program to predict, manage and monitor impacts on groundwater bores on privately-owned land; <p>(i) include a Biodiversity Management Plan, which has been prepared in consultation with BCD, which provides for the management of the potential impacts and/or environmental consequences of the proposed second workings on aquatic and terrestrial flora and fauna, with a specific focus on threatened species, populations and their habitats; endangered ecological communities; and water dependent ecosystems;</p>	<p>This Document</p> <p>Section 1.3 and Attachment 2</p> <p>Section 1.3</p> <p>Section 1.5 and Appendix G</p> <p>Section 3 and Appendices A to G</p> <p>Section 2.1 and Technical Reports 1 to 5</p> <p>Section 3 and Appendices A to G</p> <p>Appendix E</p> <p>Appendix A</p> <p>Appendix C</p>

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Table 1 (Continued): Extraction Plan Requirements

Project Approval (05_0117) Condition	Extraction Plan Reference
<p>(j) include a Land Management Plan, which has been prepared in consultation with any affected public authorities, to manage the potential impacts and/or environmental consequences of the proposed second workings on land in general;</p> <p>(k) include a Heritage Management Plan, which has been prepared in consultation with BCD and relevant stakeholders for both Aboriginal and historic heritage, to manage the potential environmental consequences of the proposed second workings on both Aboriginal and non-Aboriginal heritage items, and reflects all requirements under conditions 41-46 of Schedule 3;</p> <p>(l) include a Public Safety Management Plan, which has been prepared in consultation with Resource Regulator, to ensure public safety in the mining area;</p> <p>(m) include a Subsidence Monitoring Program, which has been prepared in consultation with Resource Regulator, to:</p> <ul style="list-style-type: none"> • 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. <p>(n) include a contingency plan that expressly provides for adaptive management where monitoring indicates that there has been an exceedance of any performance measure in Tables 18 and 19, or where any such exceedance appears likely;</p> <p>(o) proposes appropriate revisions to the Rehabilitation Management Plan required under condition 56 of Schedule 3; and</p> <p>(p) include a program to collect sufficient baseline data for future Extraction Plans.</p> <p>Note: To identify the longwall mining domains referred to in this condition, see Appendix 2.</p>	<p>Appendix B</p> <p>Appendix D</p> <p>Appendix F</p> <p>Appendix G</p> <p>Section 4.1 and Appendices A to F</p> <p>Section 3.3</p> <p>Attachment 3 and Appendices A to F</p>
<p>Condition 78A, Schedule 3</p> <p>Prior to the commencement of second workings in longwall LW12, the Proponent shall:</p> <p>(a) prepare a report:</p> <p>i. analysing the subsidence, surface water, and groundwater impacts of the cumulative progress of longwall mining for the project, including consideration of data collected from the previously mined panels up to and including commencement in longwall LW11;</p> <p>ii. updating the predicted impacts based on the available local data and current scientific understanding of these relevant fields (demonstrating compliance with the requirements of this approval);</p> <p>(b) commission suitably qualified subsidence and groundwater experts whose appointment has been approved by the Secretary to review the report, and if necessary recommend changes to the monitoring programs and/or mine plan for subsequent panels; and</p> <p>(c) submit a copy of the report and expert review to the Department, Resources Regulator, BCD and DPIE Water, including a response to any recommendations contained in the expert review; to the satisfaction of the Secretary.</p>	<p>Not applicable to this Extraction Plan LW401-408.</p>
<p>Condition 78, Schedule 3</p> <p>78. The Proponent shall ensure that the management plans required under conditions 77(g)-(l) above include:</p> <p>(a) an assessment of the potential environmental consequences of the Extraction Plan, incorporating any relevant information that has been obtained since this approval; and</p> <p>(b) a detailed description of the measures that would be implemented to remediate predicted impacts.</p>	<p>Appendices A to F</p>

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1.4 STRUCTURE OF THE EXTRACTION PLAN

This Extraction Plan comprises a main text component (this document) and supporting management plans, monitoring programs and studies, which include **Appendices A through H** and **Technical Reports 1 through 7**. An overview of the main text sections of the Extraction Plan is presented below:

Section 1 Provides an introduction to the Extraction Plan, including the purpose and scope of the Extraction Plan and a summary of the mine plan and design, subsidence predictions, subsidence impact performance measures and subsidence management approach.

Section 2 Describes the process of development of the Extraction Plan, including: the process of reviewing and updating the predictions of subsidence effects; subsidence impacts and environmental consequences; the risk assessment process for identifying key subsidence management issues; and consultation undertaken by the mine with affected agencies and other key stakeholders.

Section 3 Describes the measures that will be implemented to mitigate, manage, remediate and monitor potential subsidence impacts and environmental consequences on natural and built features.

Section 4 Addresses key elements of how the plan is going to be implemented, including an adaptive management approach, reporting, regular review and key responsibilities.

Section 5 Lists the documents referred to in Sections 1 to 4 of this Extraction Plan.

Attachment 1 Outlines the relevant requirements under the Stage 1 Project Approval (05_0117), the Guidelines for preparation of an extraction plan, applicable mining leases, and provides the relevant section of this Extraction Plan where these requirements are addressed.

Attachment 2 Provides evidence of MCO's consultation process for the Extraction Plan.

Attachment 3 Provides details of a program to collect sufficient baseline data for future Extraction Plans.

Attachment 4 Provides a consolidated list of key stakeholder contact information.

Appendices A to G contain key component management and monitoring plans of the Extraction Plan:

Appendix A UG4 Longwalls 401 to 408 Water Management Plan (LW401-408 WMP)

Appendix B UG4 Longwalls 401 to 408 Land Management Plan (LW401-408 LMP)

Appendix C UG4 Longwalls 401 to 408 Biodiversity Management Plan (LW401-408 BMP)

Appendix D UG4 Longwalls 401 to 408 Heritage Management (LW401-408 HMP)

Appendix E UG4 Longwalls 401 to 408 Built Features Management Plans (LW401-408 BFMPs)

Appendix F UG4 Longwalls 401 to 408 Public Safety Management Plan (LW401-408 PSMP)

Appendix G UG4 Longwalls 401 to 408 Subsidence Monitoring Program (LW401-408 SMP) (including Plans 1 to 7)

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Appendix H UG4 Longwalls 401 to 408 S1MC280 Subsidence Monitoring and Mitigation Program

This Extraction Plan is informed by a series of technical reports, prepared by the endorsed suitably qualified specialists, which contain a review of predictions of subsidence effects, subsidence impacts and environmental consequences. The technical reports are contained in **Technical Reports 1 to 5**:

- Technical Report 1** Subsidence Report
- Technical Report 2** Groundwater Technical Report
- Technical Report 3** Surface Water Technical Report
- Technical Report 4** Biodiversity Technical Report
- Technical Report 5** Aboriginal Cultural Heritage Technical Report

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1.5 MINE PLANNING AND DESIGN

1.5.1 Geology and Stratigraphy

The Moolarben Coal Complex is located in the northern part of the Western Coalfield, on the north-west margin of the Sydney Basin. Coal occurs in mid to late Permian age (approximately 250 to 275 million years before present) sediments collectively known as the Illawarra Coal Measures (also referred to as Permian coal measures). These units dip between 1 and 2 degrees (°) to the north-east.

The Moolarben UG4 Underground Mine will extract coal from the Ulan Seam, targeting the low ash D working section (DWS) ply (**Figure 5**). The Ulan Seam occurs toward the base of the Illawarra Coal Measures and the Moolarben Seam is approximately 40 metres (m) above the Ulan Seam. The Ulan Seam is considered the equivalent of the Lidsdale Seam, which has been extensively mined further south in the Greater Lithgow District.

The surface geology of most of the areas over UG4 is predominantly units from the Narrabeen Group Sandstones and Conglomerates. These units overlie areas from the Illawarra Coal Measures. A small area of Alluvials is located at the southern end of Longwall 401. A typical stratigraphic section for the area is shown in **Figure 5**. The major geological units in the UG4 Study Area are, from the youngest to oldest:-

- Tertiary aged palaeochannel deposits;
- Triassic aged sandstones and conglomerates of the Narrabeen Group;
- Permian aged Illawarra Coal Measures, including the Ulan Seam; and
- Carboniferous aged Ulan Granite.

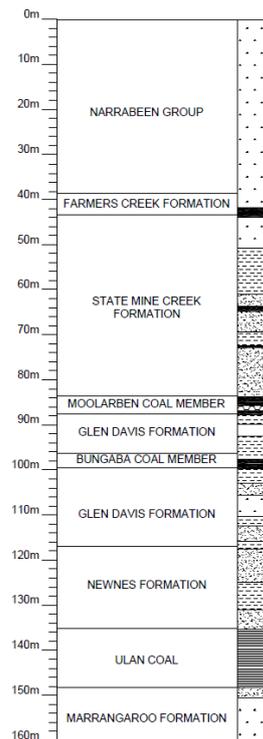
Tertiary alluvial palaeochannel deposits, with a maximum thickness of 40-50 m, have been identified to the south of the proposed UG4 longwalls. The infill sediments consist of poorly-sorted semi-consolidated quartzose sands and gravels in a clayey matrix.

The Triassic sandstone, known as Wollar Sandstone, is part of the Narrabeen Group and this sandstone unit is the main outcropping rock formation over the UG4 Study Area. Where present, the sandstones are between 14 metres and 70 metres thick and normally about 60 m, with both massive and strongly crossbedded units of individual thickness in the range of 1.5 metres to 3 metres.

The Ulan Seam ranges in thickness from around 6 to 13 m and comprises numerous coal plies separated by partings of tuffaceous claystone and carbonaceous shale. Where the Ulan Seam is fully developed, the upper working section (WS1) ranges in thickness from 5.0 to 7.5 m, and the lower working section (WS2) from 4.9 to 6.2 m. The DWS and overlying D top ply (DTP) are a subset of WS2 occurring in the lower half of the seam. This section is amenable to underground mining, having a recoverable thickness of up to 3.5 m (MSEC, 2021).

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Figure 5 Stratigraphic Column



1.5.2 Mining Geometry and Parameters

The Longwalls 401 - 408 Study Area² and mine plan is shown in **Figure 3** with key dimensions³ summarised in **Table 2**. Detailed mine layout drawings are provided in Plans 1 to 7 (**Appendix G**).

Table 2: Key Mining Parameters

Dimension	LW401	LW402	LW403	LW404	LW405	LW406	LW407	LW408
ROM Coal Extracted (Mt)	2.0	2.1	2.1	2.2	2.2	2.4	2.4	2.5
Gate Road Width (m)	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4
Gate Road Height (m)	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4
MG Chain Pillar Width (m)	34.6	34.6	34.6	34.6	34.6	34.6	34.6	19.6
TG Chain Pillar Width (m)	19.6	34.6	34.6	34.6	34.6	34.6	34.6	34.6
Longwall Void Width (m)	260.8	260.8	260.8	260.8	260.8	260.8	260.8	260.8
Longwall Void Length (m)	1859.5	1920.9	1995.9	2066.0	2017.7	2199.7	2274.8	2351.6
Extraction Height (m)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Depth of Cover (m)	85 - 165	110 - 170	115 - 200	110 - 205	95 - 180	85 - 175	80 - 170	100 - 170

Notes: ROM = Run-of mine, Mt = million tonnes, MG = maingate, TG = tailgate.

² Longwalls 401-408 and the area of land within the furthest extent of the 26.5° angle of draw and 20 millimetres (mm) predicted subsidence contour.

³ Key dimensions for Longwalls LW401 to 408 are based on the revised and approved first workings in **Section 1.6**.

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1.5.3 Mining Method

Access to the UG4 Longwalls 401 - 408 is from the OC1 highwall. UG4 North Mains head in a northern direction in the Ulan Seam initially within Mining Lease (ML) ML 1715 and continue in a northerly direction into ML1605 within the Ulan Seam (**Figure 3**). The extraction of Longwalls 401 - 408 will occur from the south to north within ML1605 and ML1628. Longwalls 401 - 408 will be extracted using retreating longwall mining methods for secondary extraction of panels approximately 260 m wide (void width) and retreat from the east to west.

The longwall panels will be formed by driving two sets of gate roads (the tailgate and maingate roads). Each gate road requires two roadways (headings) to be driven parallel to each other. The two roadways will be used for ventilation purposes, with one of the roadways used as a transport road and the other roadway used to convey the coal that will be mined back to the main conveyors. Construction of development main headings, maingates and tailgates will be undertaken using continuous miners.

The dimensions of the headings will be approximately 5.4 m wide and 3.4 m in height. The headings will be 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. The longwall layout includes approximately 260 m panel widths (void) with 35 m width pillars (solid). The maingate roads and tailgate roads will then be linked together by driving an installation road and bleeder road at the top end of the longwall panels. ROM coal will be conveyed by the maingate conveyor to the main conveyor which will carry coal to the surface of the mine.

1.5.4 Mine Schedule

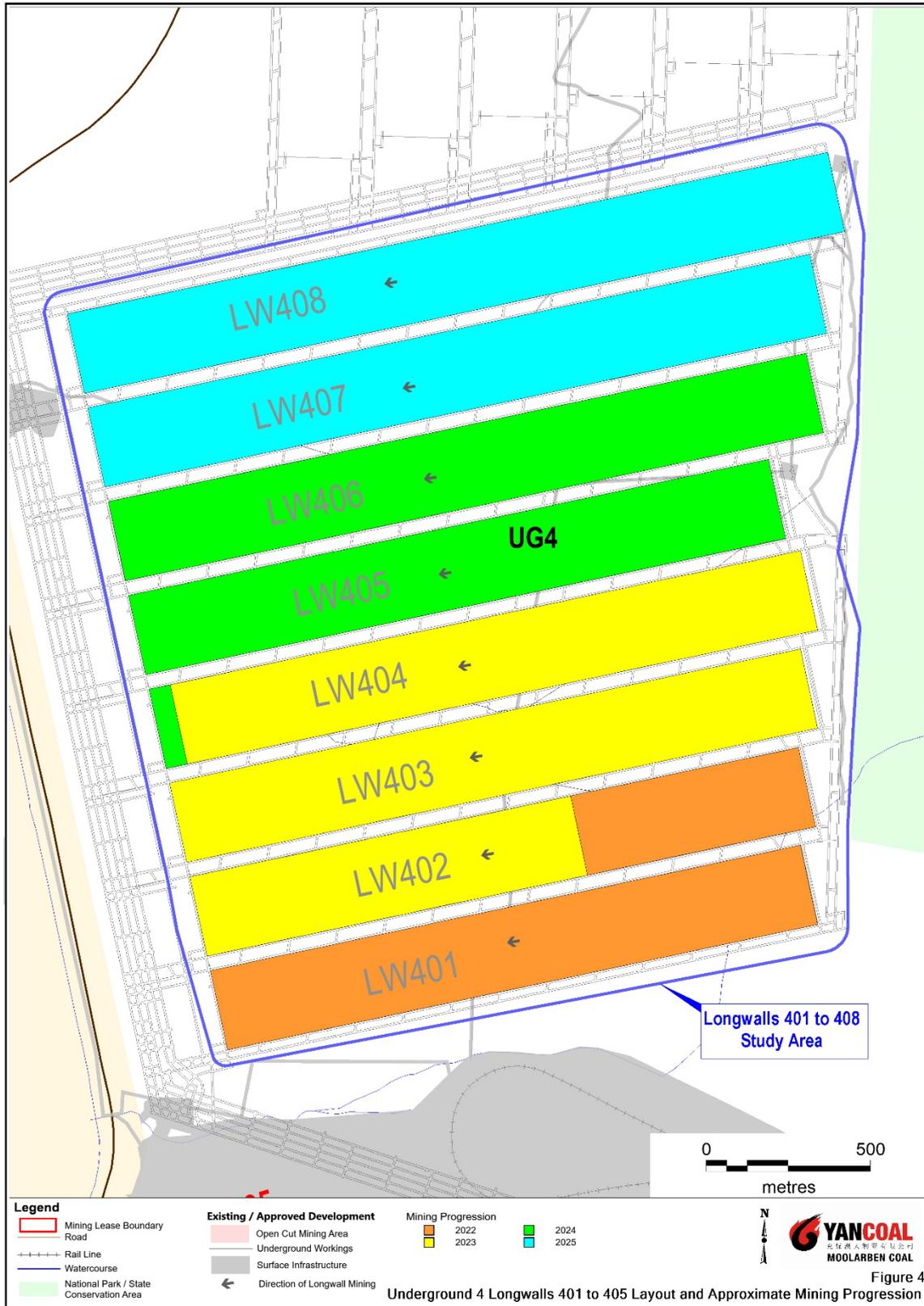
The Moolarben Coal Complex is approved to operate seven days a week, 24 hours a day. The provisional extraction schedule for Longwalls 401 - 408 is provided in **Table 3** and **Figure 4**.

Table 3: Provisional Extraction Schedule

Longwall	Estimated Start Date	Estimated Duration (months)	Estimated Completion Date
Longwall 401	June 2022	4	October 2022
Longwall 402	November 2022	4	March 2023
Longwall 403	April 2023	4	August 2023
Longwall 404	August 2023	5	January 2024
Longwall 405	February 2024	4	June 2024
Longwall 406	July 2024	5	December 2024
Longwall 407	January 2025	4	May 2025
Longwall 408	June 2025	4	November 2025

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Figure 6 Underground 4 Longwalls 401 to 408 Layout and Approximate Mining Progression



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1.5.5 Previous and Future Mining

The Moolarben Mine Complex includes four approved open cut mines, (known as Open Cut 1 mine (OC1), Open Cut 2 mine (OC2), Open Cut 3 mine (OC3) and Open Cut 4 mine (OC4)), and three approved underground mines, (known as Underground Area 1 (UG1), Underground Area 2 (UG2) and Underground Area 4 (UG4)) and the associated infrastructure (**Figure 2**).

Previous MCO open cut workings to the south of Longwalls 401 - 408 include OC1, OC2, OC3 and OC4. The nearest open cut operations to UG4 is OC1 located approximately 1km to the south of Longwall LW401. UG1 is approximately 1.2km to the south of Longwall 401 at its nearest point (**Figure 2**). Underground mining activities in UG2 have not commenced to date.

Previous and future workings in the vicinity of Longwalls 401 - 408 are shown on **Figure 2** and in Plans 1, 3 and 7 (**Appendix G**).

Currently there are no plans for mining other coal seams at the UG4 Underground Mine.

1.6 SUBSIDENCE PREDICTIONS

The predicted subsidence effects, subsidence impacts and environmental consequences of the Moolarben Coal Complex UG4 Underground Mine were originally assessed, and subsequently approved, in the *Moolarben Coal Project Environmental Assessment Report* (September 2006) (2006 EA).

As required by Condition 77(e), Schedule 3 of Project Approval (05_0117), when preparing an Extraction Plan, MCO must revise predictions of the potential subsidence effects, subsidence impacts and environmental consequences of the proposed second workings, incorporating any relevant information obtained since approval.

The predicted subsidence effects, impacts and environmental consequences in the 2006 EA for UG4 (the Approved Layout) were based on the original first workings with a greater extraction cut height.

In accordance with Condition 29, Schedule 3 of PA05_0117, MCO sought approval for the first workings of UG4 in May 2019. On the 8 July 2019 the RR approved the first workings for UG4 (**Attachment 2**) as displayed in **Figure 3** (the Extraction Plan Layout).

The original extraction cut height in the Approved Layout proposed a height of 4.2m. The revised predictions for this Extraction Plan, consider a reduced longwall extraction height of 3.0m.

Mine Subsidence Engineering Consultants (MSEC) were engaged by MCO to prepare a revised subsidence report to support the Extraction Plan for Longwalls 401 to 408 in June 2021. The predictions and impact assessments provided in this Extraction Plan are based on the Extraction Plan Layout (**Figure 3**) and the reduced extraction cut height of 3.0m, as presented in the *Subsidence Predictions and Impact Assessment for Longwalls 401 to 408* (MSEC, 2021) (**Technical Report 1**).

A summary of the main revised subsidence parameters for the Extraction Plan Layout predicted by MSEC is provided below in **Sections 1.6.1 to 1.6.4**. A summary of the revised subsidence impacts on natural features and non-MCO built features within and outside of the Study Area is provided in **Section 2.1**.

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1.6.1 Predicted Conventional Subsidence Movements

The maximum predicted conventional subsidence parameters resulting from the extraction of Longwalls 401 to 408 were determined using the calibrated Incremental Profile Method. The predicted subsidence contours are irregular due to the shallow depths of cover.

The maximum predicted tilts and curvatures are very localised and therefore do not necessarily represent the overall (i.e. macro) ground movements. The magnitudes of the localised tilts greater than 100 millimetres per metre (mm/m) and the localised curvatures greater than 3.0 km⁻¹ (1/kilometres) become less meaningful and, therefore, the specific values have not been presented. Revised standards for reporting adopted by MSEC may result in slight differences in reported values compared with previous reports (MSEC, 2021).

The maximum predicted values of incremental conventional subsidence, tilt and curvature, due to the extraction of each of the longwalls, is summarised in **Table 4** and remains unchanged for the Extraction Plan Layout.

Table 4: Maximum Predicted Incremental Conventional Subsidence, Tilt and Curvature Resulting from the Extraction of Each of Longwalls 401 to 408

Longwall	Subsidence ¹ (mm)	Tilt ² (mm/m)	Hogging Curvature ³ (km ⁻¹)	Sagging Curvature ³ (km ⁻¹)
Longwall 401	1800	60	>3.0	>3.0
Longwall 402	1800	40	1.9	1.3
Longwall 403	1800	35	1.5	1.2
Longwall 404	1800	40	1.7	1.4
Longwall 405	1800	45	2.4	2.1
Longwall 406	1800	60	>3.0	>3.0
Longwall 407	1800	60	>3.0	>3.0
Longwall 408	1800	45	2.6	1.6

Source: MSEC (2021).

¹ Subsidence refers to vertical displacements of the ground.

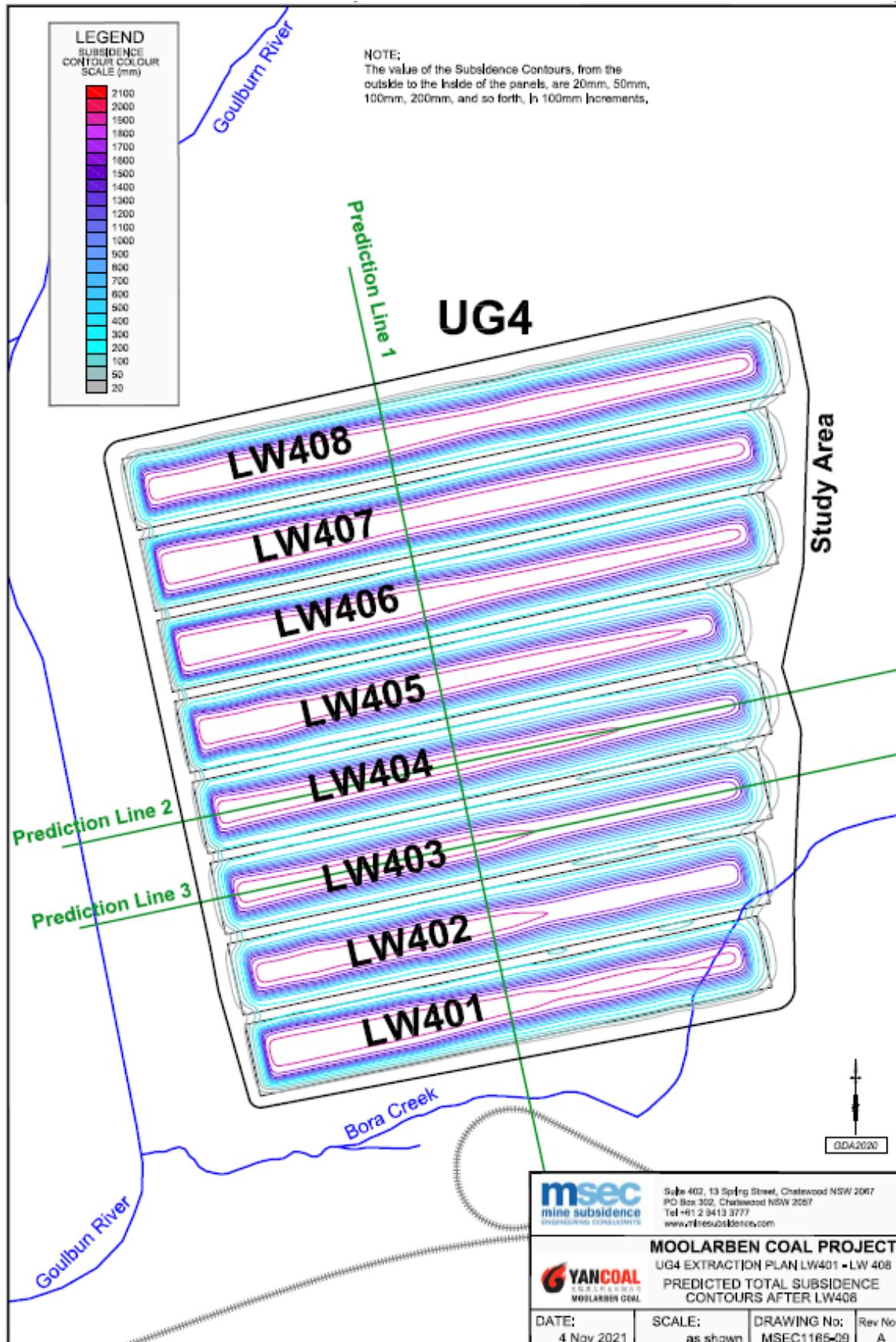
² Tilt is the change in the slope of the ground as a result of differential subsidence, and is calculated as the change in subsidence between two points divided by the distance between those two points.

³ Curvature is the second derivative of subsidence, the rate of change of tilt, and is calculated as the change in tilt between two adjacent sections of the tilt profile divided by the average length of those sections.

The maximum predicted values of total conventional subsidence, tilt and curvature, after the extraction of each of the longwalls, is summarised in **Table 5**. The predicted tilts provided in this table are the maxima after the completion of each of the longwalls. The predicted curvatures are the maxima at any time during or after the extraction of each of the longwalls. **Figure 7** provides incremental subsidence contours for Longwalls 401 - 408.

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Figure 7: Predicted Subsidence after Longwalls LW401 - 408



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Table 5: Maximum Predicted Total Conventional Subsidence, Tilt and Curvature after the Extraction of Each of Longwalls 401 to 408

Longwall	Subsidence (mm)	Tilt (mm/m)	Hogging Curvature (km ⁻¹)	Sagging Curvature (km ⁻¹)
Longwall 401	1800	60	>3.0	>3.0
Longwall 402	1900	60	>3.0	>3.0
Longwall 403	1900	60	>3.0	>3.0
Longwall 404	1900	60	>3.0	>3.0
Longwall 405	1900	60	>3.0	>3.0
Longwall 406	1900	60	>3.0	>3.0
Longwall 407	1900	60	>3.0	>3.0
Longwall 408	1900	60	>3.0	>3.0

Source: MSEC (2021)

The maximum predicted subsidence parameters and the predicted subsidence contours provided in this report describe and show the conventional movements and do not include the valley related upsidence and closure movements, nor the effects of faults and other geological structures.

1.6.2 Non-Conventional Ground Movements

MSEC considers it likely that non-conventional ground movements will occur due to near surface geological conditions, steep topography and valley related movements, which are often accompanied by elevated tilts and curvatures. In most cases, it is not possible to predict the exact locations or magnitudes of the non-conventional anomalous movements due to near surface geological conditions. For this reason, the strain predictions provided are based on a statistical analysis of measured strains, including both conventional and non-conventional anomalous strains. In addition to this, the impact assessments for the natural and built features, include historical impacts resulting from previous longwall mining which have occurred as a result of both conventional and non-conventional subsidence movements (MSEC, 2021).

1.6.3 Predicted Far-Field Movements

In addition to the conventional subsidence movements that have been predicted above and adjacent to Longwalls 401 to 408, it is also likely that far-field horizontal movements will be experienced during the extraction of the longwalls. Monitoring lines located at surface features to the north east of UG1 have been surveyed since the commencement of Longwall 101. The majority of the observed far-field horizontal movements for UG1 at the MCC are less than 25 mm, the maximum observed far-field horizontal movement is 40 mm. The impacts of far-field horizontal movements on the natural features and items of surface infrastructure within the vicinity of the Extraction Plan Layout are expected to be insignificant, except where they occur at large structures, such as railway lines and roads, which may be sensitive to small differential movements and may require monitoring and maintenance to remain in a safe and serviceable condition (MSEC, 2021).

The surface and built features which may be sensitive to such movements have been identified by MSEC (**Figure 10**) and include:

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- ARTC’s Sandy Hollow – Gulgong Railway Line;
- Electrical Infrastructure (Essential Energy 22kV powerline, UCMPL powerline and Tilt Renewables⁴ powerline);
- Telstra’s telecommunications tower, optical fibre and copper cables;
- MWRC roads and associated road culverts;
- Ulan Coal Mines Pty Limited (UCMPL) infrastructure;
- Dronvisa Quarry; and

The individual LW401-408 BFMPs (**Appendix E**) have been developed to manage the potential impacts of far-field movements on the relevant infrastructure as identified by MSEC.

Influence of the Palaeochannel south of UG4 on Horizontal Far-field Movements

There are tertiary palaeochannel deposits, with a maximum thickness of 50-60 m, located to the south of Longwall 401, where the depths of cover range from 90 to 120 m (**Figure 10**). These palaeochannels are remnants of inactive river or stream channels that have been later filled in or buried by younger sediment that can be stronger or weaker than the original strata. Palaeochannels have caused significant differences between the predicted and the observed levels of subsidence at other collieries. Where the original strata were eroded away to form a river channel and then the channel was filled in with stronger materials that formed massive conglomerate channels, then, the observed subsidence near these channels was found to be less than was expected because these channels were capable of spanning over voids (MSEC, 2021).

At MCO the palaeochannel sediments to the south of the proposed UG4 longwalls were formed when Permian strata layers were replaced with infill sediments consisting of poorly-sorted semi-consolidated quartzose sands and gravels in a clayey matrix, i.e. unconsolidated sediments, unsaturated alluvium and low permeability clays. The presence of these palaeochannel materials can modify the subsidence ground movements beyond the end of the longwalls (depending on the depth of the channel, and its location with respect to the panel edges). The presence of the palaeochannel sediments should result in less subsidence within these alluvial and unconsolidated sediment areas and reduced far-field movements within and beyond these channels (MSEC, 2021).

1.7 SUBSIDENCE IMPACT PERFORMANCE MEASURES

Project Approval (05-0117) (as modified) requires MCO to ensure the project does not cause any exceedances of the subsidence impact performance measures for Natural and Heritage Features outlined in Table 14, Condition 73, Schedule 3 and Built Features as outlined Table 15, Condition 75, Schedule 3. The subsidence impact performance measures are detailed in **Table 6** and **Table 7**.

Not all of the natural, heritage and built features listed in **Table 6** and **Table 7** are relevant to Longwalls 401 - 408. **Table 6** and **Table 7** provides a description of the features relevant to the subsidence impact performance measures for the Project Approval (05-0117).

⁴ Tilt Renewable powerline is subject to construction timing and will be assessed once these details are available to MCO. This Extraction Plan will be reviewed and updated in consultation with Tilt Renewables if construction of the proposed power line along Ulan Road commences during the extraction of UG4 Longwalls LW104-408. Subsidence predictions and impact assessment for the proposed Tilt Renewables infrastructure has been provided to Tilt Renewables (**Section 2.3.2**).

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Table 6: Subsidence Impact Performance Measures – Natural and Heritage Features

Subsidence Impact Performance Measure		Relevance to UG4 Longwalls 401 to 408 Extraction Plan
Special Feature		
<i>The Drip and Goulburn River Gorge</i>	<i>Nil impact or environmental consequences</i>	The Drip and Goulburn River Gorge are located 2.7km and 2.2km respectively from Longwall 408 and impacts to these features are considered unlikely to occur.
Water Resources		
<i>Goulburn River and the bed of the Goulburn River</i>	<i>Negligible impact or environmental consequences. Remain outside the zone of recorded subsidence damage for longwall mining.</i>	The Goulburn River is located over 425 m to 500m to the west of Longwalls 401 to 408 and may experience far-field horizontal movements.
Land		
<i>Cliff Line 3</i>	<i>Minimise subsidence damage</i>	Cliff CL3 is located over 165 m to the north of Longwall 408 and may experience far-field horizontal movements.
Heritage Sites		
<i>Aboriginal heritage sites 264, 282, 283, 286 and 287</i>	<i>Reduce the likelihood of subsidence damage to low.</i>	Aboriginal heritage sites 264, 282, 283, 286 and 287 are located to the north of the Study Area and are unlikely to experience impacts due to the extraction of Longwalls 401 to 408.
<i>Aboriginal Heritage Site 280</i>	<i>Reduce the likelihood of subsidence damage to moderate.</i>	Site 280 is located centrally above the chain pillar between Longwalls 402 and 403. Large scale failure of the rock shelter is not expected to occur and the likelihood of tensile cracks coinciding with the location of the grinding grooves is considered to be low.
<i>Historic heritage sites</i>	<i>No greater subsidence impact or environmental consequences than predicted in the EA</i>	There are no historic heritage sites within the Study Area or within the vicinity of the Study Area.
Mine workings		
<i>First workings under an approved Extraction Plan beneath any feature where performance measures in this table require negligible subsidence impacts or negligible environmental consequences</i>	<i>To remain long-term stable and non-subsiding</i>	First workings have been designed to meet the requirements of Condition 79, Schedule 3 of Project Approval (05_0117). RR confirmed their satisfaction of first workings for UG4 on 8 July 2019.
<i>Second workings</i>	<i>To be carried out only within the longwall mining domains, in accordance with an approved Extraction Plan</i>	Second workings will be carried out in accordance with an approved Extraction Plan (this Extraction Plan).

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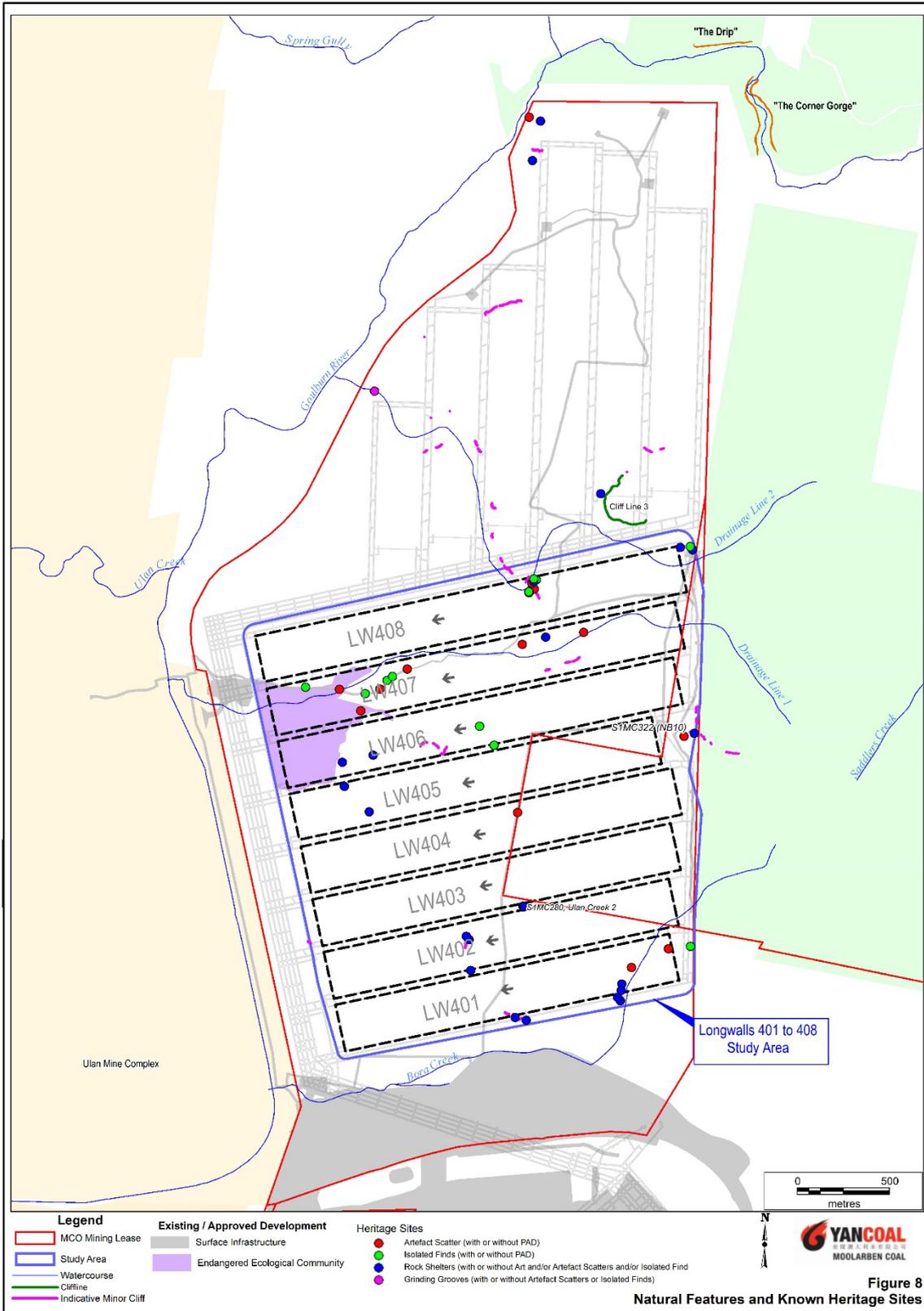
Table 7: Subsidence Impact Performance Measures – Built Features

Subsidence Impact Performance Measure		Relevance to UG4 Longwalls 401 to 408 Extraction Plan
Key Public Infrastructure:		
<i>Gulgong-Sandy Hollow Railway Line</i>	<i>Always safe and serviceable</i>	The Sandy Hollow – Gulgong Railway Line is located more than 660 m from the Extraction Plan Layout. The railway line is not expected to experience measurable conventional vertical subsidence, tilt, curvature or conventional strain; however, the railway line may experience far-field horizontal movements.
<i>Wollar-Wellington 330kV Transmission Line</i>	<i>Damage that does not affect safety or serviceability must be fully repairable, and must be fully repaired.</i>	At distances of 725 m or more between the longwalls and the transmission line, the towers will not be subjected to measurable conventional mine subsidence ground movements (i.e. less than limits of survey accuracy). The towers may experience minor far-field horizontal movements however, the movements are expected to be less than the limits of survey accuracy.
Other Infrastructure:		
<i>Roads</i>	<i>Safe, serviceable and repairable unless the owner agrees otherwise in writing.</i>	Ulan Road, Ulan Road Bridge over the Sandy Hollow Rail line and the bridge over the Goulburn River to UCMPL will not be subjected to measurable tilts, curvatures or strains; however, the road and bridges may experience far-field horizontal movements. The bridge over the Goulburn River is unlikely to experience subsidence related movements.
<i>Other built features and improvements, including fences</i>	<i>Serviceability should be maintained wherever practicable. Loss of serviceability must be fully compensated.</i> <i>Damage must be fully repairable, and must be fully repaired or else replaced or fully compensated.</i>	The 22kv powerline, telecommunications tower and telecommunications cables will not be subjected to measurable conventional mine subsidence ground movements (i.e. less than limits of survey accuracy); however, the tower and cables may experience far-field horizontal movements. The potential impacts for the current and future areas of the Dronvisa Quarry located above the longwalls will experience the full range of predicted conventional subsidence movements. The Millers Dam Compound and water pipelines are located outside the Study Area boundary and are not expected to be subjected to measurable conventional vertical subsidence, tilt, curvature or strain. However, the surface features may experience far-field horizontal movements.
Public Safety		
<i>Public safety</i>	<i>Negligible additional risk</i>	Public safety is considered in the LW401-408 PSMP.

Natural, heritage and built features relevant to this Extraction Plan are illustrated on **Figures 8 to 10**.

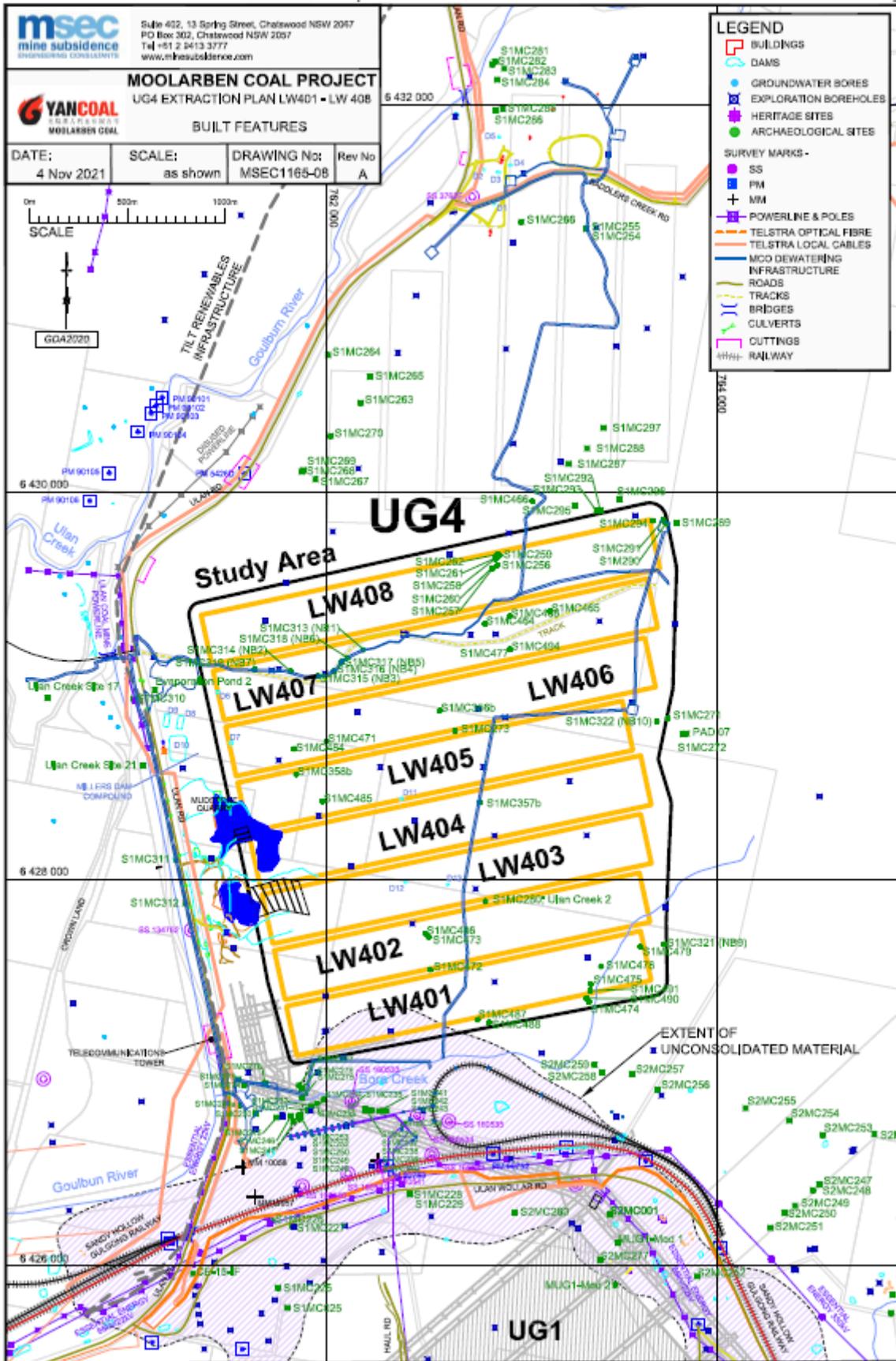
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Figure 8: Natural Features and Heritage Sites within the Study Area



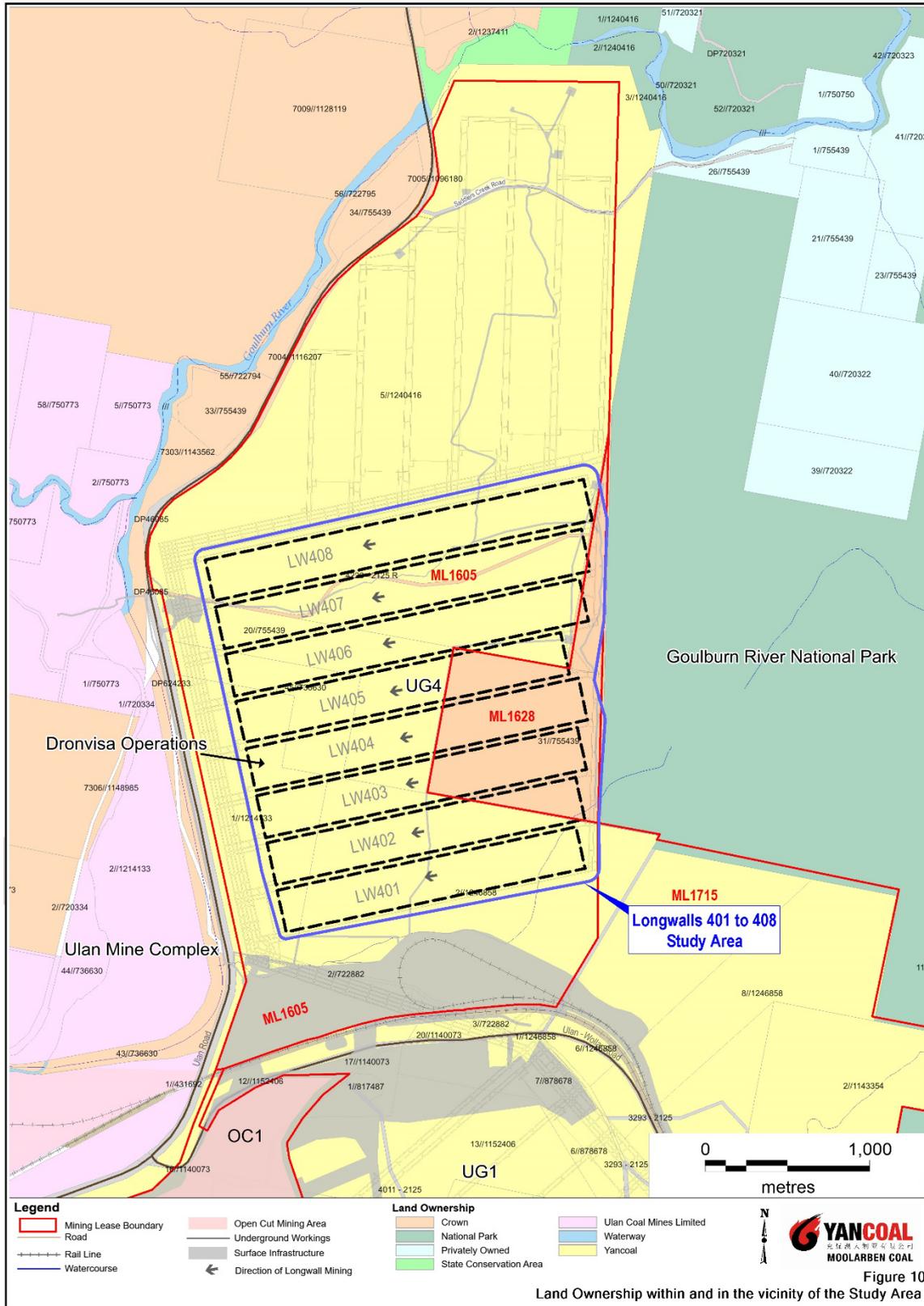
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Figure 9: Built Features within and in the vicinity of the Study Area



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Figure 10 Land Ownership within and in the vicinity of the Study Area



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1.8 SUBSIDENCE MANAGEMENT APPROACH

Potential environmental consequences during the mining of Longwalls 401 - 408 will be managed in accordance with the relevant requirements of Project Approval (05_0117) and other approvals, through:

- **Mine Design** – the layout of Longwalls 401 - 408 has been developed to meet the subsidence impact performance measures (**Section 1.5**).
- **Subsidence Monitoring** – visual and survey monitoring and reporting will be conducted to confirm predictions of subsidence effects and potential subsidence impacts and environmental consequences (**Section 3.0**).
- **Management Measures and Remediation** – implementation of management measures and/or remediation, as required, to address subsidence impacts and/or environmental consequences (in consideration of the potential impacts of the unmitigated impact [including the potential for self-healing or long-term degradation] and the potential impacts of the remediation) (**Sections 3.1 to 3.4**).
- **Contingency Plans** – implementation of Contingency Plans in the event an exceedance of a subsidence impact performance measure or if an unexpected impact is detected (**Section 4.1**), including consideration of identified potential contingency measures (**Sections 3.1 & 3.2**).
- **Adaptive Management** – adaptive management will be implemented where appropriate by reviewing and evaluating the effectiveness of management strategies, and adjusting management strategies to improve performance, particularly following an exceedance of a subsidence impact performance measure or if an unexpected impact is detected (**Section 4.2**).

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2.0 DEVELOPMENT OF THE EXTRACTION PLAN

2.1 REVIEW OF PREDICTIONS

As required by Condition 77(e), Schedule 3 of Project Approval (05_0117), when preparing an Extraction Plan, MCO must revise predictions of the potential subsidence effects, subsidence impacts and environmental consequences of the proposed second workings, incorporating any relevant information obtained since approval.

MSEC have prepared a revised subsidence report to support the Extraction Plan for Longwalls 401 to 408. The predictions and impact assessments provided in this Extraction Plan are based on the Extraction Plan Layout (**Figure 3**) and the reduced extraction cut height of 3.0m in the *Subsidence Predictions and Impact Assessment for Longwalls 401 to 408* (MSEC, 2021) (**Technical Report 1**).

A summary of the main revised subsidence parameters predicted by MSEC is provided in **Sections 1.6.1** to **1.6.3**. A summary of the revised impacts on natural features, privately owned built features and MCO owned built features within and in the vicinity of the Study Area is provided in **Section 2.1**.

The previously assessed and approved subsidence impacts and environmental consequences have been reviewed for the Extraction Plan Layout by MSEC (2021), AGE (2021), WRM (2021), Niche (2021), (**Technical Reports 1** to **5**). This section describes the process of reviewing and updating these subsidence impact predictions.

2.1.1 Predicted Subsidence Effects and Subsidence Impacts

A subsidence assessment review for Longwalls 401 - 408 has been prepared in support of this Extraction Plan by MSEC (**Technical Report 1**) with the outcomes of this assessment incorporated into the management plans in **Appendices A** to **F** as required.

Review of Subsidence Prediction Methodology

The predicted conventional subsidence parameters for Longwalls 401 - 408 were determined by MSEC using the Incremental Profile Method. The method is an empirical model based on a large database of observed monitoring data from previous mining within the Southern, Newcastle, Hunter and Western Coalfields of NSW and from mining in the Bowen Basin in Queensland.

The database consists of the observed incremental subsidence profiles, which are the additional subsidence profiles resulting from the extraction of each longwall within a series of longwalls. It can be seen from the normalised incremental subsidence profiles within the database, that the observed shapes and magnitudes are reasonably consistent where the mining geometry and local geology are similar.

Subsidence predictions made using the Incremental Profile Method use the database of observed incremental subsidence profiles, the longwall geometries, local surface and seam information and geology. The method has a tendency to over-predict the conventional subsidence parameters (i.e. is slightly conservative) where the mining geometry and geology are within the range of the empirical database. The predictions can be further tailored to local conditions where observed monitoring data is available close to the mining area.

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Comparison with Previous Predictions of Subsidence Effects

As discussed MSEC have prepared a revised subsidence report to support the Extraction Plan for Longwalls 401 to 408. A comparison of the maximum predicted subsidence parameters resulting from the extraction of Longwalls 401 to 408 (based on the Extraction Plan Layout), with those based on the Approved Layout is provided in **Table 8**. The values are the maxima anywhere above the longwall layouts.

Table 8: Comparison of Maximum Predicted Conventional Subsidence Parameters based on the Approved Layout and the Extraction Plan Layout

Layout	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Conventional Tilt (mm/m)	Maximum Predicted Total Conventional Hogging Curvature (km-1)	Maximum Predicted Total Conventional Sagging Curvature (km-1)
2006 EA Approved Layout	1900	60	>3	>3
Extraction Plan Layout	1900	60	>3	>3

As displayed in **Table 8**, the maximum predicted total subsidence parameters based on the Approved Layout are the same as those for the Extraction Plan Layout for Longwalls 401 to 408. Whilst the specific values of the maximum curvatures are not shown, due to these representing the localised irregular movements rather than the macro (i.e. overall) movements, these parameters do not change (MSEC, 2021).

Predicted Subsidence Impacts

Longwall mining can result in surface cracking, heaving, buckling, humping and stepping at the surface. The extent and severity of these mining induced ground deformations are dependent on a number of factors, including the mine geometry, depth of cover, overburden geology, locations of natural joints in the bedrock, the presence of near surface geological structures and mining conditions (MSEC, 2021).

2.1.2 Potential Environmental Consequences

Detailed discussion of potential environmental consequences for Longwalls LW401 - 408 is provided in the key component management plans in **Appendices A to F**. The management of potential environmental consequences is provided in **Section 3**. A summary of potential environmental consequences on natural and built features is provided below.

The suitably qualified experts (endorsed by the Secretary of the DPE) conducted a review of the potential environmental consequences due to the extraction of Longwalls 401 - 408 for the preparation of each management plan.

The technical reviews concluded that there are no additional potential subsidence impacts or environmental consequences resulting from the extraction of Longwalls 401 - 408 compared to those assessed and approved for the Moolarben Coal Project Stage 1 Approval (05-0115).

Goulburn River

The Goulburn River is located on the western side of Longwalls 401 to 408 at distances of 425 m to 500 m from the longwall finishing ends (**Figure 8**). The distances to the Goulburn River represent about 5

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to 6 times the depth of cover from Longwalls 401 to 408. At these distances conventional mine subsidence ground movements and valley related movements are expected to be less than limits of survey accuracy. The predicted upper limit of observed horizontal movements at 5 times the depth of cover from the Extraction Plan Layout is 50 mm with the majority of the observed data less than typical limits of survey accuracy of 25 mm. It is unlikely that fracturing of the bed of the Goulburn River would occur due to the extraction of the Extraction Plan Layout (MSEC, 2021).

Further details on the Goulburn River is provided in **Section 3.1** and **Appendix A**.

The Drip (CL5) and Corner Gorge

The Drip and Corner Gorge are located on the Goulburn River. The Drip is the more prominent feature comprising a south facing cliff (also referred as CL5) with sheer to subvertical faces up to approximately 30 m high. The Drip and Corner Gorge are located over 2.7 km and 2.2 km respectively from Longwall 408 (**Figure 8**). At over 2.2 km from Longwall 408, The Drip and Corner Gorge will not experience measurable conventional tilts, curvatures or strains from the extraction of Longwalls 401 to 408. Measurable far-field horizontal movements are therefore not expected at The Drip and Corner Gorge. At distances of 2.2 km or more, impacts to The Drip and Corner Gorge due to the extraction of Longwalls 401 to 408 are considered to be unlikely to occur (MSEC, 2021).

Further details on The Drip and Corner Gorge is provided in **Section 3.1** and **Appendix B**.

Drainage Lines (DL1, DL2 and Bora Creek)

There are no perennial streams within the Study Area. The Goulburn River Diversion is the nearest major stream, located on the western side of the Study Area and is 425 m from the finishing end of Longwall 406 at its nearest point. The only named stream within the Study Area is Bora Creek, which is an ephemeral stream and is located above the commencing ends of Longwalls 401 and 402. A number of other small ephemeral drainage lines have been identified above the longwalls and within the Study Area named Drainage Line 1 and Drainage Line 2 (**Figure 8**) (MSEC, 2021).

The maximum predicted total subsidence parameters for the drainage lines based on the 2006 EA Approved Layout are similar to those for the Extraction Plan Layout for Longwalls 401 to 408. The potential impacts for the drainage lines, based on the Extraction Plan Layout are the same as those assessed based on the 2006 EA Approved Layout (MSEC, 2021).

Potential impacts to DL1, DL2 and Bora Creek within the Study Area includes ponding, changes in grade, surface cracking, fracturing of the bedrock and erosion during subsequent rain events.

Further details on drainage lines are provided in **Section 3.1** and **Appendix A**.

Groundwater

Tertiary sediments are located within the palaeochannel to the south of UG4. The sediments vary in thickness with a maximum thickness of 50-60 m, located to the south of Longwall 401. The presence of the palaeochannel sediments should result in less subsidence within these alluvial and unconsolidated sediment areas and reduced far-field movements within and beyond these channels (MSEC, 2021).

The Triassic aged sandstones overly the Permian coal measures and are present over eastern portions of LW401 to LW408. Large extents of the Triassic strata are unsaturated, either naturally or from

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dewatering caused by previous mining activities. Where saturated, the Triassic aged sandstones above LW401 – 408 host the regional water table. The depth to the water table typically ranges from approximately 50 – 65 metres below ground (mbgl) at the eastern end of these panels (AGE, 2021).

The Triassic aged sandstones provide some water supply potential, however the sandstone is generally low yielding. The Triassic sandstone supports a small number of stock and domestic bores on private properties to the north of the Moolarben Complex. Groundwater perching within the Triassic sandstones supports the local and culturally sensitive water feature on the Goulburn River known as The Drip (AGE, 2021).

The Permian strata consists of very low permeability and very low yielding sandstone and siltstone, that comprises the majority of the Permian interburden / overburden. Low to moderately permeable coal seams make up the remainder of the Illawarra Coal Measures. The coal seams are the principal water bearing strata within the Illawarra coal measures. The Permian coal measures are hydraulically confined to semi-confined within the region. However, the coal measures are depressurised locally due to historic and current mining activities (AGE, 2021).

The Goulburn River is the main watercourse in the vicinity of UG4 and has been heavily modified by the Goulburn River Diversion adjacent to UG4. The Goulburn River is likely a losing stream along the full length of the Goulburn River Diversion and which modelling suggests is disconnected in many sections. Further downstream of the Goulburn River diversion, there is evidence to suggest that the regional groundwater system has a shallow gradient either towards or away from the Goulburn River, dependent upon location (AGE, 2021).

There is no ‘highly productive’ groundwater, as defined under the NSW Aquifer Interference Policy, mapped in the vicinity of the Moolarben Coal Complex. The nearest ‘highly productive’ groundwater is a portion of the alluvial aquifer associated with Wilpinjong Creek downstream of the Wilpinjong Coal Mine. The aquifers in the vicinity of LW401-408 are “less productive” as per the Aquifer Interference Policy (AIP) classification (AGE, 2021).

There are no high priority culturally significant sites listed in the Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009. However, a spring known as The Drip is a groundwater dependent ecosystem (GDE) with local cultural significance located over 2km from LW401-408. The groundwater seepage is observed in a cliff on the northern side of the Goulburn River. The seepage is derived from the perching of groundwater in the Triassic Narrabeen Group sediments above less permeable horizons in the Triassic sequence to the north of the Goulburn River. The perched aquifer is effectively disconnected from the underlying regional watertable and neither depressurisation of the lower hydrostratigraphic units, or a lowering of the regional water table caused by mining at LW401 to 408 will impact the water supply to The Drip (AGE, 2021).

There is one privately owned bore (GW800279) in the vicinity of the Moolarben Coal Complex, located approximately 2.5 km to the north east of UG4 Longwalls 401-408. The bore is a relatively shallow bore (24 m) developed in Triassic strata and connected to the river alluvium. The predicted drawdown is less than the 2 m minimal impact considerations as specified under the AIP (AGE, 2021).

Further details on groundwater are provided in **Section 3.1** and **Appendix A**.

Cliff Line CL3

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Cliff Line CL3 is located outside the Study Area and is 165 m to 440 m from Longwall 408. With a depth of cover of approximately 165 m at the northern end of the longwalls, Cliff Line CL3 is located over 1 depth of cover from the longwalls (**Figure 8**). At this distance conventional mine subsidence ground movements and valley related movements are expected to be less than limits of survey accuracy. However, the cliff may experience far-field horizontal movements (MSEC, 2021).

Further details on cliffs is provided in **Section 3.1** and **Appendix B**.

Land in General

The depths of cover over the underground mining areas vary from 83 m to 205 m. Where the depths of cover above Longwalls 401 to 408 are less than 100 m, surface cracking is expected to be typically in the order of 150 to 200 mm wide, but could be as large as 500 mm wide where the depths of cover are the shallowest. The surface crack widths are likely to be smaller where the depths of cover are greater, or where the surface cracks result from the travelling wave. Where the depths of cover above Longwalls 401 to 408 are 100 to 150 m, the surface crack widths are expected to be typically in the order of 100 to 150 mm wide. The surface cracking and deformation could result in safety issues (i.e. trip hazards), affect vehicle access (i.e. large deformations in access tracks), or result in increased erosion (especially along the drainage lines and the steeper slopes) (MSEC, 2021).

Further details on land in general is provided in **Section 3.1** and **Appendix B**.

Threatened Species, Threatened Populations, or Endangered Ecological Communities

Niche Environment and Heritage (Niche) completed a review for Threatened Species, Threatened Populations, or Endangered Ecological Communities within the Study Area. Vegetation within the Study Area has been stratified by Plant Community Type (PCT) and condition, to allow for conformity with the NSW Plant Classification Database.

The field validated vegetation mapping determined that six PCTs in various condition states (low, medium, high and derived native grassland [DNG]) are present in the study area, consisting of the following:

- PCT 281: *Rough-Barked Apple - Red Gum - Yellow Box woodland on alluvial clay to loam soils on valley flats in the northern NSW South Western Slopes Bioregion and Brigalow Belt South Bioregion;*
- PCT 477: *Inland Scribbly Gum - Red Stringybark - Black Cypress Pine - Red Ironbark open forest on sandstone hills in the southern Brigalow Belt South Bioregion and northern NSW South Western Slopes Bioregion;*
- PCT 479: *Narrow-leaved Ironbark- Black Cypress Pine - stringybark +/- Grey Gum +/- Narrow-leaved Wattle shrubby open forest on sandstone hills in the southern Brigalow Belt South Bioregion and Sydney Basin Bioregion;*
- PCT 1656: *Narrow-leaved Ironbark - Black Pine - Narrow-leaved Wattle shrub - grass open forest on sandstone slopes of the upper Hunter and Sydney Basin;*
- PCT 1672: *Red Ironbark - Grey Gum - Black Pine heathy woodland on sandstone ranges of the Sydney Basin; and*
- PCT 1711: *Tantoon - Lepyrodia leptocaulis shrubland on sandstone drainage lines of the Sydney Basin.*

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Of the six PCTs identified, PCT 281 is consistent with the threatened ecological community (TEC). This TEC is listed as a Critically Endangered Ecological Community (CEEC) under the NSW Biodiversity Conservation Act 2016 (BC Act) and the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). All patches of PCT 281 within the Study Area meet the criteria for listing under the BC Act whereas only patches of moderate and high condition PCT 281 meet the criteria for inclusion under the Commonwealth listing (Niche, 2021).

No threatened flora species were detected within the study area during the Stage 1 EIS (Moolarben Biota 2006) or *Moolarben Coal Complex UG4 Ancillary Works Modification Biodiversity Development Assessment Report* (ELA 2019). A population of *Androcalva procumbens* (Vulnerable, BC Act and EPBC Act) were identified during the previous surveys undertaken by Eco Logical Australia (ELA) and were confirmed by Niche during the baseline assessment and vegetation validation survey. No other threatened flora species were detected during the baseline assessment and vegetation validation survey (Niche, 2021).

Ecological surveys undertaken for the Stage 1 EIS (Moolarben Biota 2006) and subsequent surveys identified the following threatened fauna species on or adjacent to the Study Area. Eighteen threatened and/or migratory fauna species, consisting of seven mammal species (including five microbat species) and 12 bird species have been recorded. Opportunistic fauna survey undertaken during the baseline assessment confirmed the presence of habitat for the above species in addition to detecting the presence of the following threatened fauna species Spotted Harrier, and four threatened microbat species, Large-eared Pied Bat, Large Bentwing-bat, Little Bentwing-bat and Yellow-bellied Sheath-tailed Bat (Niche, 2021).

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, 2008) (Marine Pollution Research, 2017).

The baseline assessment reviewed the existing condition of the vegetation within the study area, identifying the following influences currently affecting the study area:

- Dieback and death of trees and shrubs resulting from the recent prolonged drought;
- Poor structural integrity of PCTs resulting from drought related impacts;
- Poor ecosystem function and low productivity in drought affected PCTs;
- Low levels of disturbance and signs of weeds and feral animals;
- Poor health/vigour of canopy trees on plateaus resulting from insect activity (borer);
- Limited extent and abundance of threatened fauna habitat resulting from drought related impacts; and
- Herbivory impacts resulting from native fauna species resident within the Study Area.

Further details on threatened species, threatened populations, and CEECs is provided in **Section 3.1** and **Appendix C**.

Aboriginal Heritage Sites

Niche Environment and Heritage (Niche) completed a review of Aboriginal cultural heritage and an archaeological assessment within the Study Area. A total of 45 Aboriginal heritage sites were identified

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within or in the vicinity of the Study Area which include rock shelters, isolated finds, artefact scatters, PADs and grinding grooves (**Figure 8**).

Of the above 45 sites, eight (8) Aboriginal heritage sites comprising isolated finds or open artefact scatters with/without PAD have been salvaged under existing approvals and are no longer *in situ*. The remaining 37 sites consist of the following (Niche, 2021):

- One Aboriginal Heritage site S1MC280; Ulan Creek 2 (AHIMS ID#36-3-0042) has previously been assessed as having high Scientific Significance;
- Eight (8) Aboriginal Heritage sites have been assessed to have moderate scientific significance, and twenty-eight (28) have been assessed to have low scientific significance.

Comparisons of the maximum predicted conventional subsidence parameters for the Aboriginal heritage sites within the Study Area, resulting from the extraction of Longwalls 401 to 408, with those based on the Approved Layout were the same as those based on the Approved Layout (MSEC, 2021).

Aboriginal heritage sites 264, 282, 283, 286 and 287 are located at, or outside the Study Area (**Figure 8**) and the likelihood of impacts to these features is considered to be very low (MSEC, 2021).

Site 280 includes a rock shelter, art, artefacts and grinding grooves and is located centrally above the chain pillar between Longwalls 402 and 403 (**Figure 8**). The risk of subsidence impacts to Site 280 is low to moderate consistent with the approved impacts, and includes tensile cracks and instabilities. Large scale failure of the rock shelter is not expected to occur and the likelihood of tensile cracks coinciding with the location of the grinding grooves is considered to be low (MSEC, 2021).

Open sites containing artefact scatters and isolated finds can potentially be affected by cracking of the surface soils as a result of mine subsidence movements. It is unlikely that the scattered artefacts or isolated finds themselves would be impacted by surface cracking (MSEC, 2021).

Further details on Aboriginal heritage is provided in **Section 3.1** and **Appendix D**.

Historic Heritage Sites

There are no historic heritage sites (i.e. non-Aboriginal sites) within the Study Area (**Figure 8**).

Sandy Hollow Gulgong Railway Line

The Sandy Hollow – Gulgong Railway Line is located more 660 m from the Extraction Plan Layout (**Figure 10**). The railway line is not expected to experience to measurable conventional vertical subsidence, tilt, curvature or conventional strain. However, the railway may experience far-field horizontal movements of up to 40 mm. The presence of unconsolidated sediments should result in a reduced likelihood of far-field movements at the railway line (MSEC, 2021).

Further details on the Sandy Hollow Gulgong Railway Line is provided in **Section 3.2** and **Appendix E**.

Ulan Road and Bridges

The locations of the roads maintained by Mid-Western Regional Council (MWRC) are shown in **Figure 10**. The roads in the vicinity of the Study Area include Ulan Road, Ulan Road bridge (over the Sandy Hollow – Gulgong Railway) and Ulan Road bridge (over Goulburn River). MWRC also own infrastructure associated with these roads, such as the road pavement, embankments, and culverts.

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Ulan Road is located to the west of the Extraction Plan Layout. The road is approximately parallel with the finishing ends of Longwalls 401 to 408 and is approximately 375 m from the longwall voids. The distance from Ulan Road to the Extraction Plan Layout is the same as that for the Approved Layout. The potential subsidence movements and impacts based on the Extraction Plan Layout are therefore the same as those based on the Approved Layout. Ulan Road is located outside the Study Area and is predicted to experience far-field horizontal movements of up to 55 mm. The predicted maximum far-field horizontal movements are expected to be bodily movements that are accompanied by very low levels of strain. Adverse impacts to the road, culverts and cuttings resulting from the extraction of Longwalls 401 to 408 are considered to be unlikely to occur (MSEC, 2021).

The bridge over the Sandy Hollow – Gulgong Railway line, is over 1 km from the finishing end of Longwall 401. At this distance the bridge is unlikely to experience measurable subsidence related movements (MSEC, 2021). The bridge over the Goulburn River, is over 2.3 km from Longwall 408. The bridge over the Goulburn River is unlikely to experience subsidence related movements due to the extraction of Longwalls 401 to 408 (MSEC, 2021).

Further details on Ulan Road is provided in **Section 3.2** and **Appendix E**.

22kV Voltage Electricity Power Line

The Essential Energy 22kV powerline is approximately 400 m from Longwall 401 at its nearest point (**Figure 10**). The depth of cover along the western end of Longwall 401 varies from approximately 83 m to 120 m which equates to 3.3 to 5 times the depths of cover from Longwall 401. At distances of 400 m or more from the longwalls, the 22kV powerline is outside the Study Area and are predicted to experience less than 20 mm vertical subsidence resulting from the extraction of the Approved Layout and Extraction Plan Layout. Whilst the powerlines could experience very low levels of vertical subsidence, they are not expected to experience measurable tilts, curvatures or strains. The powerlines will experience far-field horizontal movements (MSEC, 2021).

Further detail on the 22 kV powerline is provided in **Section 3.2** and **Appendix E**.

330 kV Electricity Transmission Line

A 330 kV electricity transmission line (ETL) (Wollar-Wellington 330 kV High Voltage Line) owned by TransGrid runs adjacent to Ulan-Wollar Road and the Sandy Hollow Gulgong Railway Line (**Figure 10**). At distances of 725 m or more between the longwalls and the transmission line towers and at over 7 times the depth of cover, the towers will not be subjected to measurable conventional mine subsidence ground movements (i.e. less than limits of survey accuracy). The towers may experience minor far-field horizontal movements however, the movements are expected to be less than the limits of survey accuracy. Monitoring of transmission towers at similar distances from UG1 did not measure horizontal movements greater than the levels of survey accuracy (MSEC, 2021).

In consultation with TransGrid no BFMP was required due to no predicted impacts of the Wollar-Wellington 330kV transmission line.

Telecommunication Tower, Copper Cable and Fibre-Optic Cable

The telecommunications infrastructure in the vicinity of Longwalls 401 to 408 comprises Telstra owned optical fibre and copper cables that follow the general alignments of the roads (**Figure 10**). Copper

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cables are located along Ulan road to the west of Longwall 401 to 408 and to the South along Ulan-Wollar Road. The nearest point of the copper cables along Ulan Road is approximately 310 m to the finishing ends of LW402 to 406. The distance to the copper cables represents greater than 2.4 times the depth of cover from the longwalls. Optical fibre cables are located to the south west of the Study Area along Ulan Road, and to the south along Ulan-Wollar Road. A telecommunications tower is located 410 m to the west of the finishing end of Longwall 401. The nearest point of the optical fibre cables is 390 m from Longwall 401. The distances to the Telstra tower and optical fibre cables represent approximately 5 and 4.5 times the depth of cover respectively from Longwall 401.

At distances of 310 m or more between the longwalls and the copper cables along Ulan Road the cables will not be subjected to measurable conventional mine subsidence ground movements (i.e. less than limits of survey accuracy); however, the cables may experience far-field horizontal movements. The optical fibre cables and telecommunications tower are located greater than 390 m from the nearest longwalls. At distances of 390 m or more the cables and tower will not be subjected to measurable conventional mine subsidence ground movements (i.e. less than limits of survey accuracy); however, they may experience far-field horizontal movements (MSEC, 2021).

Further detail on the telecommunication tower and cables are provided in **Section 3.2** and **Appendix E**.

Dronvisa Quarry

The Dronvisa Quarry is a gravel/clay quarry located to the west of the finishing ends of Longwalls 403 to 405 with part of one active pit located above Longwall 404 and 405. The location of the quarry is shown in **Figure 10**. The features at the quarry including access tracks, sedimentation ponds, rehabilitation areas and the site shed are located near to or outside the Study Area Boundary, between 65 m and 300 m from the longwalls. These distances equate to approximately 0.5 to 2.5 times the depth of cover from the longwalls. These features are predicted to experience less than 20 mm vertical subsidence resulting from the extraction of the Extraction Plan Layout and are not expected to experience measurable tilts, curvatures or strains. The features will however experience far-field horizontal movements (MSEC, 2021).

The current extent of the quarry includes a portion of the northern pit located above Longwalls 404 and 405. Future expansion plans for the quarry would result in the southern pit located partially above Longwalls 403 and 404 (**Figure 10**). The maximum predicted total subsidence parameters for the Dronvisa Quarry based on the Extraction Plan Layout are the same as or less than those for the Approved Layout for Longwalls 401 to 408. The potential impacts for the infrastructure, based on the Extraction Plan Layout, therefore, are the same as or lower than those assessed based on the Approved Layout. The potential impacts for the current and future areas of the quarry located above the longwalls will experience the full range of predicted conventional subsidence movements. Potential impacts to the quarry pits include cracking, stepping, rippling and ponding of the surfaces (MSEC, 2021).

Further detail on the Dronvisa Quarry are provided in **Section 3.2** and **Appendix E**.

UCMPL Built Features

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Ulan Coal Mines Pty Limited (UCMPL) operate the Millers Dam compound located to the west of Longwalls 406 and 407 (**Figure 9**). There are three dams located 200 m to 310 m from the longwalls. Two of the dams have plan dimensions of approximately 70 m x 30 m, and one larger dam has plan dimensions of approximately 85 m x 130 m. Embankments surrounding the dams are up to approximately 2 m height. Other features located 320 m to 350 m from the longwalls include a groundwater bore, pump house, two above ground concrete storage tanks, telecommunications tower, reverse osmosis plant, cyclone fencing, and underground pipes and power lines. Water pipelines are also located along Ulan road from the Millers Dam compound to the UCMPL entry road (MSEC, 2021).

The maximum predicted total subsidence parameters for the Millers Dam Compound based on the Extraction Plan Layout are the same as or less than those for the Approved Layout for Longwalls 401 to 408. The potential impacts for the Millers Dam Compound, based on the Extraction Plan Layout, therefore, are the same as or lower than those assessed based on the Approved Layout. The Millers Dam Compound and water pipelines are located outside the Study Area boundary and are not expected to be subjected to measurable conventional vertical subsidence, tilt, curvature or strain. However, the surface features may experience far-field horizontal movement. At these distances, impacts to the Millers Dam Compound is considered unlikely. The water pipelines are polyethylene pipes laid on the ground surface and are able to tolerate significant ground movements. Impacts to the water pipelines at these distances are considered unlikely (MSEC, 2021).

The nearest groundwater bore (PB1C) is located 430 m from Longwall 408, which represents 3.3 times the depth of cover at this location. Groundwater levels at PB1C have been influenced by past and continuing mining operations in the region. Monitoring piezometers PZ15 to PZ18 are located between the UCML East Pit to the west and the Goulburn River Diversion to the East. The UCML bridge over the Goulburn River diversion is located 470 m from Longwall 408, which represents 3.6 times the depth of cover at this location. (MSEC, 2021)

Further detail on the UCMPL's built features are provided in **Section 3.5** and **Appendix E**.

Tilt Renewables

The Liverpool Range Wind Farm project proposed by Tilt Renewables is located across three local government areas with wind turbines proposed within the Warrumbungle and Upper Hunter Shire Council areas, with a connecting transmission line proposed along the Ulan Road to join the TransGrid network.

The proposed location of the Tilt Renewables transmission powerline is not yet finalised. It is anticipated that the powerline will be approximately 370 m from the longwalls at its nearest point, which equates to 2.8 to 4.6 times the depths of cover from the longwalls. At distances of 370 m or more from the longwalls, the Tilt Renewables powerline is outside the Study Area and are predicted to experience less than 20 mm vertical subsidence resulting from the extraction of the Approved Layout and Extraction Plan Layout. Whilst the powerlines could experience very low levels of vertical subsidence, they are not expected to experience measurable tilts, curvatures or strains. The powerlines will experience far-field horizontal movements (MSEC, 2021).

MCO Built Features

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MCO's Coal Handling and Preparation Plant (CHPP) is located 230 m to 650 m to the south of Longwall 401 (**Figure 9**). At these distances, the CHPP is located over 1.5 times the depth of cover from the Longwalls. At distances of 230 m or more, the CHPP will not be subjected to measurable conventional mine subsidence ground movements (i.e. less than limits of survey accuracy); however, the site features may experience far-field horizontal movements (MSEC, 2021).

Dewatering infrastructure is located above the Extraction Plan Layout as shown in **Figure 10**. The dewatering infrastructure includes dewatering bores, water pipelines and electrical cables. The polyethylene pipelines and cables are flexible and laid on the ground surface. Potential impacts could occur as a result of irregular movements such as ground heave, stepping, large cracks, rock falls or tree falls. It is expected that impacts to the pipelines and cables could be readily remediated if they occur. Where dewatering bores are located above the extracted panels, it is likely, that fracturing and shearing would occur in the drill holes as the result of mining (MSEC, 2021).

The locations of the exploration drill holes within the Study Area are shown in **Figure 9**. The drill holes are located directly above and adjacent to the proposed longwalls and, therefore, could experience the full range of predicted subsidence movements. It is likely, therefore, that fracturing and shearing would occur in the drill holes as the result of mining (MSEC, 2021).

Fences are located within the Study Area and are constructed in a variety of ways, generally using either timber or metal materials. All fences are on MCO owned lands. The fences could experience the full range of predicted subsidence movements. The maximum predicted subsidence parameters for the fences, based on the Extraction Plan Layout, therefore, are the same as the maxima based on the Approved Layout. Any impacts on the fences are likely to be of a minor nature and relatively easy to remediate (MSEC, 2021).

There are five farm dams owned by MCO that have been identified within the Study Area (D6, D7, D11, D12 and D13) and their locations are shown in **Figure 9**. The dams are shallow with maximum dimensions of approximately 10 m to 20 m and are no longer in use. The maximum predicted total subsidence parameters for farm dams within the Study Area based on the Extraction Plan Layout are less than the parameters for the Approved Layout for Longwalls 401 to 408. The farm dams located above the extracted longwalls are expected to experience cracking and leakage of water. Impacts to the farm dams located outside the longwall footprints is considered unlikely to occur (MSEC, 2021).

There are a number of MCO owned four wheel drive tracks through the Study Area, some of which are shown on **Figure 9**. These tracks are not publicly accessible. The tracks could experience the full range of predicted subsidence movements. The maximum predicted subsidence parameters for these tracks, based on the Extraction Plan Layout, therefore, are the same as the maxima based on the Approved Layout. Impacts are expected to include cracking, stepping and rippling of the track surfaces (MSEC, 2021).

Further details on the MCO's built features are provided in **Section 3.2**.

2.2 RISK ASSESSMENT

In accordance with the Guidelines, a number of risk assessments have been undertaken for this Extraction Plan to ensure that appropriate consideration was given to risk assessment and risk

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management in each component management plan. The risk assessments were reviewed for the Extraction Plan layout and found to be appropriate due to the reduced level of predicted impacts.

2.2.1 Environmental Risk Assessment

An Environmental Risk Assessment (ERA) was conducted for the Extraction Plan. The ERA was held on the 15 June 2021 to establish potential risks to Water Management Plan, Land Management Plan, Heritage Management Plan and Biodiversity Management Plan. The purpose of the ERA was to identify and assess the applicable risks and develop appropriate management measures in accordance with the Guidelines.

The ERA workshop for Longwalls 401 to 408 was facilitated by independent specialist, Risk Mentoring. The suitably qualified and experienced experts endorsed by the Secretary of the DPE for the preparation of the UG4 Longwalls 401- 408 Extraction Plan and relevant MCO personnel participated in the ERA.

The ERA indicated that risks relevant to water, land, heritage and biodiversity above Longwalls LW401-408 within the Study Area were in the “Low” or “Medium” category, and it was expected that the risks could be managed with implementation of the appropriate mitigation, management and/or control measures.

2.2.2 Built Features Management Plan Risk Assessment

Individual built feature risk assessments (BFRAs) were facilitated by an independent specialist AXYS Consulting, developed and prepared for each infrastructure owner to inform the development of each respective LW401-408 BFMPs (**Appendix E**).

MCO invited all built feature owners to participate individually regarding their specific BFRA, with the exception of Dronvisa Quarry, all other built feature owners declined the invitation to participate in a formal risk assessment with MCO. EE, ARTC, TransGrid, MWRC and Telstra did not request their BFRA for review.

The BFRAs prepared by MCO for each built feature owner utilised an investigation and analysis method for:

- The identification of the infrastructure owner or manager’s assets;
- A review of the revised subsidence predictions and potential impacts on the infrastructure owner’s or manager’s assets;
- A review of the preliminary monitoring plan; and
- The identification of risk control measures and procedures.

MCO considers all risk control measures and procedures to be feasible and appropriate to manage all identified risks. Given the predicted impacts for Longwalls LW401-408 are no greater than that of the Approved Layout, all predicted impacts, with the exception of Dronvisa Quarry, are expected to be far field movements (**Section 1.6.3**).

In consultation with each built feature owner, applicable risk control measures and procedures have been incorporated in the relevant LW401-408 BFMPs (**Appendix E**) and issued to all built features infrastructure owners for their records.

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2.2.3 Moolarben Coal Operations Assets Risk Assessment

A risk assessment was held for MCO assets within and in the vicinity of the Study Area. The risk assessment for Longwalls 401-408 was held on 7 September 2021 and was facilitated by an independent specialist AXYS Consulting. The risk assessment assessed the potential impacts on the following MCO assets including:

- Coal Preparation Plant
- Skyline Conveyor Infrastructure
- Reclaim Tunnel and Train Load Out Infrastructure
- General Access Roads and Tracks
- Dewatering Infrastructure
- Dams (farm, sediment and water treatment)
- Groundwater Piezometers

A number of risk control and management measures were identified during the risk assessment. With the application of the identified controls, the consensus was that subsidence related impacts from the secondary extraction of Longwalls 401 - 408 were as low as reasonably practicable (AXYS Consulting 2021).

2.2.4 Public Safety Management Plan Risk Assessment

A risk assessment was held for the LW401-408 PSMP to identify and address potential safety hazards to the public, including:

- Potential subsidence impacts on built features;
- Potential instability of cliff formations or steep slopes caused by subsidence;
- Deformations or fracturing of any land caused by subsidence; and
- Any other impacts of subsidence.

The risk assessment was held on 7 September 2021 and was facilitated by an independent specialist AXYS Consulting. The outcomes of the risk assessments were incorporated into the LW401-408 PSMP. With the implementation of the identified control strategies, the risks due to the secondary extraction of Longwalls 401 - 408 were considered to be as low as reasonably practicable.

2.3 CONSULTATION

Consultation is being conducted for this Extraction Plan in accordance with the requirements of Project Approval (05_0117) and in consideration of the draft *Guidelines for the Preparation of Extraction Plans* (DPE and DRE, 2015). Details of MCO's consultation process for the Extraction Plan is provided in **Attachment 2**.

2.3.1 Government Agencies

The following government agencies have been consulted during the preparation of this Extraction Plan:

- Department of Planning, and Environment (DPE);
- Resources Regulator (RR)
- Department of Planning and Environment – Biodiversity, Conservation & Science (BCS)

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- Department of Planning and Environment – Water (Including the Natural Resources Access Regulator)
- Department of Planning and Environment – Crown Lands
- Environmental Protection Agency
- Mid-Western Regional Council
- Heritage NSW, Department of Premier and Cabinet

Comments received were considered before the LW401-408 EP was finalised and lodged with the Secretary of the DPE for approval.

A summary of the consultation with government agencies and the key issues raised is provided in Attachment 2 (Table A2-1).

The State of NSW (NSW Crown Land) owns a portion of land (unformed Crown Road and Lot 7010, DP1025345) and the Mid-Western Regional Council (MWRC) owns a number of roads (and associated easements) adjacent to Longwalls 401 - 408 Study Area (**Figure 10**). The Goulburn River National Park, managed by the NSW Parks and Wildlife Service (NPWS) is also located to the east of the Study Area. As such, MCO has consulted with NSW Crown Land, NPWS and MWRC as potentially affected public authorities. All other land within the Longwalls 401 - 408 Study Area is owned by MCO.

2.3.2 Public Utilities & Privately Owned Assets

A summary of consultation undertaken with relevant infrastructure owners is provided in **Attachment 2 (Table A2-2)**. Consultation with each built feature owner/manager was generally conducted in accordance with the following protocol:

- Initial contact to confirm the appropriate infrastructure representative and initial briefing.
- Provision of a specific report prepared by MSEC outlining the subsidence predictions and impact assessment for each infrastructure item⁵.
- Drafts of the LW401-408 BFMPs were distributed for comment to the relevant infrastructure owner.
- Initial risk assessment workshops were held with representatives from MCO, the infrastructure owner and relevant specialists where requested by the asset owner.
- Where relevant, MCO funded additional expertise to assist the infrastructure owner to assess appropriate monitoring and management strategies and/or measures.
- Revised drafts of the LW401-408 BFMPs were prepared incorporating the outcomes of the risk assessment.
- Final drafts of the LW401-408 BFMPs were prepared incorporating any comments received from the infrastructure owner.

2.3.3 Landholders

Landholders within the Longwalls 401 - 408 Study Area are MCO and NSW Crown Lands. MCO has consulted with NSW Crown Lands (**Sections 2.3.1 and 2.3.2**). UCMP is the nearest private landowner,

⁵ The reports prepared by MSEC are attached to the relevant LW101-105 BFMPs.

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approximately 500m to the west of the Study Area. The Goulburn River National Park is immediately to the east of the Study Area. The Dronvisa Quarry operate within mining leases PLL1294, ML268, ML1219 and ML267 within MCO owned land (**Figure 10**).

2.3.4 Public Consultation

MCO meets quarterly with its Community Consultative Committee (CCC) to provide updates on operations at the Moolarben Coal Complex, including (but not limited to) community matters, visitors to site, donations, operations and exploration, approvals, underground operations, employment and Emergency Services collaboration.

MCO have provided updates on the development of the Extraction Plan for UG4 to the CCC during meetings held in March, June, September and November 2021. Minutes from the CCC meetings are provided on MCO's website <http://www.moolarbencoal.com.au/page/community/>

The approved Extraction Plan will also be made available on MCO's website. <http://www.moolarbencoal.com.au/page/environment/extraction-management-plans/>

2.3.5 Consultation with Aboriginal Stakeholders

A draft of the LW401-408 HMP was provided to Aboriginal stakeholders registered at the Moolarben Coal Complex for their review and comment on 01 October 2021. Comments received were considered before the LW401-408 HMP was finalised and lodged with the Secretary of the DPE for approval.

A draft of the LW401-408 HMP was also provided to Heritage NSW, Department of Premier and Cabinet for their review and comment on 6 October 2021. Comments received were considered before the LW401-408 HMP was finalised and lodged with the Secretary of the DPE for approval.

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3.0 SUBSIDENCE MANAGEMENT AND MONITORING

Natural and built features within the Longwalls 401 - 408 Study Area (i.e. within the 26.5° angle of draw and/or 20 mm predicted subsidence contour) have the potential to be impacted by the secondary extraction of Longwalls 401 - 408. Additionally, features that lie outside the Longwalls 401 - 408 Study Area that may experience far-field movements.

The surface features which are sensitive to such movements have been identified and included in the subsidence assessments provided by MSEC (2021) (**Technical Report 1**) and sub plans. Natural and built features within Longwalls 401 - 408 and in the vicinity of the Study Area are listed in **Table 9**.

The sub-plans detail the management and monitoring of potential environmental consequences resulting from the extraction of Longwalls 401 - 408 and associated subsidence impacts. Descriptions of each of these features are contained within the relevant management plan referenced in **Table 9**.

Table 9: Natural and Built Features within and in the vicinity of the Study Area

Feature	Section/Management Plan Reference
Natural Features	
Watercourses and Drainage Lines	Section 3.1 and LW401-408 WMP (Appendix A)
Cliffs	Section 3.1 and LW401-408 LMP (Appendix B)
Land in General	
Threatened Species, Threatened Populations and EECs	Section 3.1 and LW401-408 BMP (Appendix C)
Areas of Archaeological and/or Heritage Significance	
Known Aboriginal Heritage Sites	Section 3.1 and LW401-408 HMP (Appendix D)
Public Utilities and Other Infrastructure	
ARTC – Sandy Hollow Gulgong Railway Line	Section 3.2 and LW401-408 BFMPs (Appendix E)
MWRC – Ulan Road	
Essential Energy –22 kV powerline	
Tilt Renewables Powerline (not yet constructed)	
Telstra – Telecommunication tower and cables	
UCMPL Built Features	
Dronvisa Quarry	
Public Safety	LW401-408 PSMP (Appendix F)

The component management plans to this Extraction Plan form part of MCO’s Environmental Management System for the Moolarben Coal Complex, as shown on **Figure 4**. In order to avoid duplication of existing Environmental Management Plans (EMPs), the component management plans reference sections of the following existing complex-wide plans:

- Water Management Plan (WMP), including:
 - Surface Water Management Plan (SWMP); and
 - Groundwater Management Plan (GWMP);
- Biodiversity Management Plan (BMP); and

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- Heritage Management Plan (HMP).

The LW401-408 SMP (**Appendix G**) has been prepared to monitor subsidence impacts and validate the subsidence predictions and analyse the relationship between the subsidence effects and subsidence impacts of the Extraction Plan and any ensuing environmental consequences. A summary of the proposed monitoring for the Extraction Plan is provided in **Section 3.8** and on **Figure 11**.

3.1 NATURAL AND HERITAGE FEATURES

3.1.1 Aspects and Management Measures

Key aspects and management measures for natural and heritage features have been listed in **Table 10** below. Each aspect has corresponding objectives and management measures in place to manage impacts from secondary extraction of Longwalls 401-408. The component management plans in which these are detailed is also provided for reference.

3.1.2 Performance Measures and Indicator

Performance measures and indicators relevant to the management of potential environmental consequences resulting from the extraction of Longwalls 401 - 408 and associated potential far-field movements are provided in **Table 11** below, with further detail included in each of the specific component management plans.

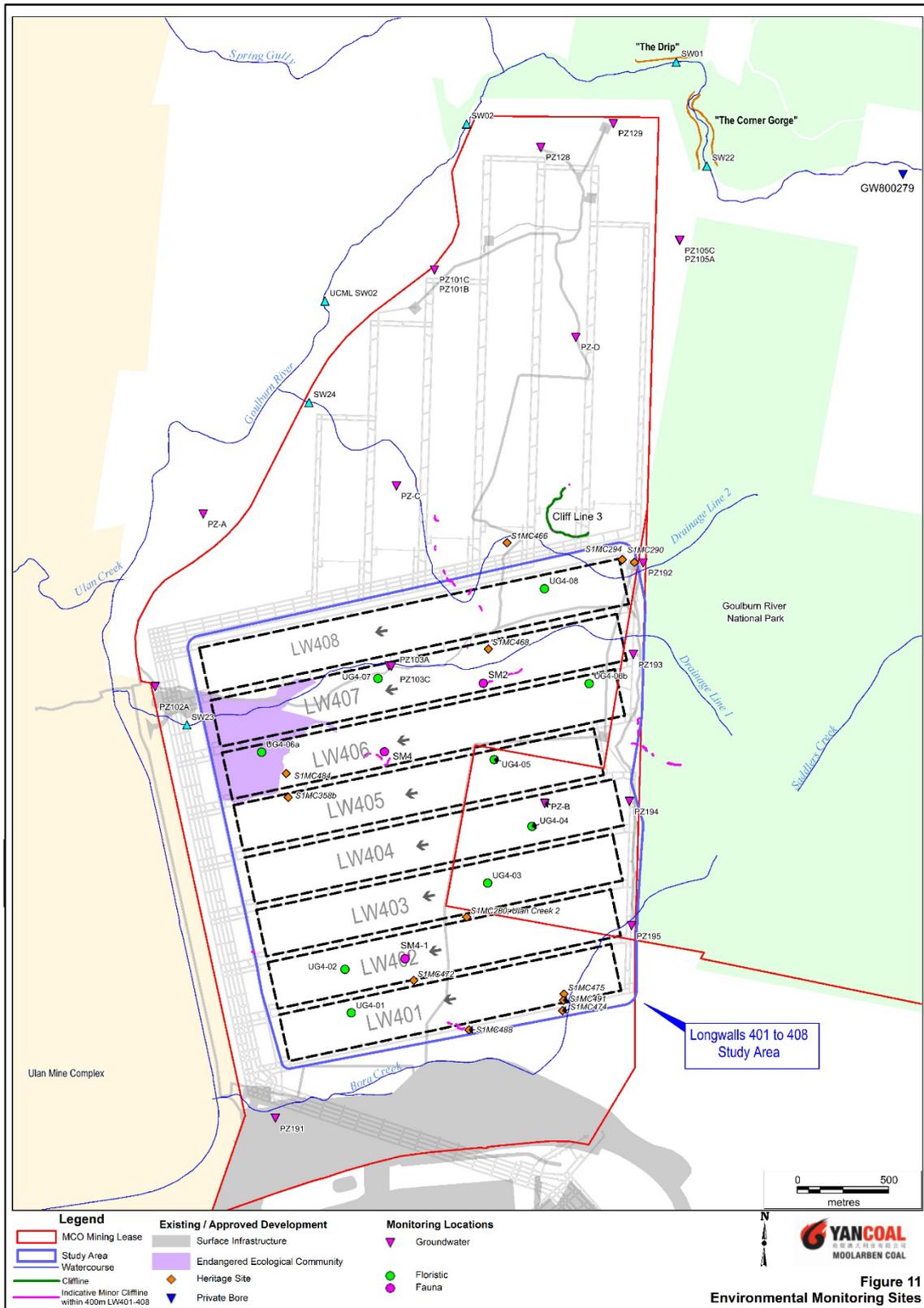
Performance measures listed correspond with those in Table 14 of Schedule 4 of Project Approval 05_0117, as they relate to the Longwalls 401-408 extent. A summary of the proposed monitoring is provided on **Figure 11**.

3.1.3 Contingency Plan

In the event that a subsidence impact performance measure relating to natural and heritage features is considered to have been exceeded, MCO will implement a Contingency Plan as described in detail in the relevant component management plans and summarised in **Section 4.1**.

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Figure 11 Environmental Monitoring Sites Relevant to Longwalls 401 to 408



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Table 10: Natural and Heritage Features Management Measures

Feature	Objective	Management Measures	Management Plan
Drainage Lines DL1, DL2 & Bora Creek	Subsidence impacts from Longwalls 401 - 408 do not result in significant increase in active erosion and/or change in stream character beyond approved.	Where mining-related activities have resulted in trigger exceedances for Bora Creek (i.e. noticeable new areas of erosion or expansion of existing erosion, initiation of headcut or noticeable upstream advance of existing headcut or development of new pools or drainage of existing pools) (<i>refer to Table 15 & 16 of the LW401-408 WMP</i>), implement contingency and remedial measures based on investigation. Potential management strategies may include slope stabilisation, drainage works to restore drainage characteristics, revegetation and bed control using natural materials such as local rock and large woody debris.	LW401-408 WMP
The Drip and Corner Gorge	Subsidence impacts from Longwalls 401 - 408 do not result in impacts or environmental consequences.	Where mining-related activities have resulted in exceedances of the Project Approval performance measures (i.e. unpredicted loss of water supply to the Drip observed), implement contingency and remedial measures in consultation with DPE.	LW401-408 WMP
Goulburn River	Subsidence impacts from Longwalls 401 - 408 do not result in impact or environmental consequences beyond negligible.	Where mining-related activities have resulted in exceedances of the Project Approval performance measures for the Goulburn River (i.e. visible cracking of bed or banks, or notable change in erosion or existing pools identified during monitoring inspections) (<i>refer to Table 15 of the LW401-408 WMP</i>), implement contingency and remedial measures in consultation with DPE.	LW401-408 WMP
Surface water quality	Subsidence impacts from Longwalls 401 - 408 do not result in significant adverse water quality impacts to the downstream water quality.	Where mining-related activities have resulted in trigger exceedances (i.e. two consecutive monthly surface water quality monitoring results exceed the trigger level) (<i>refer to Table 16 of the LW401-408 WMP</i>), implement contingency and remedial measures in consultation with DPE.	LW401-408 WMP
Groundwater quality and level	Subsidence impacts from Longwalls 401 - 408 do not result in impact or environmental consequences greater than approved.	Where mining-related activities have resulted in trigger exceedances (i.e. two consecutive monthly groundwater quality or level monitoring results exceed the lower pH limit and/or level) (<i>refer to Table 16 of the LW401-408 WMP</i>), implement contingency and remedial measures in consultation with DPE.	LW401-408 WMP

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Feature	Objective	Management Measures	Management Plan
Cliffs CL3	Subsidence impacts and damage from Longwalls 401 - 408 are minimised at CL3 consistent with EA.	Where mining-related activities have resulted in exceedances of the Project Approval performance measures for CL3 (<i>refer to Section 8 of the LW401-408 LMP</i>), implement contingency and remedial measures in consultation with DPE. Potential management strategies may include scaling or dislodgement to remove remaining loose rock, signage and barriers to restrict and warn persons of safety hazards.	LW401-408 LMP
GRNP minor cliffs	Subsidence impacts from Longwalls 401 - 408 do not result in impact or environmental consequences beyond negligible.	Potential management strategies to be undertaken in consultation with NPWS and may include visual assessments, site access control, signage and stabilisation techniques and remediation of surface tension cracks.	LW401-408 LMP
Threatened species, threatened populations, or endangered ecological communities and water dependent ecosystems	Management of subsidence impacts from Longwalls 401 – 408 on threatened species, threatened populations, or endangered ecological communities and water dependent ecosystems.	Where mining-related activities have resulted in exceedances of a biodiversity performance indicator relevant to aquatic and terrestrial flora and fauna (<i>refer to Section 8 of the LW401-408 BMP</i>), implement contingency and remedial measures in consultation with DPE. Potential management strategies may include vegetation management, habitat management, weed management and additional monitoring.	LW401-408 BMP
Land in general	Management of subsidence impacts from Longwalls 401 – 408 on land.	Potential management strategies may include erosion and sediment control, site access control, signage and stabilisation techniques and remediation of surface tension cracks.	LW401-408 LMP
Aboriginal Heritage Sites	Likelihood of subsidence impacts and damage from Longwalls 401 – 408 on Aboriginal Heritage Site 280 remain moderate (i.e. includes tensile cracks and instabilities)	A S1MC280 Site Specific Subsidence Monitoring Program (inclusive of Trigger Action Response Plans and proposed mitigation measures) developed prior to LW402. Where mining-related activities have resulted in exceedances of the Project Approval performance measures for Site 280 (<i>refer to Section 7 of the LW401-408 HMP</i>), implement contingency and remedial measures in consultation with DPE.	LW401-408 HMP
Aboriginal Heritage Sites	Likelihood of subsidence impacts and damage from Longwalls 401 – 408 on Aboriginal Heritage Sites 264, 282, 283, 286 and 287 remain very low.	Aboriginal heritage sites S1MC264, 282, 283, 286 and 287 are located to the north of the Study Area and the likelihood of impacts to these features is considered to be very low. Therefore, no management measures have been developed for LW401-408.	LW401-408 HMP

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Table 11: Natural and Heritage Features Performance Measures and Indicators

Subsidence Impact Performance Measure		Performance Indicators	Management Plan
The Drip and Goulburn River Gorge	<i>Nil impact or environmental consequences</i>	Unpredicted loss of water supply to The Drip.	LW401-408 WMP
Goulburn River and the bed of the Goulburn River	<i>Negligible impact or environmental consequences. Remain outside the zone of recorded subsidence damage for longwall mining.</i>	Unpredicted impacts on Goulburn River (cracking and or noticeable changes in erosion or pools).*	LW401-408 WMP
Cliff Line 3	<i>Minimise subsidence damage</i>	Cliff Line 3 impacts due to LW401-408 are less than 1.9m vertical conventional subsidence and 60mm/m conventional tilt.	LW401-408 LMP
Goulburn River National Park minor cliffs	N/A	Negligible impact due to longwall mining for Minor Cliffs in Goulburn River National Park.	
Aboriginal heritage sites 264, 282, 283, 286 and 287	<i>Reduce the likelihood of subsidence damage to low.</i>	Aboriginal heritage sites S1MC264, 282, 283, 286 and 287 are located to the north of the Study Area and the likelihood of impacts to these features is considered to be very low. Therefore, no performance indicators for S1MC264, 282, 283, 286 and 287 have been developed for LW401-408.	LW401-408 HMP
Aboriginal Heritage Site 280	<i>Reduce the likelihood of subsidence damage to moderate.</i>	Revised subsidence likelihood reduced to moderate	
Historic heritage sites	<i>No greater subsidence impact or environmental consequences than predicted in the EA</i>	There are no historic heritage sites within the Study Area or within the vicinity of the Study Area. Therefore, no performance indicators have been developed for LW401-408.	

Note: * Performance indicators for relevant groundwater monitoring sites north of LW408 will be established prior to mining LW405.

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3.2 BUILT FEATURES AND PUBLIC SAFETY

3.2.1 Overview

The LW401-408 BFMPs are provided in **Appendix E** and includes component plans for the individual infrastructure owners. The PSMP is provided in **Appendix F**. The purpose and scope of the LW401-408 BFMPs and PSMP is summarised below:

Purpose: To outline the management of potential subsidence impacts on built features and public safety resulting from the extraction of Longwalls 401 - 408.

Scope: To consider built features as aspects of public safety that could experience subsidence effects during the mining of Longwalls 401 - 408.

3.2.2 Performance measure, Indicators and Management Measures

Built feature and public safety performance measures, indicators and management measures of potential consequences resulting from the extraction of Longwalls 401 - 408 are provided in **Table 12** and **Table 13** respectively.

Further detail is included in each of the specific component management plans. Performance measures listed correspond with those in Table 14 of Schedule 4 of Project Approval 05_0117, as they relate to the Longwalls 401-408 extent.

3.2.3 Contingency Plan

In the event that a subsidence impact performance measure relating to built features and/or public safety is considered to have been exceeded, MCO will implement a Contingency Plan as described in detail in the relevant Management Plan and summarised in **Section 4.1**.

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Table 12: Built Features Performance Indicators and Management Measures

Built Feature	Performance Measure	Performance Indicator(s)	Relevant Management Measures	Relevant Management Plan
Gulgong-Sandy Hollow Railway Line	<i>Always safe and serviceable. Damage that does not affect safety or serviceability must be fully repairable and must be fully repaired.</i>	The performance indicators proposed to ensure that the performance measures for the Sandy Hollow Gulgong Railway in relation to subsidence induced far field movements, include: <ul style="list-style-type: none"> No defects or deformation of the rail track and associated infrastructure due to UG4 mining; and No visual displacement at joints or cracks in culverts due to UG4 mining. 	Management measures in relation to the rail line include: <ul style="list-style-type: none"> Notification to ARTC prior to the commencement of secondary extraction of LW401 and at the completion of LW401; Baseline visual inspection of Sandy Hollow Gulgong Railway infrastructure prior to the commencement of LW401; Notification to ARTC during longwall mining of LW401: <ul style="list-style-type: none"> If/when ground surveys identifies an exceedance of the predicted subsidence monitoring parameters measured along the 'UG4 ARTC Line'; and If/when visual inspection detects subsidence related impacts. Trigger Action Response Plan (TARP) - ARTC Visual inspection of Sandy Hollow Gulgong Railway and associated infrastructure to identify any post-mining remediation works required at the completion LW401. 	LW401-408 BFMP ARTC
Wollar-Wellington 330kV Transmission Line⁶	<i>Always safe and serviceable. Damage that does not affect safety or serviceability must be fully repairable and must be fully repaired.</i>	The Wollar-Wellington 330kV transmission line is located 725m from LW401 and the likelihood of impacts to the towers is considered to be very low (Section 2.1.2). Therefore no performance indicators have been developed for the Wollar-Wellington 330kV transmission line.	No management measures have been developed. In consultation with TransGrid no BFMP was required due to no predicted impacts of the Wollar-Wellington 330kV transmission line (Section 2.1.2).	Not Applicable

⁶ The nearest TransGrid assets a 330 kV electricity transmission line (ETL) and tower structures are 725m from Longwall 401. At over 7 times the depth of cover the towers will not be subject to measurable mine subsidence ground movements and therefore no specific BFMP for these assets are necessary. However, MCO have included the predictions of the 330 kV ETL in the *Subsidence Predictions and Impact Assessment for Longwalls 401 to 408* (MSEC, 2021) and has provided this information to TransGrid (**Section 2.3.2**).

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Built Feature	Performance Measure	Performance Indicator(s)	Relevant Management Measures	Relevant Management Plan
<p>Roads</p> <p>Ulan Road</p> <p>Ulan Road Bridge over the Sandy-Hollow Rail Line</p> <p>Ulan Road Bridge over the Goulburn River</p>	<p><i>Safe, serviceable and repairable unless the owner agrees otherwise in writing.</i></p>	<p>The performance indicators proposed to ensure that the performance measures for Ulan Road in relation to subsidence induced far field movements, include:</p> <ul style="list-style-type: none"> No joint displacement or cracking or other defects of the drainage structure (e.g. pipes/culverts) in excess of 5 mm (when compared against baseline condition) due to UG4 mining. <p>The Ulan Road Bridge over the Sandy-Hollow Rail Line and the Ulan Road Bridge over the Goulburn River are unlikely to experience subsidence related movements (Section 2.1.2).</p> <p>Therefore, no performance indicators have been developed the Ulan Road Bridge over the Sandy-Hollow Rail Line and the Ulan Road Bridge over the Goulburn River.</p>	<p>Management measures in relation to the Ulan Road include:</p> <ul style="list-style-type: none"> Notification to MWRC prior to the commencement of secondary extraction of LW401 and at the completion of LW408; Visual inspection and record baseline condition of Ulan Road culverts and cuttings prior to the commencement of LW401; Visual inspection and record of Ulan Road culverts and cuttings: <ul style="list-style-type: none"> If/when ground surveys identify an exceedance of the predicted subsidence monitoring parameters measured along the 'R Line' Notification to MWRC during longwall mining of Longwalls 401 – 408: <ul style="list-style-type: none"> If/when ground surveys identifies an exceedance of the predicted subsidence monitoring parameters measured along the 'R Line'; and If/when visual inspection detects subsidence related impacts). Trigger Action Response Plan (TARP) – MWRC during Longwalls 401 – 408. Visual Inspection of Ulan-Wollar Road to identify any post-mining remediation works (if) required, following the completion of LW408. 	<p>LW401-408 BFMP MWRC</p>

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Built Feature	Performance Measure	Performance Indicator(s)	Relevant Management Measures	Relevant Management Plan
<p>Other built features and improvements, including fences</p> <p>Telstra optical fibre telecommunication cable</p> <p>Telstra copper telecommunication cable</p> <p>Telstra telecommunication tower</p>	<p><i>Serviceability should be maintained wherever practicable. Loss of serviceability must be fully compensated.</i></p> <p><i>Damage must be fully repairable, and must be fully repaired or else replaced or fully compensated.</i></p>	<p>The performance indicators proposed to ensure that the performance measures for the optical fibre, copper cables and tower are achieved in relation to subsidence induced far field movements, include:</p> <ul style="list-style-type: none"> • Negligible transmission loss from mine subsidence impacts; • Negligible impacts on structural integrity of the cable lines from mine subsidence; and • Negligible impacts on structural integrity of the communications tower from mine subsidence. 	<p>Management measures in relation to the telecommunications tower and cables include:</p> <ul style="list-style-type: none"> • Notification to Telstra prior to the commencement of secondary extraction LW401 and at the completion of LW408; • Baseline condition of telecommunications tower prior to the commencement of LW401; • Notification to Telstra during longwall mining of Longwalls 401-408: <ul style="list-style-type: none"> – If/when ground surveys identifies an exceedance of the predicted subsidence monitoring parameters measured along the 'R Line'. • Comparative assessment against baseline condition of telecommunication tower at the completion of LW401; • Undertake subsidence impact inspections of the telecommunications tower; <ul style="list-style-type: none"> – If/when ground surveys identify an exceedance of the predicted subsidence monitoring parameters measured along the 'R Line' – If/when subsidence related ground movements result in a detectable impact to the tower (compared to baseline). • Trigger Action Response Plan (TARP) – Telstra during Longwalls 401 – 408. • Notification to Telstra if management measures are considered to be required. 	<p>LW401-408 BFMP TESLTRA</p>

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Built Feature	Performance Measure	Performance Indicator(s)	Relevant Management Measures	Relevant Management Plan
<p>Other built features and improvements, including fences</p> <p>Essential Energy 22kV line and power poles to telecommunication tower</p>	<p><i>Serviceability should be maintained wherever practicable. Loss of serviceability must be fully compensated.</i></p> <p><i>Damage must be fully repairable, and must be fully repaired or else replaced or fully compensated.</i></p>	<p>The performance indicators proposed to ensure that the performance measures are achieved in relation to subsidence induced far field movements, include:</p> <ul style="list-style-type: none"> The structural integrity of the 22kV powerline (power poles and transmission lines) is maintained. 	<p>Management measures in relation to the 22KV powerline include:</p> <ul style="list-style-type: none"> Notification to Essential Energy prior to commencement of secondary extraction of LW401 and at the completion of LW401 and 402; Visual inspection and survey of 22 kV powerline (baseline) - power poles to telecommunications tower (to identify management measures potentially required pre-subsidence) prior to the commencement of LW401; Notification to Essential Energy during longwall mining of Longwall 401 and 402; <ul style="list-style-type: none"> If/when ground surveys identify an exceedance of the predicted subsidence monitoring parameters measured along the 'R Line'; If/when visual monitoring detects subsidence related impacts; and If/when tilt monitoring detects subsidence related impacts. Trigger Action Response Plan (TARP) – Essential Energy during Longwalls 401 and 402. Visual Inspection of 22k - powerline power poles to telecommunications tower at the completion of mining Longwall 401 and 402. 	<p>LW401-408 BFMP Essential Energy</p>

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Built Feature	Performance Measure	Performance Indicator(s)	Relevant Management Measures	Relevant Management Plan
<p>Other built features and improvements, including fences</p> <p>UCMPL Millers Dam Compound and associated infrastructure, Bridge, Bore and Monitoring Piezometers</p>	<p><i>Serviceability should be maintained wherever practicable. Loss of serviceability must be fully compensated.</i></p> <p><i>Damage must be fully repairable, and must be fully repaired or else replaced or fully compensated.</i></p>	<p>The performance indicators proposed to ensure that the performance measures for UCMPL infrastructure within 400m of Longwalls 401-408 in relation to subsidence induced far field movements, include:</p> <ul style="list-style-type: none"> Subsidence monitoring indicates subsidence is consistent with approved impacts. 	<p>Management measures in relation to the UCMPL infrastructure include:</p> <ul style="list-style-type: none"> Subsidence Impact Assessment provided to UCMPL prior to the commencement of LW401. Notification to UCMPL prior to commencement of secondary extraction of each Longwall 401 to 408. Visual inspection and record (baseline) of UCMPL infrastructure within 400m of Longwalls 401-408 Notification to UCMPL during longwall mining of Longwalls 401-408 <ul style="list-style-type: none"> If/when ground surveys identify an exceedance of the predicted subsidence monitoring parameters measured along the 'R Line' If/when visual monitoring detects subsidence related impacts. Notification to MCO by UCMPL if If/when visual monitoring detects subsidence related impacts. Provision of supplementary water supply for PB1C or compensation for impacts if PB1C is in use and LW401-408 subsidence has demonstrated impact on PB1C. Supplementary supply to be of comparable quality and quantity to PB1C when impacted. Repair of (or compensation for) damage to UCML Infrastructure if LW401-408 subsidence has resulted in damage to UCML infrastructure. Trigger Action Response Plan (TARP) –UCMPL during Longwalls 401 and 408. Visual Inspection of UCMPL infrastructure within 400m of Longwalls 401-408 to identify any post-mining remediation works (if) required. Notification to UCMPL to inform longwall mining of Longwalls 401-408 is completed 	<p>LW401-408 BFMP UCMPL</p>

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Built Feature	Performance Measure	Performance Indicator(s)	Relevant Management Measures	Relevant Management Plan
<p>Other built features and improvements, including fences</p> <p>Dronvisa Quarry</p>	<p><i>Serviceability should be maintained wherever practicable. Loss of serviceability must be fully compensated.</i></p> <p><i>Damage must be fully repairable, and must be fully repaired or else replaced or fully compensated.</i></p>	<p>The performance indicators proposed to ensure that the performance measures for Dronvisa Quarry achieved in relation to subsidence, include:</p> <ul style="list-style-type: none"> • Subsidence monitoring indicates subsidence is consistent with approved impacts. • Compensation Agreement between MCO and Dronvisa in place for predicted impacts to Dronvisa infrastructure serviceability and damage to the Quarry. 	<p>Management measures in relation to the Dronvisa Quarry infrastructure include:</p> <ul style="list-style-type: none"> • Notification to Dronvisa prior to commencement of secondary extraction of LW401 and at the completion of LW408. • Review and update Dronvisa Quarry Safety Management System (SMS) to consider any reasonable subsidence prediction matters relating to their personnel and equipment prior to commencement of LW403. • MCO and Dronvisa to finalise Compensation Agreement for potential loss of serviceability and/or damage to Dronvisa Quarry prior to commencement of LW403. • Installation and commencement of the Dronvisa Quarry subsidence monitoring program for Longwall 401-408 prior to the commencement of LW403. • Establish the pre-mining (baseline) visual inspection of the Dronvisa Quarry and Infrastructure prior to the commencement of LW403. • Notification to Dronvisa during longwall mining of Longwalls 401-408 to facilitate management of Dronvisa Quarry activities to minimise subsidence interactions; <ul style="list-style-type: none"> – Weekly while the active mining face of LW403, LW404 and LW405 is within 400m of the active Quarry area and until completion of major subsidence – Within one month following the completion of Longwall 403, 404 and 405 – Provide a copy of the results of the subsidence parameters measured after Longwall 403, 404 and 405 to Dronvisa 	<p>LW401-408 BFMP Dronvisa</p>

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Built Feature	Performance Measure	Performance Indicator(s)	Relevant Management Measures	Relevant Management Plan
<p>Other built features and improvements, including fences</p> <p>Dronvisa Quarry</p>	<p><i>Serviceability should be maintained wherever practicable. Loss of serviceability must be fully compensated.</i></p> <p><i>Damage must be fully repairable, and must be fully repaired or else replaced or fully compensated.</i></p>	<p>The performance indicators proposed to ensure that the performance measures for Dronvisa Quarry achieved in relation to subsidence, include:</p> <ul style="list-style-type: none"> • Subsidence monitoring indicates subsidence is consistent with approved impacts. • Compensation Agreement between MCO and Dronvisa in place for predicted impacts to Dronvisa infrastructure serviceability and damage to the Quarry. 	<p>Management measures in relation to the Dronvisa Quarry infrastructure include (continued):</p> <ul style="list-style-type: none"> • Management of activities and access to quarry areas undergoing active subsidence: <ul style="list-style-type: none"> – While the active LW mining face is within 400m of the active Quarry area until completion of major subsidence (or as otherwise deemed appropriate by Dronvisa) • Visual Inspection of Dronvisa Quarry subsidence to identify management measures potentially required; <ul style="list-style-type: none"> – At the completion of each of LW403, 404 and 405 major subsidence. • Remediation Measures implemented for subsidence impacts to Quarry; <ul style="list-style-type: none"> – Following completion of each of LW403, 404 and 405. • Comparative assessment of visual inspections against baseline condition of Quarry Infrastructure; <ul style="list-style-type: none"> – Within one month following the completion of Longwall 403, 404 and 405. • Undertake subsidence impact inspection: <ul style="list-style-type: none"> – If/when ground surveys identifies an exceedance of the predicted subsidence monitoring parameters. • Trigger Action Response Plan (TARP) – Dronvisa Quarry during Longwalls 403, 404 and 405. 	<p>LW401-408 BFMP Dronvisa</p>

Note: Any dispute between the Proponent and the owner of any built feature over the interpretation, application or implementation of the performance measures in Table 15 of PA05_0117 is to be settled by the Secretary, following consultation with the Resources Regulator. Any decision by the Secretary shall be final and not subject to further dispute resolution under this approval.

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Table 13: Public Safety Performance Indicators and Management Measures

Feature	Performance Measure	Performance Indicator(s)	Relevant Management Measures	Relevant Management Plan
Public Safety	<i>Negligible additional risk</i>	<p>MCO will assess Longwalls 401- 408 against the following public safety performance indicator in the event that any hazard to the general public arising from subsidence impacts becomes evident:</p> <ul style="list-style-type: none"> No more than negligible additional risk to public safety. 	<p>Management measures in relation to Public Safety include:</p> <ul style="list-style-type: none"> Restricted public access into the Study Area <ul style="list-style-type: none"> All vehicular entry points into the Study Area are secured by MCO with a locked gate and accompanied by appropriate signage Potential management measures that will be considered to mitigate/remediate environmental consequences are detailed in the LW401-408 LMP, and include: <ul style="list-style-type: none"> stabilisation techniques; erosion and sediment control techniques; remediation of surface tension cracks; and site access control and signage. Potential management measures in relation to subsidence impacts on land include additional signage to warn persons accessing the area of safety hazard, and construction of barriers to restrict access to unsafe areas. Follow-up inspections will be conducted to assess the effectiveness of implemented management measures and the requirement for any additional management measures. 	LW401-408 PSMP

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3.3 REHABILITATION MANAGEMENT

Condition 77(o), Schedule 3 of Project Approval (05_0117) requires that the Extraction Plan propose relevant revisions to the complex-wide Rehabilitation Management Plan (RMP) required by Condition 68, Schedule 3.

The currently approved complex-wide RMP forms part of the Moolarben Coal Complex Mining Operations Plan (MOP).

The MOP (as amended) and RMP describes longwall mining in UG4. The current MOP is approved for the period up to 31 December 2022. Regarding rehabilitation associated with subsidence, the MOP and RMP also describe:

- Potential subsidence impacts associated with longwall mining in UG4 (e.g. surface cracks).
- Subsidence monitoring relevant to identifying remediation and rehabilitation requirements.
- Remediation techniques that would be implemented.
- Rehabilitation criteria, goals and objectives for areas requiring remediation, and for disturbance associated with subsidence remediation/monitoring.

Potential Subsidence Impacts and Monitoring

The overriding objective for subsidence management is to minimise the potential for, or extent of, the predicted subsidence impacts.

MSEC (2021) presents potential subsidence impacts for Longwalls 401 - 408. Potential subsidence impacts include:

- surface cracking;
- changes in stream bed gradients;
- ponding and changes in stream alignment; and
- slope instability and erosion.

Visual monitoring of potential subsidence impacts will be conducted by MCO in accordance with the LW401-408 LMP and LW401-408 WMP.

Remediation

A number of potential management measures will be implemented to mitigate/remediate subsidence impacts on land resulting from underground mining operations.

Minor cracks that develop are not expected to require remediation as geomorphologic process will result in natural filling of these cracks over time.

Remediation of typical surface cracks (generally in the order of 150 mm, but up to approximately 500 mm in areas of lower depth of cover) will be undertaken where practicable and accessible using conventional earthmoving equipment (e.g. a backhoe) and will include:

- infilling of surface cracks with soil or other suitable materials; or
- locally re-grading and re-compacting the surface.

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Notwithstanding, remediation will be undertaken in the event a crack is identified to present a significant risk to safety of people or livestock and/or presents a long-term degradation or erosion risk.

Areas of surface cracking will be stabilised using erosion protection measures (e.g. vegetation seeding and planting and/or brush matting). Drainage works and rehabilitation of subsidence troughs (i.e. areas of induced ponding) will be conducted as necessary, and may include stabilisation of banks subject to soil slumping.

If surface crack remediation works are required in remnant vegetation areas, compact mobile equipment will be used, where practicable, to minimise damage to surrounding vegetation. If the remediation work (or subsidence monitoring) requires clearing of remnant vegetation to an extent that would exceed the benefit of the remediation, the requirement for remediation will be reviewed. Vegetation that requires clearance will be subject to MCO's Ground Disturbance Permit (GDP) and Vegetation Clearance Protocol (as per the approved complex-wide BMP).

In summary, remediation of surface cracking will be undertaken where practicable and accessible using conventional earthmoving machinery and include infilling of surface cracks with soil and suitable material or locally re-grading and re-compacting the surface.

Visual monitoring of remediated subsidence areas will be conducted quarterly to identify any requirement for maintenance measures and/or remedial works in accordance with the MOP.

Rehabilitation

Rehabilitation associated with subsidence impacts, and any minor disturbance associated with subsidence remediation works or monitoring, will be undertaken in accordance with the approved MOP, RMP and the management and mitigation measures outlined in this Extraction Plan and the relevant component plans (e.g. the LW401-408 LMP).

Rehabilitation objectives and decommissioning phase performance indicators and completion criteria have been developed for the subsidence area (e.g. overlying Longwalls 401 - 408) and are described in the MOP. The relevant rehabilitation objectives and decommissioning phase performance indicators and completion criteria are:

- Rehabilitation Objectives:
 - Land affected by mine induced subsidence will be safe, stable and non-polluting.
 - Land affected by mine subsidence will not present a risk to achieving final land use options.
- Decommissioning Phase Performance Indicators and Completion Criteria:
 - No subsidence surface cracks remaining that present a risk to the environment, safety and the final land use objectives.

Rehabilitation performance will be considered to be satisfactory when monitoring data indicates the completion criteria have been met.

Changes to MOP/RMP

Following approval of the Extraction Plan, the MOP/RMP would be reviewed, and revised if required, for consistency with this Extraction Plan.

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3.4 MONITORING PROGRAM SUMMARY

The monitoring program is detailed in both the LW401-408 Subsidence Monitoring Program (**Appendix G**) and the individual management plans (i.e. for the LW401-408 WMP, LW401-408 LMP, LW401-408 BMP and LW401-408 HMP).

Monitoring includes flora and fauna, drainage lines, water, heritage sites, built features, and subsidence monitoring lines. Relevant environmental monitoring locations are presented in **Figure 11**.

Details of any subsidence impacts observed will be recorded in the relevant Subsidence Impact Register Template.

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4.0 IMPLEMENTATION

4.1 CONTINGENCY RESPONSE

In the event a subsidence impact performance measure described in **Table 6** and **Table 7** has been exceeded or is likely to be exceeded, MCO will implement the relevant Contingency Plan detailed in the LW401-408 WMP (**Appendix A**), LW401-408 LMP (**Appendix B**), LW401-408 BMP (**Appendix C**), LW401-408 HMP (**Appendix D**), LW401-408 BFMPs (**Appendix E**) or the LW401-408 PSMP (**Appendix F**). In general, the Contingency Plans include the following:

- The observation will be reported to the Underground Technical Manager and/or the Environmental and Community Manager within 24 hours.
- The observation will be recorded in the relevant Subsidence Impact Register Template (consistent with the monitoring programs described in **Section 3**).
- Undertake investigation to confirm if trigger exceedance is mining related.
- Any exceedance of a subsidence impact performance measure will be reported to the DPE, relevant agencies and relevant stakeholders as soon as practicable after MCO becomes aware of the exceedance.
- MCO will conduct an investigation to evaluate the potential contributing factors.
- MCO will identify an appropriate course of action with respect to the identified impact(s), in consultation with specialists, relevant agencies and relevant stakeholders, as necessary.
- MCO will submit the proposed course of action to the DPE for approval.
- MCO will implement the approved course of action to the satisfaction of the DPE.

In accordance with Condition 74, Schedule 3 of Project Approval (05_0117), MCO will provide a suitable offset to compensate for the impact or environmental consequence to the satisfaction of the Secretary of the DPE if either the remediation measures implemented by MCO have failed to remediate the impact or environmental consequence or the Secretary of the DPE determines that it is not reasonable or feasible to remediate the impact or environmental consequence.

Contingency measures will be developed in consideration of the specific circumstances of the feature (e.g. the location, nature and extent of the impact, and the assessment of environmental consequences). Relevant management and contingency measures are summarised in **Section 3** and outlined in the component management plans (**Appendices A to F**).

Responsibilities during contingency response are outlined in **Section 4.6**, which is designed to clearly outline actions, levels of responsibility within MCO and reporting requirements where monitoring results indicate that impacts are exceeding (or likely to exceed) predicted or approved limits. This table is designed to support the Trigger Action Response Plans (TARPs) provided in the component management plans (**Appendices A to F**). These TARPs will be developed further as this Extraction Plan is reviewed and revised.

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4.2 ADAPTIVE MANAGEMENT

MCO will implement adaptive management in accordance with Condition 2, Schedule 5 of Project Approval (05_0117) to ensure subsidence impact performance measures (**Table 6** and **Table 7**) are achieved at the UG4 Underground Mine. Adaptive management will involve:

- **Planning** – developing management strategies to meet performance measures; identifying performance indicators to assess performance; and establishing monitoring programs to monitor against the performance measures.
- **Implementation** – implementing management strategies and monitoring impacts against performance indicators.
- **Review** – reviewing and evaluating the effectiveness of management strategies by analysis of monitoring data against predicted impacts, performance indicators and performance measures.
- **Contingency Response** – implementing contingency plans where a potential exceedance of a subsidence impact performance measure or an unexpected impact is detected (**Section 4.1**).
- **Adjustment** – adjusting management strategies to improve performance, particularly following an exceedance of a subsidence impact performance measure or detection of an unexpected impact.

Where any exceedance of the subsidence impact performance measures is identified as a result of operations undertaken at the UG4 Underground Mine, MCO will, at the earliest opportunity:

- a) take all reasonable and feasible steps to ensure that the exceedance ceases and does not recur;
- b) consider all reasonable and feasible options for remediation (where relevant) and submit a report to the DPE describing those options and any preferred remediation measures or other course of action; and
- c) implement remediation measures as directed by the Secretary, to the satisfaction of the Secretary.

4.3 REPORTING FRAMEWORK

MCO has developed a reporting framework for the Extraction Plan based on the nature of the predicted subsidence impacts and consequences and streamlining of reporting requirements.

Table 14 provides a summary of the proposed reporting framework, including which stakeholders will receive copies of each report and the distribution method. The subsections below provide further detail on the contents of each reporting mechanism.

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Table 14: Summary of Reporting Framework

Report	Frequency	Distribution	Distribution Method	Responsibility for Preparation	Responsibility for Submission
Incident Report	As required Section 4.3.1	DPE RR EPA (where relevant) Other Relevant Agencies ¹ (where relevant)	Email	Environmental and Community Manager	General Manager
Annual Review	Annually	DPE RR DPE Water / NRAR CCC MWRC EPA BCS	Email NSW Planning Portal Website	Environmental and Community Manager	General Manager

Notes: ¹ Other relevant agencies as specified in component management plans

4.3.1 Incident Report

An incident is defined as a set of circumstances that causes or threatens to cause or threatens to cause material harm to the environment, and/or breaches or exceeds the limits or performance measures/criteria in Project Approval (05_0117).

The reporting of incidents will be conducted in accordance with Condition 7, Schedule 5 of Project Approval (05_0117).

MCO will notify the Secretary of DPE and any other relevant agencies of any incident associated with the UG4 Underground Mine which causes or threatens to cause material harm to the environment immediately after MCO confirms that an incident has occurred.

For any other incident associated with the UG4, MCO will notify the Secretary and any other relevant agencies as soon as practicable after becoming aware of the incident. Within seven days of the date of the incident, MCO will provide the Secretary of the DPE and any relevant agencies with a detailed report on the incident.

The report will:

- Describe the date, time and nature of the exceedance/incident;
- Identify the cause (or likely cause) of the exceedance/incident;
- Describe what action has been taken to date; and
- Describe the proposed measures to address the exceedance/incident.

4.3.2 Annual Review

An Annual Review will be prepared and submitted in accordance with Condition 4, Schedule 5 of Project Approval (05_0117). The Annual Review will review the performance of the project to the satisfaction of the Secretary of the DPE and will:

- describe the works carried out in the previous calendar year, and the development proposed to be carried out over the current calendar year;

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- include a comprehensive review of the monitoring results and complaints records of the Project over the previous calendar year, including a comparison of these results against the:
 - relevant statutory requirements, limits or performance measures/criteria;
 - monitoring results of previous years; and
 - relevant predictions in the EA;
- identify any non-compliance over the last year, and describe what actions were (or are being) taken to ensure compliance;
- identify any trends in the monitoring data over the life of the Project;
- identify any discrepancies between the predicted and actual impacts of the Project, and analyse the potential cause of any significant discrepancies; and
- describe what measures will be implemented over the next year to improve the environmental performance of the Project.

4.4 REVIEW OF THE EXTRACTION PLAN

In accordance with Condition 5, Schedule 5 of Project Approval (05_0117), this Extraction Plan will be reviewed within three months of the submission of:

- an Annual Review under Condition 4, Schedule 5;
- an incident report under Condition 7, Schedule 5;
- an audit under Condition 9, Schedule 5; or

any modification to the conditions of Project Approval (05_0117) (unless the conditions require otherwise); and if necessary, revised to the satisfaction of the Secretary of the DPE to ensure the plan is updated on a regular basis and to incorporate any recommended measures to improve environmental performance. Where this review leads to revisions to the Extraction Plan, then within four weeks of the review, the revised Extraction Plan will be submitted to the Secretary of the DPE for approval.

The revision status of this Extraction Plan is indicated on the title page of each copy.

4.5 REVIEW OF OTHER MANAGEMENT PLANS

Condition 77(o), Schedule 3 of Project Approval (05_0117) requires the Extraction to include proposed revisions to the RMP required under Condition 68, Schedule 3 of Project Approval (05_0117).

The MOP was approved by the RR on 23 November 2021 and is due to expire on 31 December 2022. A new MOP (RMP) will be prepared and submitted for approval prior to the expiry date of the current MOP.

The MOP includes the approved RMP, required under Condition 68, Schedule 3 of Project Approval (05_0117), as an appendix.

MCO will review, and, if necessary, revise the MOP and RMP within three months of the approval of the Extraction Plan.

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4.6 KEY RESPONSIBILITIES

Key responsibilities under this Extraction Plan are summarised in **Table 15**. The component management plans provide additional responsibilities under the plans.

Table 15: Key Extraction Plan Responsibilities

Responsibility	Task
General Manager	<ul style="list-style-type: none"> • Ensure resources are available to MCO personnel to facilitate the completion of responsibilities under this Extraction Plan. • Ensure the safety of MCO employees and the public in relation to MCO operations. • Approve and instruct implementation of remediation/corrective action/compensation, if necessary.
Underground Technical Manager	<ul style="list-style-type: none"> • Liaise with relevant stakeholders regarding environmental management. • Liaise with relevant stakeholders regarding management of built features. • Ensure monitoring and reporting required in accordance with this Extraction Plan are carried out within specified timeframes, are adequately checked and processed and are prepared to the required standard. • Ensure that any Incident Reports are lodged in a timely manner with all available information. • Ensure that reviews of this Extraction Plan and other plans are conducted as described in Sections 4.4 and 4.5. • Liaise with relevant stakeholders regarding subsidence impact management and related public safety hazards.
Environment and Community Manager	<ul style="list-style-type: none"> • Liaise with relevant stakeholders regarding environmental management. • Ensure monitoring and reporting required in accordance with this Extraction Plan are carried out within specified timeframes, are adequately checked and processed and are prepared to the required standard. • Ensure that any Incident Reports are lodged in a timely manner with all available information. • Ensure that reviews of this Extraction Plan and other plans are conducted as described in Sections 4.4 and 4.5.
Registered Mine Surveyor	<ul style="list-style-type: none"> • Undertake all subsidence monitoring to the required standard within the specified timeframes and ensure data are adequately checked, processed and recorded.

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5.0 REFERENCES

- Australasian Groundwater & Environmental Consultants (2021) *Groundwater Technical Report for Moolarben UG4 LW401 to LW408 Extraction Plan*
- Department of Planning and Environment and NSW Trade & Investment – Division of Resources and Energy (2015) *Guidelines for the Preparation of Extraction Plans Required under Conditions of Development Consents, Project Approvals and Mining Lease Conditions for Underground Coal Mining*. Version 5. Draft.
- Ecovision Consulting (2008) *Ecological Impact Assessment, Appendix 7 in Moolarben Coal Mines Pty Limited (2009) Moolarben Coal Project Stage 2 Environmental Assessment Report*, report prepared for Moolarben Coal Operations Pty Ltd by Ecovision Consulting.
- Marine Pollution Research Pty Ltd (2017) *Moolarben Coal Complex Open Cut Optimisation Modification Impact Assessment for Controlled Mine Water Release to the Goulburn River NSW: Aquatic Ecology Assessment*.
- Mine Subsidence Engineering Consultants (2021). *Moolarben Coal Complex: Moolarben Project Stage 1, Longwalls 401 to 408 Subsidence Predictions and Impact Assessments for the Natural and Built Features in Support of the Extraction Plan*. Report Number MSEC1165.
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- Niche Environment and Heritage (2021) *Moolarben UG4 - Longwalls 404-408 Biodiversity Technical Report*.
- Niche Environment and Heritage (2021) *UG4 Longwalls 401-408 Extraction Plan – Aboriginal Cultural Heritage Technical Report*.
- WRM *Water and Environment (2021) UG4 Longwalls 401 to 408 Extraction Plan Surface Water Technical Report*.

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