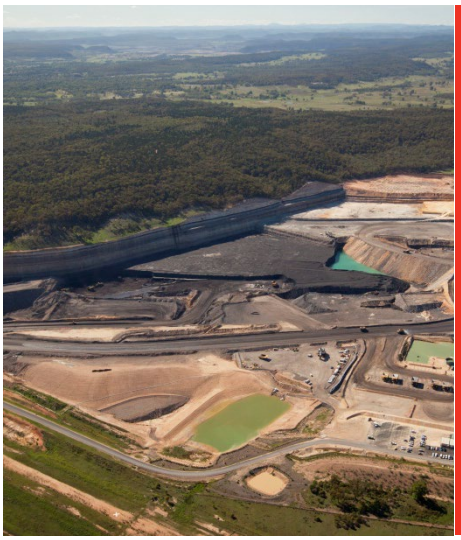

UG1 LONGWALLS 101 TO 105 EXTRACTION PLAN

Version	Issue Date	Section Revised	Description	Review Team
1	September 2017	All	Approved	MCO
2	March 2019	All	Amended 103 Layout	MCO
3	June 2020	All	Inclusion of Longwalls 104-105	MCO

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

DOCUMENT CONTROL

Applicant	Moolarben Coal Operations Pty Ltd
Mine	Moolarben Coal Complex
Development Consent	Stage 2 Project Approval (08_0135) as modified
Mining Leases	ML 1605, ML 1606, ML 1628, ML 1691 and ML 1715
Title	Moolarben Coal Complex UG1 Extraction Plan Longwalls 101 to 105
Document No.	MCO_UG1_LW101-105 _EP
General Description	Management of potential subsidence effects, subsidence impacts and environmental consequences during mining of Longwalls 101 to 105 at the Moolarben Coal Complex
Date	11 June 2020
Signature of Environmental and Community Manager	Date signed: 15/06/2020
Signature of Underground Technical Manager	Date signed: 16/06/2020
Signature of General Manager	[to be signed following DPIE Approval] S.J. Archinal Date signed: 11/06/2020

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Appendix B	UG1 Longwalls 101 to 105 Land Management Plan
Appendix C	UG1 Longwalls 101 to 105 Biodiversity Management Plan
Appendix D	UG1 Longwalls 101 to 105 Heritage Management Plan
Appendix E	UG1 Longwalls 101 to 105 Built Features Management Plans
Appendix F	UG1 Longwalls 101 to 105 Public Safety Management Plan
Appendix G	UG1 Longwalls 101 to 105 Subsidence Monitoring Program (including Plans 1 to 7)

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

1.0 OVERVIEW OF THE EXTRACTION PLAN

1.1 MOOLARBEN COAL COMPLEX OVERVIEW

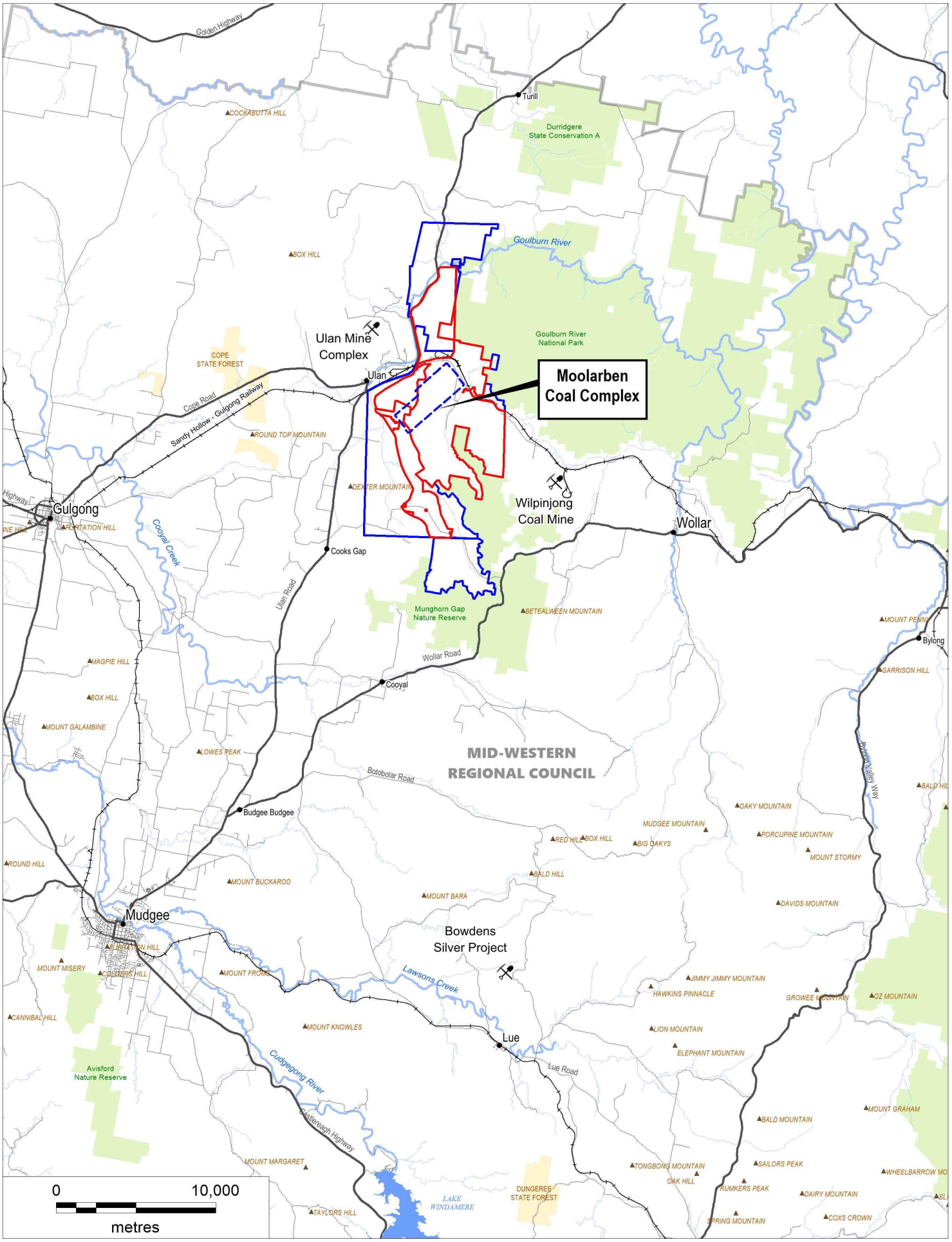
The Moolarben Coal Complex is an open cut and underground coal mining operation located approximately 40 kilometres (km) north of Mudgee in the Western Coalfield of New South Wales (NSW) (Figure 1).

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

The Moolarben Coal Complex comprises four approved open cut mining areas (OC1 to OC4), three approved underground mining areas (UG1, UG2 and UG4) and other mining related infrastructure (including coal processing and transport facilities) (Figure 2). Since commencement of coal mining operations in 2010, mining activities have occurred within OC1, OC2 OC4 and UG1 (Figure 2).

The UG1 Underground Mine is a component of the approved Moolarben Coal Complex (Figure 2). The UG1 Underground Mine commenced first workings in April 2016 and commenced secondary workings (longwall extraction) on October 2017 by longwall mining methods from Ulan Seam within Mining Lease (ML) 1605, ML1606, ML1691 and ML1715 (Figure 3).

Mining operations at the Moolarben Coal Complex are currently approved until 31 December 2038 in accordance with Project Approval (05_0117) (Moolarben Coal Project Stage 1) (as modified) and Project Approval (08_0135) (Moolarben Coal Project Stage 2) (as modified), granted under the NSW *Environmental Planning and Assessment Act, 1979* (EP&A Act).



Legend

- Exploration Licence Boundary
- Mining Lease Boundary
- Local Government Area
- National Park / Nature Reserve
- State Forest
- Mining Project

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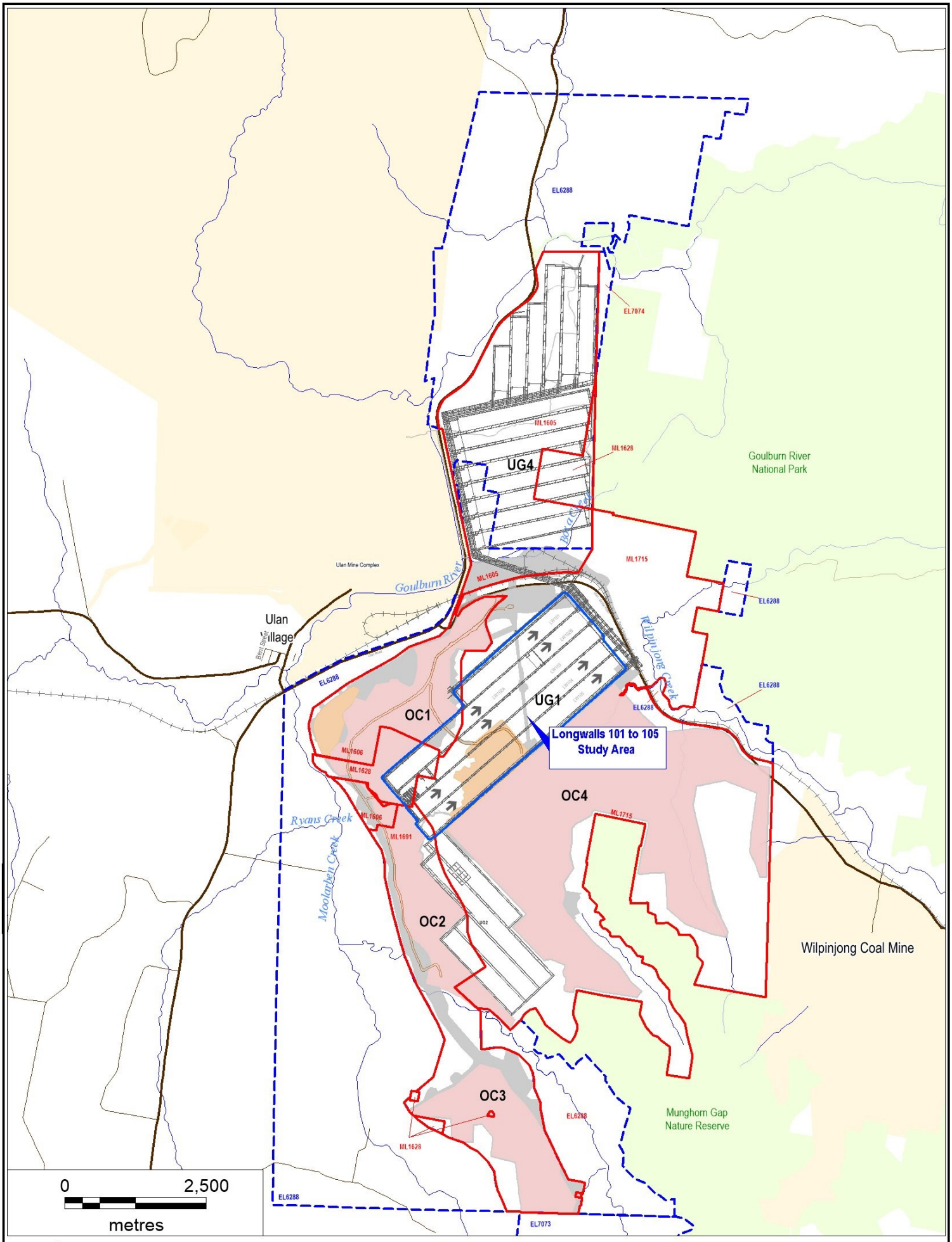
YANCOAL 兖煤澳大利亚有限公司 MOOLARBEN COAL

Figure 1
Regional Location



Legend

- Exploration Licence Boundary
- Mining Lease Boundary
- Haul Road
- Rail Line
- Watercourse

Existing / Approved Development

- Open Cut Mining Area
- Underground Workings
- Out-of-Pit Emplacement
- Surface Infrastructure

- Longwalls 101 to 105 Study Area
- Direction of Longwall Mining

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MOOLARBEN COAL

Figure 2
Moolarben Coal Complex Layout

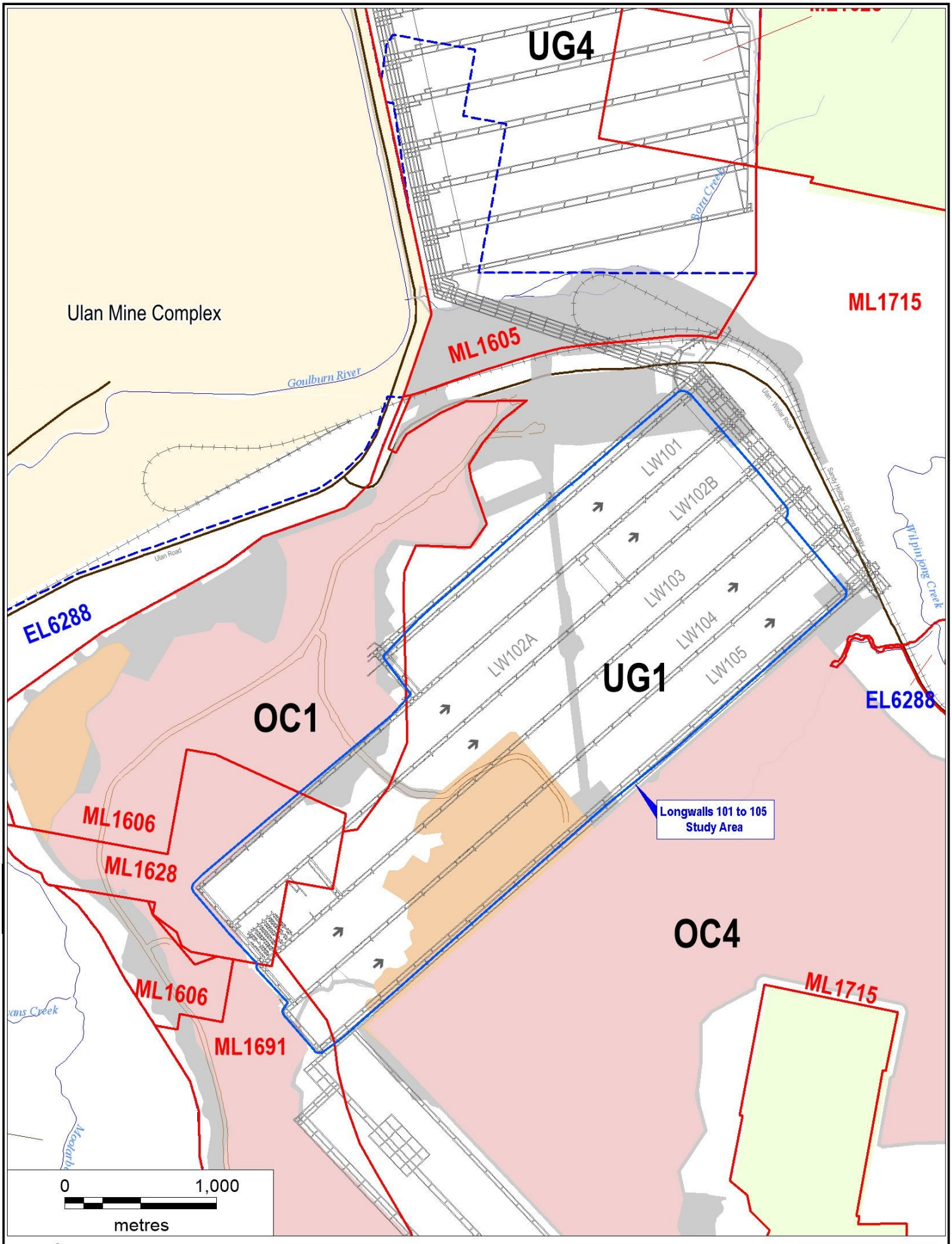


Figure 3
UG1 Longwalls 101-105 Layout

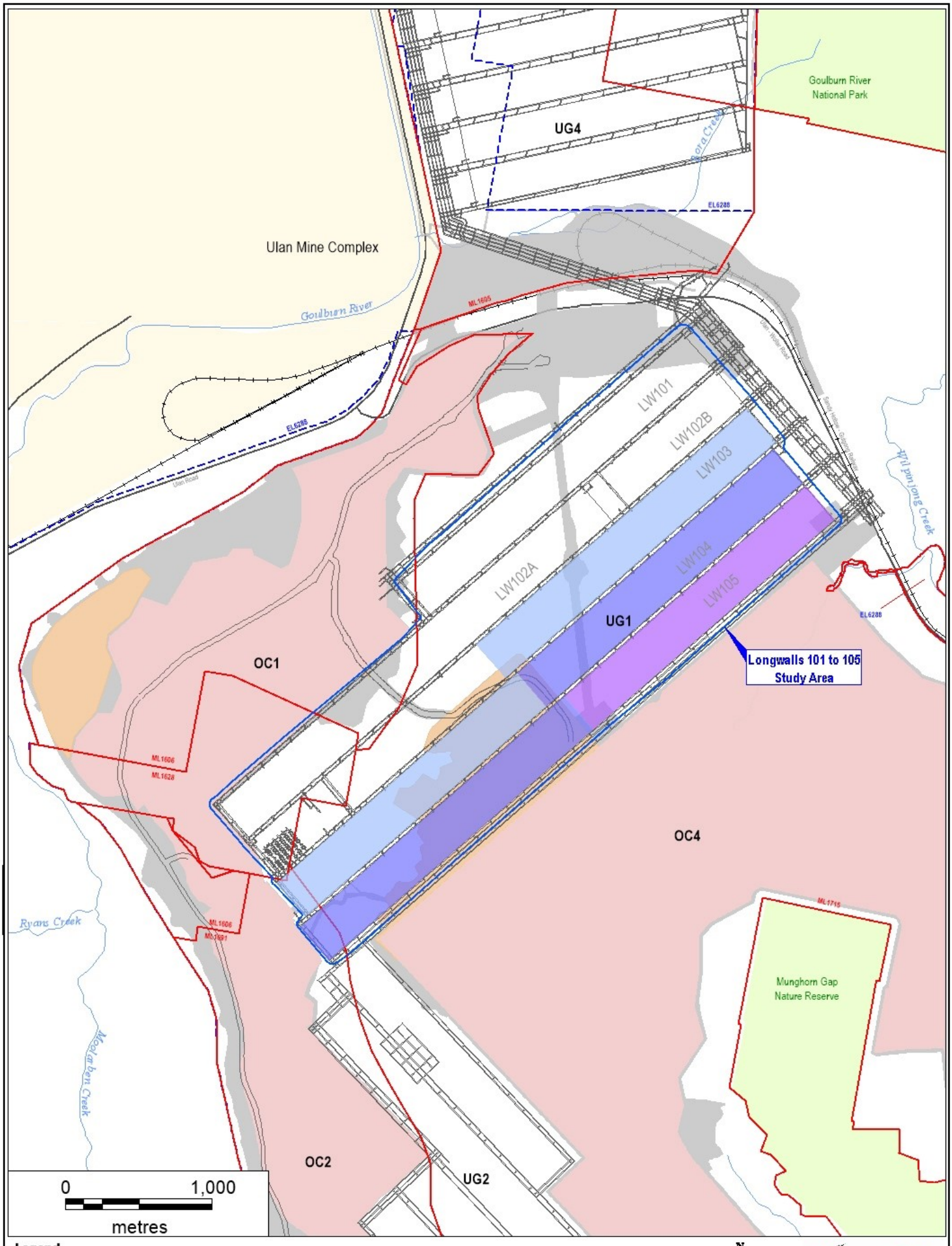


Figure 4
Longwalls 101 to 105 Layout and Approximate Mine Progression

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 UG1 mining area during the secondary extraction of Longwalls 101 to 105 (herein referred to as Longwalls 101-105).

Since the original Extraction Plan approval on the 21 September 2017, an igneous intrusion (plug) and associated dykes have been defined near the southwestern end of the approved Longwall 103 footprint. The intrusion prevents economic resource extraction by Longwall mining methods. MCO revised the mine plan to incorporate a relocated Longwall 103 installation position and a mining First-Workings Plunge Panel where Longwall extraction is not viable. These changes were approved on the 28 March 2019 in the first Extraction Plan amendment.

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

This Extraction Plan has been prepared in consideration of the NSW Department of Planning and Environment (DP&E) and NSW Division of Resources and Energy (DRE) (2015) draft *Guidelines for the Preparation of Extraction Plans*.

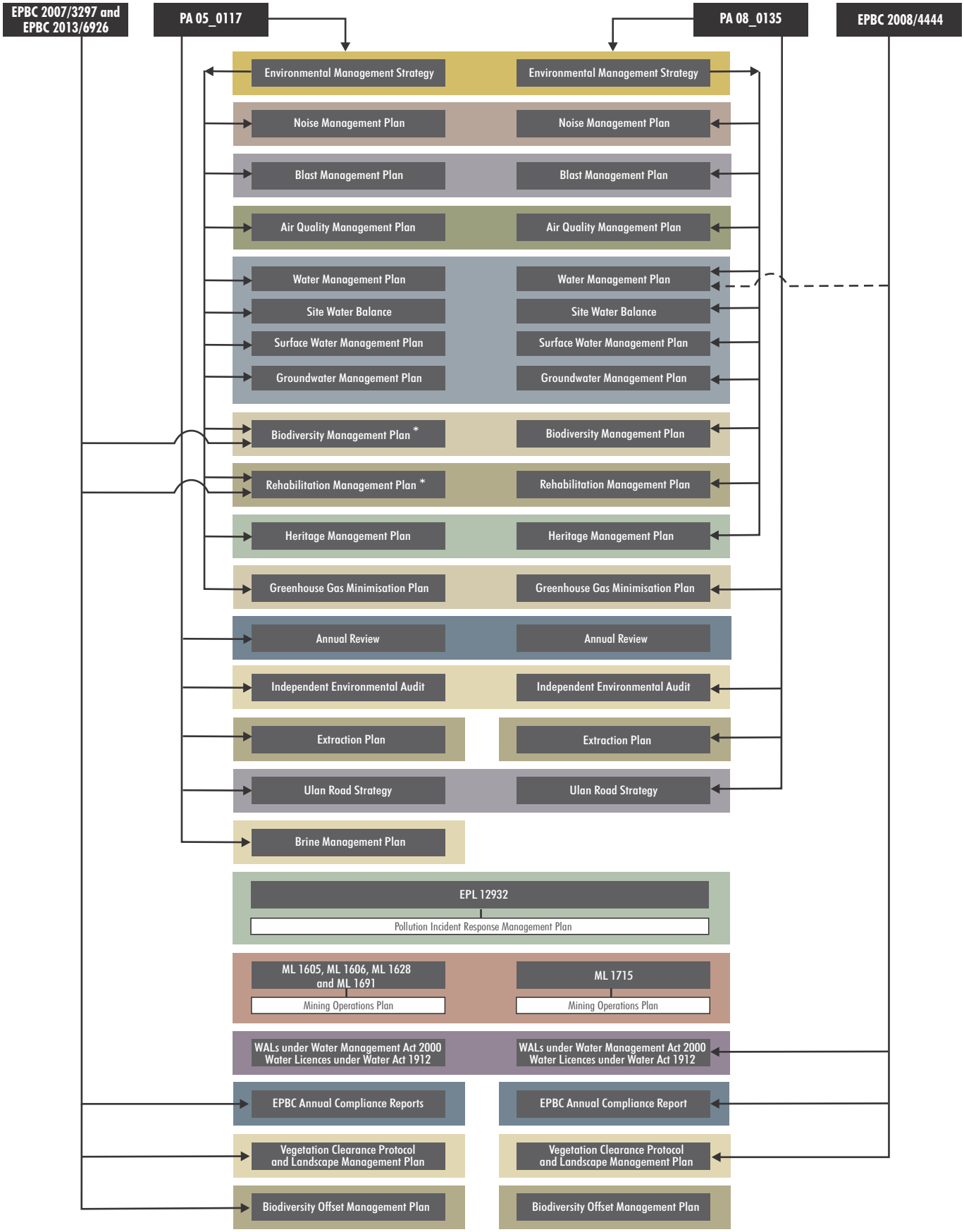
The objectives of this Extraction Plan are to:

- provide detailed plans of Longwalls 101-105;
- outline potential subsidence effects, subsidence impacts and environmental consequences due to the extraction of Longwalls 101-105;
- 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), SLR, WRM Water & Environment (WRM), Eco Logical Australia Pty Ltd (Eco Logical) and Niche Environment and Heritage (Niche). The appointment of the suitably qualified and

experienced persons has been endorsed by the Secretary of the Department of Planning, Industry and Environment (DPIE) in December 2015, November 2016 and December 2019.

This Extraction Plan forms part of MCO's Environmental Management Strategy. The relationship of this Extraction Plan to the MCO Environmental Management Structure is shown in Figure 5.



* To replace Landscape Management Plan

MOOLARBENCOAL

MOOLARBEN COAL COMPLEX

Environmental Management System
Structure Summary

Figure 5

1.2.1 Statutory Requirements

Project Approval (08_0135)

This Extraction Plan has been prepared in accordance with Conditions 5 and 6, Schedule 4 of Project Approval (08_0135) (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 (08_0135) (as modified) is provided in Attachment 1.

Mining Leases

Longwalls 101-105 are located within ML 1606, ML 1628, ML 1691 and ML 1715 (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), Stage 2 Project Approval (08_0135) (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)* (MOP) approved by the DPIE 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 will be required prior to the commencement of MCO activities that differ from those currently licensed.
- Water Access Licenses issued by the NSW Department of Primary Industries – Water (DPI-Water) under the NSW *Water Management Act, 2000*.
- Mining and occupational health and safety related approvals granted by the Resources Regulator and SafeWork NSW.

Table 1: Extraction Plan Requirements

Project Approval (08_0135) Condition	Extraction Plan Reference
Condition 5, Schedule 4	
5. *The Proponent shall prepare and implement an Extraction Plan for all second workings on site to the satisfaction of the Secretary. Each extraction plan must:*	This Document
(a) *be prepared by suitably qualified and experienced persons whose appointment has been endorsed by the Secretary;*	Section 1.3 and Attachment 2
(b) *be approved by the Secretary before the Proponent carries out any of the second workings covered by the plan;*	Section 1.3
(c) *include detailed plans of existing and proposed first and second workings and any associated surface development;*	Section 1.5 and Appendix G
(d) *include detailed performance indicators for each of the performance measures in Tables 18 and 19;*	Section 3 and Appendices A to G
(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;*	Section 2.1 and Technical Reports 1 to 5
(f) *describe the measures that would be implemented to ensure compliance with the performance measures in Tables 18 and 19, and manage or remediate any impacts and/or environmental consequences;*	Section 3 and Appendices A to G
(g) *include a Built Features Management Plan, which has been prepared in consultation with DRE and the owners of affected public infrastructure, to manage the potential subsidence impacts and/or environmental consequences of the proposed second workings, and which:* • *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;*	Appendix E
(h) *include a Water Management Plan, which has been prepared in consultation with EPA and DPI Water, which provides for the management of the potential impacts and/or environmental consequences of the proposed second workings on watercourses and aquifers, including:* • *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;* • *a program to:* – *confirm the location and saturated extent of the palaeochannel adjacent to the extents of underground 1 second workings, including drilling of additional investigation bores;* – *validate, and if necessary revise, the groundwater model for the palaeochannel; and*	Appendix A

Table 1 (Continued): Extraction Plan Requirements

Project Approval (08_0135) Condition	Extraction Plan Reference
Condition 5, Schedule 4 (Continued)	
– *monitor and report on the groundwater impacts of underground 1 second workings on the palaeochannel; and a program to monitor and report on the predicted groundwater impacts on the paleochannel adjacent to underground 1 boundary; and*	Appendix A
(i) include a Biodiversity Management Plan, which has been prepared in consultation with OEH, 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;	Appendix C
(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;	Appendix B
(k) include a Heritage Management Plan, which has been prepared in consultation with OEH 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;	Appendix D
(l) include a Public Safety Management Plan, which has been prepared in consultation with DRE, to ensure public safety in the mining area;	Appendix F
(m) include a Subsidence Monitoring Program, which has been prepared in consultation with DRE, to: • *describe the on-going subsidence monitoring program;* • *provide data to assist with the management of the risks associated with subsidence;* • *validate the subsidence predictions;* • *analyse the relationship between the predicted and resulting subsidence effects and predicted and resulting impacts under the plan and any ensuing environmental consequences; and* • *inform the contingency plan and adaptive management process*	Appendix G
(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;	Section 4.1 and Appendices A to F
(o) proposes appropriate revisions to the Rehabilitation Management Plan required under condition 56 of Schedule 3; and	Section 3.3
(p) include a program to collect sufficient baseline data for future Extraction Plans. *Note: To identify the longwall mining domains referred to in this condition, see Appendix 2.*	Attachment 3 and Appendices A to F
Condition 6, Schedule 4	
6. The Proponent shall ensure that the management plans required under conditions 5(g)-(l) above include: *(a) an assessment of the potential environmental consequences of the Extraction Plan, incorporating any relevant information that has been obtained since this approval; and* *(b) a detailed description of the measures that would be implemented to remediate predicted impacts.*	Appendices A to F

1.3 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 G 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 2 Project Approval (08_0135), draft *Guidelines for the Preparation of Extraction Plans* (DP&E and DRE, 2015) and mining leases, and provides the relevant section of this Extraction Plan where the 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	UG1 Longwalls 101 to 105 Water Management Plan (LW101-105 WMP)
Appendix B	UG1 Longwalls 101 to 105 Land Management Plan (LW101-105 LMP)
Appendix C	UG1 Longwalls 101 to 105 Biodiversity Management Plan (LW101-105 BMP)
Appendix D	UG1 Longwalls 101 to 105 Heritage Management (LW101-105 HMP)
Appendix E	UG1 Longwalls 101 to 105 Built Features Management Plans (LW101-105 BFMPs)
Appendix F	UG1 Longwalls 101 to 105 Public Safety Management Plan (LW101-105 PSMP)
Appendix G	UG1 Longwalls 101 to 105 Subsidence Monitoring Program (including Plans 1 to 7) (LW101-105 SMP)

This Extraction Plan is also supported 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

1.4 MINE PLANNING AND DESIGN

1.4.1 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 (Wells Environmental Services, 2008).

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 UG1 Underground Mine will extract coal from the Ulan Seam, targeting the low ash D working section (DWS) ply. 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 (Wells Environmental Services, 2008).

Narrabeen Group sediments (sandstones and conglomerates) of Triassic age (approximately 200 to 250 million years before present) overlie the coal measures, which in turn overlie older basement rocks of sedimentary (Shoalhaven Group) and igneous origin. Small intrusive plugs and remnant Tertiary-age (approximately 5 to 65 million years before present) basalt flows also outcrop in the area. Unconsolidated and partially consolidated Tertiary-age palaeochannel and Quaternary-age (less than approximately 5 million years before present) sediments occur as valley fill and along dominant drainage lines (Wells Environmental Services, 2008).

Within the Stage 2 Project Area, the Narrabeen Group sediments and basalt flows form low relief ridge and plateau features. In these areas, coal will be extracted using underground mining methods (Wells Environmental Services, 2008).

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 (Wells Environmental Services, 2008). 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.

1.4.2 Mining Geometry and Parameters

The Longwalls 101-105 Study Area[1] and mine plan is shown in Figure 3 with key dimensions summarised in Table 2. Detailed mine layout drawings are provided in Plans 1 to 7 (Appendix G).

Table 2: Key Mining Parameters

Dimension	Longwall 101	Longwall 102A	Longwall 102B	Longwall 103	103 Plunge Panel	Longwall 104	Longwall 105
ROM Coal Extracted (Mt)	3.7	4.4	1.5	5.4	0.1	6.3	6.4
Gate Road Width (m)	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
MG Chain Pillar Width (m)	19.6	19.6	19.6	19.6	NA	19.6	19.6
TG Chain Pillar Width (m)	-	19.6	19.6	19.6	NA	19.6	19.6
Interplunge Pillar Width (m)	NA	NA	NA	NA	≥10.5	NA	NA
Longwall Void Width (m)	310.8	310.8	310.8	310.8	NA	310.8	310.8
Longwall Void Length (m)	2,561	3,292	1,060	3,831	NA	4,469	4,544
Plunge Length (m)	NA				15	NA	
Extraction Height (m)	3.2 to 3.5				3.4	3.2 to 3.5	
Depth of Cover (m)	47 to 165				80-120	50 to 145	

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

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

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

A second geological intrusion has been located at the commencing end of LW103 preventing viable extraction by longwall mining methods in this area. As a consequence, the LW103 commencing position has been moved outbye of the influence of this structure, and a first workings and plunge panel has been established to partially extract the remanent coal that would otherwise become sterilised.

LW104 commencing end has also been shortened by 70m to facilitate the installation of a rear panel ventilation shaft and associated roadway.

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

1.4.3 Mining Method

Access to the UG1 Longwalls 101-105 is from the OC1 highwall. The extraction of Longwalls 101-105 will occur from west to east. Longwalls 101-105 will be extracted using retreating longwall mining methods for secondary extraction of panels approximately 311 m wide (void width). 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 tailgate and maingate roads will be separated by the approximately 300 m wide longwall panel. 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.

The 103 Plunge Panel operates essentially as a first workings panel utilising continuous miners. Partial extraction is afforded by taking plunges of up to 15 m length from either side of the “run outs”. The “run outs” are supported using roof bolts in a conventional manner, and once connected provide flood ventilation for the plunging process. The plunges remain unsupported and access into by personnel is prevented. Coal continues to be transported by shuttle cars and conveyors as with maingate 103 development.

The width of the plunges (5.4m) and distance between plunges (9.6m) and "run outs" (>10.5m) has been assessed to provide a long term stable environment. Extraction height is to a maximum of 3.4m for operational and coal quality purposes.

1.4.4 Mine Schedule

The Moolarben Coal Complex is approved to operate seven days a week, 24 hours a day. Longwalls 101-105 are the first longwalls to be extracted at the Moolarben Coal Complex. The provisional extraction schedule for Longwalls 101-105 is provided in Table 3.

Table 3: Provisional Extraction Schedule

Panel	Estimated Start Date	Estimated Duration	Estimated Completion Date
LW101	October 2017		Complete June 2018
LW102 (A+B)	August2018		Complete August 2019
LW103	September 2019	9 months	June 2020
103 Plunge	April 2019		Complete July 2019
LW104	July 2020	12 months	June 2021
LW105	July 2021	11 Months	May 2022

Open cut operations (OC1 and OC2) are located in the vicinity of the Longwall 102A tailgate and Longwall 102A and Longwalls 103-105 commencing ends. OC4 open cut is adjacent to Longwall 105 with out of pit emplacement over Longwalls 104 and 105. This emplacement has been considered in the pillar loading and subsidence assessments. Open cut operations would not occur simultaneously with longwall mining in the immediate proximity of the adjacent longwall panel (Figure 4).

1.4.5 Previous and Future Mining

Previous and future workings in the vicinity of Longwalls 101-105 are shown on Figure 4 and in Plans 1, 3 and 7 (Appendix G).

Previous workings in the vicinity of Longwalls 101-105 include OC1, OC2 and OC4.

Currently there are no plans for mining other coal seams at Moolarben UG1 Underground Mine.

1.5 SUBSIDENCE PREDICTIONS

A review of predictions of subsidence impacts and effects for Longwalls 101-103 was conducted by MSEC (2017). Updated assessments (MSEC, 2019 & 2020) were provided for the revised Extraction

Plan Layout in consideration of the Longwall 103 commencing position move and LW104 and LW105 layouts.

Mine Advice (2019) have assessed the subsidence and long term stability of the 103 Plunge Panel within the already approved extraction area of the Extraction Plan Layout.

1.5.1 Predicted Conventional Subsidence Movements

The maximum predicted conventional subsidence parameters resulting from the extraction of Longwalls 101 to 105 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, 2017).

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 101 to 105

Longwall	Subsidence[1] (mm)	Tilt[2] (mm/m)	Hogging Curvature[3] (km^{-1})	Sagging Curvature[3] (km^{-1})
Longwall 101	2250	65	> 3	> 3
Longwall 102A	2200	> 100	> 3	> 3
Longwall 102B	2150	45	2.1	1.5
Longwall 103	2250	70	> 3	> 3
Longwall 104	2250	90	>3	>3
Longwall 105	2150	85	>3	>3

Source: after MSEC (2020).

[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 6 provides incremental subsidence contours for Longwalls 101-105.

Table 5: Maximum Predicted Total Conventional Subsidence, Tilt and Curvature after the Extraction of Each of Longwalls 101 to 105

Longwall	Subsidence (mm)	Tilt (mm/m)	Hogging Curvature (km^{-1})	Sagging Curvature (km^{-1})
Longwall 101	2250	65	> 3	> 3
Longwall 102A	2400	> 100	> 3	> 3
Longwall 102B	2400	> 100	> 3	> 3
Longwall 103	2400	> 100	> 3	> 3
Longwall 104	2400	>100	>3	>3
Longwall 105	2400	>100	>3	>3

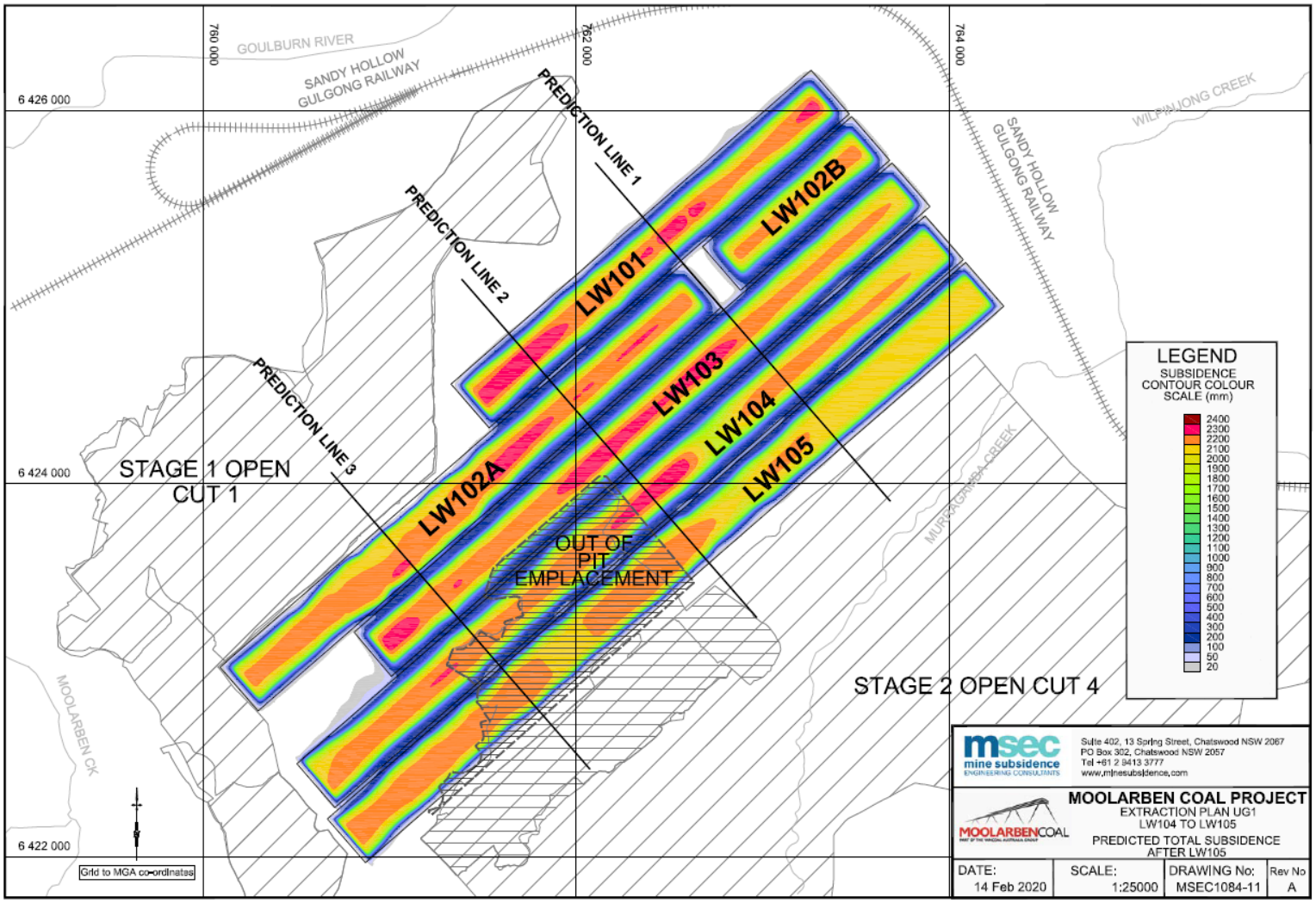
Source: after MSEC (; 2020).

The predictions of conventional subsidence parameters do not include the valley related upsidence and closure movements, or the effects of faults and other geological structures.

The 103 Plunge Panel was designed to provide a long term stable and non-subsiding (<20mm) environment despite the area having existing subsidence approval for full extraction with up to 2400mm of subsidence anticipated (MSEC, 2017). The minimum pillar dimensions between plunges of adjacent "run outs" results in a conservative Factor of Safety of 2.89 as a minimum (Mine Advice 2019), and are thus considered long term stable. Subsidence associated with elastic pillar compression of the same pillars is anticipated to be up to 16mm, being generally less than survey accuracy and within the range of natural ground movements.

1.5.2 Non-Conventional Ground Movements

MSEC (2017; 2020) 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 (MSEC, 2017; 2020).



Source; MSEC (2020)

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Predicted Subsidence
After Longwall 105
Figure **6**

1.5.3 Potential for Increased Subsidence between Longwalls 102A and 102B

It is possible that some vertical subsidence could be observed above the barrier pillar. There have been a number of examples in NSW where subsidence monitoring has shown increased vertical subsidence of the surface in areas that are located directly above an isolated coal barrier. Magnitudes of settlement have been observed between 50 and 150 mm above an isolated coal barrier which is greater than predicted using the Standard Incremental Profile Method (MSEC, 2017).

While observed subsidence may exceed predictions for the coal barrier, subsidence monitoring has shown that it is usually accompanied by relatively low conventional tilts, curvature and strains. The potential for impacts above the coal pillar, therefore, do not significantly change (MSEC, 2017).

1.5.4 Predicted Far-Field Movements

In addition to the conventional subsidence movements that have been predicted above and adjacent to Longwalls 101 to 105, it is also likely that far-field horizontal movements will be experienced during the extraction of the longwalls (MSEC, 2017; 2020).

Based on an empirical model, the impacts of far-field horizontal movements on the natural features and items of surface infrastructure within the vicinity of Longwalls 101-105 are expected to be insignificant, except where they occur at large structures, such as railway lines, which may be sensitive to small differential movements (MSEC, 2017; 2020).

The LW101-105 BFMPs have been developed to manage the potential impacts of far-field movements on relevant infrastructure.

Influence of the Palaeochannel near UG1 on Horizontal Far-field Movements

Tertiary palaeochannel deposits, which are remnants of inactive river and stream channels that have later been filled in or buried by younger sediments, have been recognised in the Goulburn River diversion (at Ulan) and in the Murragamba and Wilpinjong creek valleys, with a maximum thickness of 40 m to 50 m. Drilling investigations have determined that the extent of the saturated palaeochannel is outside the Longwall 101-103 footprint and extends over portions of the Longwall 104-105 footprint, as described in the *Moolarben Coal Complex Extraction Plan Longwalls 101-105 Technical Report (SLR, 2020).*

The presence of these palaeochannel deposits should result in reduced far-field movements within and beyond these channels (MSEC, 2017; 2020).

Influence of the Open Cut on Horizontal Far-field Movements

Open cut mining areas (OC1, OC2 and OC4) are currently in operation and are located to the north, west and south of Longwalls 101-105 (Figure 3). The open cut pits extract the overburden material and the target coal seam (i.e. down to the seam floor level of Longwalls 101-105). The effect of the removal of this material is to relieve or redistribute much of the in situ stress in the overburden strata adjacent to the pit. With the removal of the overburden material, the potential for far-field effects to develop in the vicinity of the pit are significantly reduced (MSEC, 2017; 2020).

The open cuts have been progressively backfilled with overburden material with mining progression. Potential for far-field movements where the open cut pit has been backfilled between the longwalls and the outer natural overburden is expected to be significantly reduced, similar to the open cut pit, as the backfilled material is unlikely to support any significant stress redistribution (MSEC, 2017;2020).

1.6 SUBSIDENCE IMPACT PERFORMANCE MEASURES

Project Approval (08_0135) (as modified) requires MCO to ensure the project does not cause any exceedances of the subsidence impact performance measures outlined in Table 18, Condition 1, Schedule 4 and Table 19, Condition 3, Schedule 4. The subsidence impact performance measures are detailed in Table 6.

Not all of the natural, heritage and built features listed in Table 6 are relevant to Longwalls 101-105 . Table 6 provides a description of the features relevant to the subsidence impact performance measures for the Extraction Plan Layout.

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

Subsidence Impact Performance Measure		Relevance to UG1 Longwalls 101 to 105 Extraction Plan
Water Resources		
Drainage Lines (DL1 – DL7)	*No greater subsidence impacts or environmental consequences than predicted in the EA*	Drainage Line DL6 & DL7 are predicted to be impacted by Longwalls 101-105.
Land		
Cliffs C7, C9 and C10	*Negligible environmental consequences (that is occasional rockfalls, displacement or dislodgement of boulders or slabs or fracturing, that in total do not impact more than 0.5% of the total face of such cliffs within any longwall mining domain)*	**Not relevant.** Cliffs C7, C9 and C10 are not located within the Longwalls 101-105 Study Area.

Table 6 (Continued):

Subsidence Impact Performance Measure		Relevance to UG1 Longwalls 101 to 105 Extraction Plan
Land		
Other cliffs	*No greater subsidence impacts or environmental consequences than predicted in the EA*	Cliffs C5 and C6 are located within the Longwalls 101-105 Study Area.
Minor cliffs *Rock face features* *Steep slopes*	*Minor environmental consequences (that is, occasional rockfalls, displacement of or dislodgement of boulders or slabs, or fracturing, that in total do not impact more than 5% of the total face area of each such type of features within any longwall mining domain)*	Minor cliffs, rock face features and steep slopes are located in the Longwalls 101-105 Study Area.
Biodiversity		
Threatened species, threatened populations, or endangered ecological communities	*Negligible subsidence impacts or environmental consequences*	Endangered ecological communities and habitat for threatened species are located within the Longwalls 101-105 Study Area.
Heritage Sites		
Aboriginal heritage sites S2MC 236 (AHIMS No.s 36-3-0016 and 36-3-0134)	*Negligible subsidence impacts or environmental consequences*	Not relevant. Aboriginal heritage sites S2MC 236 (AHIMS No.s 36-3-0016 and 36-3-0134) are not located within the Longwalls 101-105 Study Area.
Historic heritage sites	*No greater subsidence impact or environmental consequences than predicted in the EA*	Historic Heritage Site 18 is located above Longwall 105.
Mine workings		
First workings under an approved Extraction Plan beneath any feature where performance measures in this table require negligible subsidence impacts or negligible environmental consequences	*To remain long-term stable and non-subsiding*	First workings have been designed to meet the requirements of Condition 7, Schedule 4 of Project Approval (08_0135).
Second workings	*To be carried out only in accordance with an approved Extraction Plan*	Second workings will be carried out in accordance with an approved Extraction Plan.
Key public infrastructure:		
Gulgong-Sandy Hollow Railway Line *Ulan-Wollar Road*	*Always safe and serviceable.* *Damage that does not affect safety or serviceability must be fully repairable, and must be fully repaired.*	The Sandy Hollow Gulgong Railway Line and Ulan-Wollar Road are located outside the Longwalls 101-105 Study Area, but may be subject to far-field horizontal movements and non-conventional ground movements.

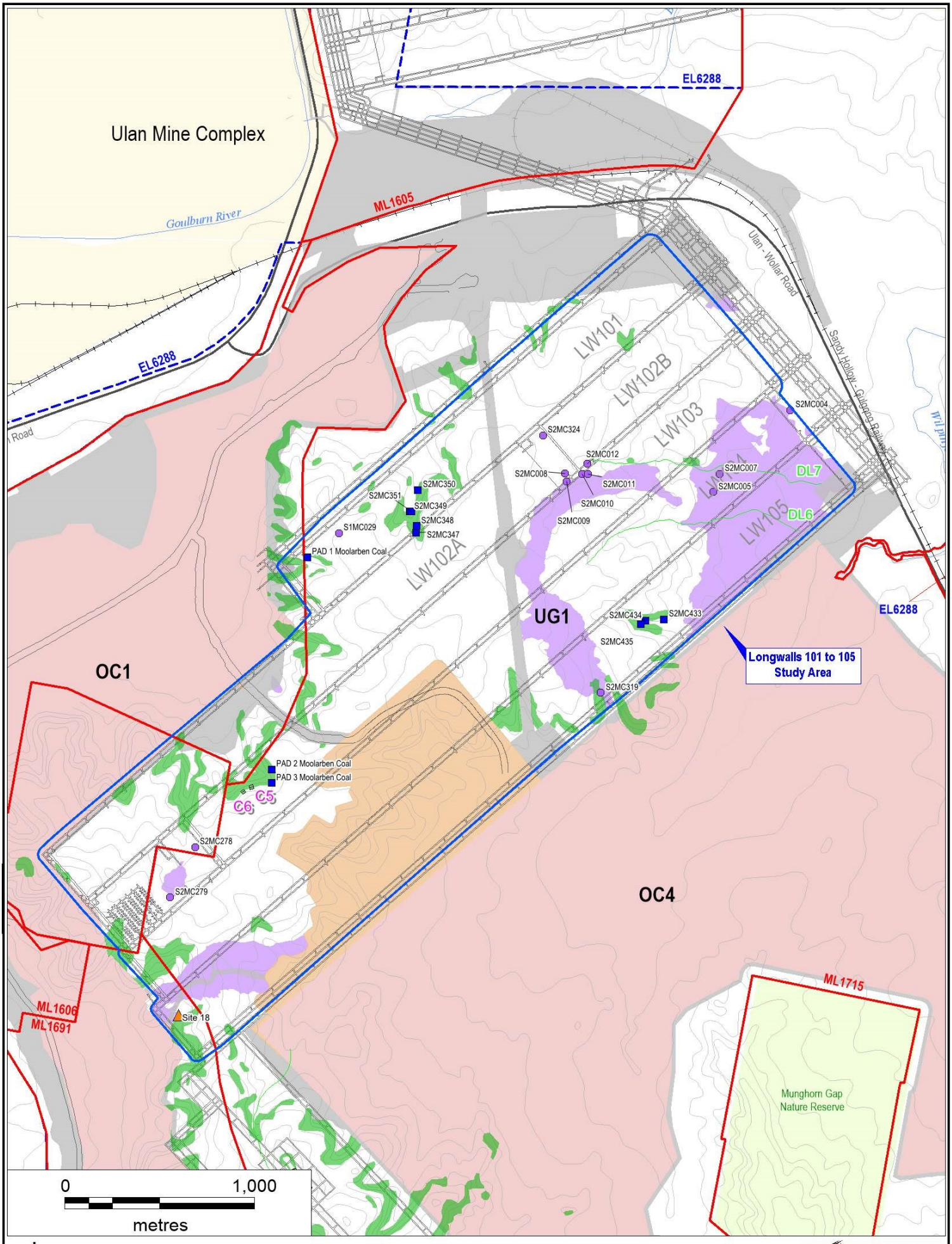
Table 6 (Continued):

Subsidence Impact Performance Measure		Relevance to UG1 Longwalls 101 to 105 Extraction Plan
Other infrastructure:		
Murragamba Road *Low voltage electricity power line*[1]	*Always safe.* *Serviceability should be maintained wherever practicable. Loss of serviceability must be fully compensated.* *Damage must be fully repairable, and must be fully repaired or else replaced or fully compensated.*	Murragamba Road is closed to the public. The low voltage electricity power line (66 kilovolt [kV]/22 kV dual circuit powerline) is located 60 m or more from Longwalls 101-105 and outside the Longwalls 101-105 Study Area, but may be subject to far-field horizontal movements and non-conventional ground movements. .
Telecommunication cable *Fibre-optic cable* *Murragamba Trig Station*	*Serviceability should be maintained wherever practicable. Loss of serviceability must be fully compensated.* *Damage must be fully repairable, and must be fully repaired or else replaced or fully compensated.*	The telecommunication cable and optical fibre cable are located outside the Longwalls 101-105 Study Area, but may be subject to far-field horizontal movements and non-conventional ground movements. The Murragamba Trig Station is located over LW105 and will be subject to full conventional subsidence parameters
Other built features and improvements, including fences	*Serviceability should be maintained wherever practicable. Loss of serviceability must be fully compensated.* *Damage must be fully repairable, and must be fully repaired or else replaced or fully compensated.*	The TransGrid power line is located outside the Longwalls 101-105 but may be subject to far-field horizontal movements and non-conventional ground movements. No other non-mine owned built features and improvements are located within the Longwalls 101-105 Study Area.
Public Safety		
Public safety	*Negligible additional risk*	Public safety is considered in the LW101-105 PSMP.

Source: after Table 18, Condition 1 and Table 19, Condition 3, Schedule 4 of Project Approval (08_0135).

[1] Low voltage powerline refers to the 66 kV/22 kV dual circuit powerline.

Natural, heritage and built features relevant to this Extraction Plan are illustrated on Figure 7, Figure 8 and Figure 9.



gend

- Exploration Licence Boundary
- Mining Lease Boundary
- Haul Road
- Rail Line
- Watercourse
- Contour

Existing / Approved Development

- Open Cut Mining Area
- Underground Workings
- Out-of-Pit Emplacement
- Surface Infrastructure

- Longwalls 101 to 105 Study Area
- Clifflines and Steep Slopes
- Cliffs
- EEC Communities
- Drainage Lines

Aboriginal Heritage Sites

- Open Artefact / Isolated Find
- PAD / Rock Shelter

European Heritage Sites

- European Heritage Site

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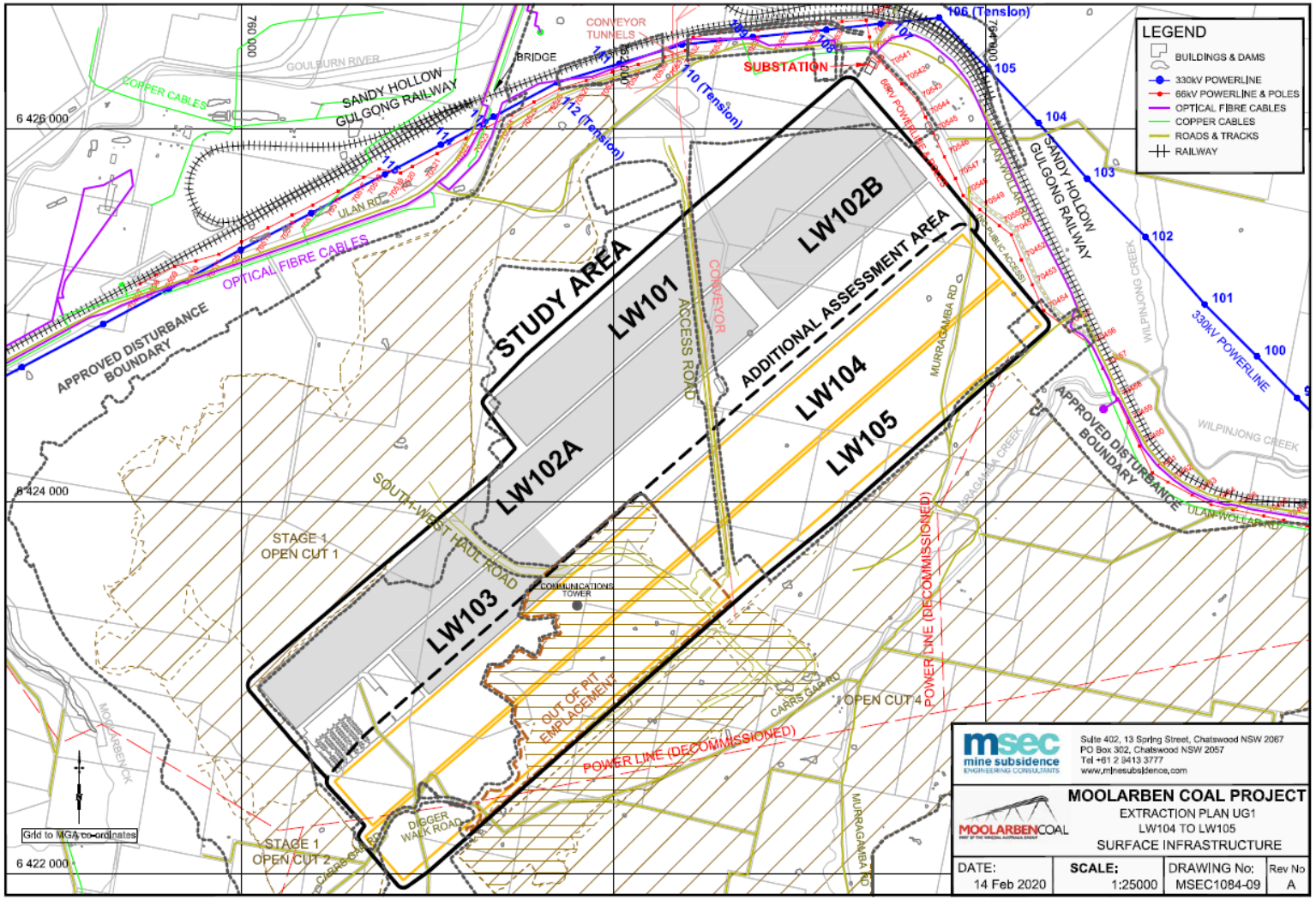
Figure 7
Natural Features &
Known Heritage Sites



Source; MSEC (2020)

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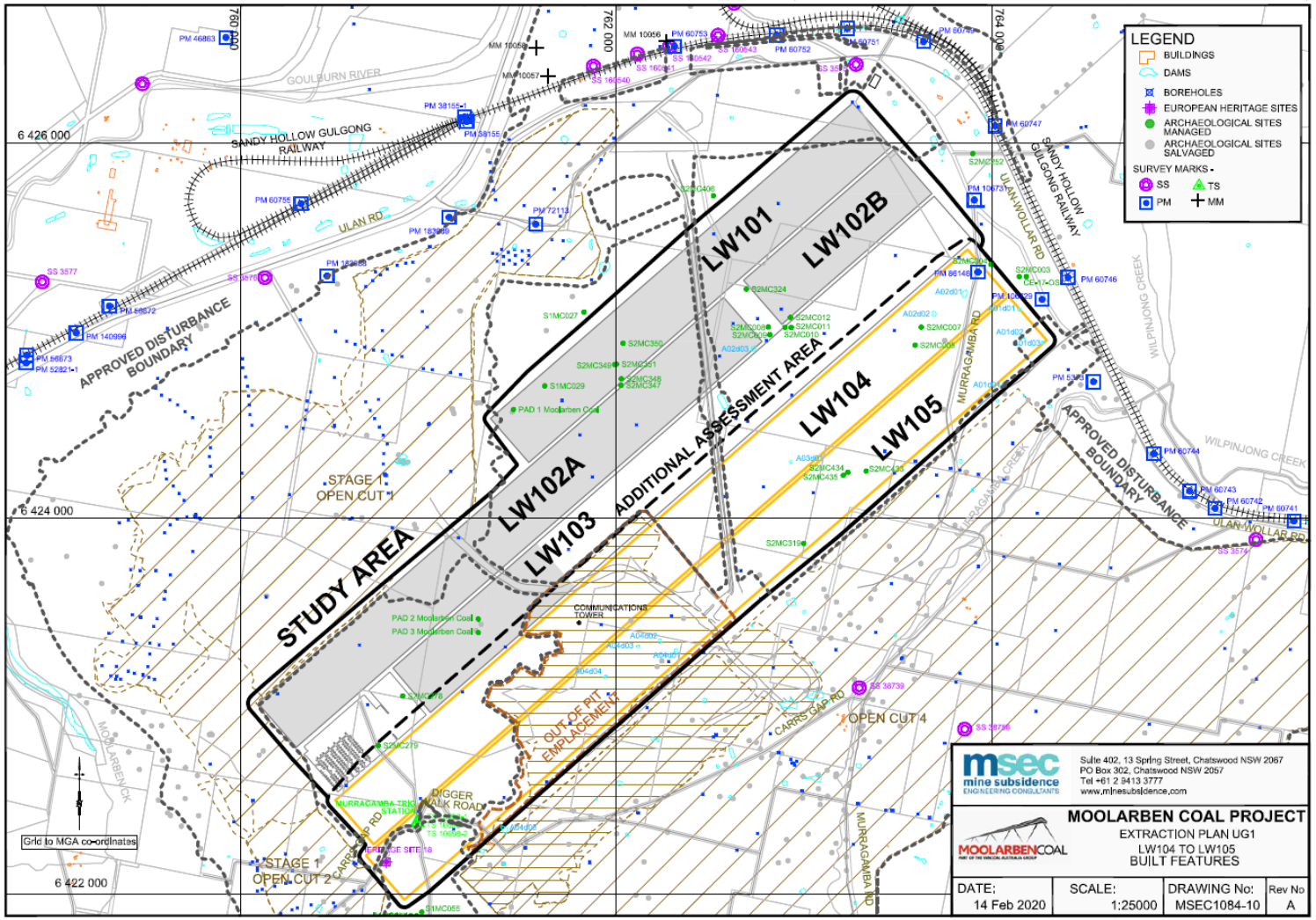
Surface Infrastructure
in the Vicinity of Longwalls 101-105

Figure 8



Source; MSEC (2020)

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Built Features
in the Vicinity of Longwalls 101-105

Figure 9

Drainage Lines (DL1 – DL7)

Four minor ephemeral drainage lines were identified by MSEC (2015) within the UG1 Study Area (i.e. associated with Longwalls 101-105) as part of the Subsidence Assessment for the *UG1 Optimisation Modification Environmental Assessment* (UG1 Optimisation Modification). All drainage lines identified in the vicinity of the Longwalls 101-105 Study Area are ephemeral as water only flows during, and for short periods after, each rain event (MSEC, 2015; 2020).

Of the drainage lines identified within the UG1 Study Area, onlyDL6 and DL7 will be impacted by Longwalls 101-105. DL6 and DL7 are tributaries of Murragamba Creek, which flows into Wilpinjong Creek.

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

Further detail on drainage lines is provided in Section 3.1 and Appendix A.

Cliffs C7, C9 and C10

Cliffs C7, C9 and C10 are not located in the vicinity of the Longwalls 101-105 Study Area, and are not considered further in this Extraction Plan.

Other Cliffs

Six cliffs (cliffs C1 to C6) were identified by MSEC (2015) within the UG1 Study Area (i.e. associated with Longwalls 101-105) as part of the Subsidence Assessment for the *UG1 Optimisation Modification Environmental Assessment* (UG1 Optimisation Modification). The locations of the cliffs were determined from site inspections and 2 m surface contours.

Of the cliffs identified within the UG1 Study Area, only cliffs C5 and C6 lie within the Longwalls 101-105 Study Area.

Cliffs C1, C2, C3 and C4 are located within the approved out-of-pit emplacement or surface infrastructure and no longer exist. These cliffs have not been considered further in this Extraction Plan.

Further detail on cliffs is provided in Section 3.2 and Appendix B.

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

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

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

Land in general refers to the general landscape other than cliffs, minor cliffs, rock face features and steep slopes. Land in general includes other land features such as fire trails and vehicular tracks, however excludes surface features such as drains, diversions, and other MCO assets including the conveyor trace, open cut highwalls and out-of-pit emplacements which are addressed elsewhere in the Extraction Plan. Unsealed vehicular tracks and fire trails are located throughout the UG1 Study Area and above Longwalls 101-105.

Further detail on minor cliffs, rock face features, steep slopes and land in general is provided in Section 3.2 and Appendix B.

Threatened Species, Threatened Populations, or Endangered Ecological Communities

Eco Logical (2016, 2020) have identified the following endangered ecological communities (EEC) and critically endangered ecological communities (CEEC), listed under either the NSW *Biodiversity Conservation Act, 1995* (BC Act) and/or under the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act), in the Longwalls 101-105 Study Area:

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

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

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

- *Diuris tricolor* (Pine Donkey Orchid) – vulnerable under the BC Act.
- *Eucalyptus cannonii* (Capertee Stringybark) – vulnerable under the BC Act.
- *Eucalyptus scoparia* (Wallangarra White Gum) – endangered under the BC Act and vulnerable under the EPBC Act.
- *Leucochrysum albicans* var *tricolor* (Hoary Sunray) – endangered under the EPBC Act.
- *Pomaderris queenslandica* (Scant Pomaderris) – endangered under the BC Act.

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

Across the Moolarben Coal Complex, a total of 32 threatened and/or migratory fauna species, consisting of seven mammal species (including six microbat species) and 25 bird species have been recorded by Moolarben Biota (2006), Ecovision (2008) and EMGA Mitchell McLennan (2013) at the Moolarben Coal Complex.

Only a subset of the threatened and migratory species recorded at the Moolarben Coal Complex has been recorded within the Longwalls 101-105 Study Area.

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

No groundwater dependent ecosystems (GDEs) have been identified in the Longwalls 101-105 Study Area.

Further detail on threatened species, threatened populations, and EECs is provided in Section 3.3 and Appendix C.

Aboriginal heritage sites S2MC 236 (AHIMS No.s 36-3-0016 and 36-3-0134)

Aboriginal heritage sites S2MC 236 (AHIMS No.s 36-3-0016 and 36-3-0134) are not located in the vicinity of Longwalls 101-105, and are not considered further in this Extraction Plan.

Further detail on Aboriginal heritage is provided in Section 3.4 and Appendix D.

Historic Heritage Sites

Historic heritage site 18 is located above longwall panel 105.

Sandy Hollow Gulgong Railway Line

The Sandy Hollow Gulgong Railway owned by the Australian Rail Track Corporation (ARTC) runs adjacent to Ulan-Wollar Road. The Sandy Hollow Gulgong Railway is located to the north and east of the Longwalls 101-105 Study Area and the nearest edge of the Longwalls 101-105 vary from approximately 255 m (Longwall 105) to 400 m (Longwall 101) from the rail track.

Further detail on the Sandy Hollow Gulgong Railway Line is provided in Section 3.5 and Appendix E.

Ulan-Wollar Road and Murragamba Road

Ulan-Wollar Road runs adjacent to the Sandy Hollow Gulgong Railway. The nearest publicly accessible sections of Ulan-Wollar Road to Longwalls 101-105 are approximately 250 m from Longwall 101 and 225 m from Longwall 105. The nearest closed sections of Ulan-Wollar Road are approximately 100 m from Longwall 103.

Additionally, sections of Murragamba Road and Carrs Gap Road directly overly Longwalls 101 to 105. These roads are closed to the public.

Further detail on Ulan-Wollar Road is provided in Section 3.5 and Appendix E.

Low Voltage Electricity Power Line[2]

A 66 kV/22 kV dual circuit powerline owned by Essential Energy runs adjacent to Ulan-Wollar Road and the Sandy Hollow Gulgong Railway Line.

The nearest sections of the 66 kV/22 kV dual circuit powerline are approximately 90 m from the northern (finishing) end of Longwall 103 (pole 70548) and 60 m from the finishing end of Longwall 105 (pole 70454). A substation is located within the Remote Services Infrastructure Facilities to the north of Longwall 101.

Further detail on the 66 kV/22 kV dual circuit powerline and substation is provided in Section 3.5 and Appendix E.

[2] Low voltage electricity power line refers to the Essential Energy 66 kilovolt (kV)/22 kV dual circuit powerline.

Telecommunication Cable and Fibre-Optic Cable

The telecommunication cables (i.e. the copper telecommunication cable and an optical fibre cable) are located to the north and east of the Longwalls 101-105 Study Area and are approximately 160m from Longwall 105 at their nearest point.

Further detail on the telecommunication cables is provided in Section 3.5 and Appendix E.

Murragamba Trig Station

A survey control mark is located above Longwall 105 within the Longwalls 101-105 Study Area (including the Murragamba Trig Station) and will be impacted by subsidence.

During mining, MCO will forward relevant notification details in regard to the destruction or disturbance of survey marks caused by extraction of Longwalls 101-105 to The Manager Survey Services, Land and Property Information (LPI) NSW in accordance with Appendix C of the *Surveyor General's Directions No.11 Preservation of Survey Infrastructure*.

It is understood that the Senior Surveyor will liaise with MCO and Subsidence Advisory NSW (formerly NSW Mine Subsidence Board [MSB]) regarding the re-establishment and/or replacement of the Murragamba Trig Station and/or other permanent marks, as necessary, on completion of subsidence.

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

It is recognised the 330 kV ETL is 'key public infrastructure' and therefore the same subsidence impact performance measures applicable to the Sandy Hollow Gulgong Railway Line and Ulan-Wollar Road will apply.

Further detail on the 330 kV ETL is provided in Section 3.5 and Appendix E.

Other Built Features and Improvements

Land within the UG1 Longwalls 101-105 Study Area is primarily owned by MCO, with a small section of Crown Land and council road easements (Figure 10).

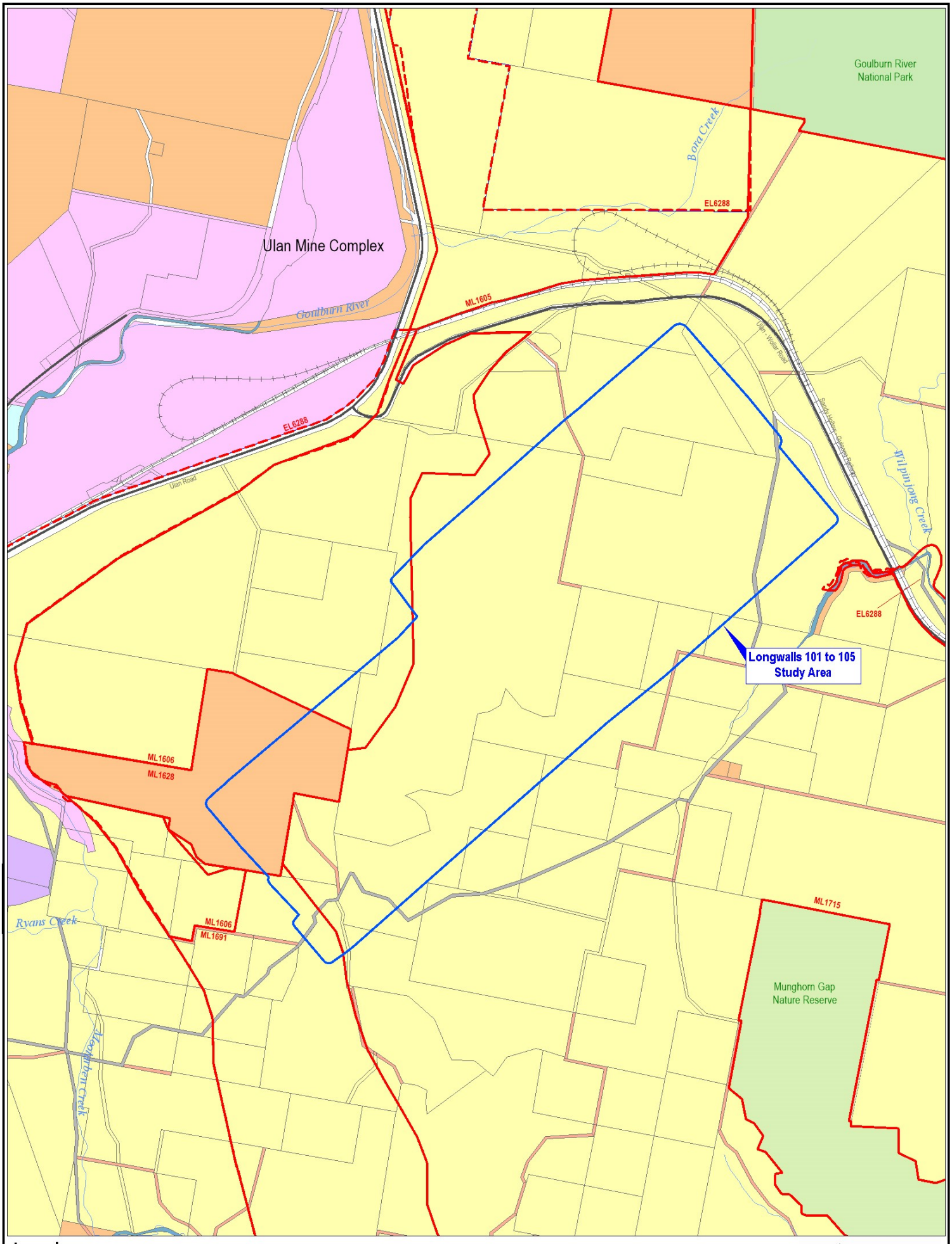
No other non-mine owned built features and improvements were identified within the Longwalls 101-105 Study Area.

Several MCO owned built features such as conveyors and haul roads, tanks, surface dams (that may be decommissioned or drained), are located on MCO owned land within the Longwalls 101-105 Study Area (MSEC 2020).

1.7 SUBSIDENCE MANAGEMENT APPROACH

Potential environmental consequences during the mining of Longwalls 101-105 will be managed in accordance with the relevant requirements of Project Approval (08_0135) and other approvals, through:

- **Mine Design** – the layout of Longwalls 101-105 and the 103 Plunge Panel has been developed to meet the subsidence impact performance measures.
- **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 3.8).
- **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 3.6).
- **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 to 3.6).
- **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).



Legend

- Exploration Licence Boundary
- Mining Lease Boundary
- Rail Line
- Watercourse
- Longwalls 101 to 105 Study Area
- Crown
- Moolarben Coal Operations Pty Ltd
- Privately Owned
- Ulan Coal Mines Limited
- National Park / Nature Reserve
- Commercial

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Figure 10
Land Ownership
in the Vicinity of Longwalls 101 to 105

2.0 DEVELOPMENT OF THE EXTRACTION PLAN

2.1 REVIEW OF PREDICTIONS

The predicted subsidence effects, subsidence impacts and environmental consequences of the Moolarben Coal Complex UG1 Underground Mine have been assessed, and subsequently approved, in the *Moolarben Coal Project Stage 2 Environmental Assessment Report* (Wells Environmental Services, 2008), the *Moolarben Coal Complex UG1 Optimisation Modification Environmental Assessment* (MCO, 2015).

The previously assessed and approved subsidence impacts and environmental consequences have been reviewed for the Extraction Plan Layout by MSEC (2017; 2020), HydroSimulations (2017), WRM (2017; 2020), Eco Logical (2017; 2020) Niche (2017; 2020), SLR (2020) (Technical Reports 1 to 5), and subsequently reviewed in MSEC (2019; 2020) and Mineadvice (2019) as a part of the Revised Extraction Plan Layout. This section describes the process of reviewing and updating these predictions.

2.1.1 Predicted Subsidence Effects and Subsidence Impacts

A subsidence assessment review for Longwalls 101-105 has been prepared in support of this Extraction Plan by MSEC (2017; 2019 and 2020) and Mineadvice (2019), with the outcomes of this assessment incorporated into the management plans in Appendices A to F.

Review of Subsidence Prediction Methodology

The predicted conventional subsidence parameters for Longwalls 101-105 were determined by MSEC (2017; 2020) 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 (MSEC, 2017; 2020).

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 (MSEC, 2017; 2020).

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. The standard Incremental Profile Method was calibrated using nearby monitoring sites that have similar geology (MSEC, 2017; 2020).

Mineadvice have assessed the first workings and pillars of the 103 plunge panel utilising an analytical model for elastic pillar compression as presented by Das (2010) and Ditton (2010).

Comparison with Previous Predictions of Subsidence Effects

Predicted subsidence parameters for Longwalls 101-105 were provided in the subsidence assessment prepared by MSEC (2015) in the *Moolarben Coal Complex UG1 Optimisation Modification Environmental Assessment* (MCO, 2015). Revised subsidence predictions associated with the shortening of LW103 and inclusion of 103 Plunge Panel are included in MSEC (2019) and Mine Advice (2019). A review of subsidence predictions for Longwalls 104 and 105 are included in MSEC (2020).

MSEC has prepared revised subsidence predictions for the Extraction Plan as described in Technical Report 1 and shown on Figure 6. These predictions are based on the actual layout presented in this Extraction Plan, which incorporates a barrier pillar separating Longwalls 102A and 102B. This barrier pillar is approximately 140 m in length. This amended Extraction Plan also includes the shortened Longwall 103 and 103 Plunge Panel.

The maximum vertical subsidence predicted by MSEC (Technical Report 1) is 2,400 mm, which is the same as the maxima presented in the *Moolarben Coal Complex UG1 Optimisation Modification Environmental Assessment* (MCO, 2015). The maximum tilt predicted by MSEC (Technical Report 1) is also the same as the maxima presented in the *Moolarben Coal Complex UG1 Optimisation Modification Environmental Assessment* (MCO, 2015), at greater than 100 mm/m. The maximum predicted subsidence effects due to the extraction of Longwall panel 103 do not change due to the modified commencing end and due to 103 Plunge Panel. However, the extent of the surface subsidence movements reduce. The predicted subsidence effects for the natural and built features reduce or do not change.

Mineadvice (2019) assessed the 103 Plunge Panel subsidence (Report 7) associated with elastic pillar compression of the to be up to 16 mm, being generally less than survey accuracy and within the range of natural ground movements.

In summary, MSEC (2017, 2020) concludes, "*the overall impact assessments for the natural and built features based on the Extraction Plan Layout are unchanged, or reduce compared to those based on the Approved Layout*". MSEC (2019) and Mineadvice (2019) further concluded that the impacts on natural and built features from shortening of Longwall 103 and extraction of the 103 Plunge Panel would remain unchanged, or reduce compared to those based on the Approved Layout.

Predicted Subsidence Impacts

Subsidence impacts predicted by MSEC (2017; 2020) above Longwalls 101-105 include surface cracking, heaving, buckling, humping and stepping. 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, 2017; 2020).

The revised subsidence impacts predicted by MSEC (Technical Report 1) are the same or less than the predictions for the *Moolarben Coal Complex UG1 Optimisation Modification Environmental Assessment* (MCO, 2015).

2.1.2 Potential Environmental Consequences

Detailed discussion of potential environmental consequences is provided in the management plans in Appendices A to F and Section 3.

The suitably qualified experts (endorsed by the Secretary of the DPIE) conducted a review of the potential environmental consequences due to the extraction of Longwalls 101-105 for the preparation of each management plan. The reviews concluded that there are no additional potential subsidence impacts or environmental consequences resulting from the extraction of Longwalls 101-105 compared to those assessed and approved for the UG1 Optimisation Modification (MCO, 2015).

2.2 RISK ASSESSMENT

In accordance with the DP&E and DRE (2015) draft *Guidelines for the Preparation of Extraction Plans*, a number of risk assessments have been undertaken for this Extraction Plan to ensure that appropriate consideration was given to risk assessment and risk management in each component management plan. The risk assessments were reviewed for the Revised Extraction Plan layout and found to be appropriate due to the reduced level of predicted impacts.

2.2.1 Environmental Risk Assessment

Environmental Risk Assessments (ERA) have been conducted for four of the key component plans of the UG1 Longwalls 101-103 Extraction Plan[3] *viz*. Water Management Plan, Land Management Plan, Heritage Management Plan and this Biodiversity Management Plan, to provide appropriate consideration to risk assessment and risk management in accordance with the draft DP&E and DRE (2015) *Guidelines for the Preparation of Extraction Plans*.

An ERA workshop for LW panels 101-103 was held on 8 December 2016 and reviewed in March 2019 to support the Longwalls 101-103 Extraction Plan Amendment and in consideration of the Revised Extraction Plan Layout. An ERA for LW panels 104-105 was held on 30 January 2020, facilitated by independent specialist, Risk Mentoring.

The suitably qualified and experienced experts endorsed by the Secretary of the DPI&E for the preparation of the UG1 Longwalls 101-105 Extraction Plan participated in the ERAs.

The ERA indicated that risks relevant to biodiversity in the Longwalls 101-103 and 104-105 panels 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 risk assessment meetings were held with each infrastructure owner[4] (facilitated by an independent specialist, AXYS Consulting) to inform the development of the LW101-103 BFMPs. These were subsequently reviewed by MCO and MSEC personnel on 29 January 2020 to account for the inclusion of Longwalls 104 and 105.

In summary, the investigation and analysis methods used during the risk assessments typically included:

- 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.

[3] Separate risk assessments have also been conducted for the built features in the vicinity of the UG1 Longwalls 101-105 Study Area and for public safety.

[4] With the exception of MWRC who advised MCO that a formal risk assessment was not required.

MCO considers all risk control measures and procedures to be feasible to manage all identified risks. Given the predicted impacts for Longwalls 104 and 105 are no greater than that assessed for Longwalls 101-103, existing risk controls measures were also considered appropriate. The risk control measures and procedures have been incorporated in the LW101-105 BFMPs (Appendix E).

MCO provided revised subsidence predictions for Longwalls 104-105 along with amended BFMP's to all Built Features infrastructure owners for consultation.

2.2.3 Moolarben Coal Operations Assets Risk Assessment

Separate risk assessments were held for MCO assets in the vicinity of Longwalls 101-103 and 104-105. The risk assessment for Longwalls 101-103 was held on 8 December 2016 and was facilitated by an independent specialist, ORM. The risk assessment for the inclusion of Longwalls 104-105 was held on 29 January 2020 and was facilitated by AXYS Consulting.

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 101-105 were as low as reasonably practicable (ORM, 2017b; AXYS Consulting 2020).

2.2.4 Public Safety Management Plan Risk Assessment

A risk assessment was held for the LW101-103 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 21 April 2017 and was facilitated by an independent specialist, AXYS Consulting. The risk assessment was reviewed on 29 January 2020 based on the revised Extraction Plan Layout including Longwalls 104-105.

The outcomes of the risk assessments were incorporated into the LW101-105 PSMP.

With the implementation of the identified control strategies, the risks due to the secondary extraction of Longwalls 101-105 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 (08_0135) and in consideration of the draft *Guidelines for the Preparation of Extraction Plans* (DP&E 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 Industry and Environment – Resources Regulator
- Department of Planning Industry and Environment – Biodiversity Conservation Division
- Department of Planning Industry and Environment – Water (Including the Natural Resources Access Regulator)
- Department of Planning Industry and Environment – Crown Lands
- Environmental Protection Agency
- Mid-Western Regional Council

Comments received were considered before the LW101-105 EP was finalised and lodged with the Secretary of the DPIE 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 (Lot 7010, DP1025345) and the Mid-Western Regional Council (MWRC) owns a number of roads (and associated easements) within the Longwalls 101-105 Study Area (Figure 8). As such, MCO has consulted with NSW Crown Land and MWRC as potentially affected public authorities. All other land within the Longwalls 101-105 Study Area is owned by MCO.

2.3.2 Infrastructure Owners

Consultation with each infrastructure 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 item[5].
- Drafts of the LW101-105 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. These were updated and sent for comment to infrastructure owners for Longwalls 104 and 105.
- 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 LW101-105 BFMPs were prepared incorporating the outcomes of the risk assessment.
- Final drafts of the LW101-105 BFMPs were prepared incorporating any comments received from the infrastructure owner.

A summary of consultation undertaken with relevant infrastructure owners is provided in Attachment 2 (Table A2-2).

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

2.3.3 Landholders

Landholders within the Longwalls 101-105 Study Area are MCO, NSW Crown Lands and MWRC. MCO has consulted with NSW Crown Lands and MWRC (Sections 2.3.1 and 2.3.2). There are no other landowners within 500m of UG 1.

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 will provide an update on the amended extraction plan following approval. The approved Extraction Plan will be made available on MCO's website.

2.3.5 Consultation with Aboriginal Stakeholders

A draft of the LW101-103 HMP was provided to Aboriginal stakeholders registered at the Moolarben Coal Complex for their review and comment on 15 March 2017. Comments received were considered before the LW101-103 HMP was finalised and lodged with the Secretary of the DPIE for approval.

A draft of the LW101-105 HMP was provided to Aboriginal stakeholders registered at the Moolarben Coal Complex for their review and comment on 14 February 2020. No comments have been received.

3.0 SUBSIDENCE MANAGEMENT AND MONITORING

Natural and Built features within the Longwalls 101-105 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 101-105. Additionally, features that lie outside the Longwalls 101-105 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 (2017; 2020) (Technical Report 1) and sub plans. Surface and sub-surface features within the vicinity of Longwalls 101-105 are listed in Table 7.

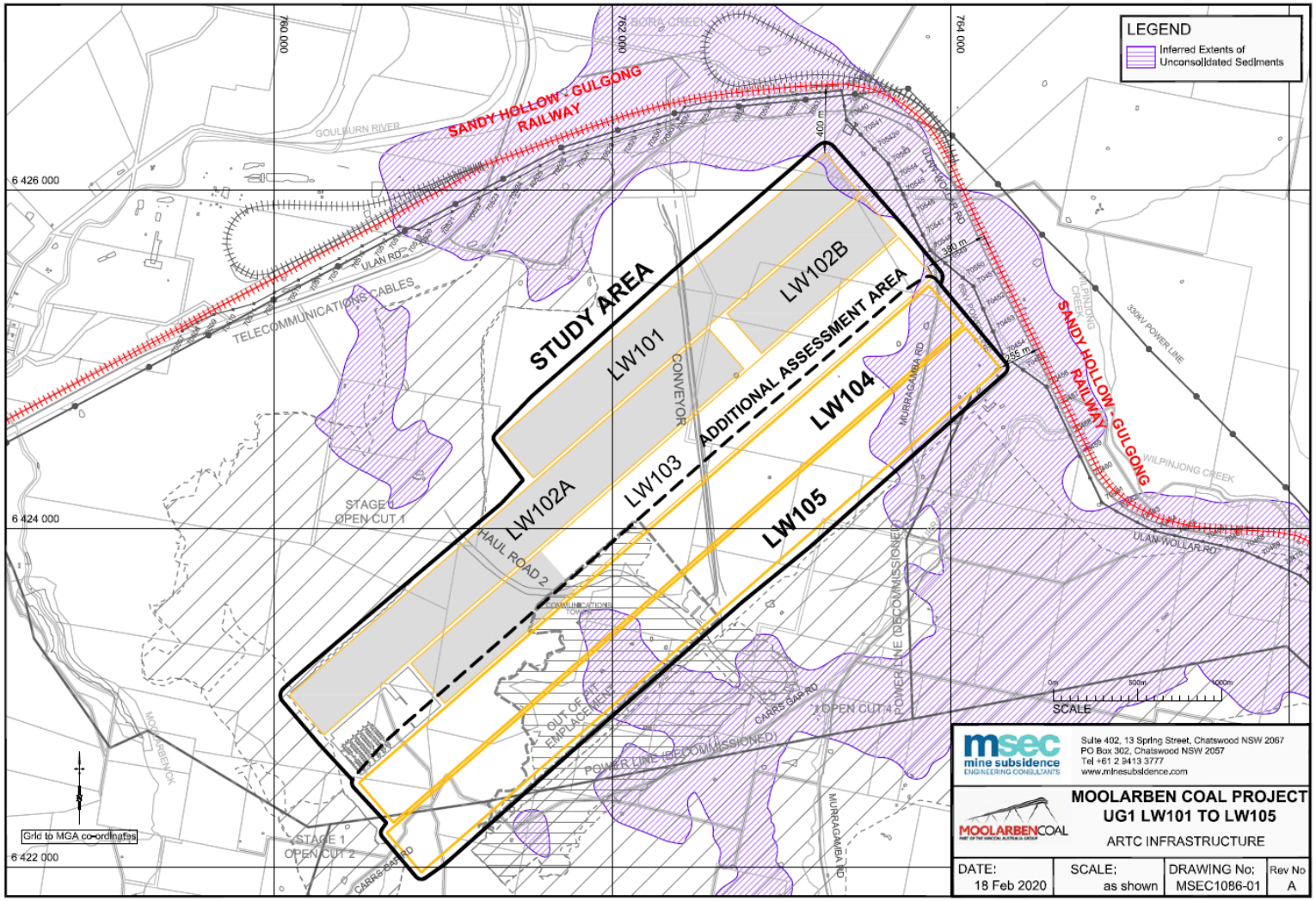
The sub-plans detail the management and monitoring of potential environmental consequences resulting from the extraction of Longwalls 101-105 and associated subsidence impacts. Descriptions of each of these features are contained within the relevant management plan referenced in Table 7.

Table 7: Surface and Sub-Surface Features in the Vicinity of Longwalls 101 to 105

Feature	Section/Management Plan Reference
Natural Features	
Drainage Lines	Section 3.1 and LW101-105 WMP (Appendix A)
Cliffs	Section 3.1 and LW101-105 LMP (Appendix B)
Minor Cliffs, Rock Face Features	
Steep Slopes and Land in General	
Threatened Species, Threatened Populations and EECs	Section 3.1 and LW101-105 BMP (Appendix C)
Natural Vegetation	
Areas of Archaeological and/or Heritage Significance	
Known Aboriginal Heritage Sites	Section 3.1 and LW101-105 HMP (Appendix D)
Public Utilities and Other Infrastructure	
ARTC – Sandy Hollow Gulgong Railway Line	Section 3.2 and LW101-105 BFMPs (Appendix E)
MWRC – Ulan-Wollar Road	
TransGrid – 330 kV electricity transmission line	
Essential Energy – 66 kV/22 kV dual circuit powerline	
Telstra – Telecommunication cables	
Public Safety	LW101-105 PSMP (Appendix F)

The location of natural features and known Aboriginal heritage sites in the vicinity of Longwalls 101-105 is shown on Figure 7. The location of surface infrastructure/built features over and adjacent to the Longwalls 101-105 Study Area is shown on Figure 8, Figure 9, and Figure 11 – Figure 15. Descriptions of each of these features are contained within the relevant management plan referenced in Table 7.

Subsidence predictions and potential impacts to surface and sub-surface features are provided and described in MSEC (2017; 2020) (Technical Report 1).



Source; MSEC (2020)

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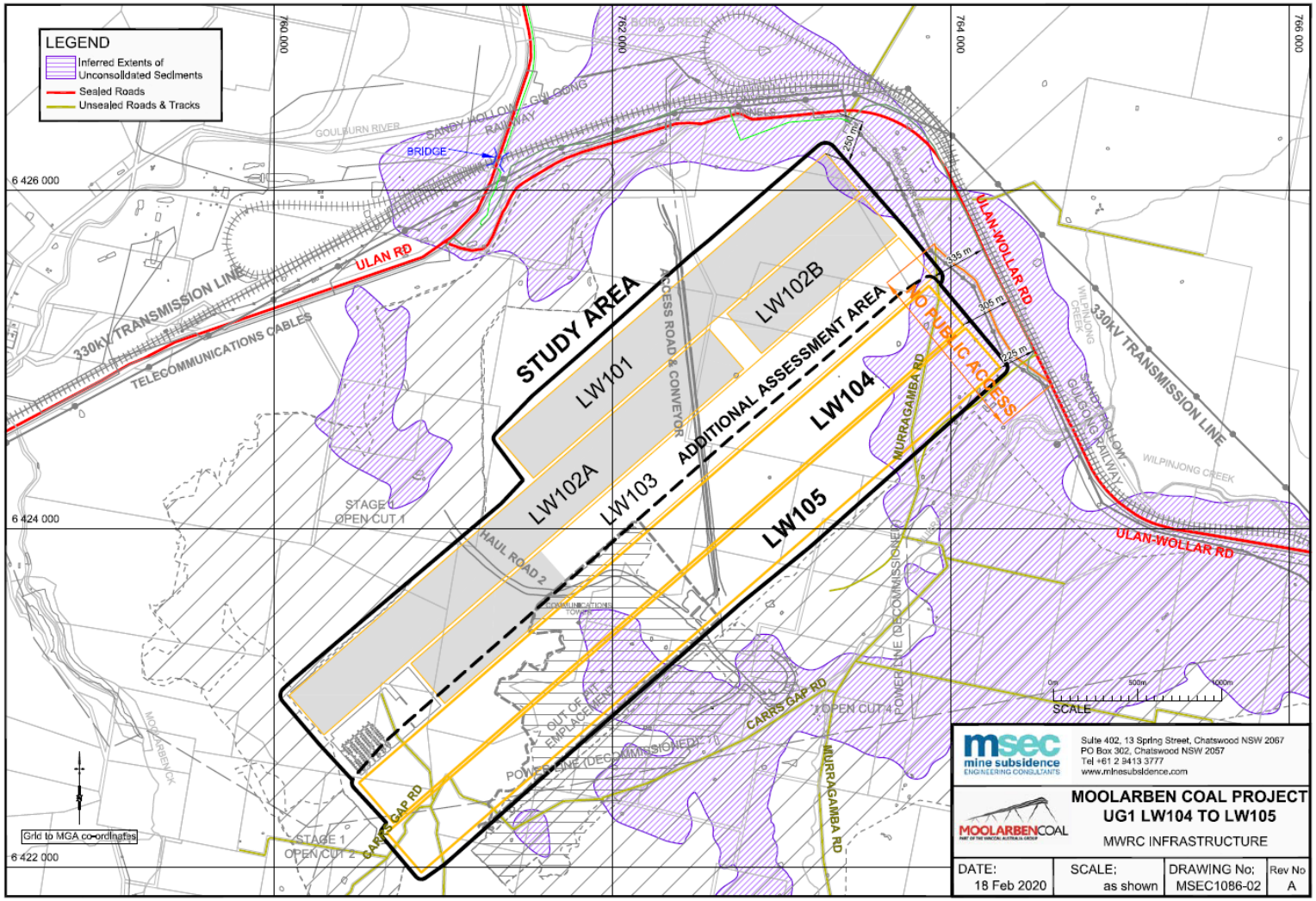
MOOLARBEN COAL

Australian Rail Track Corporation Assets

Figure 11



Source; MSEC (2020)

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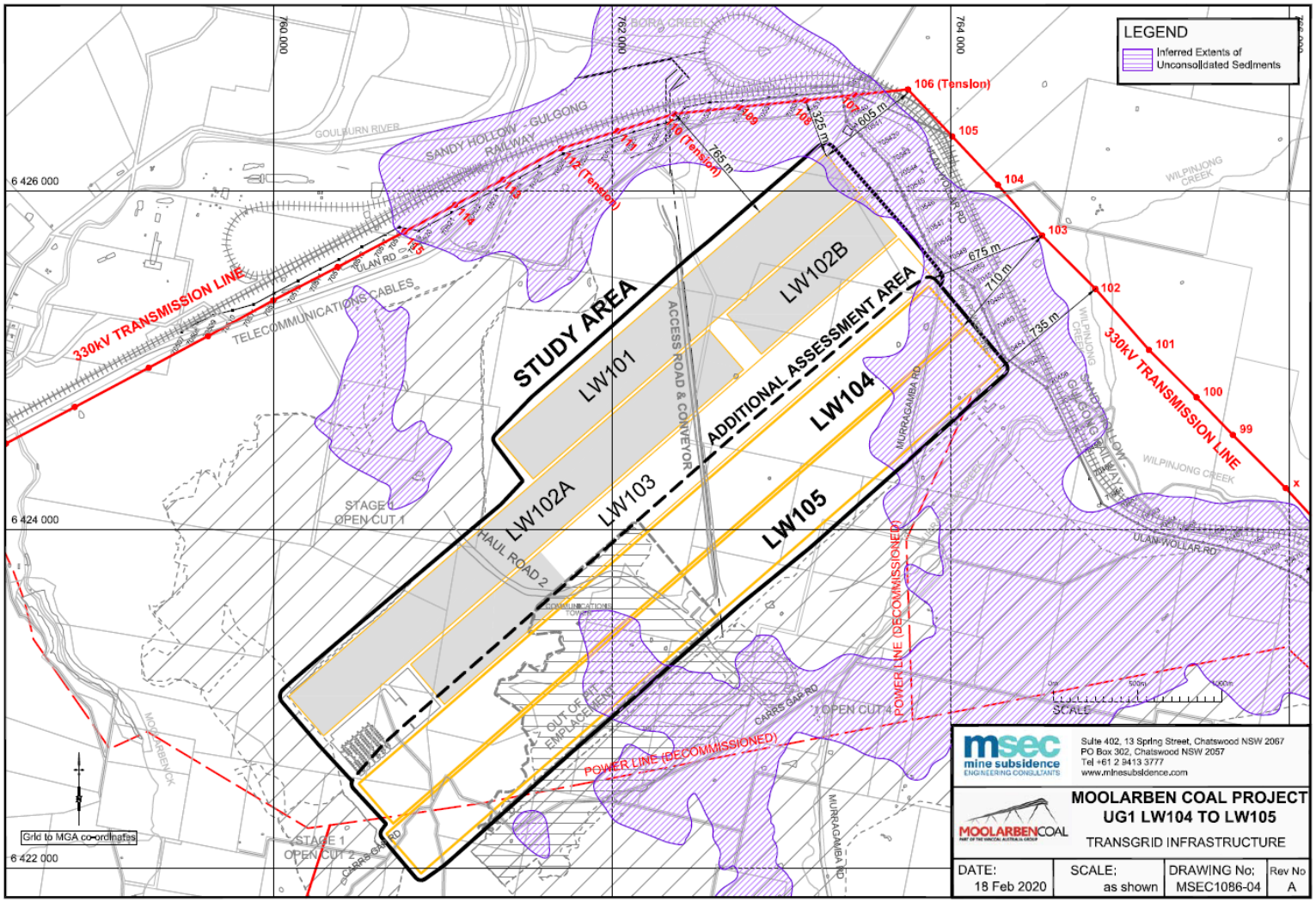
MWRC Assets

Figure 12



Source; MSEC (2020)

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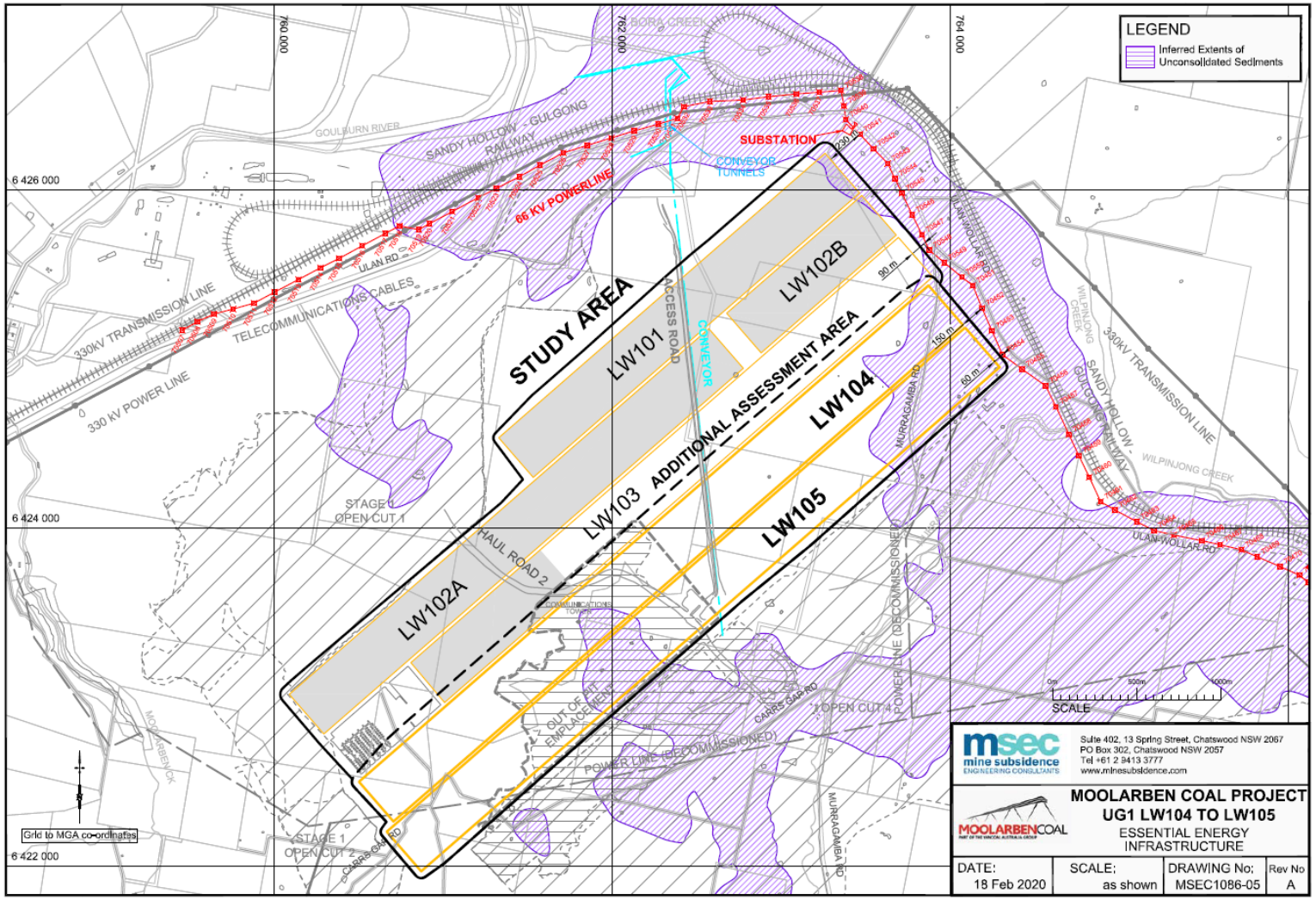
Transgrid Assets

Figure 13



Source; MSEC (2020)

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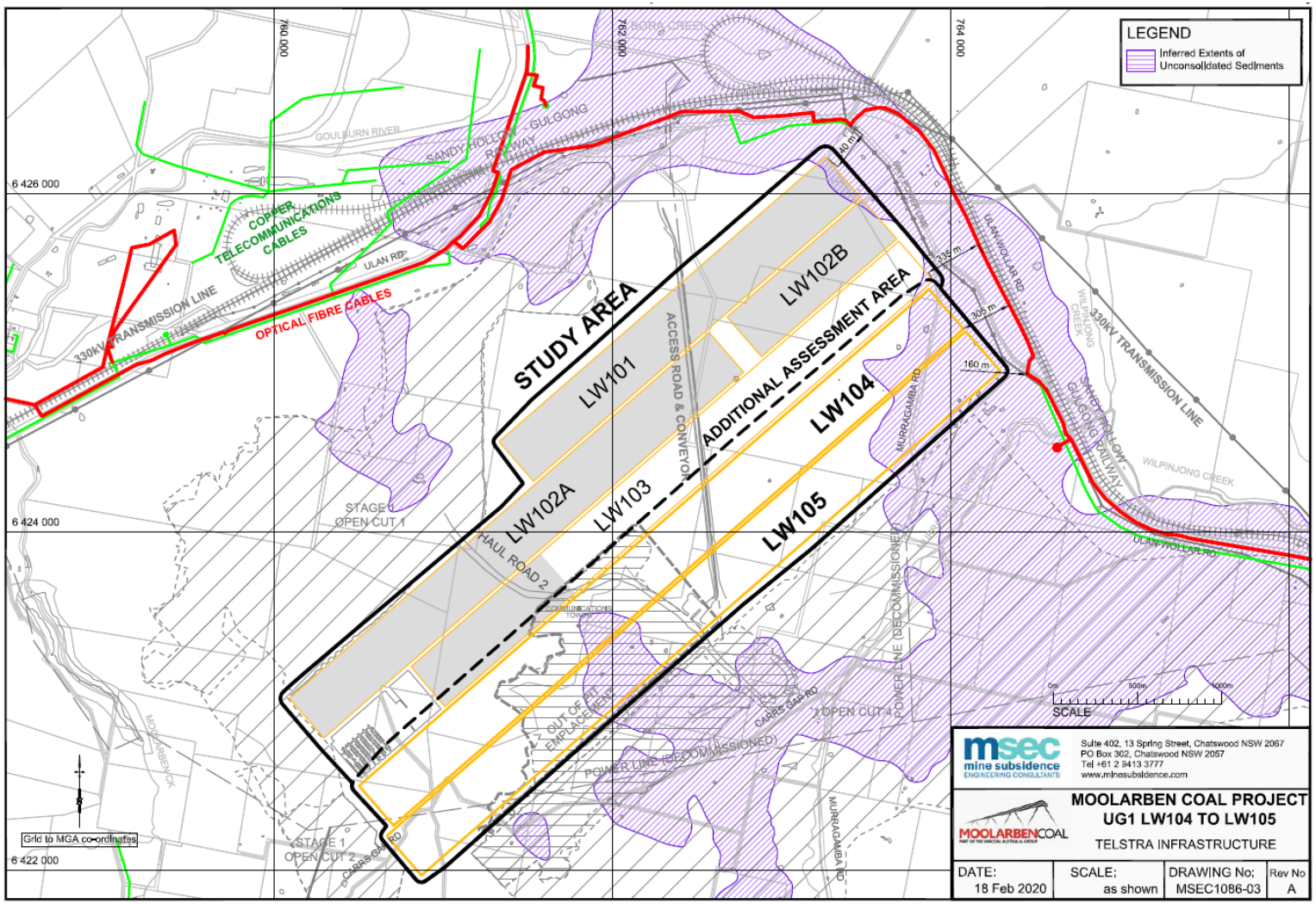
Essential Energy Assets

Figure 14



Source; MSEC (2020)

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Telstra Assets

Figure 15

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 5. In order to avoid duplication of existing Environmental Management Plans, the component management plans reference sections of the following existing complex-wide plans:

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

The LW101-105 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 16Figure 16.

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 9 below. Each aspect has corresponding objectives and management measures in place to manage impacts from secondary extraction of Longwall 101-105. The management plan 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 101-105 and associated potential far-field movements are provided in Table 10 below, with further detail included in each of the specific sub-plans. Performance measures listed correspond with those in Table 18 of Schedule 4 of Project Approval 08_0135, as they relate to the Longwall 101-105 extent. A summary of the proposed monitoring is provided on Figure 16.

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 Management Plan and summarised in Section 4.1.

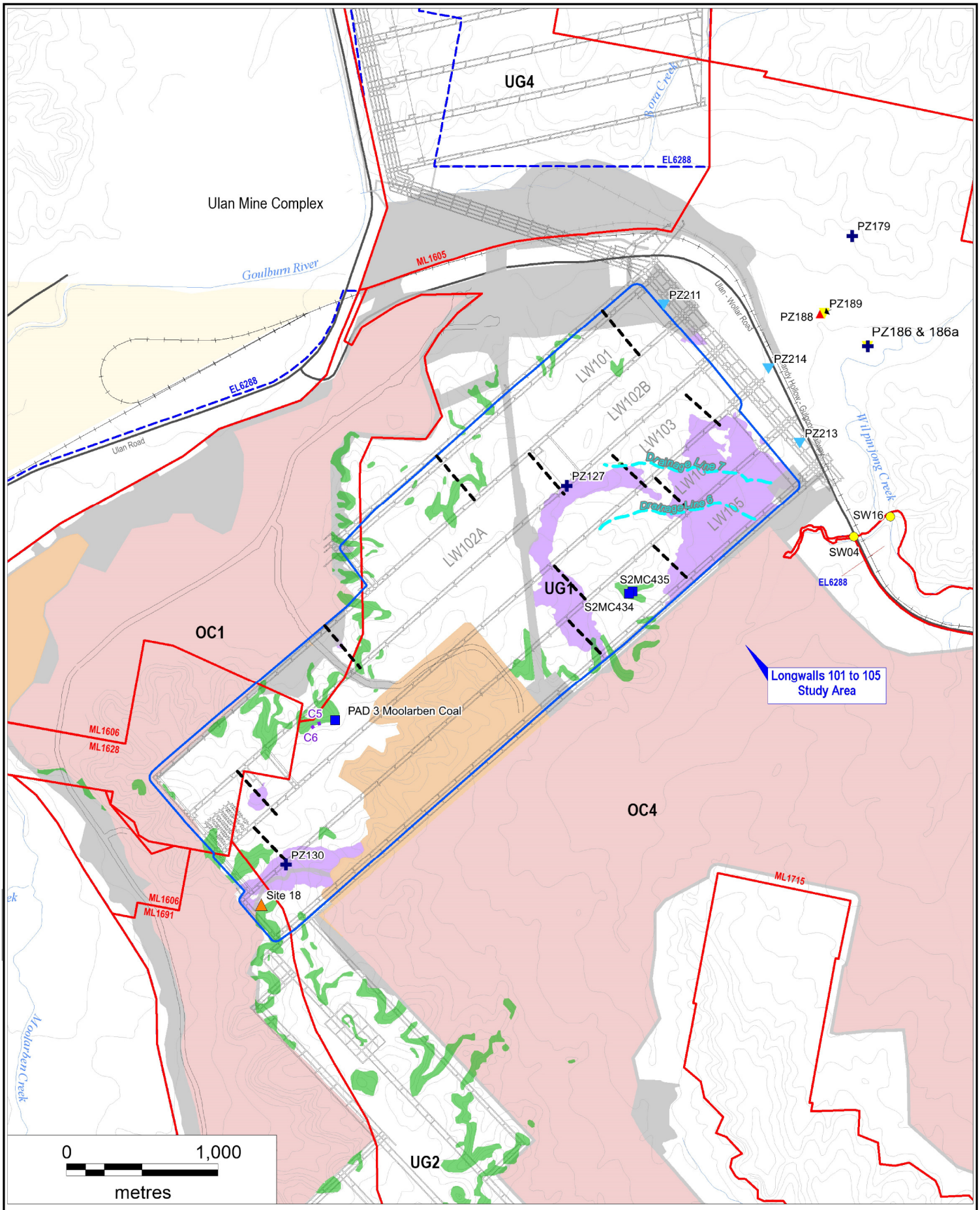

Figure 16
Environmental Monitoring Sites

Table 8: Natural and Heritage Features Management Measures

Feature	Objective	Management	Relevant Management Plan
Drainage Lines	No significant increase in active erosion in DL6 or DL7. No change in stream character for DL6 or DL7 beyond approved. No change in stream character for DL6 or DL7 beyond approved. No measurable change in downstream water quality. Minimise change in surface flow when cracks appear (as is predicted to occur)	• Erosion management. • Remediation of vegetation. • Water ponding management.	LW101-105 WMP
Surface water flow and quality	Subsidence impacts from Longwalls 101-105 do not result in adverse water quality impacts to the downstream environment.	Downstream water quality management.	LW101-105 WMP
Groundwater	Subsidence impacts from Longwalls 101-105 do not result in exceedances of the salinity, pH and groundwater level triggers in the LW101-105 WMP.	An investigation will be initiated where the groundwater monitoring identifies results outside the trigger levels (or ranges), consistent with the approved complex-wide GWMP.	LW101-105 WMP
Cliffs C5 and C6	To manage/mitigate subsidence impacts on CL5 &6. Cliff instabilities could occur on up to approximately 15% of the lengths of the exposed cliffs in the UG1 Study Area.	Management in accordance with the LW101-105 LMP, including: • Stabilisation techniques. • Erosion and sediment control techniques. • Remediation of surface tension cracks. • Salvage of artefacts (if required). Measures to address safety hazards.	LW101-105 LMP
Minor cliffs Rock face features Steep slopes	To manage/mitigate subsidence impacts on minor cliffs, Rock face features and Steep slopes. Occasional rockfalls, displacement of or dislodgement of boulders or slabs, or fracturing, that in total do not impact more than 5% of the total face area of each such type of features within any longwall mining domain.		LW101-105 LMP

Feature	Objective	Management	Relevant Management Plan
Threatened species, threatened populations, or endangered ecological communities	Negligible subsidence impacts or environmental consequences	Management in accordance with the LW101-105 BMP, including: • Vegetation management. • Terrestrial fauna and habitat management. • Weed management. • Additional monitoring.	LW101-105 BMP
Land in general	To manage/mitigate subsidence impacts on land	Management in accordance with the LW101-105 LMP, and may including: • Stabilisation techniques. • Erosion and sediment control techniques. • Remediation of surface tension cracks. • Measures to address safety hazards. • Consideration of biodiversity impacts of remediation.	LW101-105 LMP and BMP
Aboriginal Heritage	To manage/mitigate subsidence impacts on Aboriginal Heritage sites	Management in accordance with LW101-105 HMP, including: • For PAD 3, S2MC434 and S2MC 435: salvage and/or excavation will be considered in consultation with a suitably qualified archaeologist. • For S2MC005: salvage and test excavation, prior to extraction in consultation with a suitably qualified archaeologist.	LW101-105 HMP

Table 9: Natural and Heritage Features Performance Measures and Indicators

Performance Measure		Performance Indicators	Management Plan
Water Resources *Drainage Lines (DL1 – DL7)1*	*No greater subsidence impacts or environmental consequences than predicted in the EA*	• Change in visible erosion. • Development of, or change in, headcut erosion along DL6 and DL7. • Change in character, such as increased erosion or change in vegetation along drainage line. • Extensive duration of water ponding. • Downstream water quality (consistent with approved complex-wide SWMP). • Appearance of unsealed surface cracking across the bed of DL6 and DL7.	LW101-105 WMP (Appendix A)
Land *Other cliffs*	*No greater subsidence impacts or environmental consequences than predicted in the EA*	The total length of cliffs within the Longwalls 101-105 Study Area that experiences cliff instabilities (i.e. the exposure of a fresh face of rock and debris scattered around the base of the cliff) is to be less than 6 m.	LW101-105 LMP (Appendix B)
Land *Minor cliffs, rock face features, steep slopes*	*Minor environmental consequences (that is, occasional rockfalls, displacement of or dislodgement of boulders or slabs, or fracturing, that in total do not impact more than 5% of the total face area of each such type of features within any longwall mining domain)*	In each instance of an identified impact (that is, occasional rockfalls, displacement of boulders or slabs, or fracturing) to a minor cliff, rock face feature or steep slope, the affected percentage of the total face area of the feature affected will be determined. It is expected that occasional rockfalls or fracturing would not impact more than 5% of the total face area of rock ledges and overhangs in the Longwalls 101-105 Study Area (MSEC, 2017; 2020).	LW101-105 LMP (Appendix B)
Biodiversity *Threatened Species, Threatened Populations, or Endangered Ecological Communities*	*Negligible subsidence impacts or environmental consequences*	• Areas of cracking or ponding that exceed predictions in the subsidence predictions and assessments of the impacts relating to the predicted subsidence above Longwalls 101-105; • Greater than 10% decline, outside of seasonal variations, in estimated canopy foliage (determined after all longwall extraction monitoring is completed) when compared to pre-mining transect baseline results for that longwall panel. • Deterioration in tree health, outside of seasonal variation, determined after all longwall extraction monitoring is completed for that longwall panel. • Areas of weed incursion and/or infestation; or • Mortality of more than a small number of threatened flora or fauna	LW101-105 BMP (Appendix C)
Heritage Sites *Historic Heritage Sites*	*No greater subsidence impacts or environmental consequences than predicted in the EA*	Historic Heritage Site 18 (Carrs Gap Road Stone Wall) completion of historical research and archival recording.	LW101-105 HMP (Appendix D)

3.2 BUILT FEATURES AND PUBLIC SAFETY

3.2.1 Overview

The LW101-105 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 LW101-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 101-105.

Scope: To consider built features as aspects of public safety that could experience subsidence effects during the mining of Longwalls 101-105.

3.2.2 Performance measure, Indicators and Management Measures

Built Feature performance measures, indicators and management measures of potential consequences resulting from the extraction of Longwalls 101-105 are provided in Table 10 below. Further detail included in each of the specific sub-plans. Performance measures listed correspond with those in Table 19 of Schedule 4 of Project Approval 08_0135, as they relate to the Longwall 101-105 extent.

3.2.3 Contingency Plan

In the event that a subsidence impact performance measure relating to built features 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.

Table 10: Built Features Performance Indicators and Management Measures

Built Feature	Performance Measure	Performance Indicator(s)	Relevant Management Measures	Relevant Management Plan
ARTC Sandy Hollow Gulgong Railway Line	Always safe and serviceable. Damage that does not affect safety or serviceability must be fully repairable, and must be fully repaired.	No defects or deformation of the rail track and associated infrastructure due to mining. No visual displacement at joints or cracks in culverts.	Potential management measures in relation to the rail line include: • speed restriction of trains; and • minor repair of track. • Potential management measures in relation to culverts include: • point repairs; • lining; • grouting; and • culvert replacement. Follow-up inspections will be conducted to assess the effectiveness of the management measures implemented and the requirement for any additional management measures.	LW101-105 BFMP ARTC (Appendix E1)
Essential Energy 66 kV/22 kV dual circuit powerline and poles within 300 m of the relevant longwall	Always safe. Serviceability should be maintained wherever practicable. Loss of serviceability must be fully compensated. Damage must be fully repairable, and must be fully repaired or else replaced or fully compensated.	The structural integrity of the 66 kV/22 kV dual circuit powerline (power poles and transmission lines) is maintained. The electrical clearance from land, vegetation and roads is maintained. The serviceability of the access roads/tracks is maintained.	A number of potential management measures in relation to the 66 kV/22 kV dual circuit powerline and/or Essential Energy substation are considered to be applicable. These include: • alteration of conductor tensions; • modification to attachment points such as placement of stringing sheaves to earth wires and/or phase conductors; and • strengthening of pole footings. • In the event management measures are considered to be required, the appropriate action will be determined and implemented in consultation with Essential Energy. Follow-up inspections will be conducted to assess the effectiveness of the management measures implemented and the requirement for any additional management measures.	LW101-105 BFMP Essential Energy (Appendix E4)

Built Feature	Performance Measure	Performance Indicator(s)	Relevant Management Measures	Relevant Management Plan
TransGrid 330 kV ETL and towers (Towers 102 to 111)	*Serviceability should be maintained wherever practicable. Loss of serviceability must be fully compensated.* *Damage must be fully repairable, and must be fully repaired or else replaced or fully compensated.*	• The structural integrity of the 330 kV ETL (towers and transmission lines) is maintained. • The electrical clearance from land, vegetation and roads is maintained. • The serviceability of the access roads/tracks is maintained.	A number of potential management measures in relation to the 330 kV ETL are considered to be applicable. These include: • alteration of conductor tensions; • installation of temporary structures; • modification to attachment points such as placement of stringing sheaves to earth wires and/or phase conductors; and • strengthening of tower structures through installation of cruciform footings. The requirement for these management measures will be determined by TransGrid during the pre-mining inspection / baseline audit and if required, implemented prior to mining within 400 m of the relevant feature. Follow-up inspections will be conducted to assess the effectiveness of the management measures implemented and the requirement for any additional management measures.	LW101-105 BFMP TransGrid (Appendix E3)

Built Feature	Performance Measure	Performance Indicator(s)	Relevant Management Measures	Relevant Management Plan
MWRC Ulan-Wollar Road	*Always safe and serviceable.* *Damage that does not affect safety or serviceability must be fully repairable, and must be fully repaired.*	• No additional visible pavement cracking or other defects of the road pavement (when compared against baseline conditions and sections of road outside the Study Area) resulting in deterioration of road quality. • No ponding of water on the road surface as a result of changes in grade from subsidence associated with Longwalls 101-105. • No joint displacement or cracking or other defects of the drainage structure (e.g. pipes/culverts) in excess of 5 mm. • Serviceability of guard rails, marker posts and signage is maintained.	The potential management measures in relation to the Ulan-Wollar Road pavement include: • mill and/or replace pavement layers; and • crack sealing/repair. The potential management measures in relation to drainage structures (pipes/culverts) include: • point repairs; • replace sections of pipe/culvert; and • grouting/sealing of cracks. The potential management measures in relation to guard rails, marker posts and signage include repairs and/or replacement of furniture. Follow-up inspections will be conducted to assess the effectiveness of the management measures implemented and the requirement for any additional management measures.	LW101-105 BFMP MWRC (Appendix E2)
Telstra optical fibre telecommunication cable and copper telecommunication cable	*Serviceability should be maintained wherever practicable. Loss of serviceability must be fully compensated.* *Damage must be fully repairable, and must be fully repaired or else replaced or fully compensated.*	• Negligible transmission loss from mine subsidence impacts. • Negligible impacts on structural integrity of the cable lines from mine subsidence.	A number of potential management measures in relation to telecommunication cables are considered to be applicable (including stabilisation methods if required). Follow-up inspections will be conducted to assess the effectiveness of the management measures implemented and the requirement for any additional management measures.	LW101-105 BFMP Telstra (Appendix E5)

Built Feature	Performance Measure	Performance Indicator(s)	Relevant Management Measures	Relevant Management Plan
Public Safety	*Negligible additional risk*	• Negligible additional risk to public safety	• Restricted access. • Management of roads/tracks in accordance with the LW101-105 LMP and the LW101-105 BFMP-MWRC. • Management of built features in accordance with the LW101-105 BFMP. • Other general potential management measures in relation to public safety include: – traffic control including diversion of traffic; – temporary speed restrictions; – warning signs/lights; – restriction of public access; – erection of barriers; – implementation of security services; and use of emergency services for public control.	LW101-105 PSMP

3.3 REHABILITATION MANAGEMENT

Condition 5(o), Schedule 4 of Project Approval (08_0135) requires that the Extraction Plan propose relevant revisions to the complex-wide Rehabilitation Management Plan (RMP) required by Condition 56, Schedule 3.

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

The MOP and RMP describes longwall mining in UG1 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 UG1 (e.g. surface cracks).
- Subsidence monitoring relevant to identifying remediation and rehabilitation requirements.
- Remediation techniques that would be implemented.
- Rehabilitation 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 (2017; 2020) presents potential subsidence impacts for Longwalls 101-105. 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 LW101-105 LMP and LW101-105 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.

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 the Ground Disturbance Permit 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 LW101-105 LMP).

Rehabilitation objectives and decommissioning phase performance indicators and completion criteria have been developed for the subsidence area (e.g. overlying Longwalls 101-105) 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.

3.4 MONITORING PROGRAM SUMMARY

The monitoring program is detailed in both the LW101-105 Subsidence Monitoring Program (Appendix G) and the individual management plans (i.e. for the LW101-105 WMP, LW101-105 LMP, LW101-105 BMP and LW101-105 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 16.

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

4.0 IMPLEMENTATION

4.1 CONTINGENCY RESPONSE

In the event a subsidence impact performance measure described in Table 6 has been exceeded or is likely to be exceeded, MCO will implement the relevant Contingency Plan detailed in the LW101-105 WMP (Appendix A), LW101-105 LMP (Appendix B), LW101-105 BMP (Appendix C), LW101-105 HMP (Appendix D), LW101-105 BFMPs (Appendix E) or the LW101-105 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 (consistent with the monitoring programs described in Section 3).
- Any exceedance of a subsidence impact performance measure will be reported to the DPIE, 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 DPIE for approval.
- MCO will implement the approved course of action to the satisfaction of the DPIE.

In accordance with Condition 2, Schedule 4 of Project Approval (08_0135), MCO will provide a suitable offset to compensate for the impact or environmental consequence to the satisfaction of the Secretary of the DPIE if either the remediation measures implemented by MCO have failed to remediate the impact or environmental consequence or the Secretary of the DPIE 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.

4.2 ADAPTIVE MANAGEMENT

MCO will implement adaptive management in accordance with Condition 2, Schedule 6 of Project Approval (08_0135) to ensure subsidence impact performance measures (Table 6) are achieved at the UG1 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 UG1 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 DPIE 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 11 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.

Table 11: Summary of Reporting Framework

Report	Frequency	Distribution	Distribution Method[1]	Responsibility for Data Collation and Preparation	Responsibility for Submission
Incident Report	As required – see Section 4.3.1	DPIE Resources Regulator EPA (where relevant) Other relevant agencies as specified in management plans	Email	Environmental and Community Manager	General Manager
Annual Review	Annually	DPIE Resources Regulator DPIE Water / NRAR CCC	Email, Website	Environmental and Community Manager	General Manager

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 (08_0135).

The reporting of incidents will be conducted in accordance with Condition 7, Schedule 6 of Project Approval (08_0135).

MCO will notify the Secretary of DPIE and any other relevant agencies of any incident associated with the UG1 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 UG1, 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 DPIE 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 6 of Project Approval (08_0135). The Annual Review will review the performance of the project to the satisfaction of the Secretary of the DPIE 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;
- 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 6 of Project Approval (08_0135), this Extraction Plan will be reviewed within three months of the submission of:

- an Annual Review under Condition 4, Schedule 6;
- an incident report under Condition 7, Schedule 6;
- an audit under Condition 9, Schedule 6; or
- any modification to the conditions of Project Approval (08_0135) or Project Approval (05_0117) (unless the conditions require otherwise); and

if necessary, revised to the satisfaction of the Secretary of the DPIE 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 DPIE 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 5(o), Schedule 3 of Project Approval (08_0135) requires the Extraction to include proposed revisions to the RMP required under condition 56, Schedule 3 of Project Approval (08_0135).

The MOP was approved by the Resources Regulator on 19 December 2019. The MOP includes the approved RMP, required under Condition 56, Schedule 3 of Project Approval (08_0135), as an appendix.

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

4.6 KEY RESPONSIBILITIES

Key responsibilities under this Extraction Plan are summarised in Table 12. The component management plans provide additional responsibilities under the plans.

Table 12: Key Extraction Plan Responsibilities

Responsibility	Task
General Manager	• 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	• 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.
Environmental and Community Manager	• 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	• Undertake all subsidence monitoring to the required standard within the specified timeframes and ensure data are adequately checked, processed and recorded.

5.0 REFERENCES

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