YANCOAL
兖煤澳大利亚有限公司
MOOLARBEN COAL

UG4 LONGWALLS 409 TO 414 WATER MANAGEMENT PLAN

Version	Issue Date *(Month/YYYY)*	Revision Detail *(Include the main areas reviewed, trigger / why the change)*	Author *(Name/s)*	Review Team *(Name/s)*
1	October 2024	Original WMP for the UG4 Longwalls 409-414 Extraction Plan	MCO	MCO
2	January 2025	Updated to Address Agency Consultation	MCO	MCO
3	April 2026	Updated in response to Comments from the IEAPM	MCO	MCO
4	June 2026	Updated in response to comments from DPHI	MCO	MCO

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1.0 INTRODUCTION

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

Moolarben Coal Operations Pty Ltd (MCO) is the operator of the Moolarben Coal Complex on behalf of the Moolarben Joint Venture. MCO is a wholly owned subsidiary of Yancoal Australia Limited.

The UG4 Underground Mine (UG4) is a component of the approved Moolarben Coal Complex (**Figure 2**). First workings for UG4 commenced in October 2020 (**Figure 3**). Secondary extraction in UG4 of the first Longwall (LW) 401 commenced in July 2022. LW401 to 407 were completed in January 2026. The extraction of LW409 to 414 (hereafter referred to as LW409-414) within UG4 is scheduled to commence in September 2026.

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

1.1 PURPOSE AND SCOPE

This UG4 Longwalls 409 to 414 Water Management Plan (LW409-414 WMP) has been prepared to satisfy the requirements of Condition 77(h), Schedule 3 of Project Approval (05_0117) for the management of potential impacts to watercourses and aquifers due to secondary extraction of LW409-414.

This LW409-414 WMP forms a part of the Extraction Plan developed for LW409-414 of the approved UG4. This LW409-414 WMP has been prepared by MCO, with input from WRM Water & Environment Pty Ltd (WRM) (surface water), Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) (groundwater) and Mine Subsidence Engineering Consultants Pty Ltd (MSEC) (subsidence), to satisfy the requirements of Project Approval (05_0117) as modified and the *Extraction Plan Guideline* (NSW Department of Planning and Environment [DPE], 2022).

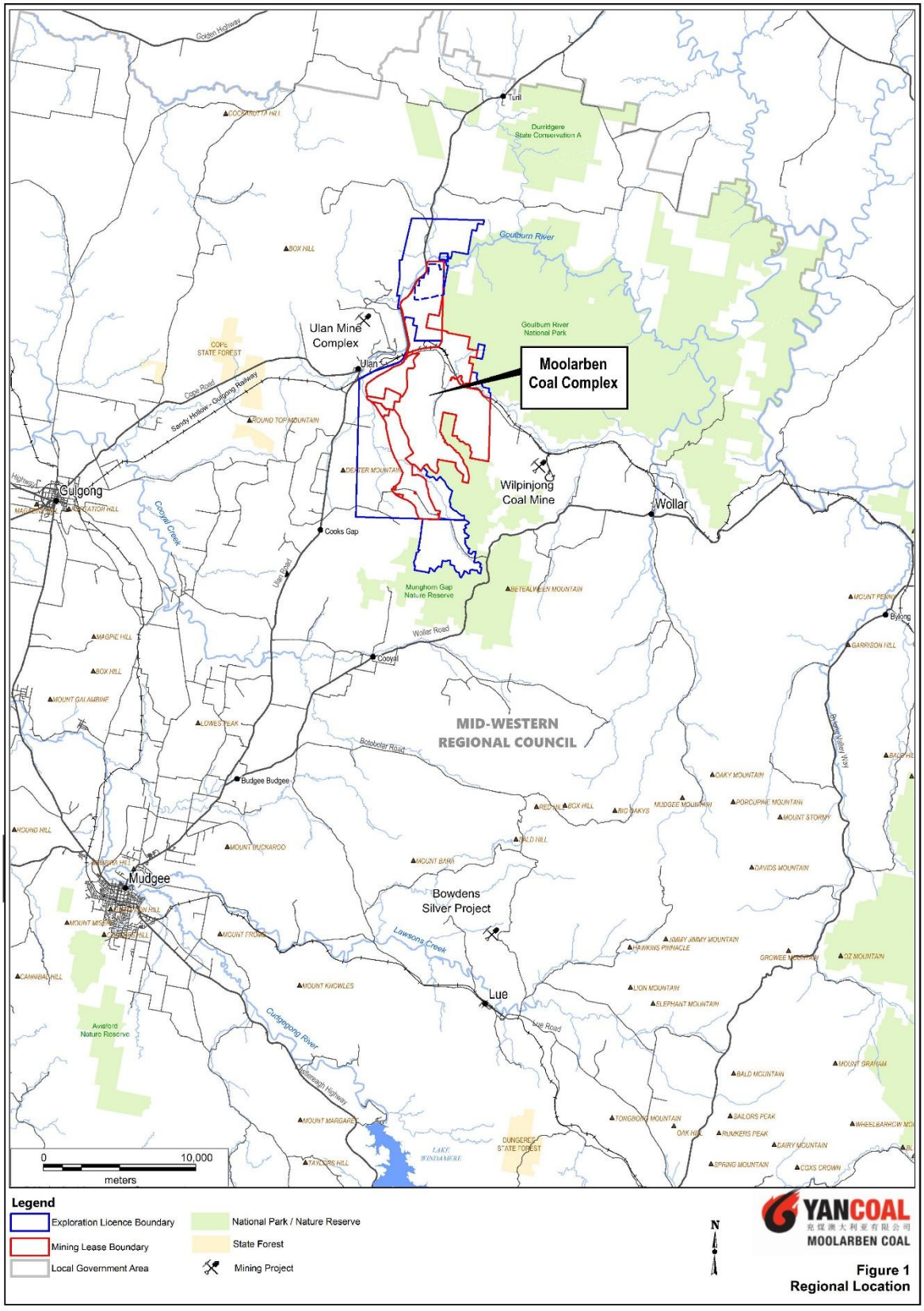
The appointment of the team of suitably qualified and experienced persons (which includes representatives of MCO, WRM, AGE and MSEC) was endorsed by the Secretary of the Department of Planning, Housing and Infrastructure (DPHI) on 9 May 2024 (**Attachment 2** of the Extraction Plan).

Purpose: This LW409-414 WMP outlines the management of potential environmental consequences on watercourses and aquifers resulting from the extraction of LW409-414.

Scope: This LW409-414 WMP considers the watercourses and aquifers within the LW409-414 Study Area[1].

[1] The LW409-414 Study Area is defined as the area of land within the furthest extent of the 26.5 degree (°) angle of draw and 20 millimetres (mm) predicted subsidence contour.

Figure 1: Regional Location



Document	Version	Issue Date	Status	Author
MCO_UG4_LW409-414_WMP	4	June 2026	Approved	MCO

Figure 2: Moolarben Coal Complex Layout

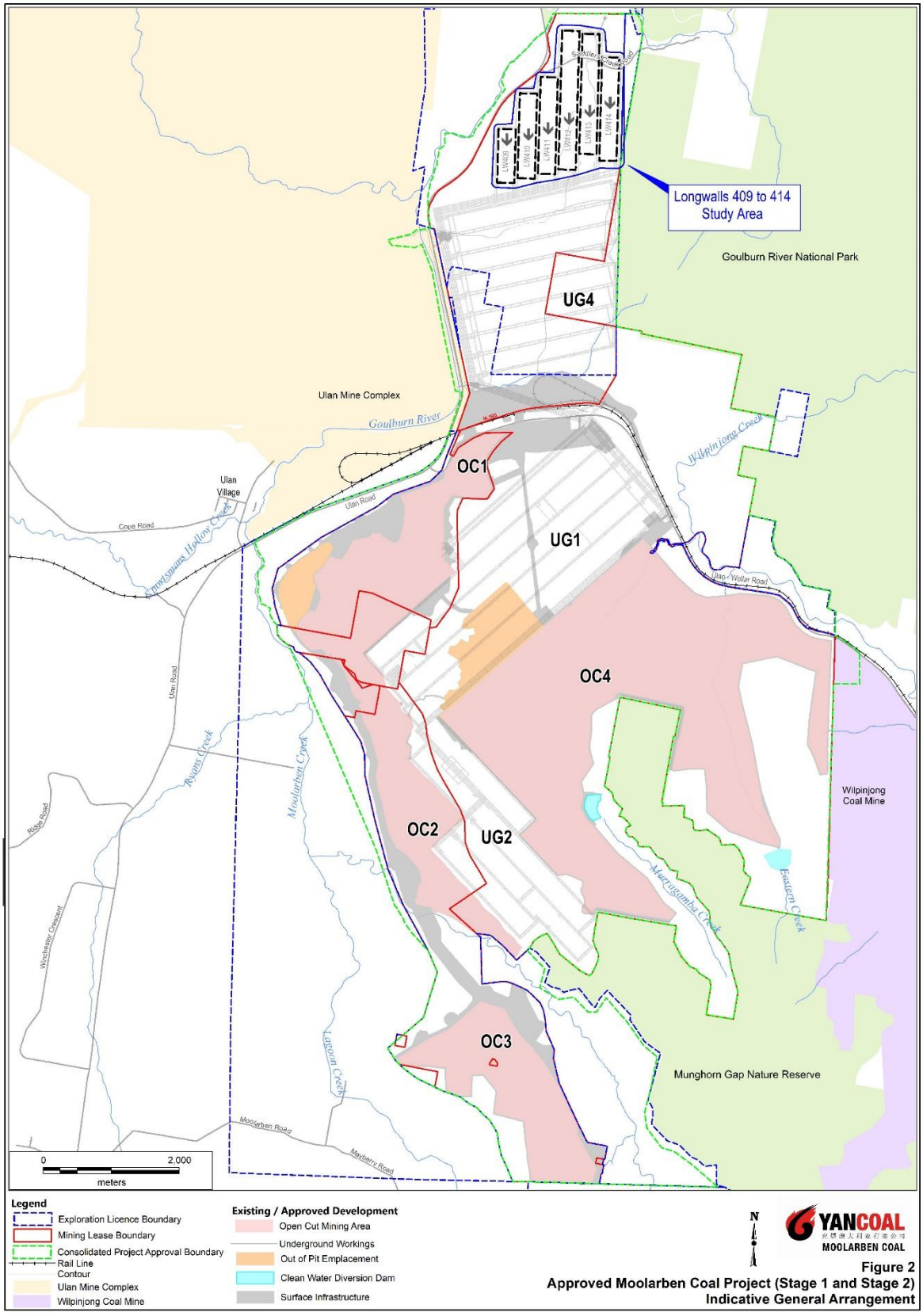
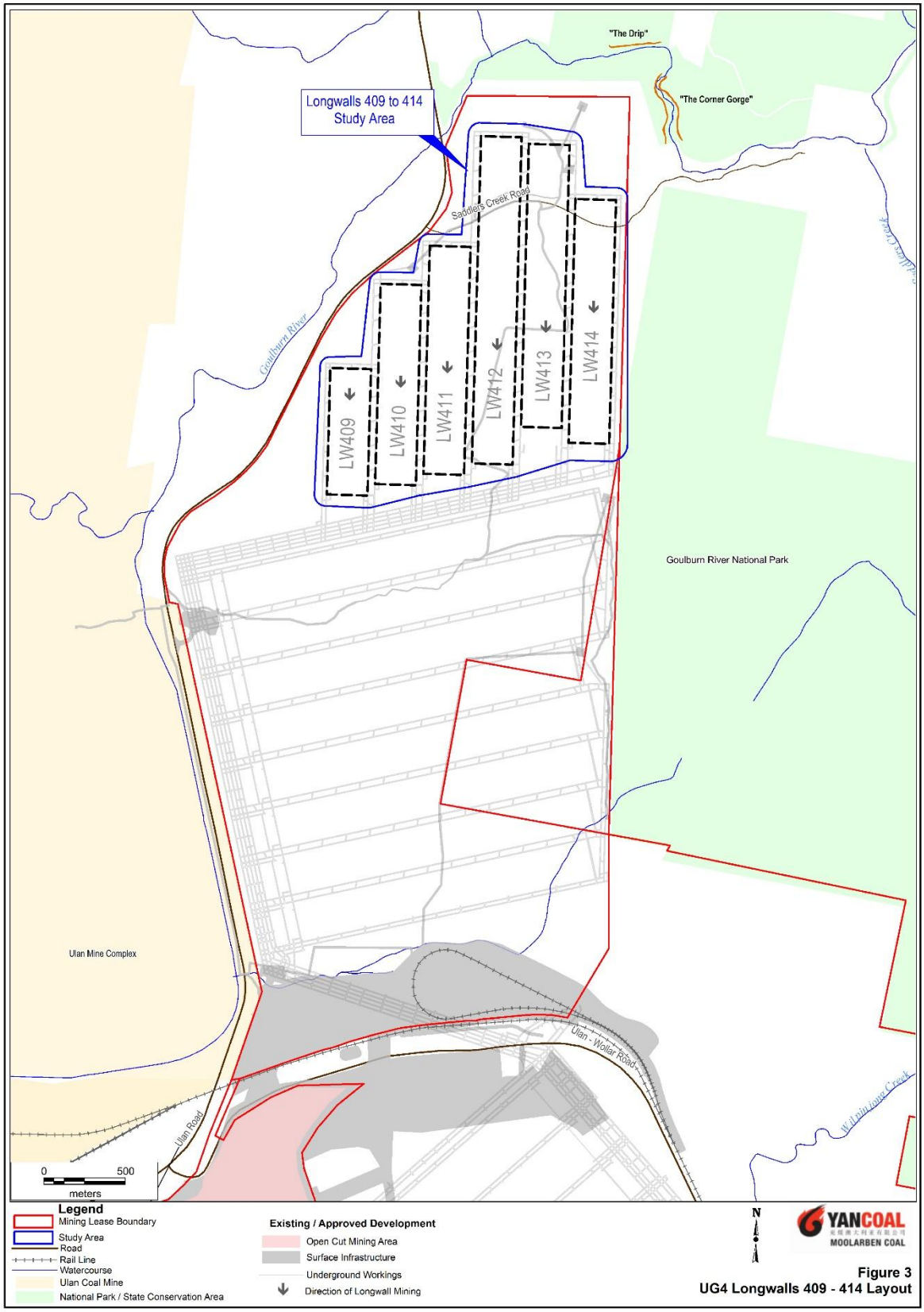


Figure 3: UG4 Longwalls 409 – 414 Layout



Management of potential impacts to the Drip, Corner Gorge and Goulburn River due to secondary extraction of LW409-414 is detailed in the *UG4 Longwalls 409 to 414 Drip, Corner Gorge and Goulburn River Monitoring and Reporting Program* (the Monitoring Program), which is provided as **Appendix H** of the LW409-414 Extraction Plan.

The approved complex-wide Water Management Plan (WAMP) (as amended) is implemented to manage surface water and groundwater related impacts across the Moolarben Coal Complex (including the LW409-414 Study Area). The approved complex-wide WAMP is publicly available on Yancoal's website (yancoal.com.au/our-sites/moolarben/moolarben-coal-documents).

To avoid duplication of existing Environmental Management Plans, this LW409-414 WMP references components of the approved complex-wide WAMP and the Monitoring Program. Where there is any overlap in monitoring or management measures in this LW409-414 WMP with the complex-wide WAMP, the measures described in this Plan will supersede them (once approved). Where there is any overlap in monitoring or management measures in this LW409-414 WMP with the Monitoring Program, the measures described in the Monitoring Program will supersede them.

Any update required to other management plans once this LW409-414 WMP is approved would occur separately.

1.2 STRUCTURE OF THE LONGWALLS 409 TO 414 WATER MANAGEMENT PLAN

The remainder of the LW409-414 WMP is structured as follows:

Section 2 Describes the review and update of the LW409-414 WMP.

Section 3 Outlines the statutory requirements applicable to the LW409-414 WMP.

Section 4 Provides baseline data, extraction schedule, revised assessment of the potential subsidence impacts and environmental consequences for LW409-414, as well as the outcomes of the risk assessment.

Section 5 Details the performance measures relevant to watercourses and aquifers.

Section 6 Describes the monitoring program.

Section 7 Describes the potential management and contingency measures and the Trigger Action Response Plan (TARP) management tool.

Section 8 Describes the Annual Review, audits, regular reporting, improvement of environmental performance and the program to collect sufficient baseline data for future Extraction Plans.

Section 9 Outlines the management and reporting of incidents.

Section 10 Outlines the management and reporting of complaints.

Section 11 Outlines the management and reporting of any non-compliance with statutory requirements.

Section 12 Lists the documents referred to in this LW409-414 WMP.

2.0 LONGWALLS 409 TO 414 WATER MANAGEMENT PLAN REVIEW AND UPDATE

In accordance with Condition 5, Schedule 5 of Project Approval (05_0117), this LW409-414 WMP will be reviewed as followed:

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

2.1 ACCESS TO INFORMATION

In accordance with Condition 11, Schedule 5 of Project Approval (05_0117), MCO will make the approved LW409-414 WMP publicly available on the Yancoal's website.

3.0 STATUTORY REQUIREMENTS

MCO's statutory obligations are contained in:

- the conditions of the Project Approval (05_0117) (as modified);
- the conditions of Commonwealth Approvals (EPBC 2007/3297, EPBC 2013/6926, EPBC 2008/4444 and EPBC 2017/7974);
- relevant licences and permits, including conditions attached to the Environment Protection Licence (EPL No. 12932) and Mining Leases (MLs) (i.e. ML 1605, ML 1606, ML 1628, ML 1691 and ML 1715);
- water access licences (WALs) under the *Water Management Act 2000* and water licences under the *Water Act 1912*; and
- other relevant legislation.

Obligations relevant to this LW409-414 WMP are described below.

3.1 ENVIRONMENTAL PLANNING & ASSESSMENT ACT 1979 PROJECT APPROVAL

Condition 77(h), Schedule 3 of Project Approval (05_0117), requires the preparation of a Water Management Plan as a component of the Extraction Plan. In addition, Conditions 73, 77(n), 77(p) and 79, Schedule 3 and Condition 3, Schedule 5 of Project Approval (05_0117) outline general management plan requirements that are applicable to the preparation of this LW409-414 WMP.

Table 1 presents these requirements and indicates where they are addressed within this LW409-414 WMP.

Table 1: Water Management Plan Requirements

Project Approval (05_0117) Condition	LW409-414 WMP Section
Condition 77, Schedule 3	
77. The Proponent shall prepare and implement an Extraction Plan for all second workings on site to the satisfaction of the Secretary. Each extraction plan must:	
...	
(h) include a Water Management Plan, which has been prepared in consultation with EPA and DPIE Water, which provides for the management of the potential impacts and/or environmental consequences of the proposed second workings on watercourses and aquifers, including:	**This document**
i. surface and groundwater impact assessment criteria, including trigger levels for investigating any potentially adverse impacts on water resources or water quality;	**Section 5**
ii. a program to monitor and report stream flows, assess any changes resulting from subsidence impacts and remediate and improve stream stability;	**Sections 6, 7 and 8**
iii. a program to monitor and report groundwater inflows to underground workings;	**Sections 6 and 8**
iv. a program to predict, manage and monitor impacts on groundwater bores on privately-owned land; and	**Sections 6 and 7**
...	
(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 14 and 15, or where any such exceedance appears likely;	**Section 7**
...	
(p) include a program to collect sufficient baseline data for future Extraction Plans.	**Sections 6 and 8.3**

Table 1 (Continued): Water Management Plan Requirements

Project Approval (05_0117) Condition	LW409-414 WMP Section
Condition 78, Schedule 3	
78. The Proponent shall ensure that the management plans required under conditions 77(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	**Section 4**
(b) a detailed description of the measures that would be implemented to remediate predicted impacts.	**Section 7**
Condition 3, Schedule 5	
3. The Proponent shall ensure that the management plans required under this approval are prepared in accordance with any relevant guidelines, and include:	
(a) detailed baseline data;	**Sections 4.4, 4.5.1, 4.6.1 to 4.6.3**
(b) a description of:	
• *the relevant statutory requirements (including any relevant approval, licence or lease conditions);*	**Section 3**
• *any relevant limits or performance measures/criteria;*	**Section 5**
• *the specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the project or any management measures;*	**Section 5**
(c) a description of the measures that would be implemented to comply with the relevant statutory requirements, limits, or performance measures/criteria;	**Section 7**
(d) a program to monitor and report on the:	**Sections 6 and 8**
• *impacts and environmental performance of the project;*	
• *effectiveness of any management measures (see c above);*	
(e) a contingency plan to manage any unpredicted impacts and their consequences;	**Section 7**
(f) a program to investigate and implement ways to improve the environmental performance of the project over time;	**Sections 6 and 8**
(g) a protocol for managing and reporting any:	
• *incidents;*	**Section 9**
• *complaints;*	**Section 10**
• *non-compliances with statutory requirements; and*	**Section 11**
• *exceedances of the impact assessment criteria and/or performance criteria; and*	**Section 7**
(h) a protocol for periodic review of the plan.	**Section 2**

3.2 OTHER LEGISLATION

MCO operates the Moolarben Coal Complex consistent with Project Approval (05_0117) (as modified) and Project Approval (08_0135) (as modified) and any other legislation that is applicable under the *Environmental Planning and Assessment Act 1979*.

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

- *Crown Land Management Act 2016;*
- *Fisheries Management Act 1994;*
- *Heritage Act 1977;*
- *Coal Mine Subsidence Compensation Act 2017;*
- *Mining Act 1992;*
- *National Parks and Wildlife Act 1974;*
- *Biodiversity Conservation Act 2016;*
- *Protection of the Environment Operations Act 1997;*
- *Roads Act 1993;*
- *Water Act 1912;*
- *Water Management Act 2000;*
- *Work Health and Safety Act 2011;* and
- *Work Health and Safety (Mines and Petroleum Sites) Act 2013.*

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

3.3 WATER LICENCES HELD BY MCO

The water licences held by MCO are listed in **Table 2**. Groundwater use including incidental use or "take" of groundwater will be assessed for each water source affected by the Moolarben Coal Complex and accounted for by way of the groundwater licences held by the Moolarben Coal Complex.

Table 2: Water Licences Held by MCO

Licence Number	Description
WALs 19424, 36340 and 37583	Wollar Creek Water Source
WALs 37582, 41888 and 19052	Upper Goulburn River Water Source
WALs 39799, 43977 and 43978	Sydney Basin – North Coast Groundwater Source

4.0 PREDICTED SUBSIDENCE IMPACTS AND ENVIRONMENTAL CONSEQUENCES

4.1 LONGWALLS 409 TO 414 EXTRACTION SCHEDULE

LW409-414 and the area of land within the Study Area are shown on **Figure 3**. Longwall extraction will occur from the north to the south for each panel. The longwall layout includes approximately 260 metres (m) panel widths (void) with 35 m width pillars (solid). The provisional extraction schedule for LW409-414 is provided in **Table 3**.

Table 3: Provisional Extraction Schedule

Longwall	Estimated Start Date	Estimated Duration (months)	Estimated Completion Date
LW409	September 2026	3	November 2026
LW410	December 2026	3	March 2027
LW411	April 2027	3	July 2027
LW412	August 2027	4	December 2027
LW413	January 2028	4	May 2028
LW414	June 2028	4	September 2028

4.2 REVISED SUBSIDENCE AND IMPACT PREDICTIONS

Revised subsidence predictions of the potential subsidence effects, subsidence impacts and environmental consequences of the proposed second workings, have been prepared by MSEC (2024) incorporating any relevant information obtained since approval (e.g. additional data from underground mining in UG1 and LW401-408 to date), in accordance with Condition 77(e), Schedule 3 of Project Approval (05_0117).

The development of this LW409-414 WMP has incorporated the subsidence predictions and impacts applicable to surface water and groundwater in the *Moolarben Coal Complex: Moolarben Project Stage 1 – Longwalls 409 to 414 Subsidence Predictions and Impact Assessments for the Natural and Built Features in Support of the Extraction Plan* (MSEC, 2024), *UG4 Longwalls 409 to 414 Extraction Plan – Surface Water Technical Report* (WRM, 2024) and *UG4 LW409-414 Extraction Plan Groundwater Technical Report* (AGE, 2024) which are summarised in **Section 4.4** to **Section 4.6**.

Predicted subsidence impacts to the Goulburn River, the Drip and Corner Gorge from the extraction of LW409-414 are described in the Monitoring Program (**Appendix H**).

4.3 ENVIRONMENTAL RISK ASSESSMENT

An Environmental Risk Assessment (ERA) was conducted for four of the key component plans of the UG4 LW409-414 Extraction Plan (Water Management Plan, Biodiversity Management Plan, Heritage Management Plan and Land Management Plan), to provide appropriate consideration to risk assessment and risk management in accordance with the *Extraction Plan Guideline* (DPE, 2022).

The ERA workshop for LW409-414 was held on 2 May 2024, facilitated by independent specialist AXYS Consulting Pty Ltd, the suitably qualified and experienced experts endorsed by the Secretary of the DPHI for the preparation of the LW409-414 Extraction Plan and relevant MCO personnel participated in the ERA. The ERA indicated that risks relevant to surface water and groundwater in the LW409-414 Study Area were in the "Low" to "Medium" category, and it was expected that the risks could be managed with implementation of the appropriate mitigation, management and/or control measures.

4.4 PREDICTED SUBSIDENCE IMPACTS

The predicted subsidence effects, subsidence impacts and environmental consequences of the Moolarben Coal Complex UG4 were originally assessed, and subsequently approved (the Approved Layout), in the Moolarben Coal Project Environmental Assessment Report (MCM, 2006).

Subsidence impact predictions for the drainage lines in the LW409-414 Study Area have been revised to reflect the latest longwall layout (the Extraction Plan Layout) (MSEC, 2024), incorporating any relevant information obtained since approval.

There are no perennial drainage lines within the Study Area. The only main drainage line flowing through the Study Area is Drainage Line 2 (**Figure 4**). A number of other small ephemeral drainage lines have been identified above LW409-414 and within the Study Area (MSEC, 2024).

MSEC (2024) completed a comparison of the maximum predicted subsidence parameters for Drainage Line 2 resulting from the extraction of LW409-414 (i.e. the Extraction Plan Layout) with those for the Approved Layout as shown in **Table 4**. The values are the maxima along the section of the drainage line located within the LW409-414 Study Area.

Table 4: Maximum Predicted Systematic Subsidence Parameters along Drainage Line 2 Resulting from the Extraction of the Approved Layout and Extraction Plan Layout

Layout	Drainage Line	Subsidence[1] (mm)	Tilt[2] (mm/m)	Hogging Curvature[3] (km^{-1})	Sagging Curvature[3] (km^{-1})
Approved Layout	Drainage Line 2	1900	40	1.9	1.6
Extraction Plan Layout	Drainage Line 2	1900	40	1.9	1.6

Source: MSEC (2024).

mm/m = millimetres per metre, km^{-1} = 1/kilometres.

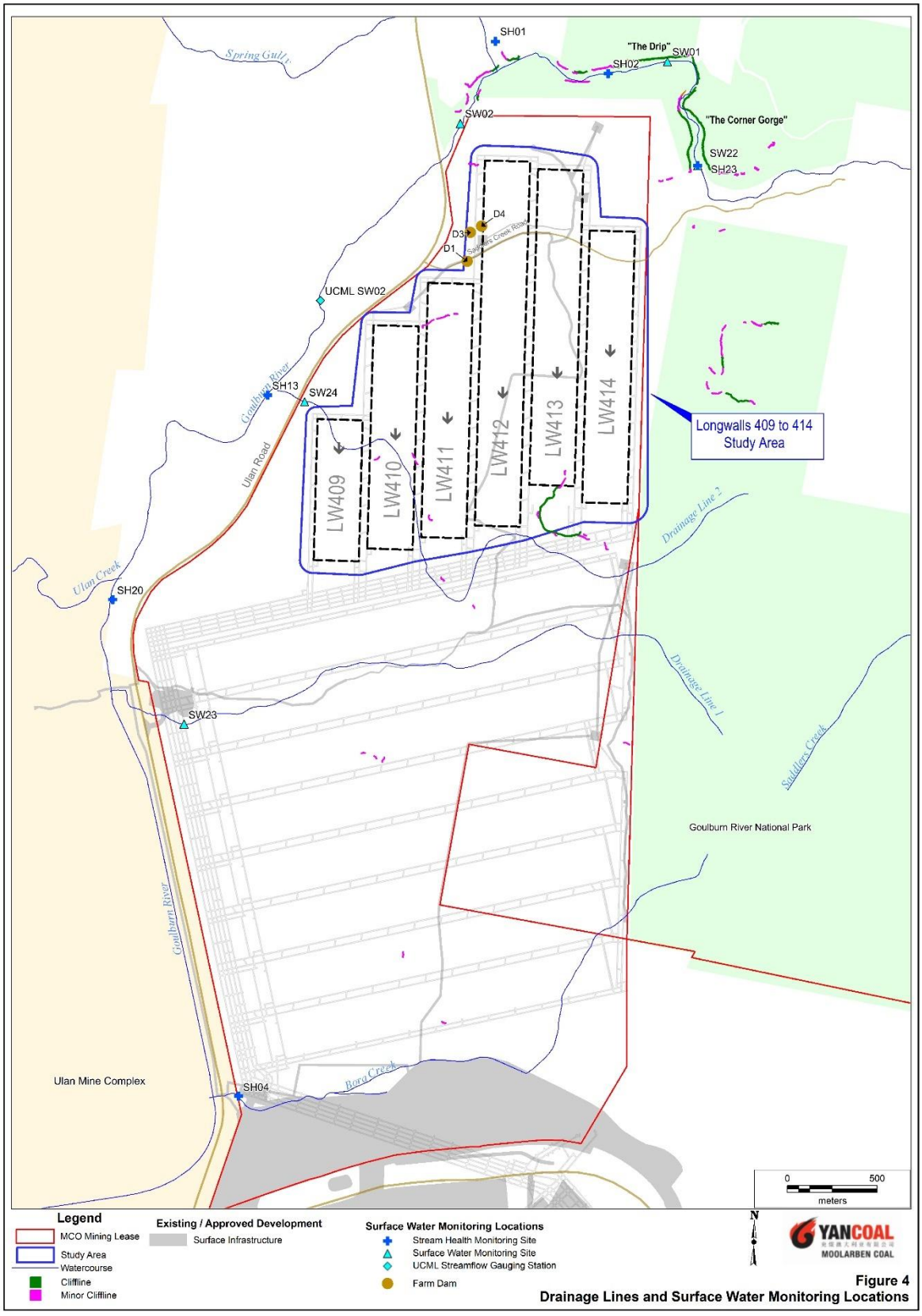
1 Subsidence refers to vertical displacements of the ground.

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 predicted total subsidence parameters for Drainage Line 2 based on the Extraction Plan Layout is the same as that for the Approved Layout (MSEC, 2024).

Figure 4: Drainage Lines and Surface Water Monitoring Locations



4.5 SURFACE WATER

4.5.1 Baseline Data

The Moolarben Coal Complex is located in the Upper Goulburn River and Wollar Creek catchments (both sub-catchments to the larger Goulburn River and Hunter River catchments), which have catchment areas of approximately 2,455 square kilometres (km^2) and 532 km^2, respectively. Both catchments drain to the Goulburn River which flows in an easterly direction, eventually joining the Hunter River approximately 150 km downstream of the Moolarben Coal Complex. The Goulburn River is located on the north-western side of LW409-414 at distances of 180 m to 440 m from the longwall commencing ends, and to the north and north-east of LW412-413 at distances of 460 m to 500 m. AGE (2024) note that the Goulburn River Diversion is not directly connected to the water table adjacent LW409-414.

The main drainage line flowing through the Study Area is Drainage Line 2 (**Figure 3**). All drainage lines identified within the Study Area are ephemeral as water only flows during, and for short periods after, each rain event. The ephemeral drainage lines within the Study Area flow to the Goulburn River (MSEC, 2024).

The ephemeral drainage lines within the Study Area comprise a rounded gravel to sandy and silty base. There is also debris along sections of the streams, including boulders, tree branches and other vegetation. The valley profiles of the drainage lines are predominantly broad and shallow with some incised sections. The natural grades of the main drainage lines within the Study Area typically vary between 5 mm/m (i.e. 0.5 percent [%] or 1 in 200) and 100 mm/m (i.e. 10 % or 1 in 10), with average natural grades of approximately 20 mm/m (i.e. 2 % or 1 in 50) (MSEC, 2024).

4.5.2 Summary of Subsidence Impacts to Drainage Lines

MSEC (2024) concluded the maximum predicted total subsidence parameters for Drainage Line 2 based on the Approved Layout are the same as those for the Extraction Plan Layout for LW409-414 (**Table 4**). The potential impacts for Drainage Line 2, based on the Extraction Plan Layout are the same as those assessed based on the Approved Layout. The following summary outlines the potential impacts to Drainage Line 2 in the Study Area (MSEC, 2024):

- The predicted changes in grade along Drainage Line 2 after the completion of LW409-414 are generally less than most of the natural grades, however the magnitudes of tilt will result in increases and decreases in grade and reversal of grade at some locations.
- Ponding naturally develops along some sections of the drainage lines, for short periods of time, after major rain events. Additional ponding may occur along Drainage Line 2 resulting from the extraction of LW409-414, predominantly upstream of the chain pillars.
- Sections of beds downstream of the additional ponding areas may erode during subsequent rain events, especially during times of high flow. It is expected that, over time, the gradients along Drainage Line 2 would approach grades similar to those that existed before mining. The extent of additional ponding along the drainage lines would, therefore, be expected to decrease with time.
- Fracturing, dilation and buckling of the bedrock would occur as a result of the extraction of LW409-414. Surface cracking is expected to develop in the base of Drainage Line 2.

- In times of low flow, a larger proportion of the surface water flow could be diverted into the strata below the beds and this could affect the quality and quantity of this water flowing through the cracked strata beds. Nevertheless, during high flow or low flow times, this small quantity is expected to have little impact on the overall quality of water flowing out of the drainage lines.

WRM (2024) considered the potential impacts to Drainage Line 2 as a result of the extraction of LW409-414 and noted the predicted maximum subsidence impacts would occur only within about 100 m of where Drainage Line 2 cross the chain pillars. There is minimal change in drainage characteristics in reaches where uniform subsidence occurs (WRM, 2024).

4.5.3 Summary of Subsidence Impacts to Water Storage Dams

There are three farm dams within the Study Area (D1, D3, and D4) (**Figure 4**). The dams are shallow with maximum dimensions of approximately 10 m to 20 m and were previously used for livestock watering but are no longer in use. The farm dams are located on land owned by MCO.

The maximum predicted total subsidence parameters for the MCO farm dams within the Study Area based on the Extraction Plan Layout are the same as the parameters for the Approved Layout for LW409-414 (MSEC, 2024).

Dams D1 and D3 are located outside the LW409-414 footprints and are expected to experience negligible predicted subsidence movements. Therefore, impacts to these dams are not expected (MSEC, 2024). The following summary outlines the potential impacts to farm dam D4, which is located above LW412 (MSEC, 2024):

- Change in freeboard of up to 200 mm.
- Expected cracking and leakage of water. Any loss of water from the farm dams would flow into the drainage line in which the dam was formed.

It is recommended that farm dams, where not decommissioned, are visually monitored as LW409-414 are extracted, such that any impacts can be identified and remediated accordingly. In this way the farm dams within the Study Area can be maintained in a safe condition throughout the mining period (MSEC, 2024).

4.6 GROUNDWATER

4.6.1 Baseline Data

Previous groundwater assessments have extensively detailed the hydrogeological regime and groundwater quality within and surrounding the Moolarben Coal Complex. Previous assessments include:

- *Moolarben Coal Project – Groundwater Assessment* (Peter Dundon and Associates Pty Ltd, 2006);
- *Moolarben Stage 2 Groundwater Assessment* (Aquaterra Consulting Pty Ltd, 2008);
- *Moolarben Complex Stage 2 – Preferred Project Report – Groundwater Impact Assessment* (RPS Aquaterra, 2011);
- *Moolarben Coal Complex Stage 1 Optimisation Modification Groundwater Assessment* (AGE, 2013);

- *Moolarben Coal Complex UG1 Optimisation Modification – Environmental Assessment – Groundwater Assessment* (Dundon Consulting Pty Limited, 2015);
- *Moolarben Coal Open Cut Optimisation Groundwater Assessment* (Hydrosimulations, 2017);
- *Groundwater Review for Moolarben UG2 Modification* (AGE, 2021);
- *Moolarben Coal Complex OC3 Extension Project – Groundwater Impact Assessment* (AGE, 2022a);
- *Technical Memorandum for Moolarben Coal Complex UG2 Modification* (AGE, 2022b); and
- *UG4 LW401-408 Extraction Plan Revised Groundwater Technical Report* (AGE, 2023).

Various groundwater studies have also been completed for the Ulan Coal Mine and Wilpinjong Coal Mine. Comprehensive groundwater monitoring is undertaken at Moolarben Coal Complex in accordance with the approved complex-wide Groundwater Management Plan (GWMP). Key existing Moolarben Coal Complex groundwater monitoring sites in the vicinity of UG4 are listed in **Table 5** and shown on **Figure 5**.

4.6.2 Hydrogeological Regime

The Moolarben Coal Complex area is located in the Western Coalfield on the north-western edge of the Sydney-Gunnedah Basin. The main hydrogeological units within and surrounding the Moolarben Coal Complex include (AGE, 2024):

- Quaternary alluvium associated with the present day drainage system.
- Tertiary alluvium associated with a palaeochannel system that is not related to the present day drainage.
- Jurassic aged Pilliga sandstone and Purlewaugh siltstone, consisting of coarse grained quartzose sandstone, lithic sandstone, conglomerates, claystone and shale.
- Narrabeen Group - Triassic sandstone consisting of quartzose sandstone and lithic sandstone.
- Illawarra Coal Measures - Permian coal measures, which includes the Ulan Seam near the base of the unit.
- Marrangaroo Conglomerate – Permian aged conglomerate.
- Basement - Units that include Carboniferous volcanics and the Gulgong or Ulan granite.

Quaternary alluvial deposits in the vicinity of the Moolarben Coal Complex are associated with the Goulburn River, Moolarben Creek, Lagoon Creek and Wilpinjong Creek.

Tertiary sediments associated with palaeochannels are remnants of inactive river or stream channels that have been filled in or buried by younger sediment. The infill sediments consist of poorly-sorted semi-consolidated quartzose sands and gravels in a clayey matrix. The sediments are unsaturated across a large proportion of the footprint of the palaeochannel. Tertiary sediments are located within the palaeochannel to the south of UG4.

Table 5: UG4 Groundwater Monitoring Network

Piezometer	Type of Bore	Screen Interval / Piezometer Depth (mbgl)	Lithology Monitored	Water Level Monitoring Frequency	Water Quality Monitoring
PZ101C	SP	24-30	Triassic	Monthly	6-monthly
PZ101B*	SP	54-60	Permian OB	Monthly	6-monthly
PZ102C	VWP	28	Permian	Monthly	NA
		64	Permian		
PZ105C	SP	20-28	Lower Triassic	Monthly	6-monthly
PZ105A	VWP	28	Permian OB	Monthly	NA
		80	Permian OB		
		118	Ulan Seam		
		130	Ulan Seam		
PZ192	VWP	68	Triassic	Monthly	NA
		166	Ulan seam roof		
		178	Ulan seam base		
PZ193	VWP	80	Top Permian	Monthly	NA
		162	Ulan seam roof		
		184	Ulan seam base		
PZ103C	SP	24-30	Triassic	Monthly	6-monthly
PZ103D^	VWP	31	Permian	Monthly	NA
		55	Permian		
		85	Permian		
PZ194	VWP	78	Base of Triassic	Monthly	NA
		173	Base of Permian		
		196	Ulan Seam Base		
PZ194B	SP	85-88	Triassic	Monthly	6-monthly
PZ194C	SP	100-106	Permian	Monthly	6-monthly
PZ195	VWP	72	Base of Triassic	Monthly	NA
		162	Base of Permian		
		175	Ulan Seam Base		
PZ195B	SP	63-66	Triassic	Monthly	6-monthly
PZ195C	SP	81-88	Permian	Monthly	6-monthly
PZ232^	VWP	45	Triassic	Monthly	NA
		75	Triassic		
		96	Permian OB		
		132	Permian OB		
PZ233A	SP	18	River Level	Monthly	6-monthly
PZ233B	SP	55	Permian	Monthly	6-monthly

Table 5 (Continued): UG4 Groundwater Monitoring Network

Piezometer	Type of Bore	Screen Interval / Piezometer Depth (mbgl)	Lithology Monitored	Water Level Monitoring Frequency	Water Quality Monitoring
PZ233C	VWP	20	Moolarben Seam	Monthly	NA
		52	Permian		
		75	Ulan OB		
		99	Ulan Seam		
		109	Permian		
PZ234A	SP	15-18	Triassic	Monthly	6-monthly
PZ234B	SP	27-30	Lower Triassic/Upper Permian	Monthly	6-monthly
PZ234C	SP	69-75	Permian	Monthly	6-monthly
PZ235B	VWP	68	Permian OB	Monthly	NA
		96	Permian OB		
		147	Ulan Seam		
PZ235C	SP	46-49	Triassic	Monthly	6-monthly
PZ236B^	VWP	85	Permian OB	Monthly	NA
		110	Permian OB		
		157	Ulan Seam		
PZ236C^	SP	55-58	Base of Triassic	Monthly	6-monthly
PZ237A	SP	14-17	Triassic	Monthly	6-monthly
PZ237B	SP	27-30	Lower Triassic/Upper Permian	Monthly	6-monthly
PZ237C	SP	66-72	Permian	Monthly	6-monthly
PZ240	VWP	59	Ulan Seam	Monthly	NA
PZ241	SP	19-22	Paleochannel	Monthly	6-monthly
PZ255A	SP	22-25	Permian	Monthly	6-monthly
PZ255B	VWP	35	Paleochannel	Monthly	NA
		49	Permian		
		69	Ulan OB		
		90	Ulan Seam		
		100	Permian		
PZ256A	SP	37-40	Triassic	Monthly	6-monthly
PZ256B	VWP	60	Triassic	Monthly	NA
		96	Permian		
		120	Ulan OB		
		145	Ulan Seam		
		155	Permian		
PZ256C	SP	67-70	Permian	Monthly	6-monthly

Table 5 (Continued): UG4 Groundwater Monitoring Network

Piezometer	Type of Bore	Screen Interval / Piezometer Depth (mbgl)	Lithology Monitored	Water Level Monitoring Frequency	Water Quality Monitoring
PZ257A	SP	58-61	Triassic	Monthly	6-monthly
PZ257B	VWP	63	Triassic	Monthly	NA
		120	Permian		
		140	Ulan OB		
		167	Ulan Seam		
		175	Permian		
PZ257C	SP	81-84	Permian	Monthly	6-monthly

OB = overburden, VWP = Vibrating Wire Piezometer, SP = Standpipe, mbgl = metres below ground level

** To be decommissioned prior to extraction for safety of underground operations or where impacted by subsidence. Will continue to be monitored until decommissioned.*

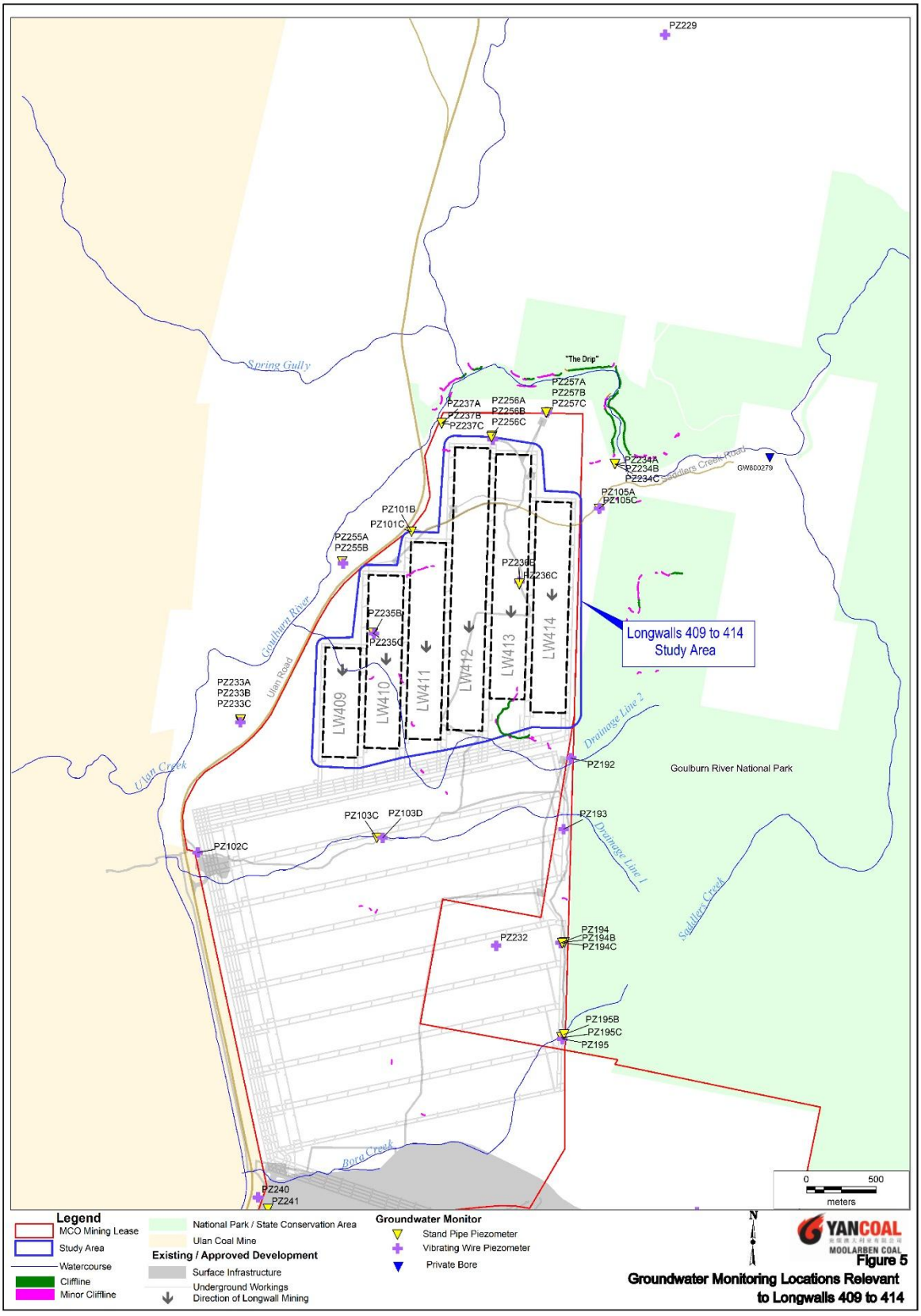
^ To be monitored until impacted by mining.

The Jurassic Formations do not exist in the Moolarben Coal Complex area, but occur as caps on Triassic strata in more elevated areas to the north. The Pilliga Sandstone is the youngest consolidated formation and comprises cross-bedded sequences of ferruginous, coarse grained quartzose sandstone, conglomerates, claystone and shale. The underlying Purlewaugh Formation comprises siltstone, mudstone and fine to medium grained lithic sandstone. The Purlewaugh Siltstone is a low permeability unit that likely forms an aquitard.

Triassic aged sandstones overly the Permian coal measures and are present over LW409-414. Large extents of the Triassic strata are naturally unsaturated (especially the higher and more permeable upper Triassic quartzose). Data from monitoring point PZ128 Vibrating Wire Piezometer (VWP) located 20 m north of LW412 show the sensor has been unsaturated for the entire period of monitoring. Where saturated, the Triassic sandstones provide some water supply potential for bores, however the sandstone is generally low yielding (AGE, 2024).

The Triassic sandstone supports a small number of stock and domestic bores on private properties to the north of the Moolarben Coal Complex. Groundwater within the Triassic sandstones north of the Goulburn River also supports the local and culturally sensitive water feature on the Goulburn River known as the Drip, which is located on the northern side of the Goulburn River. The Drip is a perched water table within the Triassic sandstone and effectively disconnected from the underlying regional water table (AGE, 2024).

Figure 5: Groundwater Monitoring Locations Relevant to Longwalls 409 to 414



The Permian aged Illawarra Coal Measures underlie the Triassic Narrabeen Group and comprise interbedded claystones, siltstones, fine to coarse grained sandstones and coal seams, including the Ulan Seam which will be mined at UG4 (AGE, 2024).

The Permian strata can be categorised into the following hydrogeological sub-units (AGE, 2024):

- very low permeability and very low yielding sandstone and siltstone, that comprises the majority of the Permian interburden/overburden; and
- low to moderately permeable coal seams, which are the principal water bearing strata within the Illawarra Coal Measures.

The Permian coal measures are hydraulically confined to semi-confined within the region. Groundwater levels are locally depressurised due to extensive historic and current mining activities (AGE, 2024).

The Marrangaroo Conglomerate, which is a conglomerate or sandstone in this area, sits around 5 m below the Ulan Seam Floor (MCO, 2022). Regionally the Marrangaroo Conglomerate is known to be moderately permeable and considered an aquifer in some local areas being able to sustain reliable yields to bores. Hydrogeological data from six piezometers at the Moolarben Coal Complex that have been completed in the conglomerate indicate that the unit has a relatively low permeability, with very limited water supply potential (AGE, 2024).

Recharge to the groundwater system occurs by the direct infiltration of rainfall and downward percolation through the near surface weathered rock, and alluvium where present. Recharge to the deeper units within the Permian coal measures occurs by downward seepage into the units where they subcrop beneath the alluvium or weathered rock cover (AGE, 2024).

The Goulburn River is the main watercourse in the vicinity of UG4 and has been heavily modified by the Goulburn River Diversion adjacent to UG4. In November 2023 MCO installed two additional gauging stations, namely SW02 and SW22 (**Figure 4**), and two shallow standpipe monitoring bores PZ237A and PZ234A (**Figure 5**), to compare surface / groundwater levels at two locations along the Goulburn River. The data collected at these monitoring locations to date indicates both gaining and losing conditions between surface water and groundwater occur along the length of the Goulburn River adjacent to LW409-414 (AGE, 2024). The proposed monitoring network and TARPs to manage the extraction of LW409-414 with respect to the Goulburn River are provided in the Monitoring Program (**Appendix H**).

There is no 'highly productive' groundwater, as defined under the *NSW Aquifer Interference Policy* (AIP), mapped in the vicinity of the Moolarben Coal Complex. The aquifers in the vicinity of LW409-414 are "less productive" as per the AIP classification. The nearest 'highly productive' groundwater is a portion of the alluvial aquifer associated with Wilpinjong Creek downstream of the Wilpinjong Coal Mine.

The AIP describes the following minimal impact considerations for less productive groundwater sources:

> *Less than or equal to 10% cumulative variation in the water table, allowing for typical climatic "post-water sharing plan" variations, 40m from any:*
>
> *(a) high priority groundwater dependent ecosystem; or*
>
> *(b) high priority culturally significant site;*
>
> *listed in the schedule of the relevant water sharing plan.*
>
> *A maximum of a 2m decline cumulatively at any water supply work.*

Springs and groundwater seeps in nearby creek valleys and localised pools and soaks along the creeks support riparian vegetation (AGE, 2024). None of these features constitute high priority groundwater dependent ecosystems (GDEs) listed under the Water Sharing Plans relevant to the Moolarben Coal Complex (AGE, 2024).

Mapping from the Groundwater Dependent Ecosystems Atlas (Bureau of Meteorology, 2024) identifies the Goulburn River as a low to moderate potential aquatic GDE as well as vegetation identified as low to high potential terrestrial GDEs in the vicinity of UG4. The significant depth to water in more elevated areas of the catchments such as the UG4 area where the depth to the water table is approximately 25 m to 65 m indicates that GDEs are unlikely to be present within the LW409-414 area (AGE, 2024).

There are no high priority GDEs listed in the *Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009* within or in the vicinity of the Study Area (AGE, 2024).

The Drip is a GDE with local cultural and community significance. The groundwater seepage is observed in a cliff on the northern side of the Goulburn River and is derived from the perching of groundwater in zones that are exposed in the cliff faces. The perching occurs in the Triassic Narrabeen Group sediments and is formed by accumulations of groundwater above less permeable horizons in the Triassic sequence to the north of the Goulburn River. As described above, the perched aquifer is effectively disconnected from the underlying regional water table and therefore depressurisation caused by mining of LW409-414 will not impact the water supply to the Drip (AGE, 2024). The proposed monitoring network and TARPs to manage the extraction of LW409-414 with respect to the Drip are provided in the Monitoring Program (**Appendix H**).

4.6.3 Private Bores

There is one private bore in the vicinity of the Study Area, located to the east of LW414 (**Figure 5**). The bore is a relatively shallow bore (24 m) installed within Triassic strata and connected to the river alluvium. No private bores are predicted to experience greater than minimal impact (i.e. will be less than the AIP minimal impact definition of drawdown greater than 2 m drawdown) due to LW409-414 (AGE, 2024).

4.6.4 Predicted Impacts

Potential groundwater impacts due to the extraction of LW409-414 were originally assessed, and subsequently approved as part of the Moolarben Coal Project Stage 1 (Project Approval [05_0117]).

AGE (2024) has prepared updated groundwater predictions for LW409-414 based on contemporary groundwater understanding, monitoring results and an updated numerical groundwater model. The groundwater modelling indicates that the Extraction Plan Layout would result in the same, or lower, potential impacts in comparison to the Approved Layout.

Key outcomes of the updated groundwater modelling for LW409-414 are (AGE, 2024):

- Continuous fracturing is not predicted to occur at the land surface, with the zone of continuous fracturing being 16 m deep or more.
- Groundwater drawdown within the Permian Illawarra Coal Measures due to LW409-414 will generate localised cumulative impacts. The drawdown predictions show the extent of the 2 m drawdown contour within the Permian strata extends less than 5.5 km from LW409-414, while regionally cumulative drawdown of greater than 50 m is not uncommon.

- No private bores are predicted to experience greater than minimal impact (i.e. drawdown greater than 2 m drawdown due to LW409-414.
- The predicted maximum takes due to mining activities for the Moolarben Coal Complex including LW409-414 are:
  - 3,079 megalitres per annum from Sydney Basin-North Coast Groundwater;
  - 254 megalitres per annum from the Upper Goulburn River Water Source; and
  - 282 megalitres per annum from the Wollar Creek Water Source.

MCO has, and will continue to, hold sufficient licence entitlements for its annual water take as is required under the *Water Management Act 2000*. If licence entitlements held by MCO (including when considering carry-over entitlements) are not predicted to be sufficient to account for licensable take, in the first instance, MCO would seek to trade entitlements with other Yancoal operations, where relevant.

5.0 PERFORMANCE MEASURES, PERFORMANCE INDICATORS AND INVESTIGATION TRIGGER LEVELS

5.1 SUBSIDENCE IMPACT PERFORMANCE MEASURES

Subsidence impact performance measures relevant to the Drip, Corner Gorge and Goulburn River (and the bed of the Goulburn River) are described in the Monitoring Program (**Appendix H**), which has been prepared in accordance with Condition 73, Schedule 3 of Project Approval (05_0117). The proposed monitoring network and TARPs to demonstrate there is no exceedance of the subsidence impact performance measures for the Drip, Corner Gorge and Goulburn River are provided in the Monitoring Program (**Appendix H**).

Project Approval (05_0117) does not include any specific performance measures for the drainage lines within the Study Area. Notwithstanding, WRM (2024) have recommended monitoring and management of any impacts to Drainage Line 2.

Project Approval (05_0117) also does not include any specific performance measures for monitoring the extent of groundwater drawdown against the model predictions. Notwithstanding, AGE (2024) have recommended ongoing monitoring of the existing groundwater monitoring network is undertaken to review observed drawdown against predicted levels. **Section 6.0** describes the monitoring that will be conducted to assess LW409-414 against the relevant performance measures and indicators. Associated trigger levels are detailed in **Sections 5.2** and **5.3** and TARPs are detailed in **Section 7.0**.

5.2 SURFACE WATER TRIGGER INVESTIGATION LEVELS

The complex-wide Surface Water Management Plan (SWMP) includes water quality investigation trigger levels (**Table 6**). As Drainage Line 2 is a tributary of the Goulburn River, the water quality investigation trigger levels established for the Goulburn River at monitoring site SW01 (**Figure 4**) (based on analysis of surface water quality monitoring data) are relevant to this LW409-414 WMP, to confirm subsidence impacts from LW409-414 do not result in adverse water quality impacts to the downstream environment.

Table 6: Surface Water Quality Trigger Investigation Levels

Waterway	Monitoring Site	pH		EC (µs/cm)		Turbidity (NTU)	
		20th/80th %ile Trigger Values	ANZECC Guideline	80th %ile Trigger Value	ANZECC Guideline	80th %ile Trigger Value	ANZECC Guideline
Goulburn River	SW01	6.5 – 8.5	6.5 – 8.0	900*	350	11	25
Drainage Line 2**	SW24	TBC	6.5 – 8.0	TBC	350	TBC	25

Note: The shaded cells indicate the adopted water quality trigger level. %ile = percentile, EC = electrical conductivity, µS/cm = microSiemens per centimetre and NTU = Nephelometric Turbidity Units.

** EC trigger levels reflect approved discharge limits at the Ulan Mine Complex (Ulan's discharge points are located upstream of SW01).*

** Preliminary Investigation Triggers for Drainage Line 2 will be based on ANZG (2018)/ANZECC (2000) default guideline values until updated sufficient baseline data is collected.

Given the ephemeral nature of Drainage Line 2, with flow related to large rain events, it is likely that water quality will exceed default guideline values. The preliminary investigation triggers for Drainage Line 2 will be updated when sufficient baseline data is collected.

The relevant trigger events for potential surface water impacts to the Goulburn River are provided in the Monitoring Program (**Appendix H**).

5.3 GROUNDWATER TRIGGER INVESTIGATION LEVELS

A summary of groundwater levels and quality investigation triggers relevant to LW409-414 is provided below. Trigger levels for bores listed in **Tables 7** and **8** supersede any trigger levels prescribed as part of other management plans associated with these bores.

Salinity and pH Triggers

Salinity and pH investigation trigger levels are defined in **Table 7** and are a sub-set of those in the approved complex-wide GWMP.

Table 7: Salinity and pH Trigger Levels

Bore	Depth (m)	Lithology Screened	Salinity Triggers			pH Trigger Level (5th to 95th percentile)[1]
			Historical lab EC (5th to 95th percentile) (µS/cm)[1]	EC Trigger Level (µS/cm)	Beneficial Use Category Based on Lab EC 95th Percentile	
PZ101C^	30	Lower Triassic	610 – 810 (655)	810	Marginal Potable	6.1 – 7.7 (6.7)
PZ105C	28	Lower Triassic	198 – 319 (265)	319	Potable	5.3 – 7.4 (6.1)

[1] Historical values in brackets are median values.
^ To be monitored until impacted by mining.

Groundwater Level Triggers

The groundwater investigation protocol detailed in the approved complex-wide GWMP would be initiated in cases where groundwater monitoring identifies the potential for a greater than 2 m reduction in the groundwater level at a private bore, determined against groundwater level hydrograph trends.

Groundwater Level Investigation Triggers relevant to the extraction of LW409-414 have been developed based on the updated groundwater model predictions with the objective of identifying any non-natural or expected (predicted and approved) impacts from LW409-414 which may adversely affect local water supply work (as per Table 1: Less Productive Groundwater Sources of the AIP) or sensitive environmental receptor and require further investigation. Groundwater level investigation triggers in this LW409-414 Extraction Plan are only relevant for extraction of LW409-414 and may be revised as an outcome of ongoing review of observed monitoring data against predictions. Groundwater level investigation triggers are presented in **Table 8.** Groundwater level investigation triggers with respect to the Goulburn River are provided in the Monitoring Program (**Appendix H**).

Table 8: Interim Groundwater Investigation Trigger Levels

Piezometer	Screened Interval	Screened Depth (mbgl)	Minimum Observed Groundwater Level (mAHD)	Trigger Level (mAHD)
PZ105C	Triassic[1]	20 – 28	373.3	372.4
PZ255A	Permian	22 – 25	380.9	380.3[2]

Note: mAHD = metres Australian Height Datum.

[1] Screened interval for PZ105C also includes a small portion of underlying Permian.

[2] Interim trigger level. The investigation trigger levels will be reviewed and updated (if required) to reflect the outcomes of the updated modelling.

The above trigger levels are intended to trigger an investigation to determine whether the cause of the groundwater level/pressure decline is caused by MCO's mining activity, excluding borefield pumping, and to recommend an appropriate response action. The TARP would be implemented following two consecutive monitoring rounds where a trigger level is identified as exceeded. These actions will identify if the investigated trigger exceedances are related to permanent mining induced effects, or more short-term temporary effects such as climatic variations, drilling of adjacent dewatering bores or drilling of piezometers.

The additional monitoring site has been established as part of the LW409-414 Extraction Plan (i.e. PZ255A). This additional monitoring point is designed to monitor observed groundwater drawdown compared to model predictions, and its indicative location is given in **Figure 5**. Further detail is provided in **Section 6.3**. The interim investigation trigger level has been established at monitoring location PZ255A, which would apply until groundwater model update. The interim investigation trigger levels will be reviewed and updated (if required) to reflect the outcomes of the updated modelling.

The groundwater monitoring program to measure potential impacts on the Goulburn River downstream of UG4 (i.e. the natural part of the Goulburn River downstream of the diversion, where some baseflow interaction is understood to occur) and the Drip, including additional monitoring sites established as part of the LW409-414 Extraction Plan and associated TARPs, are detailed in the Monitoring Program (**Appendix H**).

6.0 MONITORING

6.1 POTENTIAL SUBSIDENCE IMPACTS

A monitoring program has commenced to monitor the impact of the secondary extraction of LW409-414. The key components of the monitoring program are summarised in **Table 9**.

The subsidence monitoring program for the Goulburn River, the Drip and the Corner Gorge is detailed in the Monitoring Program (**Appendix H**).

Table 9: Subsidence Monitoring Program for Surface Water Features

Monitoring Component	Parameter	Timing/Frequency	Responsibility
Pre-mining			
Visual inspection of Drainage Line 2	Identify and mark the upstream and downstream limits of LW409 and LW410 along Drainage Line 2. Undertake a baseline inspection by walking along Drainage Line 2 over LW409 and LW410 and noting the condition of vegetation in the channel and any areas of active erosion, sediment deposition, water ponding or streambed cracking. Collect photographic record of channel condition along Drainage Line 2 over LW409 and LW410.	Prior to undermining of Drainage Line 2.	Environment and Community Manager.
During and Post Mining			
Visual inspection at access points along Drainage Line 2	Undertake periodic walkover inspection and update photographic record.	Within 3 months of undermining of Drainage Line 2. Ongoing inspections every 6 months for one year after undermining Drainage Line 2.	Environment and Community Manager.

Subsidence parameters will be measured in accordance with the Longwalls 409 to 414 Subsidence Monitoring Program (**Appendix G** of the LW409-414 Extraction Plan).

6.2 SURFACE WATER FLOW AND QUALITY

Surface water monitoring for receiving watercourses is undertaken for flow, water quality, stream health and channel stability as described in the approved complex-wide SWMP. Water quality sampling of receiving streams will continue to be undertaken in accordance with the approved complex-wide SWMP. Appropriate existing water quality monitoring at locations downstream of Drainage Line 2 on the Goulburn River are shown on **Figure 4**. Monitoring parameters are detailed within the complex-wide SWMP. The existing sites are replicated in **Table 10** below along with additional monitoring sites.

The surface water monitoring program for the Goulburn River is detailed in the Monitoring Program (**Appendix H**).

Table 10: Complex-wide SWMP Monitoring Program

Site	Frequency	Parameters	Site Justification
SW01	Monthly (if flowing)	Flow – Observation pH, EC, TSS, TDS, temperature, turbidity	Located downstream of LW409-414 mining operations and downstream of open cut and CHPP on Goulburn River.
	Six-monthly (in addition to above)	Al, Cu, Pb, Zn, Ni, Fe, Mn, As, Se, Cd, Cr, Li, Ba, Sr, DO, Total P and Total N	
	After rainfall event (>30 mm in 24 hours)	Flow – Observation pH, EC, TSS, TDS, Zn, Fe	
SW24	Monthly (if flowing)	Flow – Observation pH, EC, TSS, TDS, temperature, turbidity	Located downstream of UG4 LW409-414 on Drainage Line 2.
	Six-monthly (in addition to above)	Al, Cu, Pb, Zn, Ni, Fe, Mn, As, Se, Cd, Cr, Li, Ba, Sr, DO, Total P and Total N	
	After rainfall event (>30 mm in 24 hours)	Flow – Observation pH, EC, TSS, TDS, Zn, Fe	

Note: TSS = Total Suspended Solids, TDS = Total Dossolved Solids, CHPP = Coal Handling and Preparation Plant, > = greater than

Rainfall event sampling is to occur where safe access is available within 48 hours of the rainfall event as determined by the rainfall data at the weather station (WS03) established on Ulan Road.

6.3 GROUNDWATER

Groundwater monitoring is undertaken for groundwater extraction, groundwater levels, groundwater quality and leachate/seepage losses from water storages as described in the approved complex-wide GWMP.

The existing baseline groundwater monitoring program in the vicinity of UG4 is shown on **Figure 5**. The groundwater monitoring program for the Goulburn River, the Drip and Corner Gorge is detailed in the Monitoring Program (**Appendix H**).

Additional Monitoring Sites

As described in **Section 5.3**, an additional monitoring site has been established as part of the LW409-414 Extraction Plan:

- Site 1 (PZ255A): In addition to the shallow standpipe trigger monitoring bore, this site also comprises an additional shallow standpipe monitoring bore and a VWP (**Table 5**).

In addition to this site, the shallow standpipe monitoring bore PZ233A has been established as a commitment from the LW401-LW408 Extraction Plan.

The additional monitoring sites have been established prior to secondary extraction of LW409, to provide sufficient time to collect data and establish appropriate triggers for the mining of LW409-414. As some sites are located in proximity to existing VWPs it is possible that water level changes associated with installing the new bores are detected. Any short term effects are expected to be readily identifiable and separated from climatic or mining effects (AGE, 2024).

Monitoring sites impacted by subsidence will be decommissioned to reduce risk of hydraulic connection.

Groundwater Monitoring Frequency

Piezometers listed in **Table 5** and proposed additional monitoring points will be monitored for level/pressure on a monthly basis, or continuously via means of automatic dataloggers. Monitoring at piezometer locations proximal to mine workings will be discontinued as mining progresses in these areas.

Groundwater quality will be monitored in the standpipe bores listed in **Table 5** and proposed additional monitoring points. Samples are taken six-monthly and sent for laboratory analysis (**Table 11**). Field measurements of EC and pH are recorded at the time of water quality sampling conducted for relevant bores.

Table 11: Groundwater Quality Monitoring

Class	Parameters
Physical parameters	EC, Total Dissolved Solids (TDS), Total Suspended Solids (TSS) and pH
Major cations	calcium, magnesium, sodium, potassium
Major anions	carbonate, bicarbonate, chloride and sulphate
Dissolved metals	aluminium, arsenic, boron, cobalt, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, selenium, silver and zinc
Nutrients	ammonia, nitrate, phosphorus, reactive phosphorus

Groundwater Inflows

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

6.4 SUBSIDENCE – ENVIRONMENTAL CONSEQUENCES

MCO will compare the results of the subsidence impact monitoring against the water performance indicators (**Section 5.1**).

In the event that any observed subsidence impact exceeds a performance indicator, additional monitoring and assessment will be undertaken (**Section 7.0**).

In the event that any observed subsidence impacts exceed the performance indicators, MCO will assess the consequences of the exceedance in accordance with the measures described in **Section 9.0**.

7.0 TRIGGER ACTION RESPONSE PLAN

Water management at the Moolarben Coal Complex is currently undertaken in accordance with the approved complex-wide WAMP and associated subplans (Site Water Balance, SWMP and GWMP). Sections 4.0 and 8.0 of the approved complex-wide SWMP provide details of the management system and management measures for surface water, respectively. Section 8.0 of the approved complex-wide GWMP describes management measures for groundwater systems.

In addition to the management systems and measures detailed in the approved complex-wide SWMP and GWMP, WRM (2024) and AGE (2024) have recommended measures which are specific to LW409-414 that will be implemented, where appropriate.

Management measures and TARPs for the Drip, Corner Gorge and Goulburn River are provided in the Monitoring Program (**Appendix H**).

7.1 SUBSIDENCE

Potential management measures to mitigate/remediate subsidence consequences are provided in **Table** 12. The implementation of these management measures will be considered with regard to the specific circumstances of the subsidence impact (e.g. the location, nature and extent of the impact) and the assessment of environmental consequences. The implementation of management measures will be related to the scale of impact and the ability to, and value in, undertaking mitigation measures on a case by case basis.

The requirement and methodology for any subsidence remediation techniques will be determined in consideration of:

- Potential impacts of the unmitigated impact, including potential risks to public safety and the potential for self-healing or long-term degradation.
- Potential impacts of the remediation technique, including site accessibility.

7.2 SURFACE WATER AND GROUNDWATER

Details of trigger events, investigations required, notifications to be undertaken, management and contingency actions for surface water and groundwater are provided in **Table 13**.

An investigation will be initiated where the monitoring identifies results outside the trigger levels (or ranges) described in **Sections 5.1, 5.2** and **5.3**.

Review of Groundwater Model

As provided in Section 5.1 of the approved complex-wide GWMP and consistent with the commitments within Project Approval (08_0135), a groundwater modelling review and model recalibration (where required) will be conducted 2 years (and 5 yearly thereafter) after commencing Stage 2 coal extraction. Should any groundwater modelling review indicate a significant variance from the model predictions, MCO will initiate an investigation by a suitably qualified and experienced specialist and where required obtain additional groundwater licence allocations and/or implement remedial actions developed in consultation with DPHI.

Table 12: Subsidence TARP

Performance Indicator	Trigger Event	Action	Response
Drainage Line 2			
Unpredicted impacts on Drainage Line 2	Noticeable new areas of erosion or expansion of existing erosion, initiation of headcut or noticeable upstream advance of existing headcut or development of new pools or drainage of existing pools.	1. Obtain survey of ponded area to identify ponding depth and extent. 2. Undertake investigation (e.g. further monitoring, review of other data) to confirm if remediation works are required. 3. If necessary, obtain specialist advice on appropriate remediation works. 4. Investigate potential management strategies. Preferred management strategies would include slope stabilisation, drainage works to restore drainage characteristics, revegetation and bed control using natural materials such as local rock and large woody debris. *Note: disturbance of existing vegetation increases the risk of erosion. Hence, machinery access for remediation works can potentially cause greater impacts than those caused by subsidence.*	Where mining-related activities have resulted in trigger exceedances, implement contingency and remedial measures based on investigation.

Table 13: Surface Water and Groundwater TARP

Performance Indicator	Trigger Event	Action	Response
Groundwater Quality			
No greater than minimal impact for water users or high priority GDEs (as defined in the AIP for less productive groundwater) due to mining-related activities (i.e no change in beneficial use category).	Two consecutive groundwater quality monitoring results exceed (or below in the event of a lower pH trigger limit) investigation triggers at monitoring location.	1. Check and validate data. 2. Notify Environment and Community Manager or delegate. 3. Undertake investigation to confirm if investigation trigger exceedance is mining-related: a. If necessary, engage a suitably qualified person. b. Consider relevant recent conditions, including climate and land-use activities. c. Consider relevant monitoring data, e.g. other monitoring bores. d. If investigation confirms trigger exceedance is not mining-related, record data and cease investigation. 4. If trigger exceedance is mining-related, confirm if mining-related activities have caused, or have the potential to cause, exceedance of the performance indicator. a. If so, notify DPHI and other relevant agencies immediately. b. If not, notify DPHI and other relevant agencies as soon as practicable. 5. Notify DPHI and other relevant agencies if performance indicator are exceeded as soon as practicable. 6. Complete Preliminary investigation report and provide to DPHI and relevant agencies within 7 days of identifying the incident.	Where mining-related impacts have resulted in trigger exceedances, implement contingency and remedial measures based on investigation. Potential measures are described in the approved complex-wide GWMP.

Table 13 (Continued): Surface Water and Groundwater TARP

Performance Indicator	Trigger Event	Action	Response
Groundwater Level			
No greater than minimal impacts to water users due to mining impacts	The monitored groundwater level trend indicates greater than 2 m mine related drawdown at the monitoring location for two consecutive monthly monitoring rounds (subject to access agreement with the relevant landholder).	1. Check and validate data. 2. Notify Environment and Community Manager or delegate. 3. Undertake investigation to confirm if investigation trigger exceedance is mining-related: a. If necessary, engage a suitably qualified person. b. Consider relevant recent conditions, including climate and land-use activities. c. Consider relevant monitoring data, e.g. other monitoring bores. d. If investigation confirms trigger exceedance is not mining-related, record data and cease investigation. 4. If trigger exceedance is mining-related, confirm if mining-related activities have caused, or have the potential to cause, exceedance of the performance indicator. a. If so, notify DPHI and other relevant agencies immediately. b. If not, notify DPHI and other relevant agencies as soon as practicable. 5. Notify DPHI and other relevant agencies if performance indicator are exceeded as soon as practicable. 6. Complete Preliminary investigation report and provide to DPHI and relevant agencies within 7 days of identifying the incident. 7. A detailed Investigation Report (inclusive of any management/mitigation measures) would be provided to the DPHI within 3 months of an incident occurring where a performance indicator is exceeded.	Where mining-related impacts have resulted in trigger exceedances, implement contingency and remedial measures based on investigation.

Table 13 (Continued): Surface Water and Groundwater TARP

Performance Indicator	Trigger Event	Action	Response
Surface Water Quality			
No significant adverse mining related effects to downstream water quality (when compared to baseline and/or ANZECC limits).	Two consecutive monthly surface water quality monitoring results exceed (or below in event of a trigger of the lower pH limit) investigation triggers at trigger monitoring location.	1. Check and Validate Data. 2. Notify Environment and Community Manager or delegate. 3. Undertake investigation to confirm if investigation trigger exceedance is mining related: a. If necessary, engage a suitably qualified person(s) to determine if impact is related to LW409-414 extraction. b. Review subsidence monitoring results and any other relevant data. c. If investigation confirms trigger exceedance is not mining-related, record data and cease investigation. d. Engage suitably qualified person(s) to determine any potential downstream impacts and provide advice on appropriate remediation works. 4. If trigger exceedance is mining-related, confirm if mining-related activities have caused, or have the potential to cause, exceedance of indicator. a. If so, notify DPHI and other relevant agencies immediately. b. If not, notify DPHI and other relevant agencies as soon as practicable. 5. Notify DPHI and other relevant agencies if performance indicator are exceeded as soon as practicable. 6. Complete Preliminary investigation report and provide to DPHI and relevant agencies within 7 days of identifying the incident.	Where mining-related activities have resulted in trigger exceedances, implement contingency and remedial measures based on investigation. Potential measures are described in the SWMP.

Water Take

Groundwater extraction (take) is determined as described in Section 6.0 of the approved complex-wide GWMP and is reported in the Annual Review (**Section 8.1**). If water take exceeds the Available Water, an investigation will be undertaken and relevant non-compliances reported in accordance with **Section 11.0**. Available water for each licence will vary from year to year as a result of Available Water Determinations, water trading and carry-over provisions. Where mining-related activities have resulted in water take in excess of Available Water, MCO will investigate reasonable and feasible contingency and remedial measures.

8.0 REVIEW AND IMPROVEMENT OF ENVIRONMENTAL PERFORMANCE

8.1 ANNUAL REVIEW

In accordance with Condition 4, Schedule 5 of Project Approval (05_0117) (as modified), MCO will conduct an Annual Review of operations conducted at the Moolarben Coal Complex (including the performance of the LW409-414 WMP) prior to 31 March for the preceding calendar year, or as otherwise agreed by the Secretary of the DPHI.

The Annual Review 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 Environmental Assessment;
- 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.

In accordance with Condition 11, Schedule 5 of Project Approval (05_0117), the Annual Review will be made available on the Yancoal's website. As described in **Section 2.0**, this LW409-414 WMP will be reviewed within three months of the submission of an Annual Review, and, if necessary, revised to ensure the plan is updated on a regular basis and to incorporate any recommended measures to improve environmental performance.

8.2 AUDITS

In accordance with Condition 9, Schedule 5 of Project Approval (05_0117), the most recent independent environmental audit of the Moolarben Coal Complex was conducted in July 2024, and will continue to be conducted every three years. A copy of the independent environmental audit will be provided to the Secretary of the DPHI and made available on the Yancoal's website.

The independent environmental audit will be conducted by suitably qualified, experienced and independent team of experts whose appointment has been endorsed by the Secretary of the DPHI. The independent environmental audit will assess the environmental performance of the Project and assess whether it is complying with the requirements of Project Approval (05_0117), and any other relevant approvals, and recommend measures or actions to improve the environmental performance of the Project.

As described in **Section 2.0**, this LW409-414 WMP will be reviewed within three months of the submission of an independent environmental audit, and, if necessary, revised to ensure the plan is updated on a regular basis and to incorporate any recommended measures to improve environmental performance.

8.3 FUTURE EXTRACTION PLANS

In accordance with Condition 77(p), Schedule 3 of Project Approval (05_0117), MCO will collect baseline data for future Extraction Plans (e.g. for the next underground mining domain). In addition to the baseline data collection, consideration of the environmental performance and management measures, in accordance with the review(s) conducted as part of this LW409-414 WMP, will inform the appropriate type and frequency of monitoring of the assets relevant to any future Extraction Plan at the Moolarben Coal Complex.

9.0 INCIDENTS

An incident is defined in Project Approval (05_0117) as a set of circumstances that:

- causes or threatens to cause material harm to the environment; and/or
- breaches or exceeds the limits or performance measures/criteria in Project Approval (05_0117) (as modified).

In the event that an incident which causes, or threatens to cause, material harm to the environment occurs, the incident will be managed in accordance with the Environmental Management Strategy.

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

MCO will notify the Secretary of DPHI and any other relevant agencies of any incident associated with LW409-414 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 mining of LW409-414, 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 DPHI 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.

10.0 COMPLAINTS

MCO maintains a Community Complaints Line (Phone Number: 1800 556 484) that is dedicated to the receipt of community complaints. The Community Complaints Line is publicly advertised and operates 24 hours per day, seven days a week, to receive any complaints from neighbouring residents or other stakeholders.

MCO has developed a Community Complaints Procedure which details the process to be followed when receiving, responding to and recording community complaints. The Community Complaints Procedure is supported by a Complaints Database.

The Community Complaints Procedure is a component of the MCO Environmental Management Strategy which requires the recording of relevant information including:

- the nature of the complaint;
- method of the complaint;
- relevant monitoring results and meteorological data at the time of the complaint;
- site investigation outcomes;
- any necessary site activity and activity changes;
- any necessary actions assigned; and
- communication of the investigation outcome(s) to the complainant.

In accordance with Condition 11, Schedule 5 of Project Approval (05_0117), the complaints register will be updated monthly and made available on the Yancoal's website.

11.0 NON COMPLIANCE WITH STATUTORY REQUIREMENTS

A protocol for the managing and reporting of non-compliances with statutory requirements has been developed as a component of MCO's Environmental Management Strategy and is described below.

Compliance with all approvals, plans and procedures will be the responsibility of all personnel (staff and contractors) employed on or in association with the Moolarben Coal Complex.

The Environment and Community Manager (or delegate) will undertake regular inspections, internal audits and initiate directions identifying any remediation/rectification work required, and areas of actual or potential non-compliance.

As described in **Section 9.0**, MCO will notify the Secretary of the DPHI, and any other relevant agencies, of any incident associated with LW409-414 immediately after MCO becomes aware of the incident. Within seven days of the date of the incident, MCO will provide the Secretary of the DPHI, and any relevant agencies, with a detailed report on the incident.

A review of MCO's compliance with all conditions of Project Approval (05_0117), mining leases and all other approvals and licenses will be undertaken prior to (and included within) each Annual Review. The Annual Review will be made publicly available on the Yancoal's website.

As described in **Section 8.2**, the most recent independent environmental audit was conducted in July 2024, and will be conducted every three years thereafter. A copy of the independent environmental audit will be provided to the Secretary of the DPHI and made available on the Yancoal's website.

12.0 REFERENCES

Aquaterra Consulting Pty Ltd (2008) *Moolarben Stage 2 Groundwater Assessment*.

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Australasian Groundwater & Environmental Consultants Pty Ltd (2023) *UG4 LW401-408 Extraction Plan Revised Groundwater Technical Report.* Dated 31 August 2023

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Bureau of Meteorology (2024) *Groundwater Dependent Ecosystem Atlas.* Available at: http://www.bom.gov.au/water/groundwater/gde/map.shtml

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Department of Planning and Environment (2022) *Extraction Plan Guideline*.

HydroSimulations (2017) *Moolarben Coal Open Cut Optimisation Groundwater Assessment*

Mine Subsidence Engineering Consultants (2024) *Moolarben Coal Complex: Moolarben Project Stage 1 – Longwalls 409 to 414 Subsidence Predictions and Impact Assessments for the Natural and Built Features in Support of the Extraction Plan.*

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Moolarben Coal Operations Pty Ltd (2022). MCO Stage 3 Feasibility – Geology and Resource Knowledge.

Peter Dundon and Associates Pty Ltd (2006) *Moolarben Coal Project Groundwater Assessment*.

RPS Aquaterra (2011) *Moolarben Complex Stage 2 – Preferred Project Report – Groundwater Impact Assessment.*

WRM Water and Environment (2024) *UG4 Longwalls 409 to 414 Extraction plan, Surface Water Technical Report.*