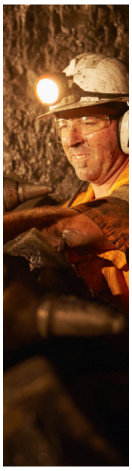
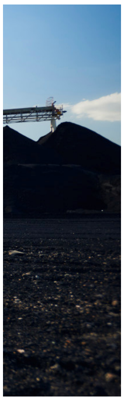





Ashton-Ravensworth Underground Mine Integration Modification

Ashton Coal Project Modification Report

APPENDIX A

Groundwater Review

YANCOAL
兖煤澳大利亚有限公司

Australasian Groundwater & Environmental Consultants

8 November 2021

Ashton Coal Operations Pty Ltd
Glennies Creek Road,
Camberwell NSW 2330

Attention: Phillip Brown
via email: Phillip.Brown@yancoal.com.au

Dear Phillip,

Ashton-Ravensworth Integration Modification Groundwater Review

1 Introduction

The Ravensworth Mine Complex and Ashton Mine Complex are neighbouring open cut and underground coal mining operations, located in the Singleton Local Government Area, in the Hunter Valley region of New South Wales (NSW).

The Ashton Mine Complex includes the Ashton Coal Project (including the completed North-East Open Cut [NEOC] and the Ashton Underground Mine) and approved Ashton South-East Open Cut (SEOC) Project. The Ashton Coal Project is operated by Ashton Coal Operations Pty Limited (ACOL), a wholly owned subsidiary of Yancoal Australia Limited (Yancoal). The SEOC Project has not yet commenced.

The Ravensworth Mine Complex includes the Ravensworth Operations Project and the Ravensworth Underground Mine (RUM). The RUM is owned and operated by Resource Pacific Pty Ltd. As the majority shareholder of Resource Pacific Pty Ltd, Glencore oversees the management of RUM.

The Ashton Underground Mine and RUM share a common mining lease boundary and are approved to extract coal from similar coal seams.

The Ashton Underground Mine includes longwall mining in the Pikes Gully, Upper Liddell, Upper Lower Liddell and Lower Barrett Seams. Mining in the Pikes Gully Seam, Upper Liddell Seam and Upper Lower Liddell Seam (Longwalls [LW] 201-204) has been completed. Mining of Longwalls 205-208 in the Upper Lower Liddell Seam is in progress, and mining of the Lower Barrett Seam is yet to commence.

In October 2014, after the completion of Longwalls 1-9 in the Pikes Gully Seam, operations at RUM were placed into care and maintenance and no further underground mining has occurred since. Mining is approved in the remaining Pikes Gully Longwalls 10-15, Liddell (Upper and Middle) and Barrett Seams.

An opportunity therefore exists for ACOL to access and extract the approved but unmined RUM coal resources and Yancoal has commenced commercial negotiations with Glencore to realise this opportunity. ACOL is seeking to modify Ashton Coal Project Development Consent DA 309-11-2001-i and the RUM Development Consent DA 104/96 to access and mine approved coal resources at the RUM (herein referred to as the Modification).

The modifications to the Ashton Coal Project Development Consent DA 309-11-2001-i would involve the following (Figure 1.1):

- underground connection from the existing Ashton Underground Mine workings to the approved RUM in the Pikes Gully and Middle Liddell coal seams via first workings;
- receipt of run-of-mine (ROM) coal mined in the RUM Pikes Gully and Middle Liddell coal seams for handling, processing and transportation using the existing Ashton Coal Project infrastructure;
- management of RUM ROM coal coarse rejects and tailings by emplacement in the NEOC void and at the Ravensworth Void 4 Tailings Dam;
- receipt and management of water and gas from the ACOL-operated portion of the RUM;
- extension of mining operations until approximately December 2035; and
- other administrative changes to facilitate management of the ACOL-operated portion of the RUM and integration with the Ashton Coal Project, such as integrated environmental management plans as appropriate.

Groundwater impacts for the approved Ashton Underground Mine layout were assessed in Aquaterra (2009) and validated in subsequent groundwater model updates (AGE 2016 and 2020). The Modification does not propose any increase in the extent of approved longwall mining at the Ashton Underground Mine but would require additional first workings (main gate drives) to connect the two underground mines, as well as a delay in timing of approved Lower Barret Seam longwall extraction (i.e. to be mined after the RUM longwall panels).

The modifications to the RUM Development Consent DA 104/96 would involve the following (Figure 1.1):

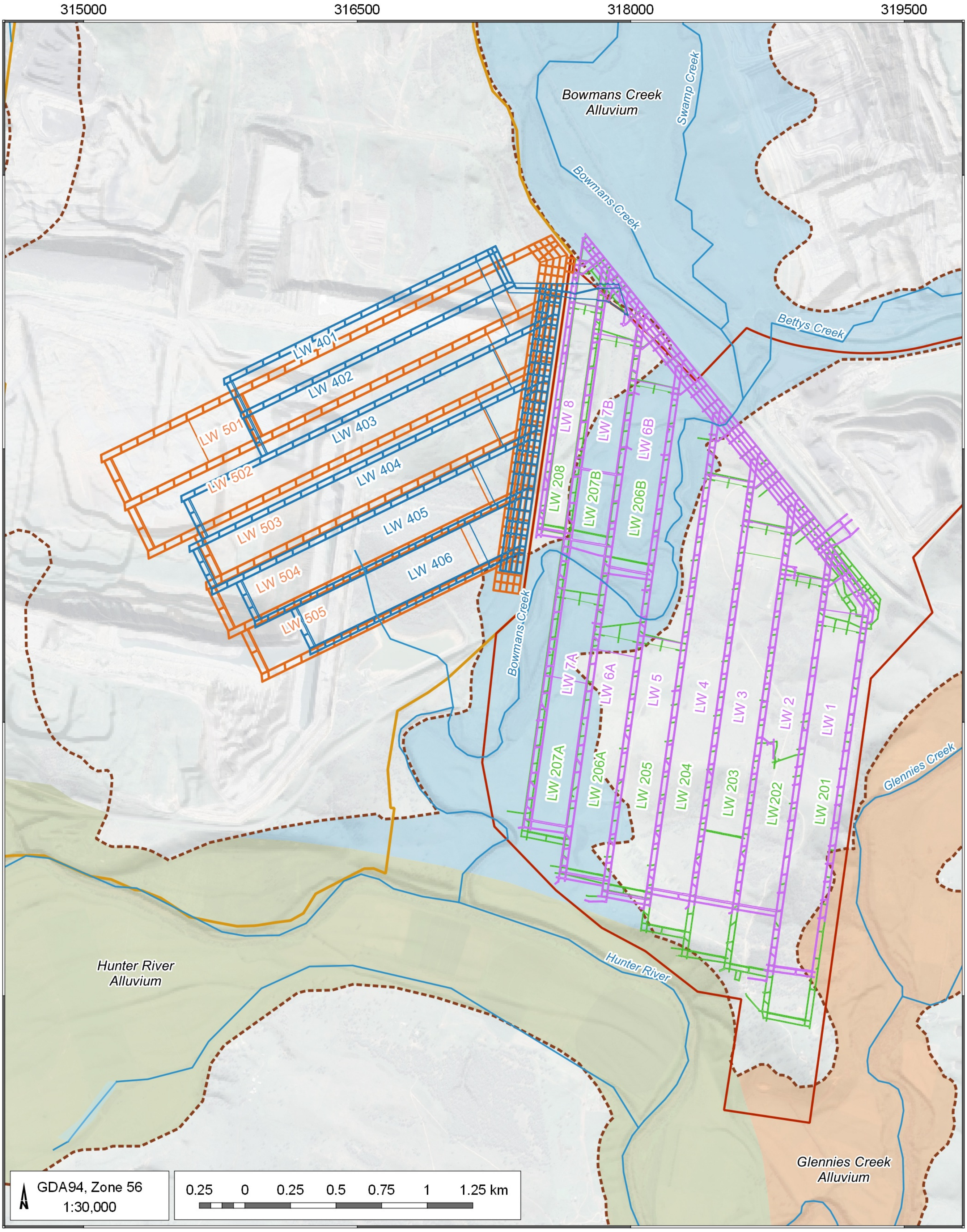
- transfer of ROM coal from the RUM Pikes Gully and Middle Liddell coal seams to the Ashton Coal Project for handling, processing and transport;
- minor changes to the approved Pikes Gully Seam Longwalls 10-15 (narrowing and shortening of some longwall panels) and Middle Liddell Seam Longwalls 14-18 (shortening of some longwalls);
- transfer of water and gas from the ACOL-operated portion of the RUM to the Ashton Coal Project;
- minor adjustments to the gas and ventilation management infrastructure to ensure continued safe operation of the ACOL-operated portion of the RUM;
- extension of mining operations until 31 December 2032; and
- other administrative changes to facilitate management of the ACOL-operated portion of the RUM and integration with the Ashton Coal Project, such as integrated environmental management plans (as appropriate).

Groundwater impacts for the approved RUM layout were assessed in Mackie Environmental Research [MER] (2012). The Modification does not propose any increase in the extent of approved longwall mining at the RUM, and would actually decrease the extent of some of the targeted panels (i.e. shortening and narrowing of longwall panels) (Figure 1.2). The approved Upper Liddell and Lower Barrett seams at the Ashton Coal Project and approved Lemington and Barrett Seams at the RUM are not shown on this figure.

Australasian Groundwater and Environmental Consultants (AGE) were engaged to undertake groundwater modelling to support section 4.55 modifications to the Ashton Underground Mine and RUM approvals under the NSW *Environmental Planning and Assessment Act 1979*.

The main purpose of the revised modelling was to predict groundwater inflows due to the combined operations of the modified RUM and Ashton Underground Mine (i.e. the Modification) to assess water take from relevant water sources. The modelling was also undertaken to verify that impacts of the Modification are consistent with, or in some cases less than, the approved impacts at the Ashton Underground Mine and RUM. In some cases, a direct comparison between the approved and modified RUM quantitative impacts has not been possible and, therefore, AGE has provided qualitative comparisons between the approved and modified projects. This is considered appropriate for this proposal as the primary change between the two projects is a reduction in longwall footprint at the RUM (compared to the approved layout).

This short report details the predicted impacts of the Modification against the requirements of the NSW *Aquifer Interference Policy* (AIP) (NSW Office of Water 2012). Licencing is tabulated with respect to ACOL's existing licences under the Water Sharing Plan (WSP) for the North Coast Fractured and Porous Groundwater Sources (NSW Legislation 2018) and the Hunter Unregulated and Alluvial Water Sources Water Sharing Plan (NSW Legislation 2018), while the predicted impacts to groundwater levels, groundwater dependent ecosystems and private bore users are assessed against the minimal impact criteria of the AIP.



LEGEND

- Drainage
- AUM Pikes Gully panels
- AUM Upper Lower Liddell panels
- RUM Pikes Gully panels
- RUM Middle Liddell panels
- Ravensworth complex
- Ashton mining lease
- Quaternary alluvium/colluvium

Alluvium boundaries

- Bowmans Creek Alluvium
- Glennies Creek Alluvium
- Hunter River Alluvium

Note:
The approved Upper Liddell and Lower Barrett seams at the Ashton Coal Project and approved Lemington and Barrett Seams at the RUM are not shown on this figure

Ashton Ravensworth Integration Modification (ASH5001.001)

Ashton-Ravensworth Integration Modification proposed mine layout

AGE

DATE 05/11/2021

FIGURE No: **1.1**

Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.;
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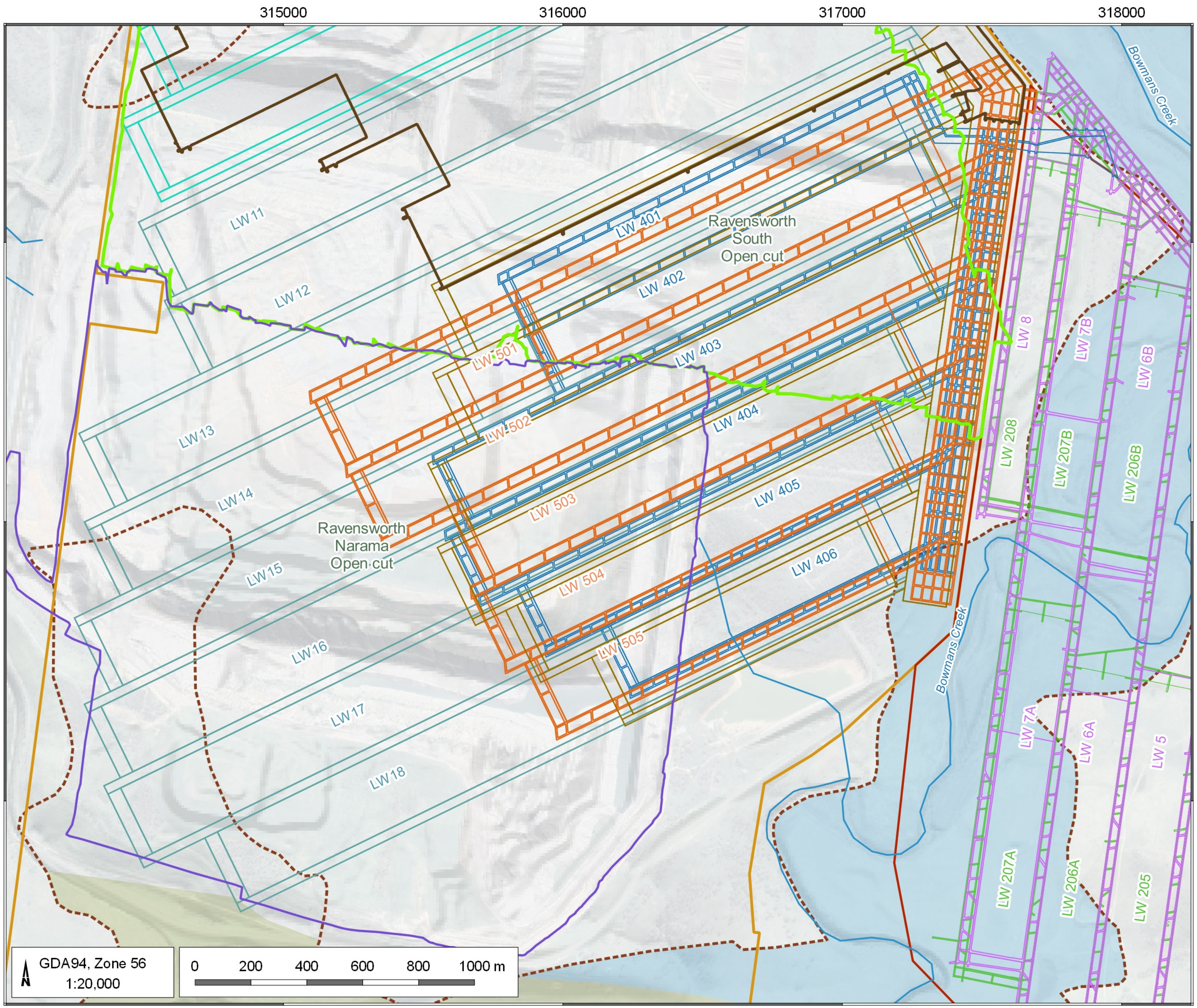

LEGEND

- Drainage
- AUM Pikes Gully panels
- AUM Upper Lower Liddell panels
- Approved RUM Pikes Gully panels
- Approved RUM Middle Liddell panels
- Proposed RUM Pikes Gully panels
- Proposed RUM Middle Liddell panels
- Ravensworth South open cut mine
- Ravensworth Narama open cut mine
- Ravensworth complex
- Ashton mining lease
- Quaternary alluvium/colluvium
- Completed RUM Pikes Gully workings

Alluvium boundaries

- Bowmans Creek Alluvium
- Hunter River Alluvium

Ashton Ravensworth Integration Modification (ASH5001.001)

Approved RUM vs. proposed modification panel layout

AGE

DATE
05/11/2021

FIGURE No:
1.2

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2 Legislative framework

2.1 Aquifer Interference Policy

The NSW AIP (NSW Office of Water 2012) was developed as a component of the NSW Government's *Strategic Regional Land Use Policy*. The AIP was developed to ensure equitable sharing of water resources water users, and details water licencing and impact assessment requirements. The AIP applies to all aquifer interference activities, with a focus on high-risk activities such as mining, coal seam gas extraction, injection of water, extractive industries and dewatering for civil construction works (NSW Office of Water 2012).

2.2 Licensing requirements

The AIP requires that all water taken by aquifer interference activities be accounted for within the extraction limits set by the relevant WSP. Aquifer interference activities are defined as:

- removal of water from a water source
- the movement of water within an aquifer system
- the movement of water from one water source to another water source, such as:
  - from an aquifer to an adjacent aquifer
  - from an aquifer to a river/lake; and
  - from a river/lake to an aquifer.

The water sources relevant to the Modification are regulated under the:

- *Water Sharing Plan for the North Coast Fractured and Porous Groundwater Sources 2016;*
- *Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009; and*
- *Water Sharing Plan for the Hunter Regulated River Water Source 2016.*

ACOL is required to hold sufficient licence entitlements under each of these WSPs to account for all predicted aquifer interference activities induced by the Modification. This is documented further in Section 4.1.3.

2.3 Minimal impact considerations

In addition to licensing requirements, the AIP includes minimal impact considerations to satisfy the concept of "no more than minimal harm". Groundwater is classified as 'highly' or 'less' productive according to its quality and yield. Each category is assessed according to the predicted impacts to the water table, to groundwater pressure, and to groundwater and surface water quality. Changes to water table elevation are assessed close to significant receptors including high priority groundwater dependent ecosystems, high priority culturally significant sites and water supply works such as supply bores.

The predicted impacts of the Modification are less extensive than the sum of those already approved under the respective development consents for Ashton Underground Mine and RUM. It thereby follows that the predicted impacts are less extensive than those already authorised. The predicted impacts of the Modification are assessed against the minimal impact considerations in Section 4.

3 Groundwater model overview

AGE updated the Ashton Coal Project groundwater model for the Modification. The model was constructed in 2015 with a further revision in 2019 (AGE, 2016, 2020). The model is built on MODFLOW-USG (Panday et al. 2017) and comprises 17 layers and 370,468 nodes. This model was used to review and confirm or revise the predicted groundwater impacts for the Modification (i.e. including the RUM Pikes Gully and Middle Liddell seams).

The model structure, general head and no-flow boundary conditions were identical to those of the previous editions. For the Modification, the fracture model was adjusted to improve representation of fracturing in the increased overburden thickness at RUM (Ditton & Merrick, 2014; Guo et al., 2007). The model was then recalibrated using PEST HP (Watermark Numerical Computing 2021). Two datasets were input as calibration targets; the groundwater levels from ongoing Ashton Underground Mine monitoring were supplemented by a monthly water balance model based on Ashton Underground Mine metered pumping data to June 2021. The inclusion of the water balance model in the calibration reduced parameter non-uniqueness and ensured that recent inflows to Ashton Underground Mine were reflected in the model parameters. The model calibration achieved 7.7% SRMS which was considered acceptable.

To generate the predictions, six longwall panels were added to the Pikes Gully seam (model Layer 8) and five longwall panels were added to the Middle Liddell seam (model Layer 14) at RUM (Figure 1.1). Mining of the Lower Barrett seam at Ashton Underground Mine (model Layer 17) followed completion of the Middle Liddell Seam. The mining schedule used in the simulation is documented in Table 3.1.

For consistency with MER (2012), the starting condition of the overlying Ravensworth Narama open cut mine (shown on Figure 1.2) was largely dewatered spoils and any final landforms, voids, additional recharge to voids and spoil or any other features of water level recovery were not simulated. As mining-induced hydraulic parameter changes were applied to model cells beneath the Narama spoil, a simple analytical model based on Darcy's Law was applied to predict the volume of potential additional inflows between the spoil and the proposed underground workings (Section 4.1.3).

Table 3.1 Modification mining schedule applied in groundwater model

Seam	Panel	Start Date	Completion Date
Pikes Gully (RUM)	Mains Level 4	14/08/2022	2/04/2025
	LW401	2/01/2024	18/03/2024
	LW402	30/04/2024	16/09/2024
	LW403	3/11/2024	30/04/2025
	LW404	6/06/2025	22/10/2025
	LW405	8/12/2025	17/04/2026
	LW406	25/05/2026	17/08/2026
Middle Liddell (RUM)	Mains Level 5	9/04/2025	14/01/2028
	LW501A	4/10/2026	6/12/2026
	LW501B	18/01/2027	8/07/2027
	LW502	14/08/2027	27/03/2028
	LW503	9/05/2028	3/11/2028
	LW504	10/12/2028	31/05/2029
	LW505	8/07/2029	24/11/2029

Seam	Panel	Start Date	Completion Date
Lower Barrett (Ashton Underground Mine)	Mains Level 3	17/01/2028	9/08/2033
	LW301	14/12/2029	11/08/2030
	LW302	10/09/2030	9/07/2031
	LW303	8/08/2031	17/04/2032
	LW304A	18/05/2032	10/10/2032
	LW304B	1/11/2032	27/02/2033
	LW305	29/03/2033	12/08/2033
	LW306A	11/09/2033	6/02/2034
	LW306B	28/02/2034	1/07/2034
	LW307A	31/07/2034	20/11/2034
	LW307B	12/12/2034	26/04/2035
	LW308	26/05/2035	27/09/2035

4 Model predictions and impact assessment

Potential future changes in groundwater levels and water take as a result of the Modification were interrogated using the groundwater model. This included a consideration of:

- drawdown in groundwater levels in saturated proximal Quaternary alluvium and in the Permian coal measures as a result of mining;
- the volume of groundwater directly intercepted by mining from the coal measures, and the indirect take from Quaternary alluvium and surface water features;
- change to alluvial fluxes and baseflow;
- impact on private bores;
- drawdown impact to potential groundwater dependent ecosystems (GDEs); and
- individual water sources water licensing requirements.

Two models were run to compare the impacts of the Modification on the groundwater system and surrounding surface water sources from that previously assessed and approved. This included an initial null or ‘no mining’ model scenario to provide a baseline against which the Modification could be compared. The no mining model included surrounding historical and approved future mining, but no mining at Ashton Underground Mine or in any of the Modification workings at RUM. The second model scenario included surrounding mining plus the Modification and all Ashton underground mining.

The impacts of the Modification were generated by comparing the outputs of the no mining and Modification models.

As previously described, the proposed mining of the RUM Pikes Gully and Middle Liddell seams is already approved under RUM Development Consent DA 104/96. Further the Modification does not propose any increase in the extent of approved longwall mining at the RUM, and would actually decrease the extent of some of the targeted panels (i.e. shortening and narrowing of longwall panels). The smaller extent of mining proposed under the Modification is expected to reduce groundwater impacts compared to the approved RUM layout (Figure 1.2).

4.1.1 Groundwater inflows to mining area

The predicted inflow rate per seam over time (Figure 4.1) was converted to a volume, with the volumes accumulated per water year to calculate the total predicted inflows for the Modification (Figure 4.2).

The predicted inflows to the Pikes Gully workings (RUM) are consistent with the 0.6 megalitres (ML)/day inflows reported by MER (2012) and ACOL holds water access licences (WALs) with sufficient entitlements to account for the predicted take. As discussed in MER (2012), if connected fracturing above the longwalls causes hydraulic conductivity increases greater than those predicted by the groundwater model, additional inflows may occur. The potential for additional inflows from the overlying Ravensworth Narama open cut spoils was quantified per model cell using Darcy's Law, with a maximum rate of 16 ML/year predicted over the life of the Modification. Similarly, should fracturing connect any water held in the goaf of Longwalls 1-9 with the new workings, additional inflows may occur. The peak predicted inflows to the Pikes Gully seam are 0.49 ML/day in March 2026, which is less than the 1.1 ML/day predicted in MER (2012), thought to be the result of continued depressurisation of the Pikes Gully Seam as underlying seams at Ashton Underground Mine were mined.

The predicted inflows to the Middle Liddell workings (RUM) are slightly greater than those observed at Ashton Underground Mine. This is consistent with the site conceptual model, as the saturated thickness of interburden and unmined coal above the Middle Liddell seam exceeds that of Ashton Underground Mine (e.g. the Upper Liddell Seam is mined at Ashton Underground Mine but would not be mined at RUM). The peak predicted inflow to the Middle Liddell seam is 2.02 ML/day in December 2028, which is consistent with the 1.8 ML/day peak inflow reported in MER (2012).

The predicted inflow rate to the Lower Barrett workings (Ashton Underground Mine) peaks at 1.05 ML/day in December 2030 (Figure 4.1). Although the extraction schedule has changed, the volume of inflows to the Lower Barrett workings is consistent with the predictions of AGE (2016).

The total predicted inflows are contributed by dewatering of the surrounding rock mass, known as direct take (Figure 4.3), as well as by unconsolidated sediments such as alluvium and surface water features. The latter, referred to collectively as indirect take or passive take (Section 4.1.2) are not directly connected to the underground workings but are intercepted by mining-induced drawdown, which results in reduced baseflow compared to the pre-mining scenario.

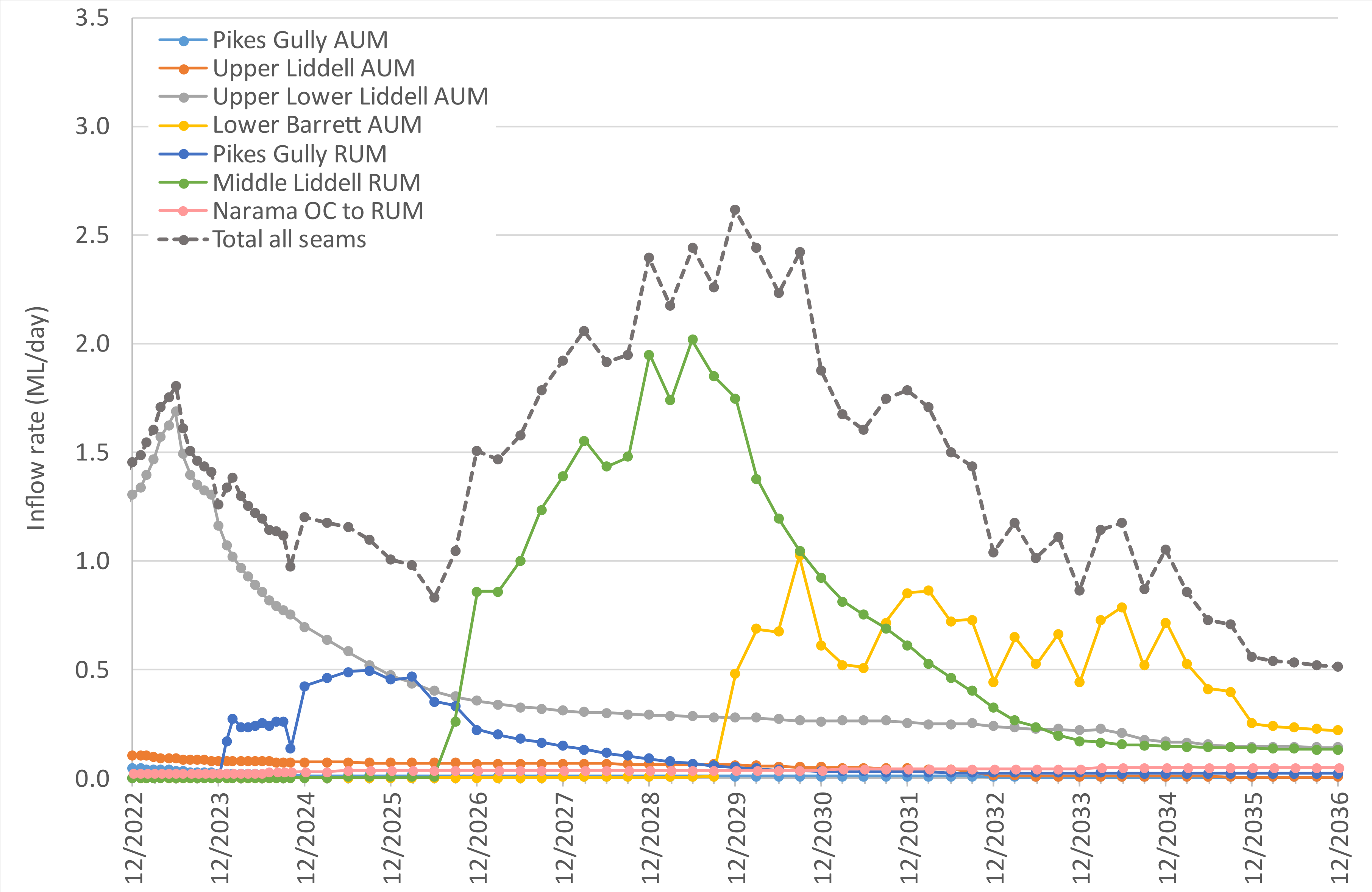


Figure 4.1 Predicted inflow timeseries for the Modification

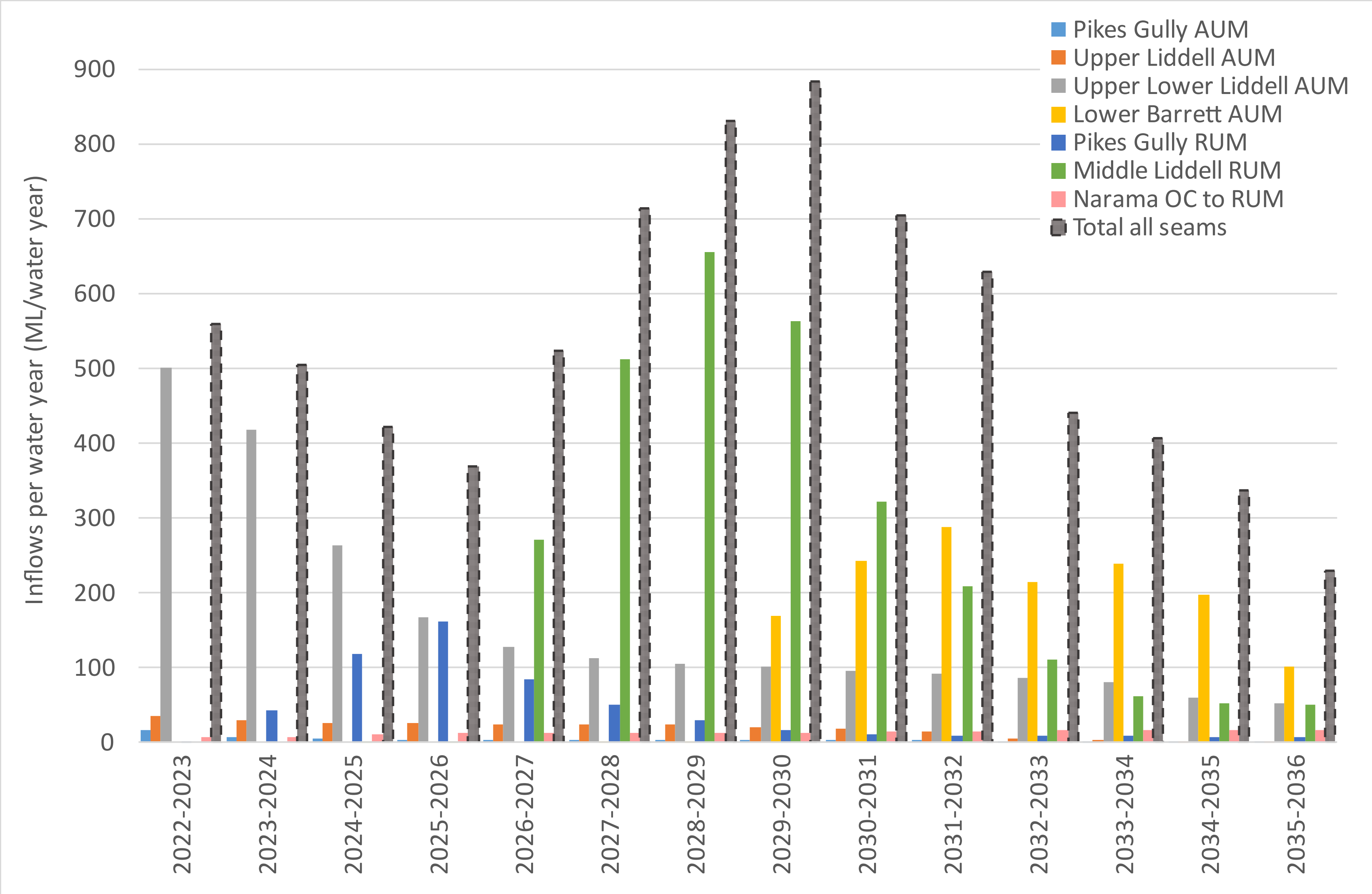


Figure 4.2 Predicted inflows per water year to the Modification

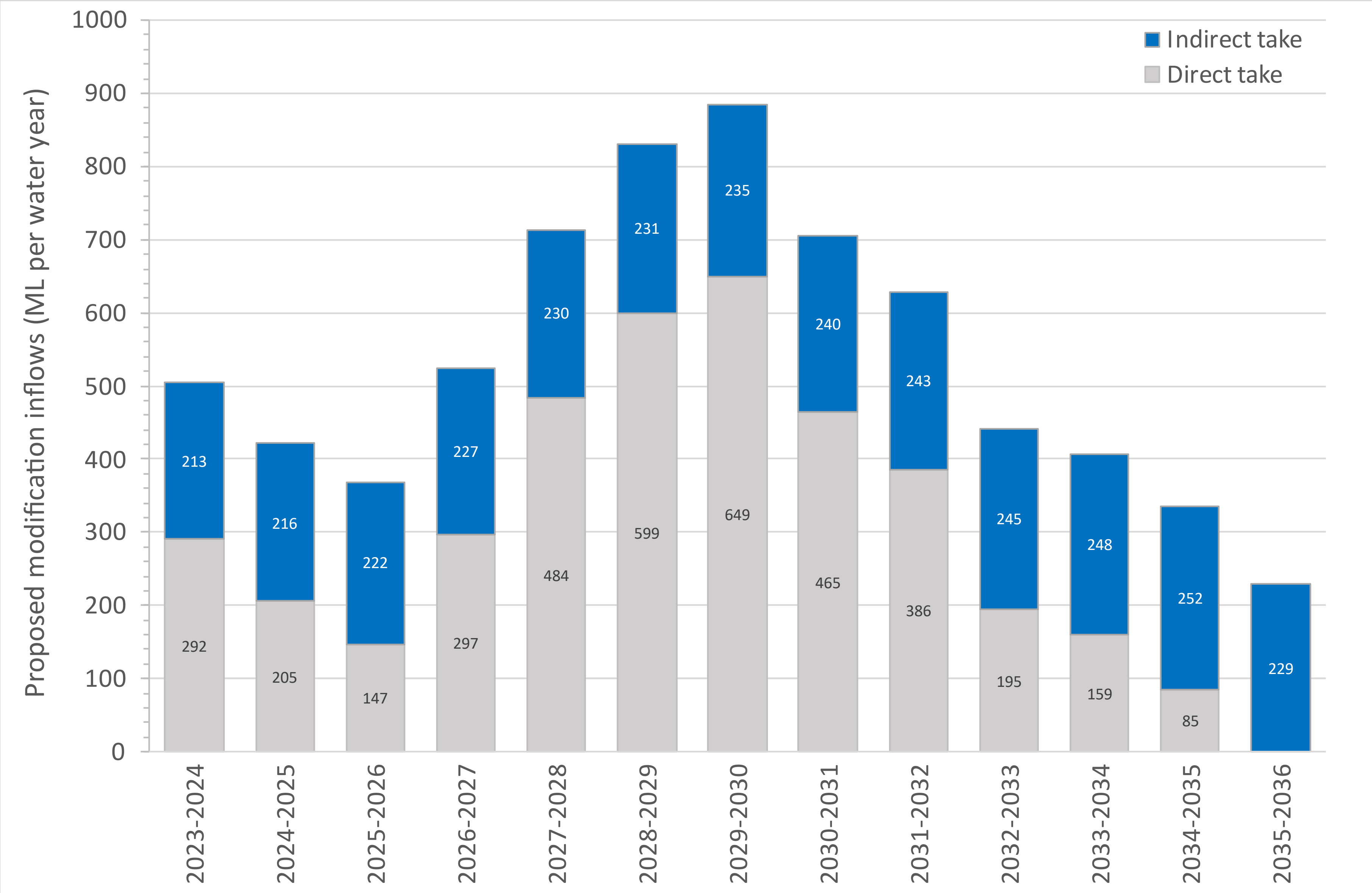


Figure 4.3 Predicted direct and indirect take per water year

4.1.2 Change in alluvial and surface water flows

The model was used to determine the potential for mining to interfere with the alluvial groundwater systems and to provide estimates of indirect 'water take' in accordance with the WSPs. Mining will not directly intercept alluvial aquifers, however, an indirect impact or 'water take' occurs as the Permian strata become depressurised and the volume of groundwater flowing from the Permian to the Quaternary alluvium reduces progressively. Whilst this alluvial groundwater does not necessarily enter the mine workings, the volume of groundwater entering the alluvial groundwater systems is reduced by lower pressures within the Permian or the reversal of flow direction due to mining, and this has been considered 'water take' that needs to be licensed.

The change in alluvial water resources was determined by comparing water budgets for alluvial zones using versions of the Modification model that either contained or excluded the Modification. The indirect take at the beginning of the modelling accounts for the mining of the Pikes Gully, Upper Liddell and Upper Lower Liddell Seams at the Ashton Underground Mine. The indirect take values presented for the Modification include both the modified RUM area and Ashton Underground Mine up to 2035. To ensure consistency with previous models, a correction was made in which the change in baseflow was subtracted from the change in alluvial flow to prevent double accounting under the same WSP.

The indirect take presented here is not directly comparable to that of MER (2012), which details the cumulative impacts of all surrounding mines rather than isolating the impact of mining at RUM. Notwithstanding, given the reduction in longwall footprint at the modified RUM the indirect take from the combined RUM and Ashton Underground Mine is expected to be less than the currently approved projects.

The following predictions are those generated using the updated groundwater model, reflecting the reduced longwall footprint at RUM and adjustments to the approved mining schedule at Ashton Underground Mine.

4.1.2.1 Indirect take from alluvium

The rate of indirect take from the Hunter River, Glennies Creek and Bowmans Creek Alluviums over the life of the Modification can be seen in Figure 4.4.

The indirect take from the Glennies Creek Alluvium increased from 107 ML to 117 ML/year over the duration of the Modification. The year-on-year change during mining of the RUM panels was insignificant. The indirect take from the Bowmans Creek Alluvium was 60 ML/year at the beginning of 2023, increasing to 82 ML/year by the end of 2036. The predicted change to the indirect take from the Hunter River Alluvium was insignificant, with an increase of only 2 ML/year over the duration of the Modification.

The predicted volume of take is consistent with existing approval for Ashton Underground Mine (Section 4.3) and ACOL holds WALs with sufficient entitlements to account for the predicted take (Section 4.1.3).

4.1.2.2 Indirect take from surface water

Predicted baseflow to the Hunter River, Glennies Creek and Bowmans Creek is presented in Figure 4.5.

Compared with the no mining scenario, the baseflow to Glennies Creek is reduced by 25 ML/year by the end of 2036, with insignificant year-on-year increase attributed to mining at RUM. For Bowmans Creek, baseflow is reduced by a maximum of 22 ML/year by the end of 2036, of which 6 ML occurs from the end of the Middle Liddell (Ashton Underground Mine) to the end of the Lower Barrett (Ashton Underground Mine). For the Hunter River, the baseflow reduction of 2 ML/year by the end of 2036 is insignificant over the duration of the Modification (Figure 4.6).

Again, the predicted volume of take is consistent with existing approval for Ashton Underground Mine (Section 4.3) and ACOL holds WALs with sufficient entitlements to account for the predicted take (Section 4.1.3).

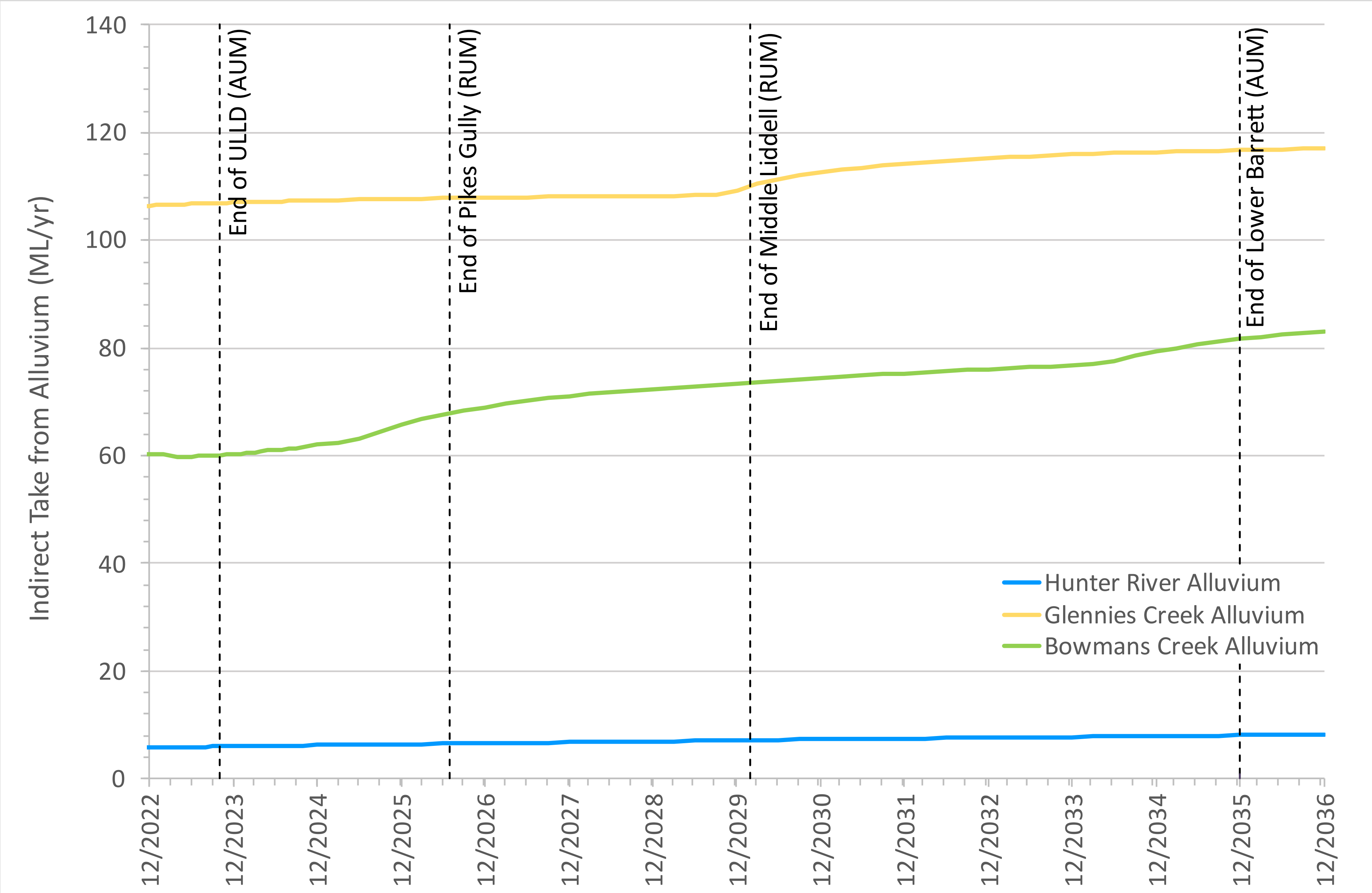


Figure 4.4 Indirect take from alluvium bodies surrounding the Modification

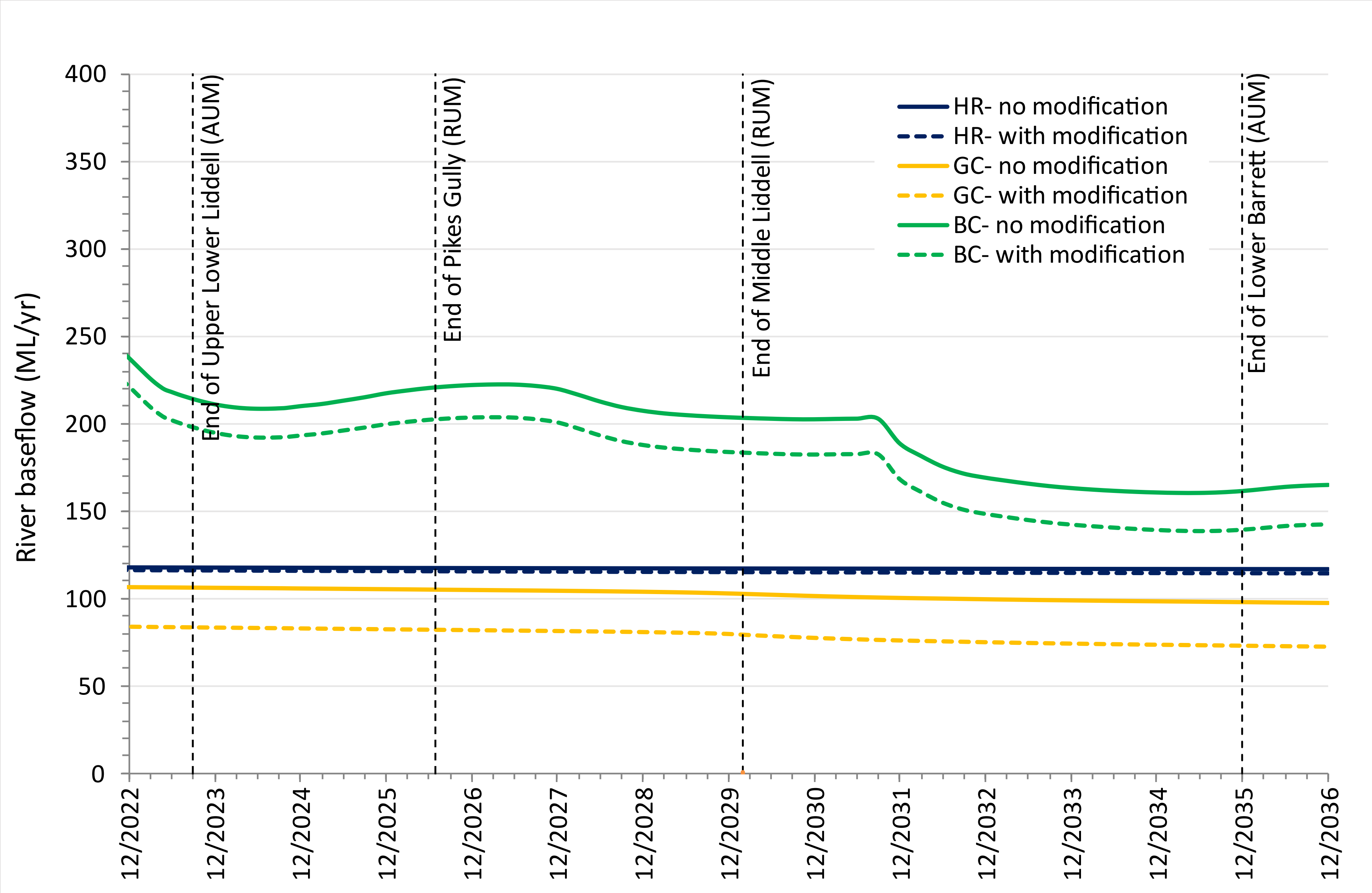


Figure 4.5 Baseflow to surface water bodies- mine vs no mine simulations

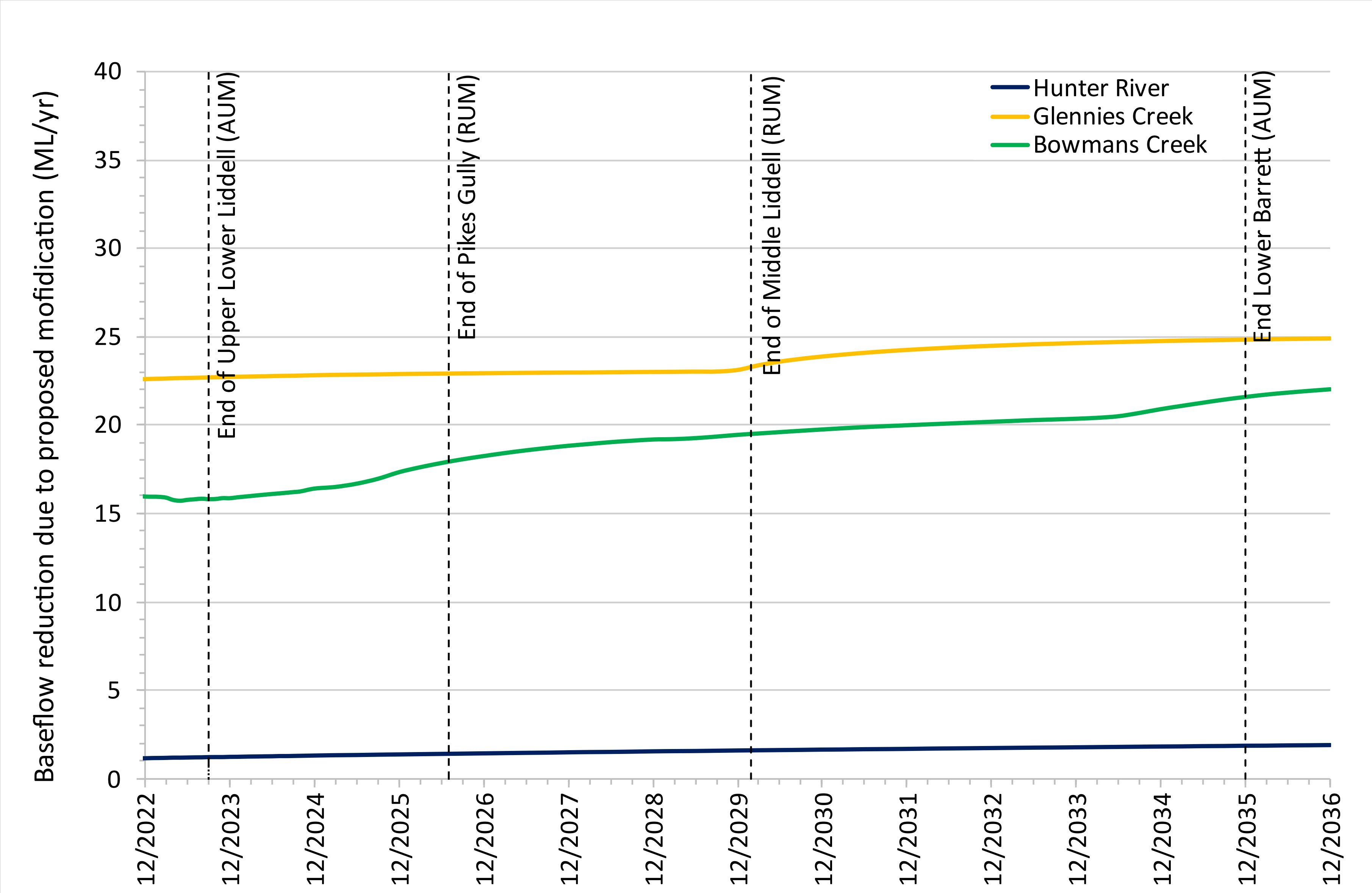


Figure 4.6 Reduction in baseflow due to the Modification

4.1.3 Water licensing and water sharing plan rules

As described in Section 2.1, the AIP requires that all groundwater taken, either directly or indirectly, is accounted for via water licences. Groundwater intercepted from the mining area is considered a direct take from the Permian groundwater system, whilst the changes in flow occurring within the Quaternary alluvium and rivers resulting from depressurisation of the underlying Permian is considered an indirect take.

ACOL holds WALs with sufficient entitlements to account for the predicted take. A summary of WALs held by or available to ACOL is provided in Table 4.1.

The proportion of inflows from the various water sources is presented in Figure 4.7 and the division of alluvial and surface flows presented in Figure 4.8. The volume per water year from all sources is documented in Table 4.2.

Table 4.1 ACOL water licences

Licence No.	Water Source / Category	Entitlement (ML/year)
WAL 984	Hunter Regulated River - Glennies Creek (General Security)	9
WAL 15583	Hunter Regulated River - Glennies Creek (General Security)	354
WAL 997	Hunter Regulated River - Glennies Creek (High Security)	11
WAL 8404	Hunter Regulated River - Glennies Creek (High Security)	80
WAL 1358	Hunter Regulated River - Glennies Creek (Supplementary)	4
WAL 1121	Hunter Regulated River - Zone 1B (General Security)	335
WAL 6346	Hunter Regulated River - Zone 1B (Supplementary)	15.5
WAL 1120	Hunter Regulated River - Zone 1B (High Security)	3
WAL 19510	Hunter Regulated River - Zone 1B (High Security)	130
WAL 23912	Jerrys Water Source (Unregulated River)	14
WAL 36702	Jerrys Water Source (Unregulated River)	116
WAL 36703	Jerrys Water Source (Unregulated River)	150
WAL 29566	Jerrys Water Source (Aquifer)	358
WAL 41501	Sydney Basin-North Coast Groundwater Source (Aquifer)	100
WAL 41552	Sydney Basin-North Coast Groundwater Source (Aquifer)	511
WAL 41553	Sydney Basin-North Coast Groundwater Source (Aquifer)	81
WAL 41529*	Sydney Basin-North Coast Groundwater Source (Aquifer)	400

Note: * WAL 41529 to be transferred to ACOL on completion of the sale agreement between Yancoal and Glencore.

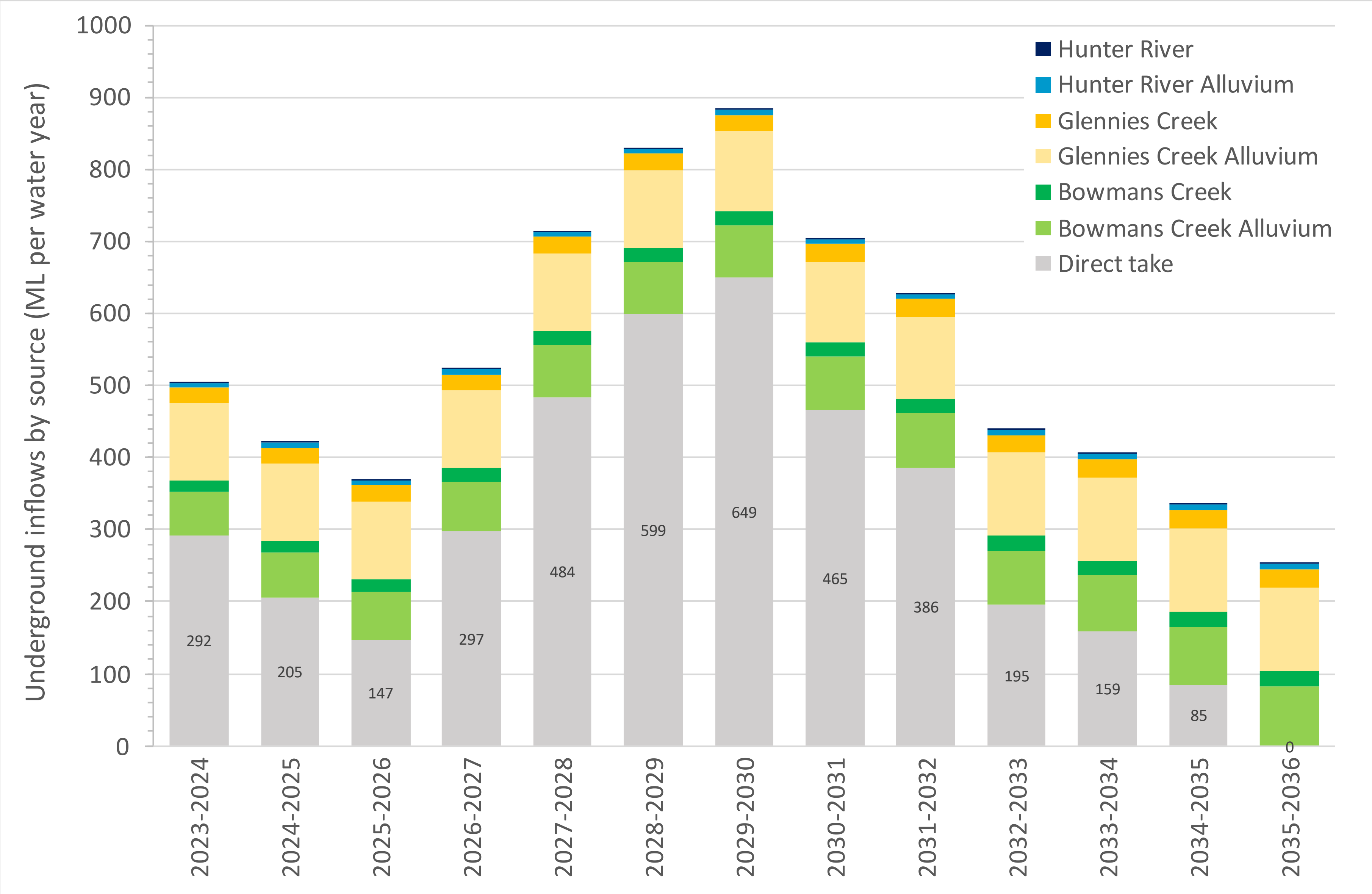


Figure 4.7 Underground inflows by source per water year

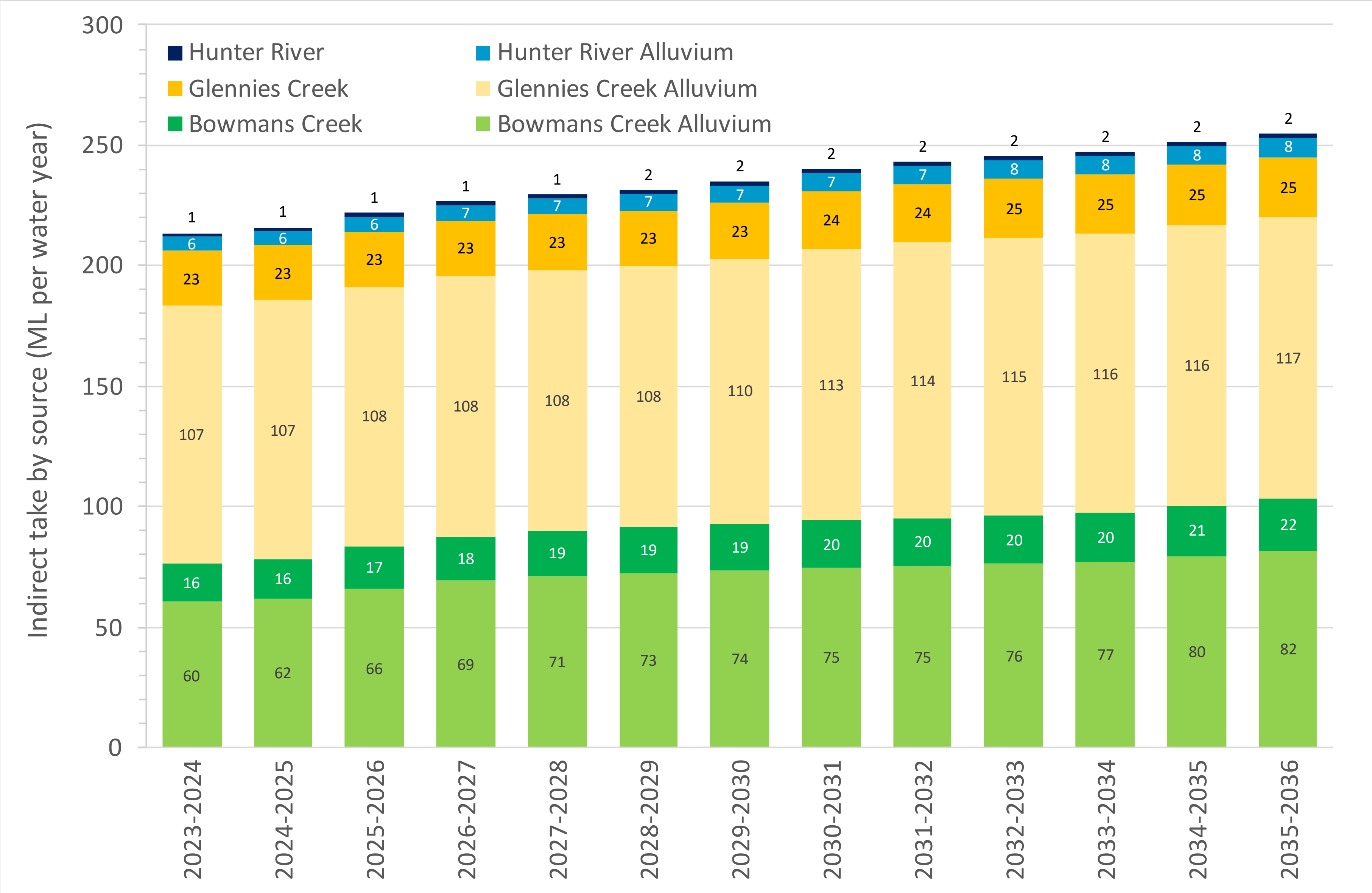


Figure 4.8 Indirect take induced by the Modification per water year

Table 4.2 Inflows to the Modification by source (ML/water year)

Water Year	Total underground inflows	From Hunter River Alluvium	From Glennies Creek Alluvium	From Bowmans Creek Alluvium	From Hunter River	From Glennies Creek	From Bowmans Creek	From Rock Mass
2023-2024	504.9	6.0	107.0	60.4	1.2	22.7	15.9	291.6
2024-2025	421.4	6.2	107.4	61.9	1.3	22.8	16.3	205.4
2025-2026	369.1	6.4	107.8	66.2	1.4	22.9	17.4	147.1
2026-2027	523.8	6.6	108.0	69.3	1.4	22.9	18.3	297.2
2027-2028	714.0	6.8	108.1	71.3	1.5	23.0	18.8	484.4
2028-2029	830.3	7.0	108.3	72.5	1.5	23.0	19.2	598.8
2029-2030	884.3	7.2	109.9	73.6	1.6	23.3	19.5	649.5
2030-2031	705.1	7.4	112.8	74.6	1.6	23.9	19.8	465.0
2031-2032	629.0	7.5	114.4	75.4	1.7	24.3	20.0	385.8
2032-2033	440.5	7.6	115.3	76.1	1.7	24.5	20.2	195.0
2033-2034	406.8	7.8	116.0	77.0	1.8	24.7	20.4	159.3
2034-2035	336.2	8.0	116.5	79.6	1.8	24.8	21.0	84.7
2035-2036	228.7	8.1	116.8	81.8	1.8	24.8	21.6	0.0

4.2 Minimal impact considerations

4.2.1 Drawdown due to mining operations

In addition to the Ashton Mine Complex, the RUM is surrounded by a number of open cut operations targeting the same coal seams (i.e. Pikes Gully and Middle Liddell). For the approved RUM, MER (2012) concluded that historical mining operations in proximity to RUM had extensively depressurised the coal measures. Notably the West Pit at Hunter Valley Operations North, located approximately 4 kilometres (km) to the west of the approved RUM longwall, and the Glendell Open Cut, north-east of Ashton Underground Mine, target coal seams down to the Barrett seam. Predictions in MER (2012) show significant depressurisation of coal measures including Pikes Gully, Liddell and Barrett seams associated with these operations surrounding the RUM. In addition, mining at Ravensworth North, located between Ravensworth Narama open cut mine and the West Pit at Hunter Valley Operations North, targets seams to the Barrett ahead of the Modification.

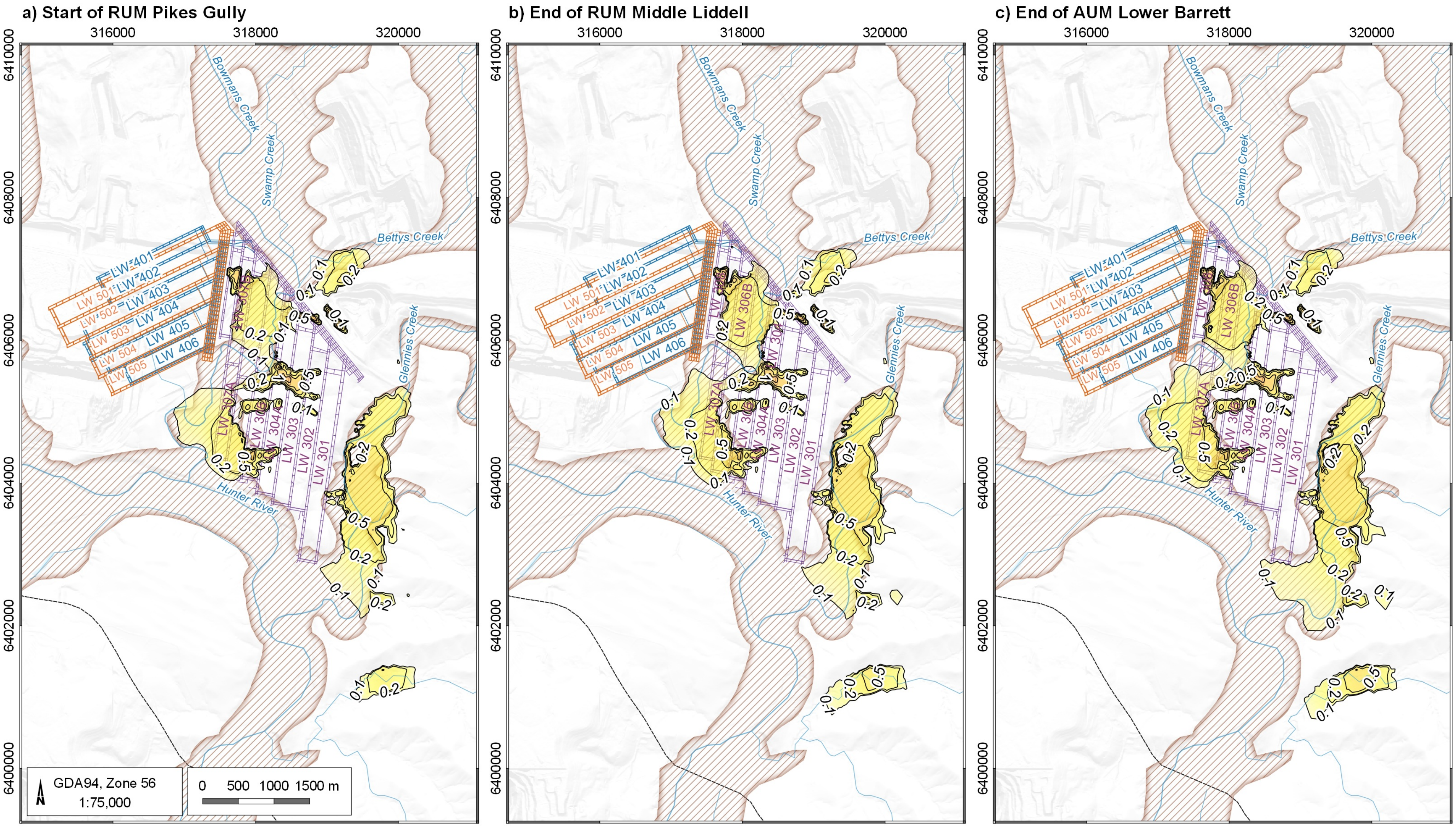
The predicted drawdown due to mining the Modification (Table 4.3) is more extensive than drawdown attributed to Ashton Underground Mine alone, due to addition of the proposed panels at RUM (i.e. combined drawdown impacts on the Ashton Underground Mine and modified RUM area are presented).

Table 4.3 Drawdown induced by the Modification

Model Layer	Start of proposed Modification	End of RUM Middle Liddell seam	End of proposed Modification
1 (Alluvium and regolith)	< 1 m HRA and GCA, 1 m BCA		
8 (Pikes Gully)	100 m Ashton Underground Mine, 20-100 m RUM	100 m Ashton Underground Mine and RUM	
11 (Upper Liddell)	100 m Ashton Underground Mine, 20-100 m RUM	100 m Ashton Underground Mine and RUM	
14 (Middle Liddell)	200 m Ashton Underground Mine, 50 m RUM	200 m Ashton Underground Mine and RUM	
17 (Lower Barrett)	100 m Ashton Underground Mine, 10-100 m RUM	100 m Ashton Underground Mine, 50-100 m RUM	200 m Ashton Underground Mine, 100 m RUM

Note: Hunter River Alluvium (HRA), Glennies Creek Alluvium (GCA) and Bowmans Creek Alluvium (BCA).

Drawdown maps are presented for the alluvium and regolith (Layer 1;Figure 4.9), Pikes Gully seam (Layer 8; Figure 4.10), Upper Liddell seam (Layer 11; Figure 4.11), Middle Liddell seam (Layer 14; Figure 4.12) and Lower Barrett seam (Layer 17; Figure 4.13). The drawdown presented is that attributed to Ashton Underground Mine plus the proposed panels at RUM (as shown on Figure 1.1). The key times presented are the beginning of the Modification (a), on completion of the actively mined seam (b) and on completion of the Modification (c).



LEGEND

- Drainage
- Drawdown contour (m)
- AUM Lower Barrett panels
- RUM Pikes Gully panels
- RUM Middle Liddell panels
- Quaternary alluvium/colluvium
- Model boundary

Drawdown (m)

- 0
- 0.1
- 0.2
- 0.5
- 1
- 2

AGE

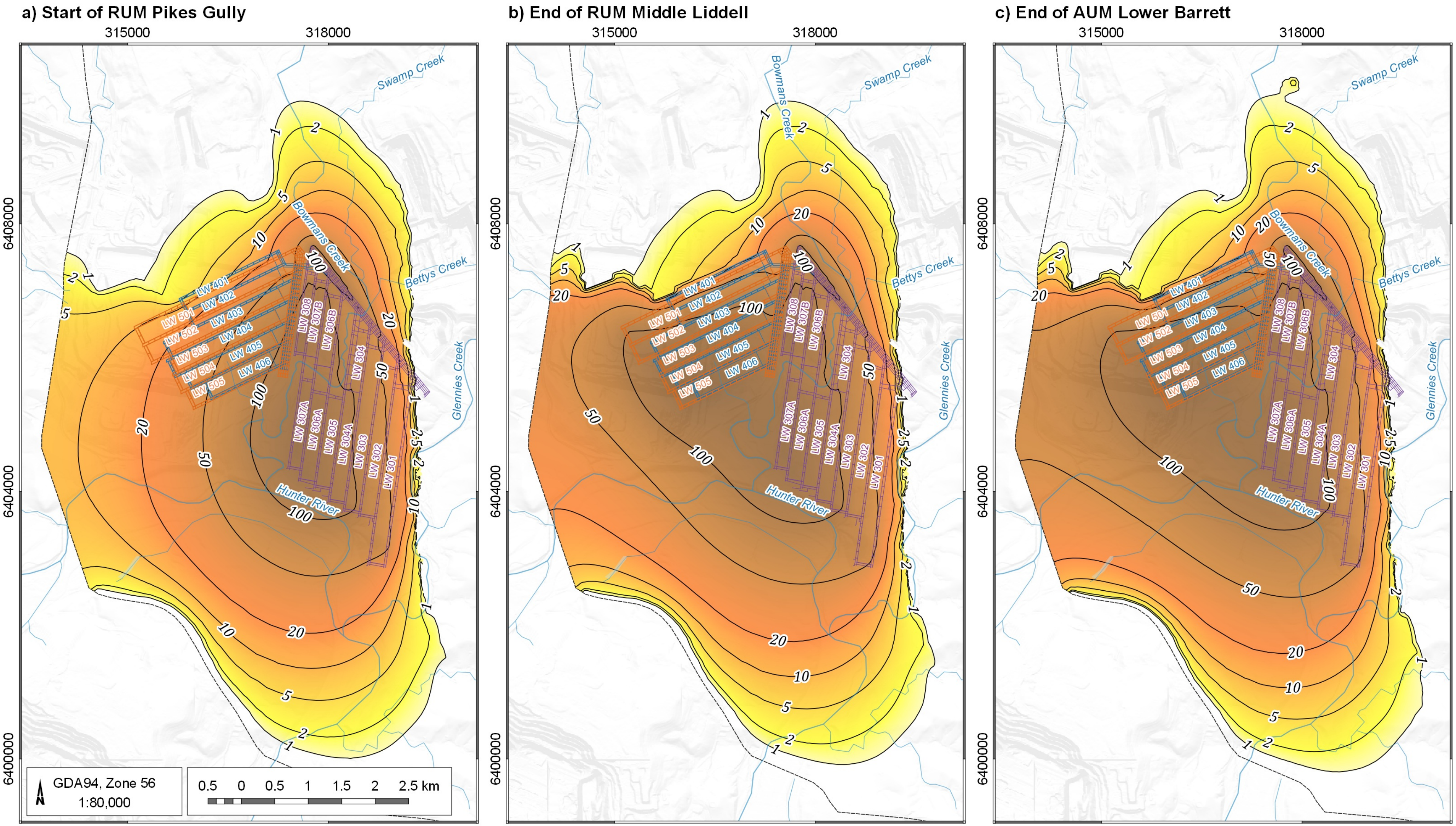
Ashton Ravensworth Integration Modification
(ASH5001.001)

Simulated drawdown in alluvium (Layer 1)

DATE
05/11/2021

FIGURE No:
4.9

Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.;
G:\Projects\ASH5000.001.Ashton_Ravensworth_Integration_Modification\3_GIS\Workspaces\002_Letter_Report\04.09_AHS5000.01_Simulated drawdown in alluvium (Layer 1).qgs



LEGEND

- Drainage
- Drawdown contour (m)
- AUM Lower Barrett panels
- RUM Pikes Gully panels
- RUM Middle Liddell panels
- Model boundary

Drawdown (m)

0, 1, 2, 5, 10, 20, 50, 100, 200, 500

AGE

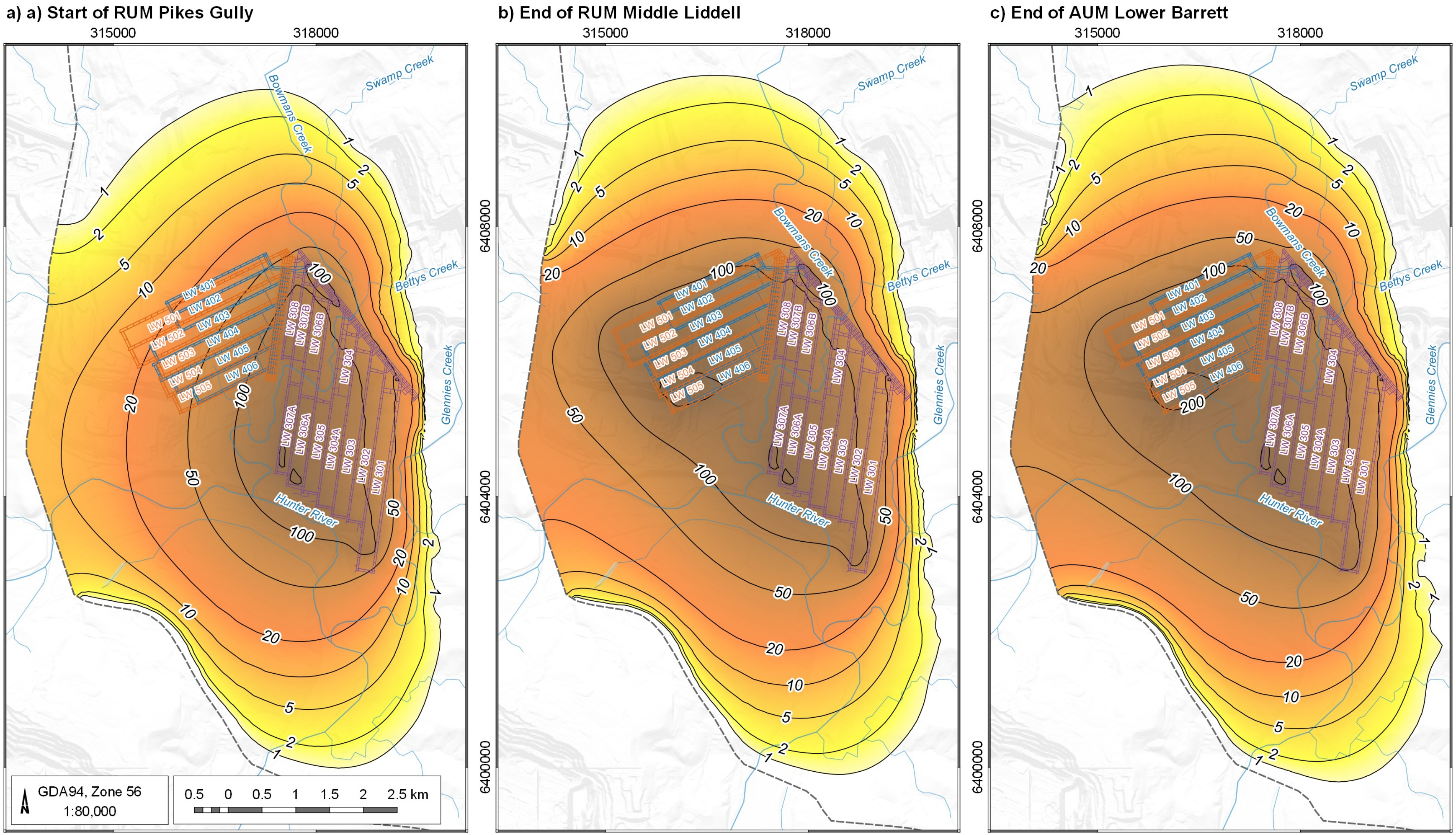
Ashton Ravensworth Integration Modification (ASH5001.001)

Simulated drawdown in Pikes Gully seam (Layer 8)

DATE 08/11/2021

FIGURE No: **4.10**

Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.;
G:\Projects\ASH5000.001.Ashton_Ravensworth_Integration_Modification\3_GIS\Workspaces\002_Letter_Report\04.10_AHS5000.01_Simulated drawdown in Pikes Gully seam (Layer 8).qgs



LEGEND

- Drainage
- Drawdown contour (m)
- AUM Lower Barrett panels
- RUM Pikes Gully panels
- RUM Middle Liddell panels
- Model boundary

Drawdown (m)

0, 1, 2, 5, 10, 20, 50, 100, 200, 500

AGE

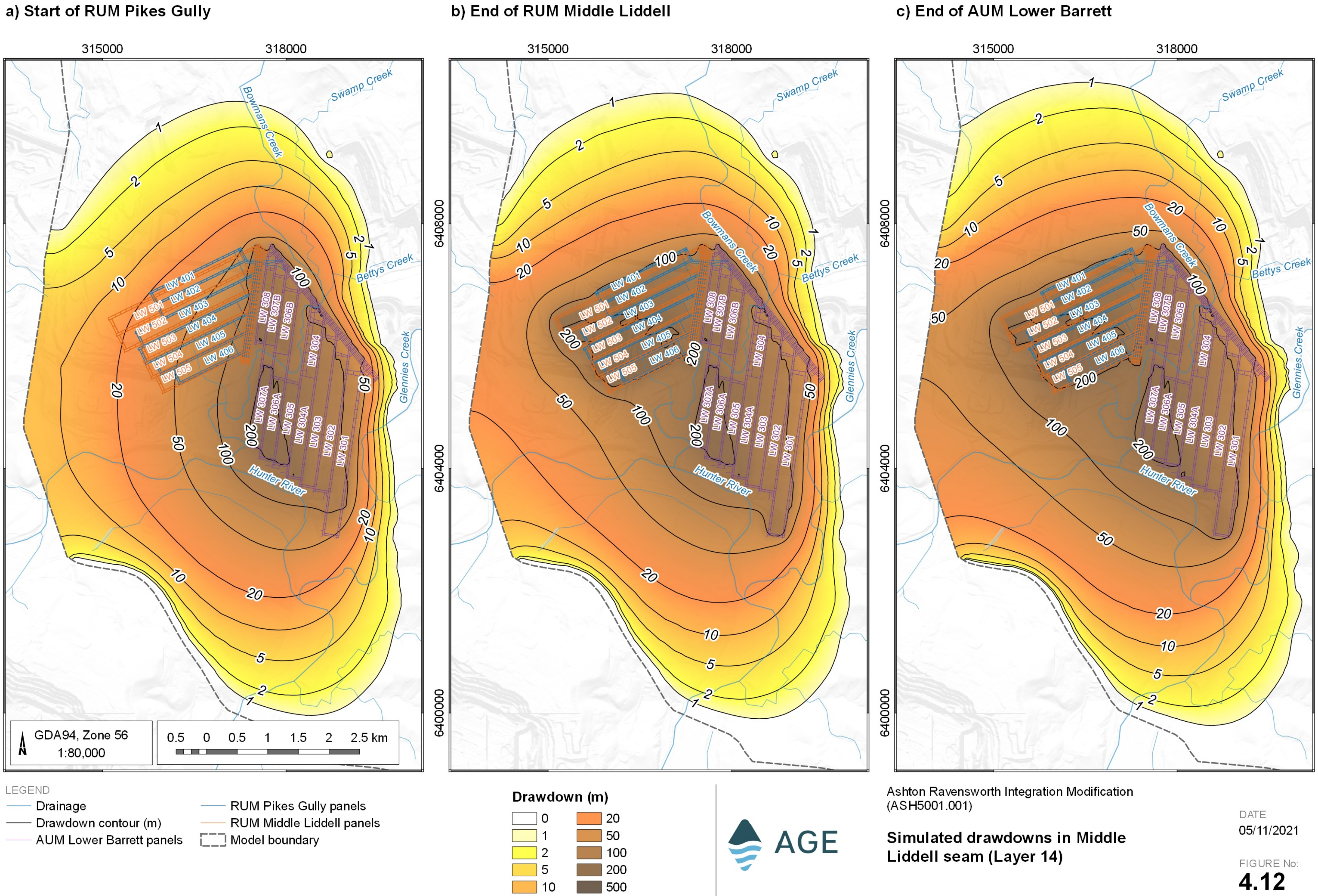
Ashton Ravensworth Integration Modification
(ASH5001.001)

Simulated drawdowns in Upper Liddell seam (Layer 11)

DATE
05/11/2021

FIGURE No:
4.11

Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.;
G:\Projects\ASH5000.001.Ashton_Ravensworth_Integration_Modification\3_GIS\Workspaces\002_Letter_Report\04.11_AHS5000.01_Simulated Drawdown in Upper Liddell seam (Layer 11).qgs



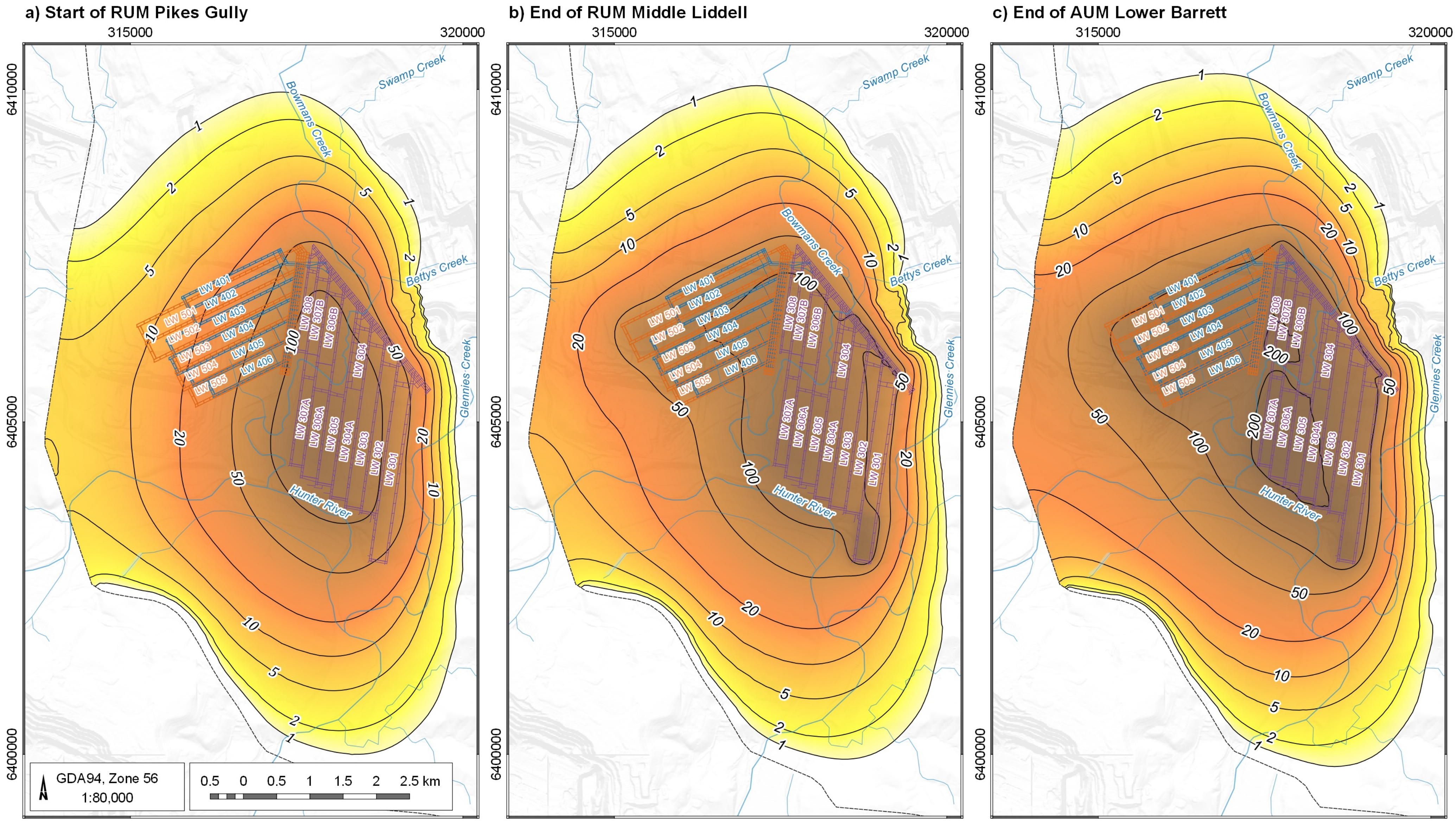
AGE

Ashton Ravensworth Integration Modification (ASH5001.001)

Simulated drawdowns in Middle Liddell seam (Layer 14)

DATE
05/11/2021

FIGURE No:
4.12



LEGEND

- Drainage
- Drawdown contour (m)
- AUM Lower Barrett panels
- RUM Pikes Gully panels
- RUM Middle Liddell panels
- Model boundary

Drawdown (m)

0, 1, 2, 5, 10, 20, 50, 100, 200, 500

AGE

Ashton Ravensworth Integration Modification (ASH5001.001)

Simulated drawdown in Lower Barrett seam (Layer 17)

DATE
05/11/2021

FIGURE No:
4.13

Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.;
G:\Projects\ASH5000.001.Ashton_Ravensworth_Integration_Modification\3_GIS\Workspaces\002_Letter_Report\04.13_AHS5000.01_Simulated drawdown in Lower Barrett seam (Layer 17).qgs

4.2.2 Drawdown in private bores

There are two shallow wells near the Modification (Table 4.4) on privately owned land (Figure 4.14). GW049720 is 10.7 metres (m) deep and is located along a tributary 450 m south of the Hunter River, south-west of the Ashton Underground Mine. This well is unaffected by alluvial drawdown induced by the Modification. GW064515 is located along Glennies Creek to the south of ACOL's former NEOC mine, with less than 0.1 m of drawdown expected by completion of the Modification (Figure 4.14).

Table 4.4 Private wells near the Modification

Well ID	Easting	Northing	Location	Depth	Maximum predicted drawdown (m)
GW049720	316444	6403743	Hunter River tributary	10.7	0
GW064515	320397	6406064	Glennies Creek	5.5	< 0.1

4.2.3 Impact on groundwater dependent ecosystems

Groundwater dependent ecosystems (GDEs) are defined by the *Guidelines for groundwater quality protection in Australia* (Department of Agriculture and Water Resources 2013) as ecosystems that are connected to groundwater and rely on groundwater for survival. There are no high priority GDEs identified in the area on either the Hunter Regulated or Hunter Unregulated and Alluvial Water Sources WSPs.

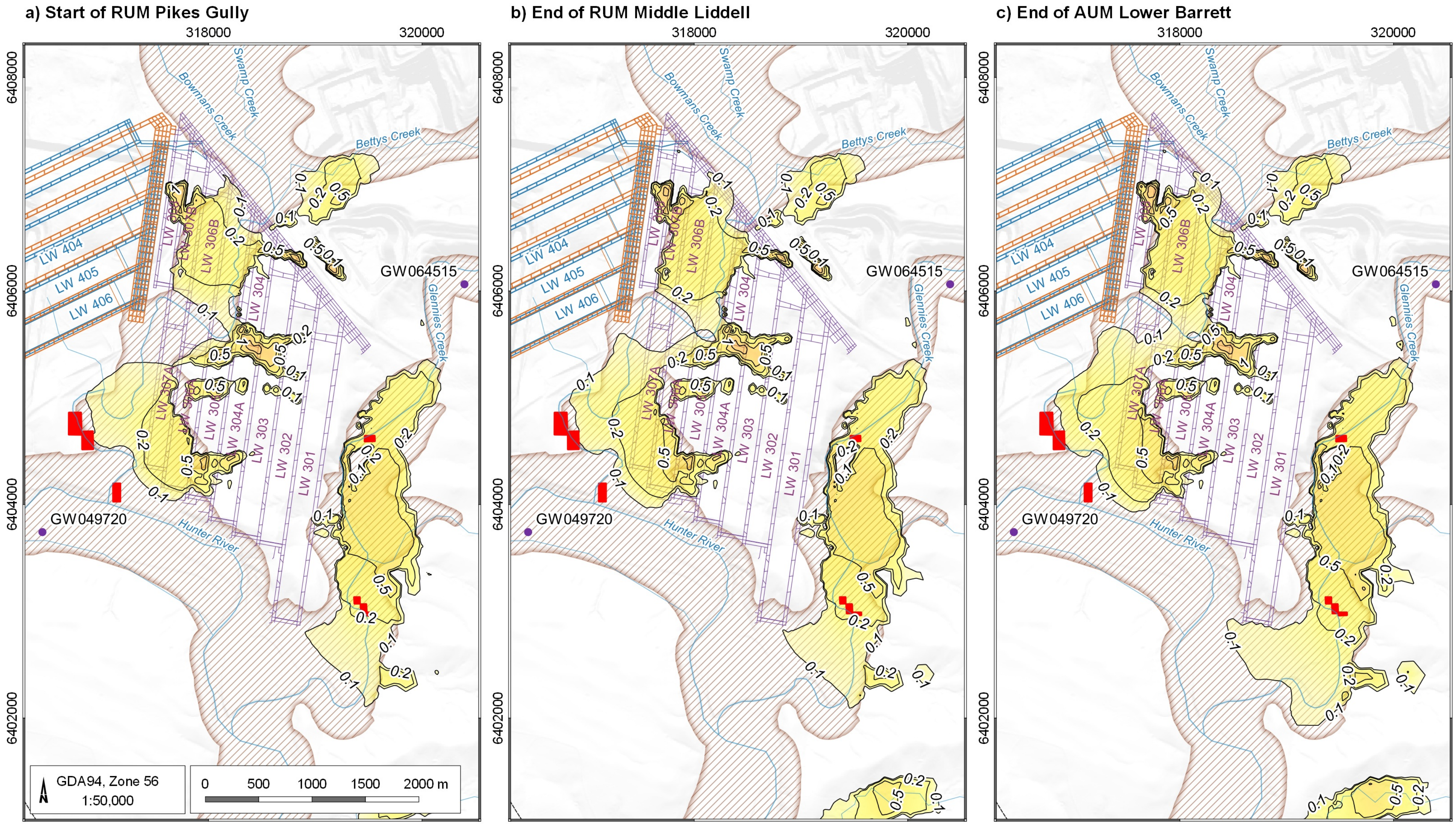
River Red Gums (RRG) are the only identified GDEs in the vicinity of the Modification. Small stands of RRGs are located on the lower reaches of Bowmans Creek, within 1 km of the Hunter River confluence, and the lower reaches of Glennies Creek. These GDEs are likely to access shallow alluvial groundwater, supported by baseflow from creeks.

Along Glennies Creek, the maximum predicted alluvial drawdown resulting from the Modification is 0.2 m in the area of the RRG stands (Figure 4.14). To date, there is no observed drawdown in the Glennies Creek Alluvium. It is likely that any mining-related impact to the alluvial water level will be mitigated by recharge from Glennies Creek, which is regulated by surface water discharge from Lake St Clair, resulting in no significant impact to the RRGs.

There are three stands of RRGs in the riparian zone of Bowmans Creek. The predicted drawdown of < 0.1 m on completion of the Modification is also considered insignificant.

4.2.4 Groundwater quality during mining operations

Mining activities at Ashton Underground Mine and RUM promote a downward vertical hydraulic gradient due to underground dewatering and subsidence, which minimises the potential risk of saline groundwater from the Permian strata flowing into alluvium and creeks. Discharge from the Permian strata to the alluvial groundwater is reduced by increasing depressurisation of the underlying seams, and therefore the salinity of alluvial groundwater is likely to decrease over time. This finding is consistent with previous approvals (Aquaterra 2009).



LEGEND

- Private bores
- Drainage
- Drawdown contour (m)
- AUM Lower Barrett panels
- RUM Pikes Gully panels
- RUM Middle Liddell panels
- Quaternary alluvium/colluvium
- Model boundary
- River Red Gum areas

Drawdown (m)

- 0
- 0.1
- 0.2
- 0.5
- 1
- 2

AGE

Ashton Ravensworth Integration Modification (ASH5001.001)

Predicted maximum alluvial drawdown near private bores and GDEs

DATE
05/11/2021

FIGURE No:
4.14

Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.;
G:\Projects\ASH5000.001.Ashton_Ravensworth_Integration_Modification\3_GIS\Workspaces\002_Letter_Report\04.14_AHS5000.01_SPredicted maximum alluvial drawdown near private bores and GDEs.qgs

4.3 Comparison of revised groundwater impacts to 2001 EIS and 2009 EA

The predicted impacts to the end of the Modification were compared to those documented in the 2009 Environmental Assessment (EA) and 2001 Environmental Impact Statement (EIS) for Ashton Underground Mine (Table 4.5). As discussed in Section 4.1.2.2, the baseflow impacts presented in MER (2012) detailed the cumulative impacts of all mines rather than isolating the impact of RUM. Consequently, the impacts of the Modification are quantified within those approved for Ashton Underground Mine.

For the Bowmans Creek Alluvium, the predicted drawdown resulting from the Modification is between those predicted in the 2009 EA and 2001 EIS. For the Glennies Creek Alluvium, the predicted drawdown is lower than both the 2009 EA and 2001 EIS. For the Hunter River Alluvium, the predicted drawdown is consistent with those of the 2009 EA and greater than those of the 2001 EIS.

The impacts to stream baseflow are similar to those predicted in both the 2009 EA and 2001 EIS. For Bowmans Creek and Glennies Creek, the predicted maximum baseflow loss per day is between the predictions of the 2009 EA and 2001 EIS, while for the Hunter River the predicted baseflow impacts are lower than those of the 2009 EA and 2001 EIS.

Mining related impacts on groundwater quality have not been observed to date. Consistent with the conceptual understanding of the groundwater system and modelled directions of groundwater flow, future impacts to groundwater quality are not expected and salinity is likely to decrease.

The peak mine inflow rates for the Modification were compared to those predicted for the Ashton Underground Mine in the 2009 EA and 2001 EIS and to those predicted for RUM in MER (2012) and were consistent with the predictions of each (Table 4.5). The volume of inflow per water year (Table 4.2) was compared to ACOL's entitlements under its WALs (Table 4.1). ACOL holds WALs with sufficient entitlements to account for the predicted direct and indirect takes for the life of the Modification.

Table 4.5 Comparison of impacts to 2001 EIS and 2009 EA

Impact description	Location	Observed	Proposed Modification	2009 EA	2001 EIS
		Impact to September 2021	Completed mine impact (end of 2035)	Completed mine impact	Completed mine impact
Drawdown	Bowmans Creek Alluvium	No drawdown observed in WMP* bores (WMLP311, WMLP323, WMLP328, T2A)	≤ 1 m	< 3 m	No significant drawdown
	Glennies Creek Alluvium	No drawdown observed in WMP bores (WML120B, WML129, WML239)	< 1 m	< 2 m	2.5 m
	Hunter River Alluvium	No drawdown observed in WMP bores (WMLP279, WMLP280, WMLP337)	< 1 m	< 1 m	No significant drawdown
Stream baseflow loss	Bowmans Creek	-	0.22 ML/day	0.13 ML/day	0.4-1.4 ML/day
	Glennies Creek	-	0.32 ML/day	0.23 ML/day	0.6 ML/day
	Hunter River	-	0.02 ML/day	0.06 ML/day	0.3 ML/day
Salinity	Bowmans Creek	No mining related impact observed in WMP bores (WMLP311)	Likely decrease in salinity	Likely decrease in salinity	EC: great variability - maximum increase of 70 µS/cm attributable to mining related impacts
	Glennies Creek	No mining related impact observed in WMP bores (WML120B, WML239)	Likely decrease in salinity	Likely decrease in salinity	Similar quality to pre-mining
	Hunter River	No mining related impact observed in WMP bores (WMLP337)	Likely decrease in salinity	Likely decrease in salinity	N/A
Peak predicted mine inflows	Ashton Underground Mine		2.61 ML/day (combined Ashton Underground Mine and RUM)	1.76 ML/day	1.75 ML/day
	Ravensworth Underground Mine			1.8 ML/day (RUM only; MER, 2012)	

5 Conclusions

Underground mining of the RUM Pikes Gully and Middle Liddell seams is already approved under RUM Development Consent DA 104/96. The Modification does not propose any increase in the extent of approved longwall mining at the RUM, and would actually decrease the extent of some of the targeted panels (i.e. shortening and narrowing of longwall panels). The smaller extent of mining proposed under the Modification is expected to reduce groundwater impacts compared to the approved RUM layout.

An updated groundwater model predicting the impacts of the Modification was compared to a no-mining scenario. The predicted impacts were consistent with the 2009 EA and 2001 EIS approvals for Ashton Underground Mine. In addition, ACOL holds WALs with sufficient entitlements to account for both direct and indirect takes for the life of the Modification.

The extent of drawdown was consistent with previous predictions close to the longwall panels, though could not be definitively established as the contours intersected the no-flow boundary along the western edge of the model domain. However, it is unlikely that potential drawdowns extending beyond the no-flow boundary would result in significant impacts as extensive depressurisation of the coal measures has already occurred due to existing mining operations in the vicinity of the RUM, which target the same coal seams.

There were no significant impacts predicted to groundwater dependent ecosystems or private bore holders neighbouring the Modification.

The use of a contemporary model that incorporates recent observed groundwater responses to mining, has produced predicted impacts that are smaller than combined existing approvals for Ashton Underground Mine and RUM. It can be concluded that the Modification would not result in any additional groundwater impacts compared to those already approved for RUM and Ashton Underground Mine.

Yours faithfully,

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Senior Hydrogeologist / Groundwater Modeller

Andrew Durick
Director / Principal Groundwater Modeller

Australasian Groundwater and Environmental Consultants Pty Ltd

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