WAMBO
GROUNDWATER MANAGEMENT PLAN

Document No. WA-ENV-MNP-509.1
November 2020

Document Control

Document No.	WA-ENV-MNP-509.1
Title	Wambo Groundwater Management Plan
General Description	Groundwater Management at Wambo Coal Mine
Document Owner	WCPL Environment & Community Manager

Revisions

Rev No	Date	Description	By	Checked	Signature
1	August 2020	New Groundwater Management Plan (Version 1) for Wambo Mine, following approval of DA305-7-2003 (Modification 16) & DA177-8-2004 (Modification 3). Replaces the Wambo Groundwater Monitoring Program (Version 12).	WCPL	CB	
2	November 2020	Revised to address minor comments from DPIE	WCPL	-	

CONTENTS

Tables

Figures

1.0 Introduction

1.1 Purpose and Objectives

This Groundwater Management Plan (GWMP) has been developed by Wambo Coal Pty Ltd (WCPL) to address the relevant requirements of WCPL's development consent DA305-7-2003, as relevant to Phase 2 mining operations at the Wambo Coal Mine (Wambo). This GWMP also addresses the requirements of Condition 12 of Exploration Licence EL7211 for the preparation of a Groundwater Monitoring and Modelling Plan (GWMMP).

The key objectives of groundwater management at Wambo are to:

- satisfy regulatory requirements, including meeting required performance criteria;
- ensure there are negligible impacts to adjacent groundwater users (both consumptive users and the environment);
- ensure the underlying and adjacent groundwater resources are not degraded;
- reuse mine impacted water within the WMS to reduce reliance on raw/clean water; and
- minimise adverse effects on downstream waterways (including hydraulic and water quality impacts).

The GWMP has also been prepared in accordance with Condition D5 of DA305-7-2003 (Management Plan Requirements). There are no conditions specific to groundwater management in DA177-8-2004 or WCPL's Environment Protection Licence (EPL) 529.

1.2 Scope

This GWMP applies to all Phase 2 operational activities at the Wambo Coal Mine, including underground mining operations, CHPP and train loading operations (**Figure 1**). It does not apply to open cut mining operations associated with the United Wambo Open Cut Project.

This GWMP applies to all WCPL employees and contractors working for, or on behalf of WCPL within the project approval boundary (**Figure 1**).

This GWMP covers all groundwater management activities undertaken within Wambo's mining authorisations and approved mining areas as well as regional groundwater bores. This GWMP has been prepared to manage groundwater impacts from Wambo on local groundwater systems.

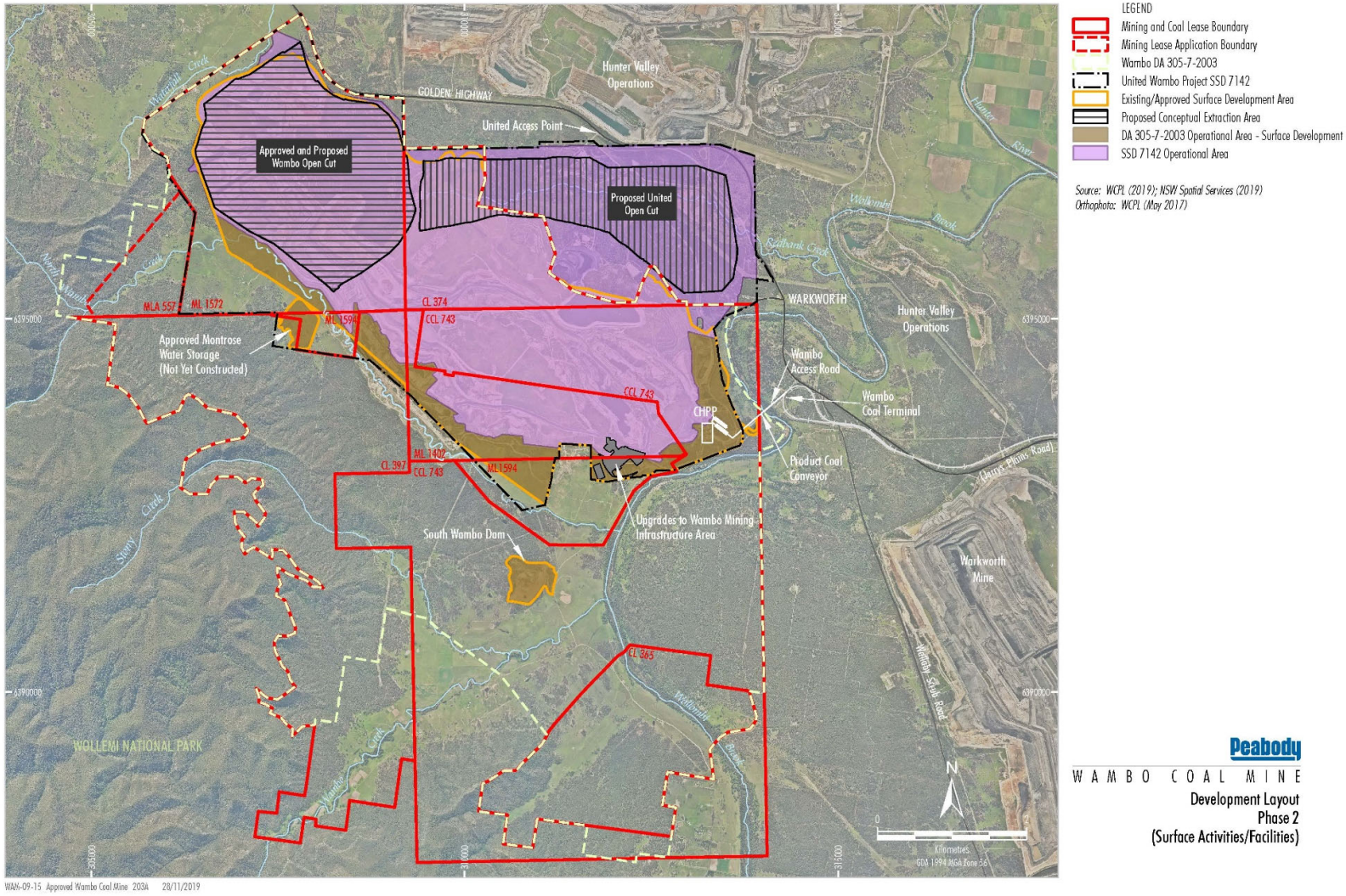

Figure 1: Approved Wambo Coal Mine – Phase 2

1.3 Relationship to Other Management Plans

This GWMP is part of a set of documents that together form the WCPL Water Management Plan (WMP) for the Wambo Coal Mine (**Figure 2**). The WMP is one of a series of Environmental Management Plans that together forms part of the WCPL Environmental Management System.

As part of Phase 2 operations, WCPL has combined the surface and ground water monitoring programs at Wambo with the United Wambo Open Cut surface and ground water monitoring programs. This combined monitoring program is now contained within the new ***United Wambo Open Cut and Wambo Water Monitoring Program (WMProg)*** (WA-ENV-MNP-509.8). A brief description of WCPL's groundwater monitoring program is included in **Section 6.0** of this GWMP however the monitoring program itself is now included in the ***WMProg.***

As part of the United Wambo Open Cut project Environmental Assessment (Umwelt 2016), WCPL's site water balance (and salt balance) was expanded to include the United Wambo Open Cut project. The ***United Wambo Open Cut and Wambo Site Water and Salt Balance*** (***SWSB***) (WA-ENV-MNP-509.4) is now a shared document, managed by WCPL. The ***SWSB*** will be updated annually using monitoring data from the ***WMProg.***

This GWMP should be read in conjunction with the other components of the Water Management Plan, particularly the overarching Wambo ***Water Management Plan*** (WA-ENV-MNP-509), ***WMProg*** (WA-ENV-MNP-509.8) and the Wambo ***Environmental Management Strategy*** (***EMS***) (WA-ENV-MNP-501).

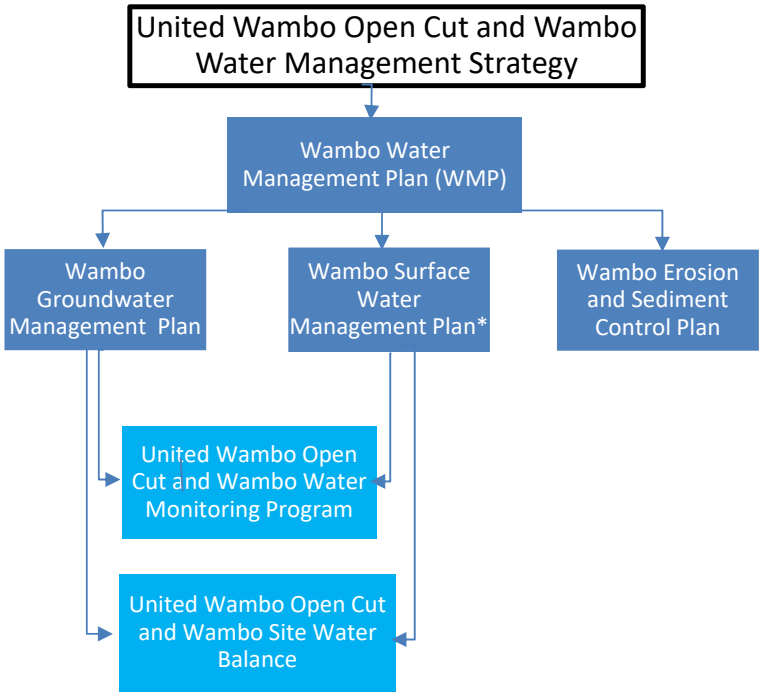

Figure 2: Wambo Water Management Plan

Notes to **Figure 2:**

Shared Document with United Wambo Open Cut Operations (refer Table 2 **of *WMP***)

Wambo Document (refer Table 2 **of *WMP***)

* SWMP incorporates the ***North Wambo Creek Diversion Management Plan*** (***NWCD MP***) – refer **Section 1.3.1**

1.3.1 Obsolete Plans

Prior to Modification 16 of DA305-7-2003, WCPL was required to prepare a ***Surface and Groundwater Response Plan*** (***SGWRP***) for the Wambo Coal Mine. The ***SGWRP*** detailed WCPL's response to observed impacts on surface and ground water as a result of WCPL's operations. Following approval of Modification 16, the Groundwater Response Plan has now been incorporated into this GWMP (refer **Section 7.0**). The Surface Water Response Plan has been incorporated into the ***SWMP***.

1.3.2 Relationship to EL7211 Groundwater Monitoring and Modelling Plan

Condition 12 of EL7211 requires WCPL to develop a Groundwater Monitoring and Modelling Plan (GWMMP) for exploration activities in EL7211. In 2016 WCPL developed a GWMMP to satisfy this condition and submitted it to DPIE Water on 16 January 2017 for review and comment. Feedback was received on 18 January 2017 and this feedback was addressed in the revised GWMMP (Version 2).

Condition B66(v) of DA305-7-2003 requires WCPL to develop a GWMP that is consistent with *Groundwater Monitoring and Modelling Plans – Introduction for prospective mining and petroleum activities* (DPI Water, 2014) (refer **Table 1** in **Section 2.2**).

For simplicity and to avoid duplication of management plans, the GWMMP for EL7211 has been incorporated into this GWMP. **Table 5** (**Section 2.5**) shows where the requirements of Condition 12 (of EL7211) are addressed in this GWMP.

1.4 Preparation of the GWMP

In recognition of the requirements of Condition B66(a) of DA305-7-2003, this GWMP prepared by WCPL has been reviewed by a suitably experienced and qualified person, Ms Claire Stephenson from SLR Consulting (refer **Section 1.5.2** regarding NSW Department of Planning, Industry and Environment (DPIE) endorsement of Ms Stephenson).

1.5 Stakeholder Consultation

1.5.1 History of Consultation

There is a long history of consultation with various stakeholders regarding WCPL's Water Management Plan. Over the years WCPL has undertaken extensive consultation with government agencies, the Wambo Community Consultative Committee (CCC) and affected landholders in relation to management plan updates, including for various extraction plans.

Prior to the approval of DA305-7-2003 Modification 16 (in August 2019), this consultation was undertaken for WCPL's Groundwater Monitoring Program. The last update to the WCPL Groundwater Monitoring Program (version 12) was undertaken in consultation with DPIE, as part of the Extraction Plan for South Bates Underground Extension LW17-20. This update addressed comments from the DPIE and Independent Expert Scientific Committee (IESC) and built on consultation undertaken on previous versions of the document.

A summary of historic consultation, including how comments from DPIE Water, the IESC and DPIE have been addressed in previous versions of the GWMP, is provided in **Appendix A.**

1.5.2 Consultation for this GWMP

Dr Noel Merrick (SLR Consulting) was approved by DPIE on 28 February 2020 as the suitably qualified groundwater expert for the preparation of the South Bates Underground Extension (SBUE) Extraction Plan for Longwalls 21-24. In April 2020, WCPL wrote to DPIE and requested

Ms Claire Stephenson from SLR also be endorsed as a suitably qualified experienced expert. DPIE provided endorsement for Ms Stephenson 29 May 2020 (refer to correspondence in **Appendix A**).

As required by Condition B66 (b) of DA305-7-2003, WCPL must prepare this GWMP in consultation with DPIE Water and the EPA, to the satisfaction of the Planning Secretary. This GWMP (including all appendices) was provided to DPIE Water and EPA on 26 August 2020 for review and comment. Correspondence was received from the EPA 4 September 2020 to advise that the EPA does not provide comments on management plans. No comments were received from DPIE Water.

Version 2 of the GWMP was approved 20 November 2020. Correspondence in relation to consultation is attached as **Appendix A**.

1.5.3 Consultation for the Groundwater Dependent Ecosystem Study

On 5 February 2020 WCPL received correspondence from DPIE advising that they were satisfied with WCPL's Groundwater Dependent Ecosystem (GDE) Study, required by Condition B64 of DA305-7-2003.

Correspondence in relation to the GDE Study is attached as **Appendix A**.

1.6 Statement of Commitments

A Summary of Commitments for this GWMP is included in **Appendix B**.

2.0 Statutory Requirements

This GWMP has been prepared to fulfil all statutory requirements relating to groundwater management at the Wambo Coal Mine, including:

- Relevant legislation, policies, guidelines and standards;
- DA305-7-2003 Conditions of Consent (CoC);
- Recommendations from the 2017 Independent Environmental Audit (Hansen Bailey, 2018);
- Groundwater licence conditions; and
- Mining Tenement and Exploration Licence Conditions.

There are no conditions specific to groundwater management in WCPL's EPL 529 or DA177-8-2004.

There are no commitments in the *United Wambo Open Cut Project Environmental Impact Assessment* (Umwelt, 2016) relevant to this GWMP, however there are commitments relating to groundwater management and monitoring for the United Wambo Open Cut project that are addressed as part of the shared ***WMProg*** and ***SWSB***. Further information on these commitments and how they have been addressed is contained in the United Wambo Groundwater Management Plan.

2.1 Legislation, Policies, Guidelines and Standards

The legislation relevant to this GWMP is described in Section 2.1 of the ***WMP.***

The policies, guidelines and standards relevant to this GWMP are described in Section 2.2 of the ***WMP.***

This plan has been prepared to be consistent with *Groundwater Monitoring and Modelling Plans – Introduction for prospective mining and petroleum activities* (DPIE Water 2014).

2.2 DA305-7-2003 Conditions of Consent

WCPL received development consent (DA305-7-2003) in accordance with the *Environmental Planning & Assessment Act 1979* (EP&A Act) from DPIE, formerly NSW Department of Planning and Environment (DP&E), on 4 February 2004. The most recent modification to DA305-7-2003 was granted by the Independent Planning Commission of NSW on 29 August 2019 (Modification 16).

DA305-7-2003 requirements related to the development of this GWMP are summarised in **Table 1.** Groundwater management performance measures, as specified in Condition B62 of DA305-7-2003, are listed in **Table 2.**

Table 1: DA305-7-2003 Requirements for this GWMP

Condition	Condition Details	GWMP Section
B66	(v) Groundwater Management Plan, which is consistent with *Groundwater Monitoring and Modelling Plans – Introduction for prospective mining and petroleum activities* (DPI Water, 2014) and includes:	**Entire document**
	• detailed baseline data of groundwater levels, yield quality for	**Section 3.4**

Condition	Condition Details	GWMP Section
	groundwater resources and groundwater dependent ecosystems potentially impacted by the development, including groundwater supply for other water users;	
	• a detailed description of the groundwater management system;	**Section 5.1**
	• groundwater performance criteria, including trigger levels for identifying and investigating any potentially adverse groundwater impacts associated with the development, on: o regional and local aquifers (alluvial and hardrock);	**Section 4.0**
	o groundwater supply for other water users such as privately-owned licensed groundwater bores; and	
	o groundwater dependent ecosystems;	
	• a program to monitor and evaluate: o compliance with the relevant performance measures listed in Table 8, and the performance criteria established above, including monitoring of regional groundwater levels and quality during the life of the development and at least 10 years post-mining;	**Sections 6.0 and 9.2**
	o water loss/seepage from water storages into the groundwater system (particularly from South Wambo Dam and Montrose East Dam);	
	o groundwater inflows, outflows and storage volumes to inform the Site Water Balance;	
	o any hydraulic connectivity between the alluvial and hardrock aquifers;	
	o impacts on groundwater dependent ecosystems;	
	o impacts on groundwater supply for other water users; and	
	o the effectiveness of the groundwater management systems;	
	• reporting procedures for the results of the monitoring program;	**Section 9.2**
	• a plan to respond to any exceedances of the groundwater performance criteria, and repair, mitigate, compensate and/or offset any adverse groundwater impacts of the development; and	**Section 7.0**
	• a program to periodically validate the groundwater model for the development, including an independent review of the model every 3 years, and comparison of monitoring results with modelled predictions; and	**Sections 5.3 and 9.1.2**
D5	**Management Plan Requirements** The Applicant must ensure that the management plans required under this consent are prepared in accordance with any relevant guidelines, and include where relevant:	**Section 2.1**
	(a) summary of relevant background or baseline data;	**Section 2.4**
	(b) details of: • the relevant statutory requirements (including any relevant approval, licence or lease conditions);	**Section 2.0**
	• any relevant limits or performance measures and criteria;	**Table 2 and Section 4.0**
	• the specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the development or	**Section 4.0**

Condition	Condition Details	GWMP Section
	any management measures;	
	(c) any relevant commitments or recommendations identified in the document/s listed in condition A2(c);	**Section 2.0**
	(d) a description of the measures to be implemented to comply with the relevant statutory requirements, limits, or performance measures and criteria;	**Sections 5.0 and 6.0**
	(e) a program to monitor and report on the: • impacts and environmental performance of the development; and • effectiveness of any management measures set out pursuant to paragraph (d);	**Monitoring – Section 6.0 Reporting - Section 9.0**
	(f) a contingency plan to manage any unpredicted impacts and their consequences and to ensure that ongoing impacts reduce to levels below relevant impact assessment criteria as quickly as possible;	**Section 7.0**
	(g) a program to investigate and implement ways to improve the environmental performance of the development over time;	**Section 9.0**
	(h) a protocol for managing and reporting any: • incident, non-compliance or exceedance of any impact assessment criterion and performance criterion;	**Managing – Section 7.0 Reporting – Section 9.0**
	• complaint; or	**Section 8.0**
	• failure to comply with other statutory requirements; and	**Section 7.4**
	(i) a protocol for periodic review of the plan.	**Section 9.1.3**

Table 2: DA305-7-2003 Groundwater Management Performance Measures

Feature	Performance Measure[1]	GWMP Section
Water management – general[2]	• Maintain separation between clean, dirty and mine water • Minimise the use of clean and potable water • Maximise water recycling, reuse and sharing opportunities • Minimise the use of make-up water from external sources • Design, install, operate and maintain water management infrastructure in a proper and efficient manner	**Section 5.1 See also SWMP, GWMP & ESCP**

Alluvial aquifers (including Wollombi Brook alluvium and excluding North Wambo Creek alluvium)	• Negligible impacts beyond those predicted in the document/s listed in condition A2(c), including:
	  • negligible change in groundwater levels;
	  • negligible change in groundwater quality; and
	  • negligible impact to other groundwater users
		Sections 3.2.2 and 5.0 - 7.0

Aquatic, riparian and groundwater dependent ecosystems	• Negligible environmental consequences beyond those predicted in the document/s listed in condition A2(c) • Maintain or improve baseline channel stability • Develop site-specific in-stream water quality	**Sections 3.2.3 and 5.0 - 7.0 (See also WMP & SWMP)**

Feature	Performance Measure[1]	GWMP Section
	objectives in accordance with the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC & ARMCANZ, 2000) and *Using the ANZECC Guidelines and Water Quality Objectives in NSW* (DEC, 2006)	

Note:

1. The performance measures in **Table 2** do not apply to water management structures constructed prior to the approval of Modification 16 (to DA305-7-2003).

WCPL is also required to undertake a Groundwater Dependent Ecosystem Study in accordance with Condition B64 of DA305-7-2003. Further detail on this study is included in **Section 3.2.3.1.**

Other conditions relating to general water management are addressed in the ***WMP.***

2.3 Independent Environmental Audit Recommendations

In 2017 Hansen Bailey conducted an Independent Environmental Audit of the Mine, in accordance with the requirements of Condition D11 of DA305-7-2003 and DA177-8-2004 (Hansen Bailey, 2018). Recommendations from the audit report relating to this GWMP, and where they are addressed, are included in **Table 3.**

Table 3: 2017 IEA Recommendations relevant to this GWMP

DA305-7-2003 Reference	Recommendation[1]	WCPL Response[2]	Timing	Section
Schedule 4, Condition 30	The GWMP should be updated with the suggestions provided by NSW government subsequent to approval of the GWMP in November 2015 and resubmitted. Updates should include: • A more contemporary reference to groundwater sampling techniques;	Complete, changes made in V12 of the GWMP, approved by DP&E 17 September 2018.	Complete	**Section 6.2**
	• Amendment of the text relating to purging of groundwater bores to be consistent with the latest guidelines;			**Section 6.2**
	• Outline the methods of water quality data upload from the laboratory;			**Section 6.3**
	• The bore labels in Figure 7 need to be clear for all bores; and			**Figure 5**
	• General update of text relating to historical or proposed activities.			**Various**
Schedule 4, Condition 34	Update GWMP to include Montrose Dam prior to its construction.	Current Mining Operation Plan refers to construction likely in 2023.	Prior to 2023 construction	**Section 6.1.4**
Schedule 4, Condition 34	Consideration should be made to directly monitor the quality of groundwater seepage reporting to the underground and open-cut workings.	Addressed in 2018 Annual Review of Groundwater prepared by HydroSimulations	Ongoing	**Sections 6.1.2 and 6.1.2 (see also United Wambo Water**

DA305-7-2003 Reference	Recommendation[1]	WCPL Response[2]	Timing	Section
		for the WCPL Annual Review Samples will be taken at active underground areas, to complement the extensive groundwater monitoring network.		**Management Plan)**
NA	AGE made the following recommendations for future groundwater modelling and assessments (see Appendix F): • Future groundwater modelling updates/reports need a clear description of the interactions/connectivity of the open cut and underground area and how this is represented in the modelling; • Future groundwater modelling updates/reports should comment on the interaction/connectivity of the open cut and underground areas and whether it is visible in the observational data; and	Recommendations have been emailed to HydroSimulations. Groundwater model will be rerun for the Extraction Plan for Longwalls 21 and beyond (approx 2020)[3].	Ongoing	**See notes to Table 3[3]**
	Future annual groundwater monitoring reviews should comment on the interaction/connectivity of the open cut and underground area and on the degree of match of the predicted versus observed water levels. The predictions, actual and licensing requirements should be included in a tabular format in each Annual Review.			**Section 9.2.1**
NA	The status of the single groundwater licence under the *Water Management Act* 2000 should be regularly followed up with DPI-Water	Six WCPL groundwater licences have been consolidated – WAL39738, 39803, 41528, 39375, 41520, 41494. New WAL yet to be issued by NSW Land Registry Services[4]	Complete	**Table 4**

Notes to **Table 3:**
1. As per Table 9 of the 2017 IEA Report (Hansen Bailey, 2018).
2. As per WCPL Responses to Recommendations made in the 2017 Independent Environmental Audit – Version 2 (dated 29 April 2019).
3. Recommendations relating to monitoring of groundwater inflows and seepage were considered by HydroSimulations in their annual review of WCPL's groundwater monitoring data for the 2018 Annual Review (HydroSimulations, 2019). A comparison of measured and predicted inflow volumes (to underground and open cut workings) will be undertaken annually and reported in the Annual Review (**Section 9.2.1**). Recommendations relating to future groundwater modelling and assessments will be considered as part of the groundwater model rerun for the Extraction Plan for Longwalls 21 and beyond.
4. New WAL (WAL42373) issued on 20 December 2018 (included in **Table 4** of this GWMP).

2.4 Groundwater Licence Conditions

Table 4 includes a list of groundwater entitlements held by WCPL. Surface water entitlements are outlined in the ***SWMP***.

WCPL currently holds one alluvial aquifer licence (WAL 23897, Licence 20AL211371, 70 shares) within the Lower Wollombi Brook water source of the Hunter Unregulated and Alluvial Water Sources Sharing Plan (WSP).

WCPL holds 1,647 ML of entitlements under the North Coast Fractured and Porous Rock Groundwater Sources WSP for the Sydney Basin – North Coast water source. United holds a further 300 ML of entitlements (refer United Wambo Groundwater Management Plan).

WCPL will report performance against relevant groundwater licence conditions in the Annual Review (refer **Section 9.2.1**).

Table 4: WCPL Groundwater Entitlement and Licences

Licence Number	Description	Expiry Date	Entitlement	Category	Access Licence	Nominated Water Supply Work Approval	Expiry date
Hunter Unregulated and Alluvial Water Sources (Lower Wollombi Brook Water Source)							
WAL 23897[1,2]	Well No. 2	Perpetuity	70 unit shares	Aquifer	20AL211371	20WA211372	31/7/2022
North Coast Fractured and Porous Rock Groundwater Sources (Sydney Basin - North Coast Groundwater Source)							
WAL42373[1,3]	Dewatering	Perpetuity	1549 unit shares	Aquifer	20AL219997	20MW065010	-
WAL41532[1,2]	Dewatering	Perpetuity	98 unit shares	Aquifer	20AL218994	20MW065010	-
20BL168997	Piezometer	Perpetuity	Groundwater monitoring	NA		-	-
20BL168998	Piezometer	Perpetuity	Groundwater monitoring	NA		-	-
20BL168999	Piezometer	Perpetuity	Groundwater monitoring	NA		-	-
20BL169000	Piezometer	Perpetuity	Groundwater monitoring	NA		-	-
20BL170638	Piezometer	Perpetuity	Groundwater monitoring	NA		-	-
20BL172237	Monitoring Bore (GW14, GW18, GW21)	Perpetuity	Groundwater monitoring	NA		-	-
20BL172238	Monitoring Bore (GW12)	Perpetuity	Groundwater monitoring	NA		-	-
20BL172240	Monitoring Bore (GW15)	Perpetuity	Groundwater monitoring	NA		-	-
20BL172242	Monitoring Bore (GW16, GW17)	Perpetuity	Groundwater monitoring	NA		-	-
20BL172244	Monitoring Bore (GW20)	Perpetuity	Groundwater monitoring	NA		-	-
20BL172255	Monitoring Bore (GW22)	Perpetuity	Groundwater monitoring	NA		-	-

Licence Number	Description	Expiry Date	Entitlement	Category	Access Licence	Nominated Water Supply Work Approval	Expiry date
20BL172256	Monitoring Bore (GW13)	Perpetuity	Groundwater monitoring	NA		-	-
20BL172257	Monitoring Bore (GW19)	Perpetuity	Groundwater monitoring	NA		-	-
20BL172332	Piezometer	Perpetuity	Groundwater monitoring	NA		-	-
20BL173032	Monitoring		Groundwater monitoring	NA			-
20BL173290	Monitoring Bore	Perpetuity	Groundwater monitoring	NA		-	-
20BL173291	Monitoring Bore	Perpetuity	Groundwater monitoring	NA		-	-
20BL173292	Monitoring Bore	Perpetuity	Groundwater monitoring	NA		-	-
20BL173293	Monitoring Bore	Perpetuity	Groundwater monitoring	NA		-	-
20BL173946	Monitoring	Perpetuity		NA			
20BL173999	Monitoring Bore	Perpetuity	Groundwater monitoring	NA		-	-
20BL009818	Bore	Perpetuity	Stock	NA		-	-
20BL009819	Bore	Perpetuity	Stock	NA		-	-
20BL009820	Bore	Perpetuity	Stock	NA		-	-
20BL009821	Bore	Perpetuity	Stock	NA		-	-
20BL143779	Bore	Perpetuity	Stock/Domestic	NA		-	-

Notes to **Table 4:**

1. WAL = water access licence, ML/year = megalitres per year.
2. Former licence number: For WAL 23897 = 20BL167737, WAL41532 = 20BL172156
3. 6 x WALs consolidated on 20/12/18

2.5 Mining Tenement and Exploration Licence Conditions

Mining tenement and exploration licence conditions relevant to groundwater management and where they are addressed in this GWMP are summarised in **Table 5**.

Table 5: Mining Tenement & Exploration Licence Conditions relevant to this GWMP

Tenement/ Licence	Condition No.	Condition Description	GWMP Section
EL7211	12	**Groundwater Monitoring and Modelling Plan** Prior to conducting prospecting operations involving the construction and use of boreholes, the licence holder must: a) Prepare a Groundwater Monitoring and Modelling Plan in consultation with the NSW Office of Water;	**Section 1.5**
		b) Ensure the Groundwater Monitoring and Modelling Plan: i. describes methods for identifying aquifers, their depths, behaviour, containing layers and connectivity with surrounding aquifers or surface water systems;	**Section 3.1.1 and Section 6.0**
		ii. describes methods for collection of data relevant to the type, quantity and quality of water contained within aquifer systems likely to be encountered during prospecting operations;	**Section 6.0 and WMProg**
		iii. provides for the future development of a conceptual model of regional groundwater behaviour;	**Section 3.6**

Tenement/ Licence	Condition No.	Condition Description	GWMP Section
		iv. provides for the future development of a calibrated computer model of regional groundwater behaviour, to enable the impacts of any proposed mining operations to be assessed;	**Section 9.1.2**
		v. describes how records of all data collected will be maintained;	**Section 6.3**
		vi. describes the staging process for implementation of the plan; and	**Section 1.2**
		vii. is prepared in accordance with any additional requirements prescribed by the Secretary.	**Section 2.0**
		c) The Groundwater Monitoring and Modelling Plan must address the requirements identified in b)i) and b)vii) in a level of detail commensurate with the scale, timing and potential impact of the proposed operations;	**Noted (see above sections)**
		d) have the Groundwater Monitoring and Modelling Plan approved by the Minister; and	**Noted[1]**
		e) Implement and comply with the approved Groundwater Monitoring and Modelling Plan.	**Noted[2]**
EL7211	26	**Drilling** The licence holder must: a) Construct, maintain and decommission all boreholes and petroleum wells in accordance with standards equivalent to or exceeding the *Minimum Construction Requirements for Water Bores in Australia* (NUDLC 2012), as amended or replaced from time to time. Where this condition is inconsistent with other conditions set out in this exploration licence, those conditions prevail to the extent of that inconsistency. b) Ensure that the construction, operation, maintenance and decommissioning of boreholes does not cause or enhance: i. hydraulic connection between aquifers; ii. contamination or cross-contamination of aquifers; iii. the escape of natural or noxious gases; iv. the uncontrolled surface discharge of ground waters; v. collapse of the surrounding surface; or vi. hazards to persons, stock and wildlife.	**Sections 5.1.3 and 5.4**
		e) Contain all drill cutting, fluids and groundwater returned to the surface as part of the drilling process in above-ground tanks or in-ground sumps pending recirculation or disposal. In-ground sumps must be lined with an impermeable barrier where there is a potential risk of contamination from drill cuttings or fluids;	**Section 5.1.3**
ML1594, ML1572 & CL374	15	**Exploratory Drilling** c) all drill holes are permanently sealed with cement plugs to prevent surface discharge of any groundwaters;	**Section 5.5**
		e) if any drill hole meets an artesian or sub-artesian flow it is effectively sealed to prevent contamination of aquifers.	
CCL743 & ML1402	17	**Exploratory Drilling** b) iii) all drill holes are permanently sealed with cement plugs to prevent surface discharge of any groundwaters;	**Section 5.5**
		b) v) if any drill hole meets an artesian or sub-artesian flow it is effectively sealed to prevent contamination of aquifers.	

Notes to **Table 5**:

1. The approved GWMP will be published on WCPL's website.
2. Groundwater management performance will be reported on in the Annual Review.

3.0 Existing Environment and Baseline Data

3.1 Existing Environment

The existing environment is described in detail in the EIS (Umwelt 2016) and summarised (with respect to water) in Section 3.1 of the ***WMP***. This includes information on:

- Rainfall;
- Geological setting; and
- Topography and vegetation.

3.1.1 Hydrogeology

The hydrogeological regime of the Wambo area and surrounds comprises two main systems (HydroSimulations, 2014):

- Quaternary alluvial aquifer system of channel fill deposits associated with Wollombi Brook, North Wambo Creek, Wambo Creek and Stony Creek.
- Underlying Permian strata consisting of:
    - hydrogeologically "tight" and hence very low yielding to essentially dry sandstone and lesser siltstone;
    - low to moderately permeable coal seams, which are the prime water-bearing strata within the Permian measures; and
- Triassic Narrabeen Group described as:
    - Unconformably overlying the Permian coal measures and comprising lithic to quartzose sandstone, conglomerate, mudstone and siltstone. The Narrabeen Group is not present in the mine disturbance footprint but does form the ridges and high plateau within Wollemi National Park.

3.1.1.1 Quaternary Alluvium

The alluvium in the vicinity of the GWMP area forms an unconfined shallow aquifer. The alluvium within the Wambo area is generally less than 15 m thick (Heritage Computing, 2012). Previous studies indicate that the alluvium of Wambo Creek is 4 to 7 m deep and is discontinuous, probably due to bedrock highs (HLA-Envirosciences, 1999). The alluvium of North Wambo Creek near its confluence with Wollombi Brook was found to vary between 7 and 19 m (GHD, 2007). The extent of alluvium interpreted from the TEM study is typically of a narrower alluvial body along both the lower reaches of (South) Wambo Creek and North Wambo Creek than is mapped in the publicly available mapping (HydroSimulations, 2014) (refer **Figure 3**).

A section of North Wambo Creek has been diverted to skirt the Wambo Open Cut. Groundwater conditions within the North Wambo Creek alluvium have been locally altered by historical and existing mining operations, including removal of alluvium with progression of open cut mining (Montrose Pit).

Based on a review of groundwater quality and the results of the search of the NSW Bore Database (**Section 3.2.1**) the typical yield of the alluvial aquifer is likely to be less than 5 litres per second (L/s) and the salinity varies from low to very high. Based on this information the environmental value of the alluvial groundwater is considered to be 'primary industry' (specifically stock watering) and potentially irrigation.

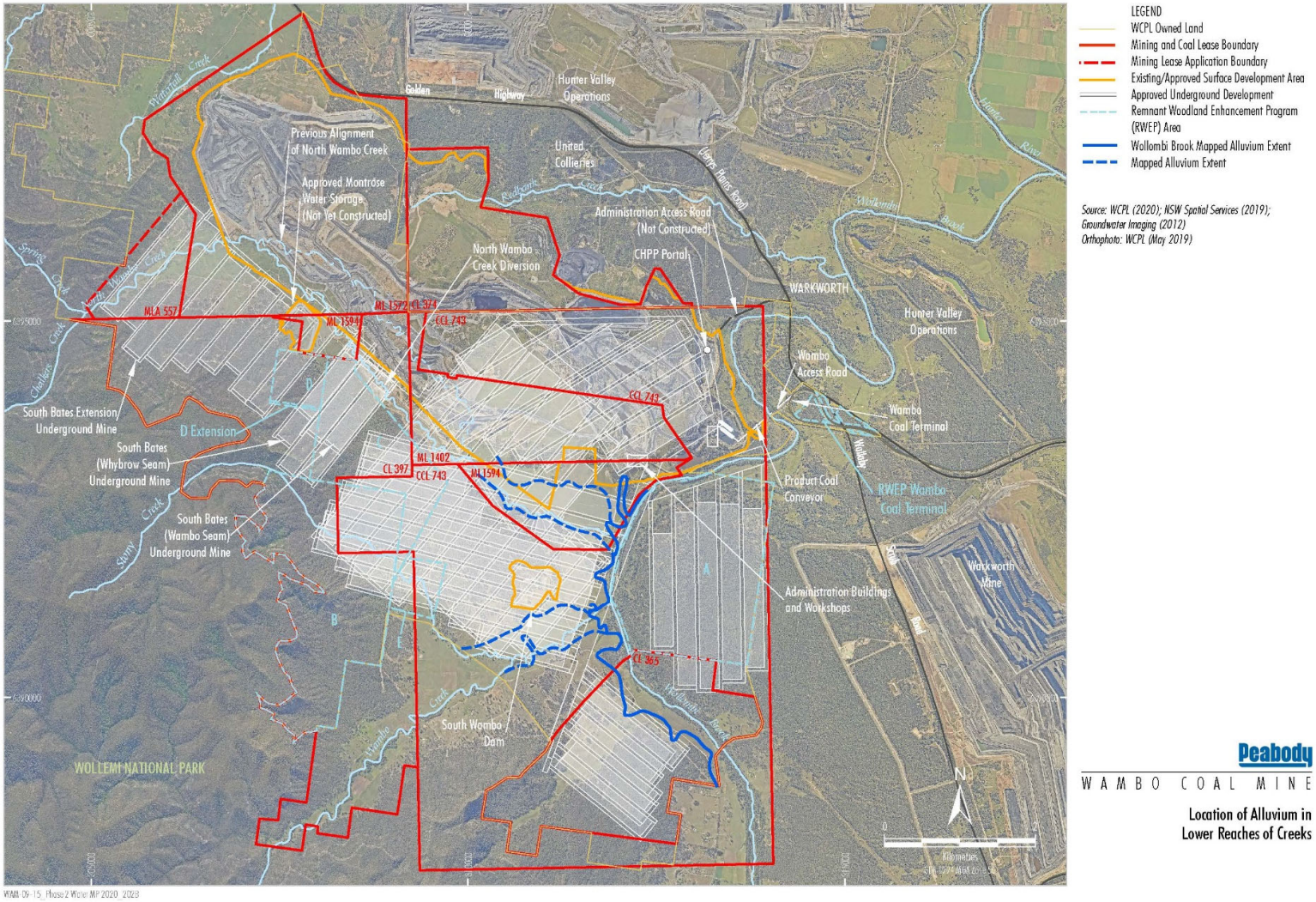

Figure 3: Location of Alluvium in Lower Reaches of Creeks

3.1.1.2 Permian Groundwater Sources

The fractured and porous groundwater sources within the Permian strata consist of both the coal seams and the interburden layers. The Permian strata includes the Wittingham Coal Measures intersected at site, and the overlying Newcastle Coal Measures. The coal measures are also weathered at surface.

Groundwater flow in the coal measures is influenced by the local geomorphology and structural geology, with unconfined conditions where the coal measures occur at outcrop, becoming confined as they dip towards the south-west. Pre-mining regional groundwater flow is generally towards the north-east. The regolith is variably saturated and shows unsaturated groundwater conditions. Previous and ongoing open cut and underground mining within the Wambo area and adjoining mining operations has resulted in a regional zone of depressurisation within the Permian coal measures (HydroSimulations, 2020).

The permeability of the fresh Permian coal measures is generally low and decreases with depth. This is due to tightening of joints between rock units as depth increases. The coal seams generally have higher permeability than the interburden layers. Overall, the Permian groundwater sources are low yielding and brackish to saline. The weathered coal measures (regolith) show variable permeability dependent on the insitu material (i.e. siltstone, sandstone, conglomerate). Water quality within the regolith is variable dependent on recharge sources, including rainfall recharge and upward seepage from underlying fresh Permian coal measures.

3.2 Groundwater Receptors

3.2.1 NSW Bore Database Search

Registered bores within a 4 km radius of Wambo and the United Wambo Open Cut based on a search of the NSW Bore Database (in 2020) and bore census findings reported by HydroSimulations (2014) and AGE (2016).

The search identified 122 bores, 23 of which are noted as abandoned and destroyed. T majority of the existing bores (41) are registered as monitoring/test bores and located within WCPL tenement boundaries (namely ML 1402, CL 743 and ML 1594). There were 15 bores identified as mining/dewatering/exploration bores and 16 bores were of unknown use. The remainder are registered for irrigation, domestic and/or stock use (27).

Bore details (including bore use and current status) are outlined in **Table 6** for all registered bores, excluding monitoring bores and bores that have been abandoned and destroyed. The approximate bore locations are shown in **Figure 4.**

Table 6: Results of NSW Bore Database Search (at 2020)

Figure 4 Ref	Bore No.	Licence No.	Location		Ground elevation	SWL (mbgl)	EC	Yield (L/s)	Bore depth (mbGL)	Aquifer	Status	Bore Use	Comment
			mE	mN									
1	10010974	316585	6394626	-	67.89	-	-	-	-	Alluvium	Unknown/ AD	Unknown	HVO land – Lemington South
2	10011156	306219	6400469	-	66.03	-	-	-	-	Alluvium	Unknown	Unknown	Access restrictions, bore not assessed.
3	GW005327	314683	6394498	20BL009540	59.92	6.1*	Excellent	0.13*	10.4	Alluvium	EX	Stock	Located in township of Warkworth.
4	GW017462	315339	6391460	20BL008224	-	-	-	-	0	-	-	Farming	-
5	GW017644	306708	6399431	-	75.3	-	salty*	-	11.6*	Weathered Permian	EX	Irrigation	Located on Wambo owned land
6	GW017646	306937	6399774	-	72.7	-	3,001-7,000*	-	11*	Alluvium	Unknown	Unknown	Located on Wambo owned land
7	GW017647	307326	6399905	-	72	-	7,001-10,000*	-	9.1*	Weathered Permian	EX	Unknown	Located on Wambo owned land
8	GW017648	307397	6400276	-	70.3	-	3,001-7,000*	25.26*	12.8*	Alluvium	Unknown	Irrigation	Located on Wambo owned land
9	GW017798	307290	6399042	-	86.6	-	1,001-3,000*	-	12.2*	Weathered Permian	EX	Unknown	Located on Wambo owned land
10	GW017799	306598	6398412	-	108.7	-	Salty*	-	12.2*	Weathered Permian	EX	Unknown	Located on Wambo owned land
11	GW017800	304413	6398000	-	133.2	-	-	-	27.4*	Triassic Narrabeen	Unknown	Unknown	Access restrictions, bore not assessed.
12	GW017801	304320	6397443	-	149	-	-	-	42.7*	Triassic Narrabeen	EX	Stock	Access restrictions, bore not assessed.
13	GW018045	302941	6398556	-	0	-	-	-	27.4*	Coal (Newcastle Coal Measures)	EX	Unknown	Access restrictions, bore not assessed.
14	GW018046	303013	6398866	-	0	-	-	-	18.3*	Coal (Newcastle Coal Measures)	Unknown	Unknown	Access restrictions, bore not assessed.
15	GW018047	302620	6398920	-	145.31	-	-	-	36.3	Newcastle CM	PRP	Unknown	-
16	GW022685	309088	6401184	-	75	10.67	1022	Continuous use	14.6	Alluvium	EX	Stock	Concrete well with pump infrastructure in place. Continuously used for stock and

Figure 4 Ref	Bore No.	Licence No.	Location		Ground elevation	SWL (mbgl)	EC	Yield (L/s)	Bore depth (mbGL)	Aquifer	Status	Bore Use	Comment
			mE	mN									
													domestic supply. Water quality sample taken.
17	GW027120	309501	6401185	-	77	10.75	822	25.26*	13.4	Alluvium	AU	Irrigation	Concrete well at surface with metal lid. Currently disused.
18	GW030731	316680	6397640	-	63	13.33	2460	No Pump	17.02	Alluvium	AU	-	Steel bore with marker post, disused. Water quality sample taken.
19	GW037184	309685	6393911	-	0	-	-	-	21*	Sandstone (overburden)	-	Exploration	Located on Wambo owned land
20	GW037734	309553	6401502	-	83	11.36	1022	15.16*	13.4	Alluvium	AU	Irrigation	Concrete well structure in paddock. No pump infrastructure present, appears disused.
21	GW037998	311589	6392530	-	62.38	-	-	-	10.9*	Alluvium	-	Irrigation	Located on Wambo owned land
22	GW037999	311482	6392713	-	64.01	-	-	-	13.7*	Shale	-	Irrigation	Located on Wambo owned land
23	GW038000	311457	6392620	-	63.59	-	-	-	9.4*	Shale	-	Irrigation	Located on Wambo owned land
24	GW038579	309738	6393882	-	0	-	-	-	20.9*	Weathered Permian	-	Exploration	Located on Wambo owned land
25	GW042364	316824	6397645	-	63	12.77	1077	-	13.3	Alluvium	AU	Unknown	Steel bore with marker post, was used for irrigation but hasn't been used for some time.
26	GW043225	303653	6398949	-	116	12.1	-	-	22.5*	Sandstone	EX	Irrigation	Private bore, 150 mm diameter PVC bore, equipped with Kenrahn LCS2DE pump. Pump currently not working, but normally used regularly for stock, and used to fill dams in dry weather.
27	GW043673	311486	6392467	-	63.11	-	-	-	9.4*	Shale	-	Exploration	Located on Wambo owned land
28	GW043674	311303	6392525	-	64.6	-	-	-	8.2*	Alluvium	-	Exploration	Located on Wambo owned land
29	GW043675	311433	6392527	-	63.73	-	-	-	8.5*	Alluvium	-	Exploration	Located on Wambo owned land
30	GW043676	311480	6392805	-	64.24	-	-	-	10.6*	Shale	-	Exploration	Located on Wambo owned land
31	GW053123	309631	6402062	-	78	12.55	993	-	13.1	Alluvium	AU	Irrigation	Concrete well structure, disused.
32	GW053173	309101	640317	-	76	13.38	967	10.1*	14.8	Alluvium	AU	Irrigation and stock	Concrete well with old pump infrastructure present, but appears disused.

Figure 4 Ref	Bore No.	Licence No.	Location		Ground elevation	SWL (mbgl)	EC	Yield (L/s)	Bore depth (mbGL)	Aquifer	Status	Bore Use	Comment
			mE	mN									
33	GW053292	317670	6398097	-	53.3	-	-	-	10*	Alluvium	EX	Irrigation	Bore not visited, located on east side of Hunter River.
34	GW060326	314104	6393348	-	-	6.7	-	-	9.8		-	Mining	-
35	GW060327	314181	6393442	-	-	6.7	0-500	-	9.8	-	-	Mining	-
36	GW060328	314205	6393534	-	-	7	-	-	10	-	-	Mining	-
37	GW060329	311904	6392474	-	-	-	-	-	6.4	-	-	Mining	-
38	GW060330	311727	6392163	-	-	3.8	0-500	-	6.2	-	-	Mining	-
39	GW060750	314310	6394923	20BL132130	59	-	-	-	24.4*	Weathered Permian	Unknown	Domestic	Bore not visited, located in township of Warkworth.
40	GW060780	305961	6399379	-	104.1	18.62	1552	No Pump	25.5	Weathered Permian	AU	Stock and domestic	Steep bore within vegetation. Uncapped and appears disused (no pump infrastructure present).
41	GW064382	303908	6394477	-	414.4	-	-	-	60*	Sandstone	-	HUSE	Access restrictions, bore not assessed.
42	GW065014	305777	6400368	-	85	-	-	-	14.5*	Weathered Permian	Unknown	Irrigation	Located on Wambo owned land
43	GW065117	311154	6390735	-	-	-	-	-	6	-	-	Irrigation	-
44	GW066606	311207	6390674	-	-	-	-	-	2.5	-	-	Domestic	-
45	GW078055	310105	6390490	-	-	-	1660	3-5 L/s	198.5		-	Test	-
46	GW078477	304007	6398988	-	109.8	11.05	3630*	-	102.5*	Sandstone	EX	Domestic	Private bore, bore in use with water license 20BL167575. 150 mm diameter PVC casing. Grundfos pump installed to 29 m depth, used approximately every 3 months and yields 3 L/s.
47	GW078574	309174	6390605	20BL167170	-	-	-	-	12	-	-	Farming	-
48	GW078575	309505	6389687	20BL167171	-	-	-	-	12	-	-	Farming	-
49	GW078576	309764	6389784	20BL167172	-	-	-	-	7	Gravel, Shale Grey Siltstone, Sandstone Conglomerate	-	Farming	-
50	GW078577	309969	6389973	20WA208559	-	-	-	-	10		-	Domestic	-
51	GW079060	314596	6394852	-	-	-	-	-	14.6		-	Unknown	-
52	GW080502	308897	6390160	20BL168017	-	105	-	-	250	Coarse Sand	-	Mining	-
53	GW080519	313622	6394161	20BL168885	57.98	7.42*	6490*	-	10.5*	Alluvium	-	Unknown	Located on Wambo owned land

Figure 4 Ref	Bore No.	Licence No.	Location		Ground elevation	SWL (mbgl)	EC	Yield (L/s)	Bore depth (mbGL)	Aquifer	Status	Bore Use	Comment
			mE	mN									
54	GW080951	314619	6394878	-	55	-	-	-	3.14*	Alluvium	Unknown	-	Bore not visited, located in township of Warkworth.
55	GW080952	314643	6394904	-	54	-	-	-	1.59*	Alluvium (sandy clay)	EX	-	Bore not visited, located in township of Warkworth.
56	GW200361	311833	6392209	20BL170638	60.97	3.12	-	-	-	Alluvium	-	Test	Located on Wambo owned land
57	GW200624	310166	6392650	20BL168939	-	6	-	-	260		-	Dewatering	-
58	GW200625	310901	6393375	20BL168940	-	-	-	-	270		-	Mining	-
59	GW200942	312325	6395750	20BL167947	-	32	-	-	37		-	Test	-
60	GW200943	312332	6395760	20BL167947	-	27	-	-	30		-	Test	-
61	GW203459	311820	6392560	-	0	-	-	-	55	Jerrys Plains SG	EX	Dewatering	-
62	Unregistered bore (near GW029155)	305430	6401656	-	76	8.2	-	-	9.8	Alluvium	EX	Stock	Private bore, well at least 50 years old, 1 m concrete well, casing 0.6 m above surface. Windmill in place and pumps at rate of 2.4 L/minute. Used for stock water supply year round.

Note: Coordinates are in MGA94, Zone 56
EX – existing bore
* - value derived from Pineena
AU – abandoned but in usable condition
AD – abandoned and destroyed

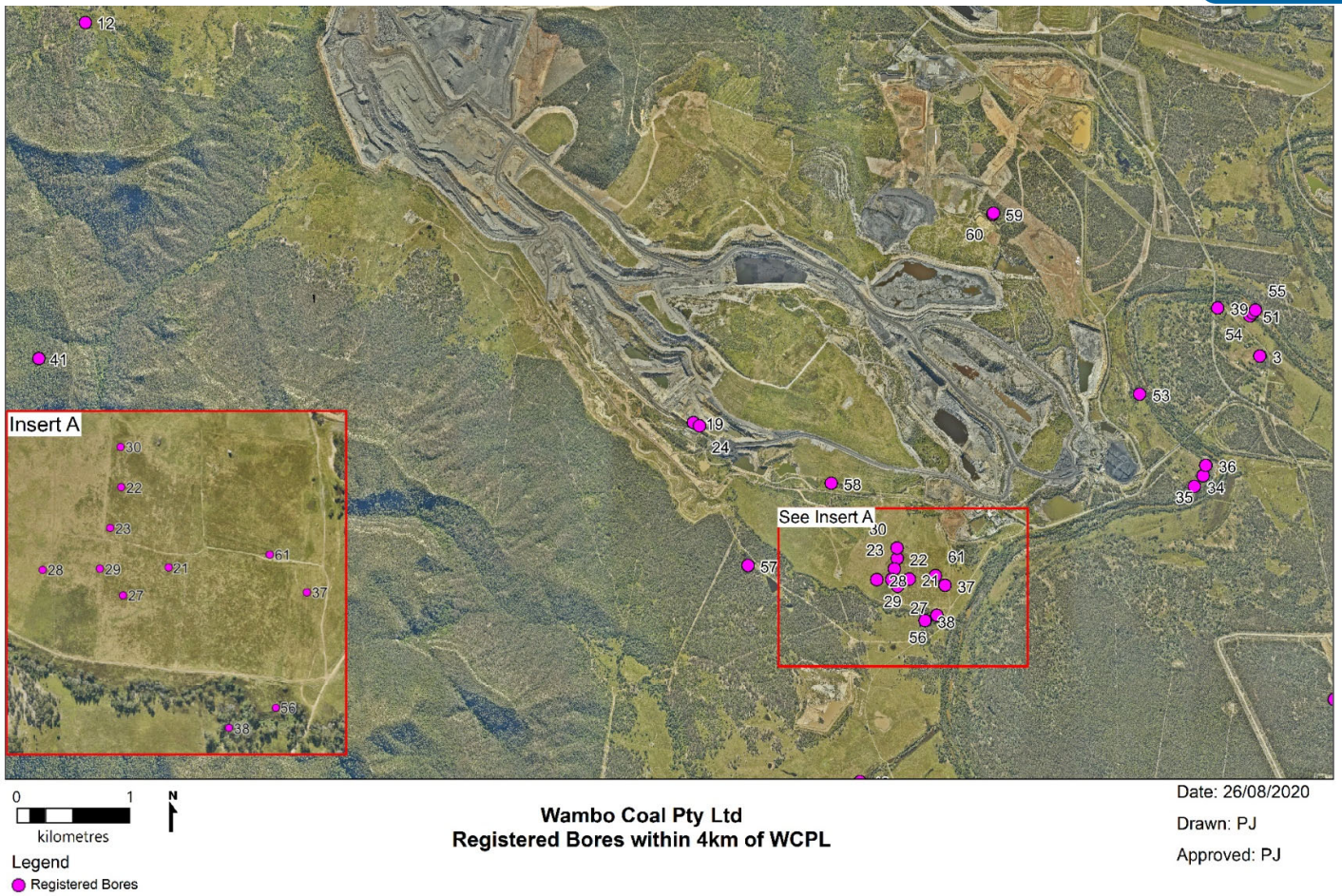

Figure 4: NSW Bore Database Search Results (at 2020)

3.2.2 Predicted Impacts on Groundwater Users

HydroSimulations (2016a) and previous groundwater assessments for Wambo predict that some privately-owned bores may experience more than 2 m cumulative drawdown as a result of the already approved operations at Wambo. These drawdowns are due to the cumulative effects of all mining in the Wambo district. In addition, it was predicted that there would be no additional privately-owned registered groundwater users affected as a result of Modification 12 or Modification 17.

Limited information is available on three privately owned bores in the vicinity of Wambo (**Figure 4**). Depending on the extraction depth and nature of bores, these bores may experience more than 2 m cumulative drawdown as a result of the approved Wambo operations.

3.2.3 Groundwater Dependent Ecosystems

The potential vegetation GDEs within the vicinity of Wambo have been mapped by BoM in the Groundwater Dependant Ecosystem Atlas. They include ecosystems that rely on the surface presence of groundwater and ecosystems that rely on the subsurface presence of groundwater.

Ecosystems that potentially rely on the presence of groundwater include various vegetation types, namely:

- Grey Box-Red Gum-Grey Ironbark.
- White Box-Ironbark-Red Gum.
- Hunter Roughbarked Apple-Red Gum.
- Roughbarked Apple-Forest Oak.
- Grey Gum - Grey Myrtle.
- Yellow Bloodwood-Stringybark.
- Yellow Bloodwood-Narrowleaved Apple.
- Blackbutt-Sydney Peppermint-Smoothbarked Apple.
- Grey Gum-Scribbly Gum.
- Grey Gum-Stringybark-Apple.
- Turpentine-Oak-Myrtle.

The Wollombi Brook and the Hunter River were also identified in the search of the Groundwater Dependant Ecosystem Atlas as being habitats for GDEs. It is considered that all or parts of the listed communities are potentially GDEs. The mapped locations of potential GDEs generally correspond with the surrounding watercourses, the neighbouring national park or the Remnant Woodlands Enhancement Program (RWEP) areas.

3.2.3.1 GDE Study for the South Bates Extension Area

Further investigations into the likely level of groundwater dependence were undertaken in 2019 by Hunter Eco Pty Ltd for the *South Bates Extension Underground - Groundwater Dependent Ecosystems Vegetative Assessment (Hunter Eco, 2019)*.

Two likely Groundwater Dependent Ecosystem communities were identified, being *Melaleuca decora* low forest and River Oak riparian grassy tall woodland. The River Oak community is restricted to the alignment of the North Wambo Creek channel, and rather than be dependent

on a permanent aquifer water source, River Oak are a facultative user of groundwater able to sustain themselves through lengthy dry periods. *Melaleuca decora* low forest appears to not have been impacted upon by earlier underground mining.

Key conclusions of the assessment were as follows:

- The riparian vegetation along North Wambo Creek does not meet the definition of a threatened ecological community under the *Biodiversity Conservation Act 2016*;
- The quality of the riparian community was moderate to poor primarily as a consequence of historic clearing and ongoing grazing;
- At the time of the study the alluvium in the vicinity of the North Wambo Creek riparian vegetation was unsaturated, but further monitoring identified periods of saturation following peak rainfall events (i.e. February-June 2020);
- South Bates Extension is unlikely to reduce the long-term ability for the River Oak vegetation community to temporarily access groundwater; and
- There is unlikely to be a long-term detrimental effect on the River Oak along North Wambo Creek.

A copy of the GDE Study was provided to DPIE on 11 April 2019 and was approved by DPIE on 5 February 2020 (refer to **Appendix A**). Monitoring of the GDE commenced in 2019 as a component of the Annual Flora and Fauna Monitoring Program (refer Wambo ***Biodiversity Management Plan (BMP)***). Groundwater monitoring bore GW36a and GW36b was installed in close proximity to the River Oak GDE in June 2020, monitoring groundwater level in the North Wambo Creek alluvium and underlying weathered Permian strata.

3.3 Groundwater Monitoring Network

Groundwater monitoring data has been collected at Wambo since 1994. The groundwater monitoring network currently consists primarily of standpipe monitoring bores installed in the alluvial groundwater sources and the Permian groundwater sources. The bores are generally monitored bi-monthly for groundwater levels and quality (pH and electrical conductivity [EC]), although there are some bores in key locations that contain a water level logger to continuously monitor groundwater levels.

Wambo has also been monitoring standing water levels and quality in a number of private bores since 2005.as well as a number of bores that are part of the United Colliery monitoring network.

At present there are 21 sites in the Wambo only groundwater monitoring network, supplemented by another 34 sites combined with United Wambo Open Cut. Vibrating wire piezometers (VWPs) have been installed to monitor water levels in the Permian measures at 12 Wambo sites and two United sites. These piezometers are downloaded on a quarterly basis. Further information is provided in the ***WMProg***.

Recent additions to the groundwater monitoring network have focused on increasing data availability for groundwater systems and key receptors near to current and future areas of active Wambo mining operations. These mine areas include South Bates Extension Underground Mine, open cut mining in the West Montrose pit, the approved South Wambo Underground Mine, as well as additional monitoring near mine water storage locations.

Since December 2017, 3 separate investigative drilling programs have been undertaken in the North Wambo Creek alluvium, upstream of the North Wambo Creek Diversion, providing

baseline data and an increased understanding of the groundwater conditions within the North Wambo Creek alluvium that will be undermined by South Bates Extension Underground Mine longwalls. These studies completed 33 investigative drill holes, of which, 13 have been converted in to alluvial (11) and weathered Permian (2) monitoring bores (refer to GW23 to GW35). A paired monitoring site has also been installed at GW36 (In-stream 4), near to the River Oak vegetation community identified as a likely GDE, to target both alluvial and weathered Permian strata. Continuous groundwater level loggers have recently been installed at two (2) sites to capture changes in groundwater level within the North Wambo Creek alluvium associated with intense weather events and periods of flow in North Wambo Creek. The new holes complement the historically monitored GW16 and GW17. VWP P317 was established in January 2018 and augmented with United monitoring bore UG139 to monitor depressurisation above South Bates Extension.

In late 2017, early 2018 and early 2020, additional monitoring locations (P316, P316a,b,c and P319) were established adjacent to South Wambo Dam to supplement shallow piezometers P114 and P116 (as requested by DPIE Water). VWPs were installed at P316 and P319 within regolith, overburden and the target seams of Homestead (Whybrow Seam) and North Wambo Underground (Wambo Seam) mining operations. These VWPs enable monitoring of recovery within and above the strata targeted by mining below South Wambo Dam and Wambo Creek alluvium. P316a,b,c was installed as a nested standpipe monitoring location, targeting the same strata as the upper three (3) sensors of P316, enabling validation of the VWP outputs and ongoing collection of water quality samples.

VWPs P320, P321, P327, P328 P329, P330, P408 and UG166A have been constructed to monitor the effects of the open cut to the north-west. With P329, P330 and P408 having a standpipe monitoring bore constructed within the Hunter River alluvium adjacent to the VWPs.

VWPs P318 and P325 are included in the program to establish baseline groundwater conditions to the south prior to the commencement of South Wambo Underground. The P325 VWP is accompanied by a standpipe monitoring bore constructed within the Wollombi Brook alluvium.

Details of the groundwater bores at Wambo are summarised in **Table 7** and locations are shown in **Figure 5**.

Table 7: Groundwater Monitoring Bore Details

Lookup ID	Monitoring Program	Responsible for Monitoring	Type	Status	Easting	Northing	Ground elevation (mAHD)	Bore depth (mbGL)	Screen/ Sensor from (mbGL)	Screen to (mbGL)	Lithology
GW02	Combined	Wambo	Well	EX	309109	6389680	82.5	11.2			Upper South Wambo Creek Alluvium
GW08.2	Combined	Wambo	MB	EX	311869	6392326		3	2.0	3	North Wambo Creek Alluvium
GW09.2	Combined	Wambo	MB	EX	311743	6392326		7.4	4.5	7.4	North Wambo Creek Alluvium
GW10.2	Combined	Wambo	MB	EX	311872	6392264		3	2	3	
GW10.2a	Combined	Wambo	MB	EX	311872	6392264		25	22	25	
GW11	Combined	Wambo	Well	EX	309228	6389699	76.335	9.6			Upper South Wambo Creek Alluvium
GW13	Combined	United Wambo	MB	EX	313810	6388990	61.839	15	6.0	15.0	Regolith
GW15	Combined	Wambo	MB	EX	313164	6392807	61.895	17.4	13.8	17.4	Wollombi Bk alluvium
GW16	Combined	Wambo	MB	EX	306641	6396034	112.445	12.15	6.2	12.2	Alluvium, Regolith
GW17	Combined	Wambo	MB	EX	306895	6396048	110.685	14	11.0	14.0	Regolith
GW21	Combined	Wambo	MB	EX	308647	6393378	121.824	36	24.0	36.0	Whybrow Coal Interburden
GW22	Combined	Wambo	MB	EX	311335	6389535	88.403	54	42.0	54.0	Whybrow Coal Interburden
GW23	Combined	Wambo	MB	EX	305791	6395668	118.8	13.2	11.7	13.2	North Wambo Creek – Consolidated Bedrock
GW25	Combined	Wambo	MB	EX	305299	6395288	129.4	13.2	11.7	13.2	North Wambo Creek – Consolidated Bedrock

Lookup ID	Monitoring Program	Responsible for Monitoring	Type	Status	Easting	Northing	Ground elevation (mAHD)	Bore depth (mbGL)	Screen/ Sensor from (mbGL)	Screen to (mbGL)	Lithology
P1	Combined	United Wambo	MB	EX	312199	6395840	86.0	37	31.0	37.0	Interburden - Blakefield - unnamed C
P2	Combined	United Wambo	MB	EX	312403	6395552	85		24	30	Interburden - Blakefield Seam
P106 (repair/ replace)	Combined	Wambo	MB	Blocked	311518	6391084	61.07	11	5.0	11.0	Alluvium
P109 (replacement)	Combined	Wambo	MB	Proposed	311215	6390768	62.44				Alluvium
P109 (replacement)	Combined	Wambo	MB	Proposed	311215	6390768	62.44				Permian
P11	Combined	United Wambo	MB	EX	312728	6395462	71.8	31	19.0	28.0	Interburden Blakefield - unnamed D
P316(a,b,c)	Combined	Wambo	MB	EX	311255	6391087		7	4.0	7.0	North Wambo Creek alluvium
								13	10.0	13.0	Weathered Permian
								26	23.0	26.0	Permian
P16	Combined	Wambo	MB	EX	313480	6394655	57.48	11.5	5.0	10.5	West Wollombi Brook Colluvium
P20	Combined	Wambo	MB	EX	313639	6394166	57.4	10.6	6.0	9.2	West Wollombi Brook Colluvium
P28	Combined	United Wambo	MB	EX	311396	6392632	63.1	-	-	-	Whybrow Coal Overburden
P29	Combined	United Wambo	MB	EX	311820	6392560	60.8	-	-	-	Whybrow Coal Overburden
P202	Combined	Wambo	MB	EX	311854	6391262	60.265	20	14.0	20.0	Overburden Whybrow
P301	Combined	Wambo	MB	EX	309360	6391466	88.18	20.4		20.4	Alluvium, shallow overburden
P315	Combined	Wambo	MB	EX	309084	6391856	94.74	9.5		9.5	Stoney Creek Alluvium/Regolith

Lookup ID	Monitoring Program	Responsible for Monitoring	Type	Status	Easting	Northing	Ground elevation (mAHD)	Bore depth (mbGL)	Screen/ Sensor from (mbGL)	Screen to (mbGL)	Lithology
P317	Combined	Wambo	VWP	Unknown	307115	6394439	155.41	248.5	35		Regolith
									100		Overburden
									174		Whybrow Seam
									213		Wambo Rider Seam
									248.5		Wambo Seam
P318	Combined	Wambo	VWP	Unknown	312599	6388922	71.05	357	11		Regolith
									150.79		Whybrow Seam
									205.25		Wambo Seam
									314.25		Woodlands HIll
									357		Arrowfield Seam
P319	Combined	Wambo	VWP	Unknown	311125	6391412	64.4	265.3	11		Regolith
									74.9		Whybrow Seam
									161.3		Wambo Seam
									265.3		Interburden Sandstone
P320	Combined	Wambo	VWP	Unknown	307573	6398890	85.86	344	92		Warkwort
									191		Vaux
									217.5		Baywater
									263		Pike Gully
									305		Lower Arties
									344		Middle Barrett
P321	Combined	Wambo	VWP	Unknown	307573	6398890	110.39	187.8	31.8		Arrowfield
									72.1		Warkworth
									161.15		Vaux
									187.82		Bayswater
UG139	Combined	United Wambo	VWP	EX	306665.45	6395172.7	128.9	402.0	263.0		Unnamed D
									281.0		Unnamed E
									319.0		interburden Glen Munro - Unnamed E
									329.0		Glen Munro

Lookup ID	Monitoring Program	Responsible for Monitoring	Type	Status	Easting	Northing	Ground elevation (mAHD)	Bore depth (mbGL)	Screen/ Sensor from (mbGL)	Screen to (mbGL)	Lithology
									375.0		interburden Arrowfield - Glen Munro
									382.0		Arrowfield
									402.0		interburden Warkworth - Bowfield
UG166A	Combined	United Wambo	VWP	EX	306488.43	6398076	141.5	260.0	130.0		Unnamed D
									153.0		Unnamed E
									183.0		Blakefield
									200.0		Glen Munro
									238.0		Arrowfield
									254.0		Bowfield
									260.0		Bowfield
BH1	Wambo Only	Wambo	MB	EX	313265	6394804	59.09	9.3	2.1	8.1	Tertiary Alluvium
BH1G	Wambo Only	Wambo	Dewatering	EX	310104	6391551		-			Whybrow Seam
BH2	Wambo Only	Wambo	Dewatering	EX	308867	6390147		-			Whybrow Seam
BH2A	Wambo Only	Wambo	Dewatering	EX	308868	6390096		-			Whybrow Seam
BH3	Wambo Only	Wambo	MB	EX	313399	6394644	54.39	65.4 -	55.4	61.4	Woodlands Hill Seam
BH4C	Wambo Only	Wambo	Dewatering	EX	309323	6391080		-			Whybrow Seam
BH4D	Wambo Only	Wambo	Dewatering	EX	??	??		-			Whybrow Seam, Wambo Seam
GW27	Wambo Only	Wambo	MB	EX	305736	6395614	117.4	2.6	1.1	2.6	North Wambo Creek - Alluvium
GW28	Wambo Only	Wambo	MB	EX	306008	6395769	115.0	5.9	2.9	5.9	North Wambo Creek - Alluvium

Lookup ID	Monitoring Program	Responsible for Monitoring	Type	Status	Easting	Northing	Ground elevation (mAHD)	Bore depth (mbGL)	Screen/ Sensor from (mbGL)	Screen to (mbGL)	Lithology
GW30	Wambo Only	Wambo	MB	EX	305867	6395617	121.8	7.1	4.1	7.1	North Wambo Creek - Alluvium
GW31	Wambo Only	Wambo	MB	EX	306073.82	6395772.1	114.968	8.5	5.5	8.5	North Wambo Creek - Alluvium
GW32	Wambo Only	Wambo	MB	EX	305863.81	6395583.2	122.12	10.0	7.0	10.0	North Wambo Creek - Alluvium
GW33	Wambo Only	Wambo	MB	EX	306393	6395828	115.05	7.0	4.0	7.0	North Wambo Creek - Alluvium
GW34	Wambo Only	Wambo	MB	EX	306592	6395946	110	7.0	4.0	7.0	North Wambo Creek - Alluvium
GW35	Wambo Only	Wambo	MB	EX	307356	6395779	104.23	4.0	2.5	4.0	North Wambo Creek - Alluvium
GW36 (Site 20)	Wambo Only	Wambo	MB	EX	306988	6396012	107.28	9	6	9	North Wambo Creek - Alluvium
N2	Wambo Only	Wambo	VWP	EX	308663	6393376	122.53	204	40		Permian Overburden
									70		Permian Overburden
									100		Permian Overburden
									140		Whybrow Seam
									172.5		Interburden
									204		Wambo Seam
N3	Wambo Only	Wambo	VWP	EX	308314	6394575	104.97	-190	30		Permian Overburden
									55		Permian Overburden
									75		Permian Overburden
									108.5		Whybrow Seam
									142		Interburden
									190		Wambo Seam

Lookup ID	Monitoring Program	Responsible for Monitoring	Type	Status	Easting	Northing	Ground elevation (mAHD)	Bore depth (mbGL)	Screen/ Sensor from (mbGL)	Screen to (mbGL)	Lithology
N5	Wambo Only	Wambo	VWP	EX	306755	6395963	110.78	133	30		Permian Overburden
									73		Whybrow Seam
									89.5		Interburden
									133		Wambo Seam
P316	Wambo Only	Wambo	VWP	EX	311252	6391128	60.39	71	10		Alluvium
									25		Regolith
									50.63		Regolith Overburden
									71		Whybrow Seam
P322	Wambo Only	Wambo	VWP	EX	312572	6395026	110.13	128	65		Regolith
									65		Whynot Seam
									128		Interburden (between Whynot & Woodlands Hill)
P323	Wambo Only	Wambo	VWP	EX	309797	6393428	76.65	85.5	23		Overburden siltstone
									33		Whybrow Seam
									85.5		Wambo Seam
P323	Wambo Only	Wambo	VWP	EX	309799	6393431	76.64	273.5	224.5		Woodlands Hill Seam,
									273.5		Arrowfield Seam
P324	Wambo Only	Wambo	VWP	EX	310471	6391983	74.44	304.5	11.5		Regolith
									95.75		–Whybrow Seam
									157		Wambo Seam
									269.75		Woodlands Hill Seam
									304.5		Interburden
P325	Wambo Only	Wambo	VWP	EX	311806	6390306	65.2	336.5	10.5		Regolith
									32.5		Permian Overburden
									82		Whybrow Seam
									159.5		Wambo Seam

Lookup ID	Monitoring Program	Responsible for Monitoring	Type	Status	Easting	Northing	Ground elevation (mAHD)	Bore depth (mbGL)	Screen/ Sensor from (mbGL)	Screen to (mbGL)	Lithology
									203		Whynot Seam
									251.5		Woodlands Hill Seam
									336.5		Arrowfield Seam
P325a	Wambo Only	Wambo	MB	EX	312062	6390137	65.2	8	5.0	8.0	Wambo Creek Alluvium
P326	Wambo Only	Wambo	VWP	EX	310087	6392874	75.48	332.5	43		Overburden–
									113.5		Wambo Seam
									234		Woodlands Hill Seam
									294.5		Arrowfield Seam
P327	Wambo Only	Wambo	VWP	EX	302941	6399995	141.25	332.5	65.25		Overburden
									228.25		Whybrow Seam
									301.05		Wambo Seam
									332.45		Whynot Seam
P328	Wambo Only	Wambo	VWP	EX	303160.33	6398869.64	131.89	338	43		Overburden
									275		Whybrow Seam
									350		Wambo Seam
									388		Whynot Seam
P329	Wambo Only	Wambo	VWP	EX	307454	6400351	72.42	150.5	67.6		Vaux Seam 1
									87.4		Vaux Seam 2/3
									117.5		Bayswater Seam
									150.5		Pikes Gully Seam
P329a	Wambo Only	Wambo	MB	EX	307456	6400352	72.42	16	10.0	16.0	Hunter River Alluvium
P330	Wambo Only	Wambo	VWP		306533	6400050	73.62	201.5	67		Vaux Seam 1
									137.25		Bayswater Seam
									201.5		Pike Gully Seam
P330a	Wambo Only	Wambo	MB	EX	306533	6400052	73.63	13	10.0	13.0	Hunter River Alluvium
Wambo-03	Wambo Only	Wambo	Dewatering	EX	311699	6392752		-			Wambo Seam

Lookup ID	Monitoring Program	Responsible for Monitoring	Type	Status	Easting	Northing	Ground elevation (mAHD)	Bore depth (mbGL)	Screen/ Sensor from (mbGL)	Screen to (mbGL)	Lithology
Wambore South	Wambo Only	Wambo	Dewatering	EX	311812	6392555		-			Wambo Seam

Note: Coordinates in MGA94Z56
EX – Existing Monitoring Bore

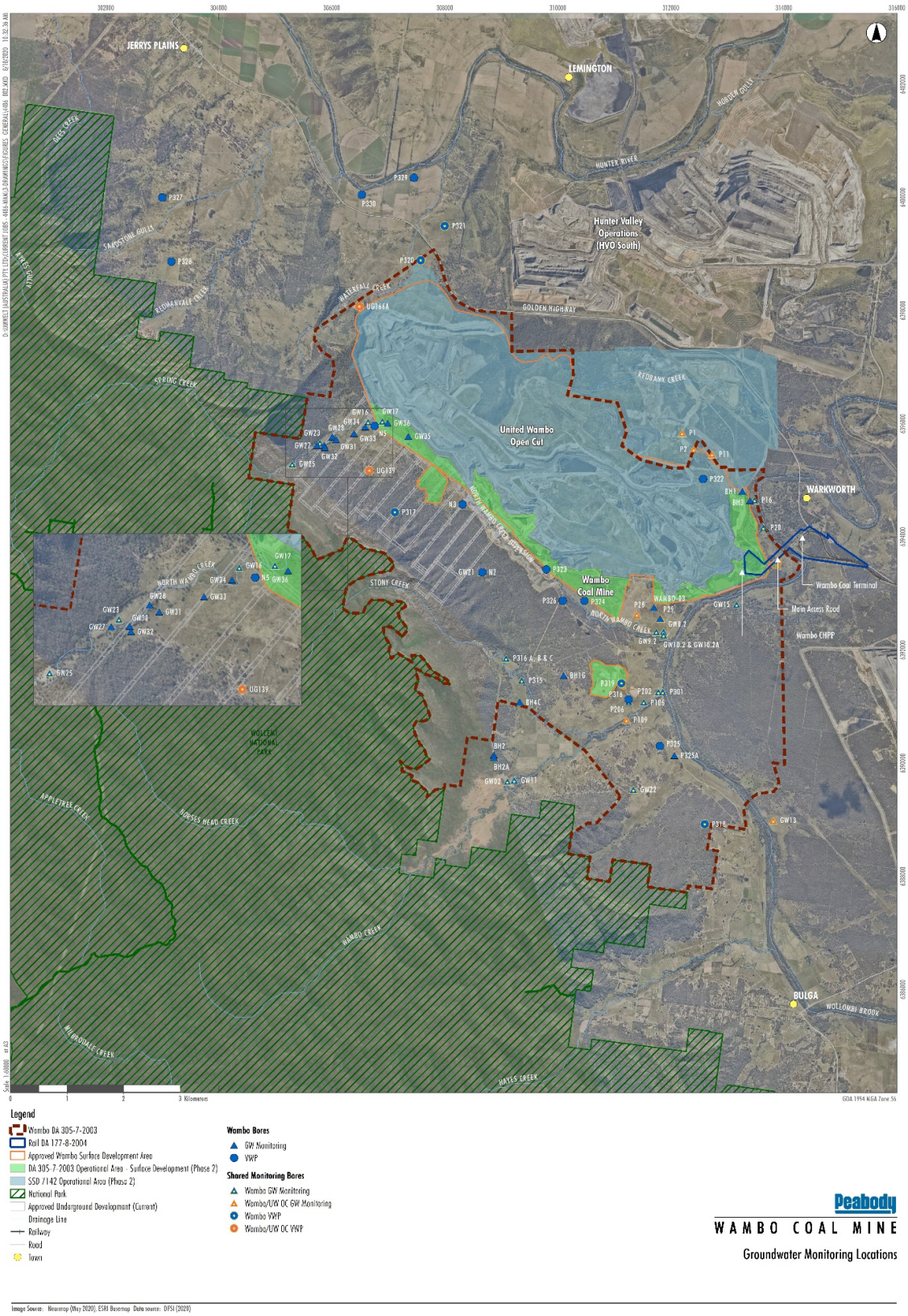

Figure 5: Wambo Groundwater Monitoring Bore Locations

3.4 Review of Baseline Data

3.4.1 Alluvial/Shallow Water Sources

Most groundwater levels at Wambo have been recorded manually. As the limit of reading of the measuring tape is about 10 mm, groundwater monitoring is unlikely to detect changes in groundwater level of less than 10 mm at a particular bore from one manual monitoring round to the next.

For the baseline period, a HARTT (Hydrograph Analysis: Rainfall and Time Trends) analysis was undertaken for each alluvial and regolith dataset and three shallow interburden bores (up to June 2014) to establish the relationship between groundwater levels and rainfall and to detect underlying trends in groundwater level that are independent of rainfall (GHD 2014). The HARTT statistical output for each alluvial hydrograph is given in **Table 8**. It should be noted that this analysis did not include review of the bore construction and geology. Recent review identified several bores intersect weathered Permian coal measures (regolith) that influences the results.

Table 8: HARTT Analysis Results for Shallow Monitoring Bores

Bore	R^2	Rainfall Coeff. *a* (m/mm)	P rain	Time Coeff. *b* (m/month)	P time	*c* (m)
ALLUVIUM/ REGOLITH						
P106	0.400	0.006	0.000	-0.005	0.365	54.751
P109	0.587	0.003	0.000	-0.002	0.446	58.690
P114	0.734	0.003	0.000	-0.004	0.005	57.173
P116	0.541	0.000	0.483	0.015	0.000	52.859
P315	0.313	0.005	0.002	-0.003	0.671	89.304
GW02	0.411	0.005	0.000	-0.012	0.000	79.447
GW08	0.643	0.000	0.273	-0.015	0.000	56.869
GW09	0.811	0.000	0.241	-0.024	0.000	64.339
GW11	0.601	0.003	0.000	0.005	0.111	75.982
GW12	0.765	0.010	0.004	-0.169	0.000	82.760
GW13	0.354	0.012	0.002	-0.113	0.010	65.201
GW15	0.360	0.002	0.006	-0.005	0.307	51.836
GW16	0.701	0.011	0.000	-0.064	0.000	108.256
GW17	0.660	0.011	0.000	-0.050	0.001	102.559
GW18	0.988	0.020	0.014	-0.581	0.006	78.010
P16	0.367	0.001	0.000	-0.008	0.000	53.445
P20	0.388	0.002	0.000	-0.017	0.000	55.512
PERMIAN						
P202	0.254	0.001	0.273	0.010	0.001	52.021
P203#	0.802	0.003	0.001	0.031	0.000	40.476
P301	0.149	0.000	0.950	-0.015	0.013	77.220

Also known as P206

The R^2 value (coefficient of determination) of the HARTT regression line gives a measure of the quality of fit of the non-linear regression line to the observed hydrograph. This value was greater than 50% for 12 of the 22 alluvial and regolith hydrographs analysed, indicating that over half of the hydrographs can be reasonably modelled by the HARTT variables (CRD and linear time trends) alone. A lower R^2 value indicates that the bore is situated at a location where the hydrograph cannot be adequately modelled by the HARTT variables and that other factors are affecting groundwater levels.

The p-value for the rainfall variable *a* is less than 0.05 for 17 of 22 bores, indicating that there is a significant relationship between groundwater level and CRD at most alluvial and regolith monitoring locations. The rainfall coefficient suggests that alluvial groundwater levels generally respond by 1 – 10 mm per mm of CRD (or atypical rainfall).

The p-value for the time variable *b* is less than 0.05 for the datasets of 17 of the 22 alluvial and regolith bores at Wambo, indicating statistically significant linear time trends (independent of rainfall) in groundwater levels at these locations. Where the p-value is greater than 0.05, time trends are statistically insignificant, and the time coefficient *b* cannot be relied upon to describe historical trends or predict future groundwater levels.

Of the 17 bores displaying statistically significant time trends, only three indicated an increasing trend. As shown in **Figure 5** these three bores (P116, P202 and P203) are all located near the confluence of Wambo Creek and Wollombi Brook. Bores P202 and P203 are screened within the Whybrow Seam interburden. It is considered that recovering water levels within the underlying previously mined Homestead workings and/or seepage from the South Wambo Dam may be attributable to these increasing trends.

At the time of the GHD (2014) analysis, the decreasing trends in groundwater levels at a number of the alluvial bores were considered possibly attributable to mining related activities. Subsequent analysis of contemporary data undertaken as part of Annual Reviews (HydroSimulations, 2019a; SLR, 2020b) found that mining activities were affecting shallow groundwater levels at monitoring locations such as GW16, GW17, GW08, GW09 and P114, but that other declines are likely attributable to a period of average and below average rainfall conditions from late 2012 to 2014.

The decreasing trends in groundwater levels within North Wambo Creek alluvium and underlying regolith at bores GW16 and GW17 were considered most likely attributable to the open cut operations at Wambo, while decreasing trends in lower North Wambo Creek alluvium and regolith at GW08 and GW09 were considered attributable to upstream impacts as well as underlying secondary extraction within the United Colliery mine and dewatering operations in the Whybrow Seam above the North Wambo Underground Mine.

Minor decreasing downward trends in groundwater at bores P16, P20 and GW13 within colluvium and regolith were considered less likely to be attributable to mining operations. The HARTT regression for these bores has a lower R^2 value which suggests that other recharge or discharge mechanisms may be affecting these locations.

Dewatering of the old Homestead Underground Mine via dewatering bores 2 and 2A may have been responsible for the slight decreasing trend in groundwater levels within Wambo Creek alluvium at GW02. It was noted, however, that there was no statistically significant trend at adjacent bore GW11.

Time series plots of groundwater pH and EC reported at alluvial monitoring bores at Wambo were presented in GHD (2014). Based on a visual assessment of the time series plots, EC appeared to be following a falling trend at most monitoring locations from 2007 to 2014. This may be attributable to increased rainfall from 2007.

Between February 2011 and June 2014 at monitoring bore P114, EC increased from below 1,000 microSiemens per centimetre (µS/cm) to almost 7,000 µS/cm. The bore is constructed within shallow alluvium and fine-grained sandstone and is located to the east of South Wambo Dam water storage which receives mine water from the open cut and underground mining operations. As the average EC in the dam was 7,350 µS/cm between July 2011 and October 2013 (Worley Parsons 2014), it was posited that the increase in EC at P114 might be due to

seepage from this water storage. Further review determined that seepage to the alluvium was unlikely based on available data (refer to **Section 6.4.2**). The variation in EC over the same time period at neighbouring bore P116 indicated a much smaller increase in EC that is within the range reported prior to construction of the dam, while EC at alluvial bore P106 and Whybrow Seam interburden bore P206 had been steady over the same time period.

At Whybrow Seam overburden bore P202, groundwater EC increased from 3,490 µS/cm in October 2011 to 6,610 µS/cm in June 2014. However, similar increases in EC are observed in 1999/ 2000 and 2007/08 prior to the construction and storage of mine water in South Wambo Dam.

Monitoring bores P114 and P116 have been removed from the monitoring network as they are constructed across both alluvial and Permian strata, inconsistent with the *Minimum Construction Requirements for Water Bores in Australia (NUDLC 2012)*. P114 and P116 have been replaced by the nested standpipe monitoring location P316, which has an alluvial, weathered rock and overburden standpipe and is located between South Wambo Dam and Wambo Creek.

3.4.2 Permian Groundwater Sources

According to Ferdowsian *et al.* (2001), the HARTT method is generally limited to the analysis of relatively shallow groundwater from unconfined aquifers, and so does not provide information for deeper lithologies. For Permian hydrographs, qualitative comparison of groundwater hydrographs with the CRD curve is sufficient to allow inference of dependence on weather or the effects of mining.

3.4.3 Groundwater Attribute Statistics

A statistical summary of baseline (to April 2015) groundwater levels and quality is shown in **Table 9**, including the maximum, minimum, median and 10th and 90th percentiles. This table includes the bores screened within both alluvium and underlying Permian interburden.

EC has a wide range at alluvial sites, from about 300 to about 12,000 µS/cm with an overall median of about 700 µS/cm. By contrast, the median at Permian sites is about 5,000 µS/cm (excluding outlier GW12). Since 2007, EC at Permian sites has been very stable with little variation.

pH is consistently between 6 and 8 at the majority of alluvial monitoring locations, with an overall median of 7.1. At Permian sites, pH is reasonably constant with minimum and maximum recorded values ranging between 5.8 and 8.6 at all locations with an overall median of 7.3.

The overall median depths to groundwater are about 7 m at alluvial sites and about 13 m at Permian sites. The range of variation (from 10th to 90th percentiles) varies from 0.6 to 4.7 m at alluvial sites, and from 1.8 to 5.5 m at Permian sites.

Table 9: Bore Groundwater Level and Quantity (baseline data to April 2015)

Bore	pH					Conductivity (µS/cm)					Depth to Groundwater (mBTOC[1])				
	Min	Max	Median	10th	90th	Min	Max	Median	10th	90th	Min	Max	Median	10th	90th
ALLUVIUM/															
P106	6.2	8.6	6.9	6.7	7.9	391	1072	593	454	941	4.7	15.1	9.3	6.6	10.7
GW02	6.3	8.4	7.0	6.7	7.4	439	908	588	481	715	4.7	9.5	6.8	5.8	8.5
GW11	6.6	8.2	7.1	6.8	7.5	372	691	529	433	592	3.7	7.6	4.8	4.0	6.5
GW15	6.3	7.5	6.9	6.7	7.2	521	879	627	599	730	10.0	11.4	10.9	10.4	11.1
ALLUVIUM and REGOLITH/REGOLITH/ COLLUVIUM															
P109	6.2	8.7	6.8	6.5	7.6	431	1164	616	525	694	4.3	9.0	6.1	4.6	6.7
P114	6.3	8.7	7.1	6.5	7.8	509	7180	611	550	6141	5.2	8.1	6.7	5.4	7.6
P116	6.1	8.0	7.1	6.6	7.5	454	6570	1710	673	5972	4.2	8.3	6.3	4.8	7.3
P315	3.7	7.7	6.4	6.0	7.4	257	758	405	298	552	3.8	9.4	7.6	4.4	9.1
GW08	5.7	8.4	7.1	6.8	7.7	1371	2248	1864	1749	1972	2.8	5.9	3.4	3.0	5.1
GW09	6.5	8.8	7.7	7.2	8.4	287	1937	1140	420	1800	2.5	7.1	3.7	3.0	6.3
GW13	6.8	7.3	7.0	6.9	7.1	575	4820	3630	3240	4370	4.8	12.9	5.1	4.8	5.4
GW16	7.1	8.1	7.5	7.3	7.8	294	889	666	454	823	4.3	9.7	7.2	4.9	8.9
GW17	6.9	7.6	7.1	7.0	7.3	4610	5480	5160	4812	5304	6.9	11.8	10.9	8.3	11.5
P16	5.1	8.1	7.4	7.0	7.7	6700	12100	9545	7697	10832	6.3	8.2	7.4	7.1	7.8
P20	5.5	8.1	7.3	7.0	7.6	6500	12390	9515	8504	10625	5.4	8.1	7.8	7.1	8.2
PERMIAN															
P202	6.4	7.9	7.3	6.7	7.7	2650	10520	4687	3552	8172	3.3	8.7	8.8	7.8	9.6
P206	6.8	8.6	7.6	7.3	8.1	213	2672	2410	2160	2630	12.9	22.8	18.8	16.1	21.6
P301	5.8	7.6	6.6	6.1	7.2	461	9270	6430	2420	9199	7.2	19.9	13.2	11.1	15.5
GW12	6.6	6.9	6.8	6.6	6.8	19400	22300	21350	19670	22210	9.8	12.9	10.8	9.9	12.9

1. mBTOC = metres below top of casing

3.5 Site Water Balance

A Site Water Balance was developed as part of the United *Wambo Open Cut Coal Mine Project Environmental Assessment* (Umwelt, 2016). Further detail on the Site Water Balance is included in the *United Wambo Open Cut Coal Mine Project Surface Water Assessment* (Umwelt, 2016a) and the ***United Wambo Site Water Balance.***

Inflows to the water balance included groundwater flows from the open cuts and underground. The average groundwater flow was predicted to be 256 ML/year from the open cuts and 505 ML/year from the underground.

The Site Water Balance will be recalculated on an annual basis and reported in the Annual Review (**Section 9.2.1**).

3.5.1 Intercepted Alluvial Groundwater

Since December 2017, three (3) separate investigative drilling programs have been undertaken in the North Wambo Creek alluvium, upstream of the North Wambo Creek Diversion, resulting in 33 investigative holes drilled. Thirteen of these have been converted in to alluvial (11) and weathered Permian (2) monitoring bores. Continuous groundwater level loggers have been installed at two (2) sites to capture rapid changes in groundwater level within the North Wambo Creek alluvium associated with intense weather events and periods of flow in North Wambo Creek.

In 2019, the Wambo groundwater model was updated to include greater temporal variability to better capture groundwater conditions along North Wambo Creek. This was further refined in the South Bates Extension LW21-24 Extraction Plan modelling undertaken by SLR (2020). The modelling noted that the alluvium and shallow weathered rock are less broadly saturated following the construction of the NWCD and interception of alluvial material by the Montrose Open cut. An integrated groundwater model will be completed by SLR in Q4 2020, to incorporate the Wambo Underground and United Wambo Open Cut mines.

Intercepted groundwater will continue to be accounted for in the Wambo Underground and United Wambo Open Cut annual site water balance, which is reported in the Annual Review.

3.6 Hydrogeological Model

Several groundwater models have been constructed within the Wambo area to simulate the stresses on the groundwater environment from mining activities i.e. Wambo, Mt Thorley Warkworth and Hunter Valley Operations (HVO) models. The most recent modelling prepared for WCPL is based on the HydroSimulations (2016a) model that was developed as part of the groundwater assessment for the South Bates Underground Mine Modification (MOD 12) application (HydroSimulations, 2016a) and was subsequently used for the South Bates Extension Modification (Modification 17 in July 2017) (HydroSimulations 2017).

The model extends 19 km from west to east and 16 km from south to north, covering an area of approximately 300 km^2. Sixteen model layers represent the stratigraphic section of the Wambo area, as indicated in **Table 10** (HydroSimulations, 2016a).

The model domain has been designed to be large enough to prevent boundary influence on internal model drawdown/depressurisation associated with mining at Wambo. The model extends beyond the subcrop trace of the deepest coal seam that is likely to be mined in the future. The model domain and boundaries have been selected to incorporate any potential receptors (i.e. surface water bodies) that could be adversely affected by mining.

Numerical modelling was undertaken to inform the Groundwater Assessments detailed above and to quantify the likelihood and magnitude of potential impacts. On each occasion the Groundwater Assessment was peer reviewed by Kalf and Associates (Dr Frans Kalf) who concluded that the hydrogeological description, conceptualisation, model design, simulations and reporting had been conducted in a professional manner.

More recently groundwater modelling has been undertaken to inform the Wambo GDE Study (HydroSimulations, 2019) and the South Bates Extension Extraction Plan for Longwalls 21-24 (SLR, 2020). The hydrogeological model predicts the lateral zone of impact of depressurisation of aquifers due to current and future mining activity. In addition, the hydrogeological model predicts groundwater inflows into the underground workings over the life of the mine.

Periodic re-calibration of the model will be undertaken based on observed piezometric heads and groundwater inflow data. This periodic review and recalibration of the groundwater model is being undertaken by SLR for completion in Q4 2020.

Table 10: Stratigraphy of the Wambo Area

Supergroup	Group	Subgroup	Formation	Seam
Singleton Supergroup	Narabeen Group	Widden Brook Conglomerate		
	Newcastle Coal Measures[1]	Glen Gallic Subgroup	Greigs Creek Coal Redmanvale Creek Formation Dights Creek Coal	
		Doyle's Creek Subgroup	Waterfall Gully Formation Pinegrove Formation	
		Horseshoe Creek Subgroup	Lucernia Coal Strathmore Formation Alcheringa Coal Clifford Formation	
		Apple Tree Flat Subgroup	Charlton Formation Abbey Green Coal	
		Watts Sandstone		
	Wittingham Coal Measures	Denman Formation		
		Jerry's Plains Subgroup	Mount Leonard Formation	Whybrow Seam
			Althorpe Formation	
			Malabar Formation	*Redbank Creek Seam*[2] *Wambo Seam*[2] *Whynot Seam*[2] Blakefield Seam
			Mount Ogilvie Formation	*Glen Munro Seam* *Woodlands Hill Seam*[3]
			Milbrodale Formation	
			Mount Thorley Formation	Arrowfield Seam[2] Bowfield Seam[2] Warkworth Seam[4]
			Fairford Formation	
			Burnamwood Formation	Mount Arthur Seam Piercefield Seam Vaux Seam

Supergroup	Group	Subgroup	Formation	Seam
				Broonie Seam Bayswater Seam
		Archerfield Sandstone		
		Vane Subgroup	Bulga Formation	
			Foybrook Formation	
			Saltwater Creek Formation	

Source: HydroSimulations, 2016a, after DMR, 1993.

Notes to **Table 10:**
1 Previously known as the Wollombi Coal Measures
2 Coal reserves currently approved to be mined at the Wambo Coal Mine
3 Coal reserves to be mined at Wambo Coal Mine as part of MOD12.
4 Coal reserves to be mined by the Wambo Coal Mine where the upper three piles of the Warkworth Seam combine with the two piles of the Bowfield Seam

4.0 Groundwater Triggers and Performance Criteria

Groundwater triggers for both groundwater levels and quality have been developed using statistical analysis of the baseline data (**Section 3.4**) and data acquired to April 2015, and the predicted effects presented in the EIS and subsequent EAs.

The trigger values are not assessment criteria but are used to initiate investigations into the groundwater levels or groundwater quality as reported by the monitoring program. Details of the monitoring program are included in **Section 6.0**. Reporting requirements for this GWMP are detailed in **Section 9.0**.

Triggers will be used to determine if the groundwater impact investigation procedure or Trigger Action Response Plan (TARP) in **Section 7.0** should be initiated. **Section 7.0** provides a protocol for the investigation, notification, and mitigation of identified exceedances of these assessment criteria.

4.1 Trigger Values for Groundwater Levels

4.1.1 Alluvial Monitoring Locations

Statistical analysis of groundwater levels in shallow bores has been undertaken in **Section 3.4.1**. The results of this analysis indicate that shallow groundwater levels are highly responsive to rainfall.

Trigger values have been adopted for shallow bores monitoring key environmental receptors near Wambo Coal mine, such as alluvium associated with Wollombi Brook, North Wambo Creek, Wambo Creek and Stony Creek where predicted impacts are less than 2 metres. The trigger values adopted are equivalent to the 10th and 90th percentiles of recorded depths to groundwater in the historical dataset. Groundwater level trigger values are shown in **Table 11**. In order to avoid false triggering, as a trigger would be initiated 20% of the time due to natural causes, triggers for groundwater level are defined to occur when two consecutive bi-monthly observations (over a 2-month interval) fall outside of the depth to groundwater trigger value range.

Bores P16 and P20 provide suitable indicators near the Chitter Dam. Bores P116, P202 and P203 provide suitable indicators near the South Wambo Water Dam.

Table 11 Shallow Bores Water Level Trigger Values

	Minimum (10th percentile)		Maximum (90th percentile)	
Bore	Depth to Groundwater (mBTOC[5])	Level (m AHD)	Depth to Groundwater (mBTOC[8])	Level (m AHD)
P109[1]	4.6	57.8	6.7	55.7
P202	7.8	52.5	9.6	50.7
P206	16.1	44.1	21.6	38.6
P315[3]	N/A[6]	N/A	N/A	N/A
GW08.2[3]	ND[7]	ND	ND	ND
GW09.2[3]	ND	ND	ND	ND
GW15	10.4	52.0	11.1	51.3
GW16[3]	N/A	N/A	N/A	N/A
GW17[3]	N/A	N/A	N/A	N/A
P16	7.1	50.4	7.8	49.7
P20	7.1	50.3	8.2	49.2

1. P109 to be replaced by paired site that separates alluvial and Permian groundwater sources, trigger levels to be updated following collection of baseline data (2yrs or 18 observations).

2. P315 has dry observations prior to NWU mining activity. Therefore, a specific depth to water trigger is not appropriate to indicate Wambo mining impacts. Data will be reviewed as part of the Annual Review to determine whether there are changes in the relationship between climate and groundwater level that can be attributed to Wambo mining activity.
3. GW08.2, GW09.2 and GW10.2 have been installed within unconsolidated strata near North Wambo Creek to serve as replacement bores to GW08 and GW09. Trigger levels for these bores will be established following the collection of baseline data and based on predicted drawdown from the revised groundwater model to be complete in Q4 2020.
4. GW16 and GW17 are located upstream of the North Wambo Creek Diversion and in close proximity to the approved open cut. There are no groundwater users located in the vicinity of North Wambo Creek upstream of the North Wambo Creek Diversion. Both GW16 and GW17 have also been constructed across both alluvium/ regolith and weathered Permian strata and are not representative of a single groundwater source. Therefore, a trigger level for these two bores is not considered warranted. Monitoring data will be reviewed annually at these bores.
5. mBTOC = metres below top of casing
6. N/A – trigger level not appropriate for assessing Wambo mining impact at this location.
7. ND – insufficient baseline data to develop meaningful trigger level.

Ongoing review of Wambo groundwater monitoring locations has indicated a number of bores that have been previously assessed against groundwater level triggers should be reclassified as Permian monitoring bores, or are no longer appropriate to assess Wambo mining impacts to the local groundwater system. **Table 12** provides justification for the bores no longer assessed using a water level trigger.

Table 12 Bores No Longer Assessed Against Groundwater Level Trigger

Bore	Justification
P106	Bore obstructed and no longer providing meaningful data
P114	Bore screened across both alluvial and Permian strata, inconsistent with *Minimum Construction Requirements for Water Bores in Australia (NUDLC 2012)*. Bore removed from monitoring network and replaced by P316a,b,c
P116	Bore screened across both alluvial and Permian strata, inconsistent with *Minimum Construction Requirements for Water Bores in Australia (NUDLC 2012)*. Bore removed from monitoring network and replaced by P316a,b,c
P202	Not shallow alluvial/ regolith bore – Permian bore with data analysed as in **Section 4.1.2**.
P206	Not shallow alluvial/ regolith bore – Permian bore with data analysed as in **Section 4.1.2**.
P301	Not shallow alluvial/ regolith bore – Permian bore with data analysed as in **Section 4.1.2**.
GW02	Landholder well with pumping equipment installed/ nearby, not appropriate to assess Wambo mining impacts at these locations. Replacement monitoring-only site recommended by SLR.
GW11	Landholder well with pumping equipment installed/ nearby, not appropriate to assess Wambo mining impacts at these locations. Replacement monitoring-only site recommended by SLR.
GW12	Bore constructed within shallow/ weathered Permian strata after the commencement of NWU mining. Length of baseline period not suitable for development of trigger. Bore removed from monitoring network with P315 to provide supplementary data for Stony Ck alluvium
GW13	Bore screened within weathered to fresh Permian strata containing coal seams. Bore also shows impacts associated with the approaching Warkworth Open Cut and is distant from current Wambo mining activity. Data to be analysed as in **Section 4.1.2**.

4.1.2 Permian Monitoring Locations

Given the lack of licensed water supply bores within the coal measures and generally poor water quality (EIS, 2003), no specific management measures are proposed. As Permian groundwater levels are predicted to fall below baseline levels(HydroSimulations, 2016a, SLR, 2020), groundwater trigger levels have not been established.

However, groundwater levels and quality are monitored for review of general groundwater behaviour. Hydrographs within Permian groundwater sources will be reviewed as part of the Annual Review (**Section 9.2.1**)and compared against groundwater model predictions to validate the groundwater model (**Section 5.3**).

Further investigations within these sources are triggered if:

- An adjacent landholder complains about declining groundwater levels in their bore; or

- Higher than predicted inflows are recorded; or
- The groundwater drawdown is greater than predicted.

Groundwater monitoring data from the Permian monitoring bores will be assessed and reviewed as part of the Annual Review (**Section 9.2.1**). Data will also be used to validate the groundwater model (**Section 5.3**).

4.2 Trigger Values for Groundwater Quality

There is considerable variability in groundwater pH and EC in both alluvial and Permian groundwater sources. In addition, the beneficial use category of Permian groundwater and alluvial groundwater along North Wambo Creek and Wambo Creek is limited due to naturally high salinity.

A water quality trigger for EC has been proposed based on the 90th percentile value observed in these bores (refer to statistical summary in **Table 9**). Although ANZECC and ARMCANZ (2018) recommend 80th percentile values as being suitable for trigger values, a trigger would be initiated 20% of the time due to natural causes. Therefore, a less stringent criterion is applicable so that the trigger would be a more meaningful indicator of a possible mining effect. Triggers for EC are to occur when *three* consecutive bi-monthly observations (that is, over a 6-month interval) exceed the specified trigger level (**Table 13**).

As described in **Section 3.4.1**, pH is consistently between 6 and 8 at the majority of alluvial monitoring locations. The 10th and 90th percentile values have been adopted as minimum and maximum exceedance values, where an investigation will not be triggered unless the value is exceeded on three consecutive bi-monthly monitoring events (over a 4-month interval) (**Table 13**).

Bores P16 and P20 provide suitable indicators near the Chitter Dam. Bores P116, P202 and P203 provide suitable indicators near the South Wambo Water Dam.

Table 13: Shallow Bores Water Quality Trigger Values

Bore	Conductivity (µS/cm)	pH	
	Maximum (Three Consecutive Bi-Monthly Exceedances)	Minimum (Two Consecutive Bi-Monthly Exceedances)	Maximum (Two Consecutive Bi-Monthly Exceedances)
P109	695	6.5	7.6
P202	8172	6.7	7.7
P206	2630	7.3	8.1
P301	9200	6.1	7.2
P315	552	6.0	7.4
GW02	715	6.7	7.4
GW11	592	6.8	7.5
GW15	730	6.7	7.2
GW16[2]	NA	NA	NA
GW17[2]	NA	NA	NA
P16	10832	7.0	7.7
P20	10625	7.0	7.6

1. GW16 and GW17 are located upstream of the North Wambo Creek Diversion and in close proximity to the approved open cut. There are no groundwater users located in the vicinity of North Wambo Creek upstream of the North Wambo Creek Diversion. Therefore, a trigger level for water quality in these two bores is not considered warranted. Monitoring data will be reviewed annually at these bores.

4.3 Groundwater Performance Criteria

Condition B62 of DA305-7-2003 (Modification 16) requires WCPL to comply with general water management performance measures. Performance indicators relevant to groundwater are outlined in **Table 14**.

Table 14: Groundwater Management Performance Indicators

Feature	Performance Indicator
Alluvial aquifers (including Wollombi Brook alluvium and excluding the North Wambo Creek alluvium)	The performance indicators will be considered to have been exceeded if the impacts are beyond those predicted in the documents listed in condition A2c) (of DA305-7-2003), including: – A greater than negligible change in groundwater levels; – A greater than negligible change in groundwater quality; and – A greater than negligible impact to other groundwater users
Groundwater dependent ecosystems	The performance indicators will be considered to have been exceeded if the impacts are beyond those predicted in the documents listed in condition A2c) (of DA305-7-2003), including: • Greater than negligible environmental consequences, beyond those predicted in the documents listed in condition A2c) • Channel stability is not maintained or improved

WCPL will report on progress against these performance indicators in the Annual Review (**Section 9.2**). In the event that a complaint is received relating to groundwater, it will be handled in accordance with the complaints management protocol (**Section 8.0**). Contingency plans for unpredicted groundwater impacts are discussed in the Extraction Plan and **Section 7.0.**

4.4 Performance Indicators for Extraction Plans

4.4.1 North Wambo Underground

Specific performance indicators have been developed for the subsidence impact performance measures relating groundwater in Section 3.1.3 of the Extraction Plan for North Wambo Underground Mine Longwalls 8 to 10A (NWU Extraction Plan). For further details of the monitoring conducted to inform the assessment of the extraction of Longwalls 8 to 10A against these performance indicators, refer to Section 3.8 of the NWU Extraction Plan.

The performance indicators outlined in the NWU Extraction Plan specific for groundwater, as outlined in **Table 15,** will be used to assess the performance of the Mine against the predicted impacts. North Wambo Underground operations were completed in December 2015.

Table 15: NWU Performance Indicators

Performance Indicator
The performance indicators will be considered to have been exceeded if Wambo receive complaints from groundwater users
The performance indicators will be considered to have been exceeded if monitoring data suggests significant divergences away from the modelled groundwater.
The performance indicators will be considered to have been exceeded if pumping of water from the North Wambo Underground Mine roadways requires regular pumping at rates higher than normal.
The performance indicators will be considered to have been exceeded if the groundwater levels in alluvial bores exceed the groundwater level criteria listed in **Table 11**
The performance indicators will be considered to have been exceeded if the groundwater quality in alluvial bores exceeds the groundwater quality criteria listed in **Table 13**

4.4.2 South Bates Underground & South Bates Extension Underground

Specific performance indicators have been developed for the subsidence impact performance measures relating to groundwater in Section 3.1.3 of the Extraction Plan for South Bates Underground Mine Longwalls 11 to 16 (SBU Extraction Plan), and Table 12 of the Extraction Plan for South Bates Extension Underground Mine Longwalls 17 to 20 and 21 to 24. For further details of the monitoring conducted to inform the assessment of the extraction of Longwalls 11 to 16 against these performance indicators, refer to Section 3.8 of the SBU Extraction Plan.

The performance indicators outlined in the SBU Extraction Plan specific for groundwater, as outlined in **Table 16**, will be used to assess the performance of the Mine against the predicted impacts.

Table 16: SBU Performance Indicators

Performance Indicator
Wollombi Brook
The performance indicators will be considered to have been exceeded if the groundwater levels in alluvial bores exceed the groundwater level criteria in the GWMP (**Table 11**).
The performance indicators will be considered to have been exceeded if the groundwater quality in alluvial bores exceeds the groundwater quality criteria in the GWMP (**Table 13**).
The performance indicators will be considered to have been exceeded if the impacts observed on riparian, aquatic or groundwater dependent ecosystems are beyond negligible.

5.0 Groundwater Management Measures

5.1 Groundwater Management System

WCPL's groundwater management system forms part of the United Wambo mining complex Water Management System, and mainly consists of dewatering infrastructure, water supply bores and groundwater monitoring bores (or piezometers). Further detail on the site Water Management System is included in the ***WCPL WMP***.

5.1.1 Dewatering Infrastructure

Dewatering infrastructure generally consists of water pumps and pipelines (including flow meters), which are used to convey groundwater to the surface, where it is then managed as part of the surface water management system. Management of dewatering infrastructure is undertaken in accordance with WCPL's procedures.

Key dewatering infrastructure is monitored by WCPL, with real time alarms to detect potential issues such as pump or pipeline failures. Data from monitoring of dewatering infrastructure will be used in the annual Site Water Balance calculations (**Section 5.2**) and groundwater model validation (**Section 5.3**).

5.1.2 Water Supply Bores

Water supply bores provide for the extraction of groundwater from underlying aquifers in accordance with WCPL's various water licences (**Table 4**). Water volumes extracted from these bores are monitored by WCPL and reported in the Annual Review (**Section 9.2**). Data from monitoring of water supply bores will also be used in the annual Site Water Balance calculations (**Section 5.2**) and groundwater model validation (**Section 5.3**).

5.1.3 Groundwater Monitoring Bores

Groundwater monitoring bores allow WCPL to monitor groundwater levels and quality in underlying aquifers. Further detail on WCPL's current groundwater monitoring network is included in **Section 3.3.** The groundwater monitoring program is described in **Section 6.0**

Data from the groundwater monitoring program is used in the annual Site Water Balance calculations (**Section 5.2**) and groundwater model validation (**Section 5.3**). Groundwater monitoring data is reported in the Annual Review (**Section 9.2.1**). Bi-monthly updates are also provided on WCPL's website.

Where required, new monitoring bores are constructed in accordance with standards equivalent to or exceeding the *Minimum Construction Requirements for Water Bores in Australia* (NUDLC 2012). All drill cutting, fluids and groundwater returned to the surface as part of the drilling process is contained in above-ground tanks or in-ground sumps pending recirculation or disposal. In-ground sumps are lined with an impermeable barrier where there is a potential risk of contamination from drill cuttings or fluids.

5.2 Annual Site Water Balance and Salt Balance

A Site Water Balance is completed each year as part of the Annual Review (**Section 9.2.1**). The Site Water Balance incorporates and assesses all of the data collated from the surface water and groundwater monitoring programs including inflows, outflows and storage volumes.

A Salt Balance is also prepared annually and reported in the Annual Review (**Section 9.2.1**). Water monitoring data, including EC results, will be used in the calculation of the Salt Balance.

5.3 Hydrogeological Model Validation

Periodic re-calibration of the model (refer **Section 3.6**) will be undertaken based on observed piezometric heads and groundwater inflow data. An independent review of the model will be undertaken every 3 years, in accordance with Condition B66(d)(v) of DA305-7-2003. Revision of the regional groundwater model is being undertaken in the second half of 2020 consistent with this requirement

5.4 Decommissioning of Bores

Decommissioning of monitoring bores will be undertaken in accordance with *Minimum Construction Requirements for Water Bores in Australia* (NUDLC, 2012). In most cases, this will involve:

- Removal of above ground casing and monuments.
- Injection of a cement bentonite grout from the base of the bore to the surface with a tremie pipe.

5.5 Exploration Drill Holes

In accordance with mining tenement conditions (refer **Table 5**), exploration drill holes not required for monitoring purposes are permanently sealed with cement plugs to prevent surface discharge of any groundwaters. If any drill hole meets an artesian or sub-artesian flow it is effectively sealed to prevent contamination of aquifers.

5.6 Training

Generic training on the aspects of the GWMP will be provided to all employees and contractors through the WCPL Site Induction process.

Regular workforce communication days and toolbox talks allow for discussion of the objectives and requirements of this and any other relevant Plans.

Selected site personnel whose duties directly involve the management of water at Wambo will undertake specific training with respect to site Operational Procedures which incorporate water management measures.

5.7 Auditing

Audits (both internal and external) will be undertaken to assess the effectiveness of environmental controls, compliance with this GWMP, consent conditions, and other relevant approvals, licenses, and guidelines.

Audit requirements are detailed in the ***EMS***.

6.0 Groundwater Monitoring Program

The purpose of the groundwater monitoring program is to monitor groundwater quality and levels to detect potential impacts on surrounding groundwater users, assess the performance of the Mine against the performance indicators and to ensure that relevant legislative and policy requirements are met.

Data collected will:

- Enable verification and refinement (where necessary) of the hydrogeological model developed for Wambo (**Section 5.3**);
- Be used in the continued development of groundwater investigation triggers (**Section 4.0**); and
- Provide input to annual reviews of groundwater monitoring data (**Section 9.1.1**).

The monitoring program takes into account the existing site groundwater data, both from WCPL and the neighbouring United Colliery, as well as the historical and current mining operations. Furthermore, it incorporates the recommendations from the annual review of groundwater, included in the Annual Review each year.

A review of the groundwater monitoring program was undertaken following approval of DA305-7-2003 (Modification 16). Changes to the monitoring program include:

- Expansion of the groundwater quality suite for some bores to include key analytes to determine any changes in beneficial groundwater use i.e. livestock drinking water;
- The addition of new bores monitoring pressure, groundwater level and water quality in various seams including alluvials; and
- Removal of decommissioned bores.

A general description of the groundwater monitoring program for Wambo is included in this section. The groundwater monitoring locations, parameters, frequency and methodology of monitoring for the Wambo Underground Mine (and United Wambo Open Cut Mine) are outlined in the combined ***WMProg***.

6.1 Monitoring Network, Parameters and Frequency

Ongoing groundwater monitoring requirements at Wambo are as follows:

- Groundwater monitoring bores to monitor groundwater sources above and in close proximity to mine workings;
- Monitoring of potential groundwater leakage from Wollombi Brook and associated alluvial aquifers;
- Monitoring of groundwater inflows to underground and open cut mining operations; and
- Monitor for potential water loss from the Chitter Dam and Wambo South Water Dam, including potential migration of sub-surface water toward Wollombi Brook.

6.1.1 Groundwater Monitoring Bores

Wambo's groundwater monitoring network consists of purpose-constructed monitoring bores (also referred to as piezometers), water supply bores and vibrating wire piezometers (VWPs). The GWMP includes the monitoring of water levels and water quality.

Particular areas that require monitoring are alluvium associated with Wollombi Brook, Wambo Creek (also known as South Wambo Creek), North Wambo Creek and Stony Creek.

Additional monitoring bores may be required in the future as underground mining progresses. Any additional monitoring locations should target alluvial groundwater and areas where depth of cover above the seam is lowest. Any additional monitoring bores will be installed so that at least two years of monitoring data are collected prior to undermining. All new monitoring bores are constructed in accordance with the *Minimum Construction Requirements for Water Bores in Australia* (NUDLC, 2012).

Bi-monthly monitoring of groundwater levels, pH and EC will be undertaken at all standpipe bores in the groundwater monitoring program. Comprehensive analysis of major ions will occur at each standpipe bore annually. VWPs, which continuously record groundwater levels, are downloaded quarterly.

6.1.2 Inflows to Underground Workings

Currently there is no dewatering required in underground workings.

Dewatering volumes and underground water levels will be recorded and data will be incorporated into the site water balance on an annual basis to allow calculation of groundwater inflows including loss of groundwater from alluvium and to verify whether WCPL holds sufficient groundwater licence entitlements.

Where the annual assessment for mine inflows to the South Bates Underground Extended Mine exceeds the peak estimate predicted by HydroSimulations (2017) (316 ML/year) by 50% or more (that is more than 474 ML/year), WCPL will:

- Investigate if there is a change in the predicted take of water from the Lower Wollombi Brook Water Source from mining related activities;
- Where there is an increased take from the Lower Wollombi Brook Water Source, investigate any influence on low flow cease-to-pump criteria specified in the HUA WSP;
- Define the Mine inflow volume value triggering this response procedure; and
- Submit a report summarising the assessment to DPIE Water.

WCPL must notify DPIE Water as soon as practicable on becoming aware of any take of water in excess of its licensed entitlement.

The water quality of inflows to the underground workings are measured indirectly through monthly water quality monitoring of mine water storages. This is the most practical method to routinely sample for water quality. An unexpected increase in water make or change in water quality of mine water storages will be investigated by WCPL. If warranted, direct measurement of water quality at the source of inflow may be conducted.

6.1.3 Chitter Dam and South Wambo Water Dam Monitoring Program

In accordance with Condition B66 (v) of DA305-7-2003, WCPL has expanded the GWMP to investigate and monitor potential water loss from the Chitter Dam and South Wambo Water Dam, including potential migration of sub-surface water toward Wollombi Brook.

The Chitter Dam was drained and decommissioned by WCPL in 2016, it has subsequently been mined out as the Glen Munro Boxcut. Investigation was undertaken by SLR (2020c) to

characterise the groundwater regime and potential flow pathways. Recommendations were included for a groundwater monitoring program and collection of additional data to further inform understanding of the current groundwater conditions. The GWMP will be updated to include these changes to the monitoring program if required.

South Wambo Dam has been drained as far as practical since January 2015, prior to undermining by NWU longwalls 9, 10 and 10a, and has subsequently not been used to store mine water. However, to detect potential sub-surface water loss from South Wambo Dam, WCPL will monitor existing groundwater monitoring bores P202, P206, newly installed nested standpipe P316 (a,b,c) and surface water quality of any water stored in the dam. Water quality analysis will include annual analysis of major cations (sodium, potassium, magnesium and calcium) and major anions (chloride, sulphate and alkalinity) in addition to bi-monthly monitoring of pH and EC. Water chemistry and water levels will be analysed to identify evidence of connection between dams and the shallow groundwater systems downgradient.

In September 2018, an investigation was conducted by HydroSimulations titled *Update on Possibility of Mine Water Seepage to Wollombi Brook* (HydroSimulations, 2018). This report utilised key findings from previous assessments (HydroSimulations 2016, 2017a, 2017b), as well as new data and more extensive historical data and concluded "*The leakage of mine water from South Wambo Dam is unlikely to be the cause for the increase in EC from fresh to saline at P114. Instead, it is likely related to the construction and storage of water within the dam, and to natural fluctuations in groundwater levels due to rainfall.*"

South Wambo Dam will only be recommissioned after further geotechnical assessment, structural repairs and following relevant consultation with NSW Dams Safety Committee (DSC) and NSW DPIE Resources Regulator. WCPL met with DPIE Water Group in April 2020 to commence consultation regarding the re-use of the South Wambo Dam.

SLR Consulting Australia is currently undertaking further investigation into the local groundwater conditions, geology and construction design of South Wambo Dam to build on the HydroSimulations (2018) investigation and assess groundwater related risks associated with recommissioning the dam. This work will determine an appropriate monitoring network to detect seepage from the dam, and help develop a series of actions to be undertaken if seepage is detected.

6.1.4 Montrose Dam Monitoring Program

WCPL will develop a program to investigate and monitor potential water loss from the Montrose Dam prior to construction. The GWMP will be updated to include any changes to the monitoring program.

6.1.5 Groundwater Dependent Ecosystems

The GDE Vegetation Assessment Report (referred to in **Section 3.2.3.1**) recommended an additional monitoring bore in the channel of North Wambo Creek, near the River Oak riparian grassy tall woodland. A paired site GW36a & b (refer to **Table 7**) was installed in June 2020, with ground level dataloggers installed at both sites. Monitoring of the areas identified as GDEs are included in the annual flora and fauna monitoring program, which commenced Spring 2019 (refer ***BMP***). The GDE Vegetation Assessment Report recommended monitoring continue for at least five years beyond the completion of mining.

6.2 Monitoring Methodology

The monitoring methodology for the groundwater monitoring program is described in Section 3.3 of the ***WMProg.***

6.3 Data Management Procedures

Data management procedures for the groundwater monitoring program are described in Section 3.4 of the ***WMProg.***

6.4 Data Review and Investigation

Data review and investigation procedures for the groundwater monitoring program are described in Section 3.6 of the ***WMProg.***

Further details outlining the response procedures for exceedance of trigger values are outlined in **Section 7.0**.

6.4.1 Investigation of Levels in GW08 and GW09

An investigation into the declining water levels in bores GW08 and GW09 has been undertaken to further investigate potential impacts on the North Wambo Creek alluvium in the vicinity of these bores and potential licensing implications (HydroSimulations, 2015a). The investigation report was provided to the DPIE and DPIE Water.

The investigation concluded that the drawdown at GW08 and GW09 is due to pumping of water from (dewatering of) the old mine workings. The numerical model, was updated by HydroSimulations in 2015 to assess the South Bates underground operations (HydroSimulations, 2015b), and was not optimised at the location of GW08 and GW09, despite being well-calibrated elsewhere. Since then, HydroSimulations (2016a) updated and recalibrated the numerical model to better replicate shallow groundwater effects in the area around GW08 and GW09 with groundwater modelling associated with the South Bates Extension LW21-24 Extraction Plan (SLR, 2020a), that has built on the HydroSimulations (2016a) model, serving as the current model for compliance and impact assessment purposes.

The status of the two bores has been assessed in recent monitoring reviews such as the 2019 Annual Review (SLR, 2020b) using model results from SLR (2020a).

SLR (2020a) Modelled heads at GW08 show a good match with the overall trends seen in the observed data. The timing of mining related drawdown in both modelled and observed heads, following the extraction of NWU LW5 is well correlated despite simulated heads being lower than observed. At GW08, observed water levels fell below simulated heads in 2013. This relationship continues during the 2019 monitoring period with modelled heads showing a milder response to drawdown than that seen in the observed heads. Despite this, the difference in elevation between modelled and observed heads is quite small, being within 1 m of one another. GW08 was dry from the beginning of 2019, limiting the ability to compare modelled versus observed groundwater levels for the reporting period.

Calibration performance at GW09 in SLR (2020a) is poorer than previously reported in HydroSimulations (2017a). Simulated groundwater levels at GW09 show a response to climatic inputs of a similar magnitude to the observed data but do not show any drawdown associated with NWU LW5 mining. GW09 observations indicate drawdown in the order of 3 m at GW09 prior to going dry in December 2014 in response to NWU mining. It is possible that the interaction between NWU and the overlying historical Homestead Underground Mine has not been sufficiently captured within the SLR (2020) model. The revision of fracture zone parameters and extents associated with longwall extraction is recommended for consideration within future model updates.

HydroSimulations (2015a) recommended replacement bores be established for GW08 and GW09. Bores GW8.2, GW9.2, GW10.2 and 10.2a were installed in early 2020, and will be monitored to supplement the data collected at GW08 and GW09.

6.4.2 Investigation of Water Quality in P114

An investigation into the increased EC in shallow bore P114 has been initiated to further investigate the potential for impacts on this bore as a result of possible leakage from South Wambo Water Dam and potential remediation/mitigation measures.

As described in **Section 6.1.3**, South Wambo Water Dam has been disused following secondary extraction of Longwall 9, Longwall 10 and Longwall 10A at the North Wambo Underground Mine. South Wambo Water Dam has been drained as far as practical since January 2015. Therefore, any possible leakage mechanism that may have impacted bore P114 may no longer be present.

HydroSimulations (2018) assessed the likelihood of leakage of saline mine water from South Wambo Dam to the Wambo Creek alluvium. This assessment found no clear evidence for leakage from South Wambo Dam and also found evidence of P114 being screened across both alluvial and Permian strata. The 2019 Annual Review (SLR,2020) determined the rapid observed decline in groundwater level at P114 is related to the extraction of NWU Longwall 10a, and that observed increases in EC are associated with periods of lower groundwater level most likely related to the interception of saline Permian groundwater below the base of the Wambo Creek Alluvium (refer to **Section 6.1.3**).

Two additional monitoring sites in the vicinity of P114 have been included in the program from 2018 (P316 and P319). These sites are VWPs and will help inform whether groundwater levels are recovering below the Wambo Creek alluvium. Three open standpipes, screened within alluvial, weathered Permian, and Whybrow Seam overburden, were established and added to the monitoring program early 2020 (P316a, P316b and P316c). Data collected in these bores will assist with ongoing investigations into increased salinity within the Wambo Creek alluvium. P114 has been removed from the groundwater monitoring network as its construction is not consistent with *Minimum Construction Requirements for Water Bores in Australia* (NUDLC, 2012)

It is noted that South Wambo Water Dam can only be recommissioned after secondary extraction has been completed following receipt of relevant approvals from the NSW Dams Safety Committee.

7.0 Groundwater Response Plan

7.1 Adaptive Management

Potential groundwater impacts are detailed in the *Wambo Development Project Environmental Impact Statement (EIS)* (Wambo Coal, 2003), the *North Wambo Underground Mine Modification Environmental Assessment* (Resource Strategies, 2012) and the *United-Wambo Project Environmental Assessment* (Umwelt, 2016).

The WCPL Water Management Plan, of which this GWMP forms a part, has been developed to manage and monitor water-related risks associated with the Wambo Coal Mine, to minimise the risk of exceedances of the criteria and/or performance measures detailed in the relevant development consents and licences. If an exceedance of these criteria and/or performance measures occurs, WCPL will, at the earliest opportunity:

- Take all reasonable and feasible steps to ensure that the exceedance ceases and does not recur;
- Consider all reasonable and feasible options for remediation (where relevant) and submit a report to DPIE describing those options and any preferred remediation measures or other course of action; and
- Implement remediation measures as directed by the Planning Secretary, to the satisfaction of the Planning Secretary.

7.2 Incident Definition

An incident is defined in DA305-7-2003 as:

An occurrence or set of circumstances that causes or threatens to cause material harm and which may or may not be or cause a non-compliance.

Incident reporting will be undertaken in accordance with **Section 9.2.2**.

7.3 Impacts on Groundwater

Following the receipt of groundwater monitoring results, a data review will be undertaken. In the event that a trigger level is exceeded, or a complaint is received in relation to loss of groundwater supply, an investigation will be undertaken as soon as possible. The investigation will include a detailed review of monitoring data trends and climatic information along with operational activities and surrounding land uses, to determine if the impact on groundwater is a result of Wambo's activities.

If the investigation identifies actual groundwater impacts and attributes those impacts to Wambo's activities, WCPL will implement the adaptive management process in **Section 7.1**. Appropriate remediation measures will be developed and implemented in consultation with relevant government agencies and affected landowners, as required.

Measures may include:

- Modification to the groundwater monitoring program;
- Review of the water balance modelling for relevant underground / open cut mining activities;
- Review of mine plan and/or methodology; or

- Implementation of mitigation measures, especially where use of groundwater resources are interrupted.

The outcomes of this process will be reported in the Annual Review (**Section 9.2.1**). If an incident is deemed to have occurred (**Section 7.2**), WCPL will notify and report to DPIE and any other relevant government departments in accordance with **Section 9.2.2**.

7.3.1 Trigger Action Response Plans

WCPL has developed a number of TARPs for impacts on groundwater. These TARPs were developed and included in the ***SGWRP***. As the ***SGWRP*** is no longer required under the modified DA305-7-2003 (Modification 16), WCPL has incorporated the relevant groundwater TARPs into this GWMP. TARPs were developed in consultation with DPIE Water. Evidence of this consultation is included in **Appendix A**.

7.3.1.1 Impacts on Private Bores

WCPL has developed a TARP that must be implemented in the event that:

- A complaint is received from a private bore holder in relation to decreasing levels in a private bore; or
- Groundwater monitoring of private bores identifies a decreasing trend approaching 2 metres below the modelled statistical trends.

This TARP is summarised in **Table 17**.

Table 17: TARP for Impacts on Private Bores

TARP Code	Level 1 Response Management Measures	Level 2 Response Contingency Phase
Trigger	•Groundwater monitoring of Private Bores (where access granted) for standing water levels, identifies a decreasing trend approaching 2m below the modelled statistical trends.	•Groundwater monitoring of Private Bores (where access granted) for standing water levels, identifies a decreasing trend greater than 2m below modelled statistical trends for three consecutive sampling events. •WCPL receives a community complaint in relation decreasing water levels in a Private Bore.
Action	•Maintain monitoring of Private Bores to identify if decreasing trends has stabilised and displays signs of increasing trends. •Review recent rainfall data to identify potential correlation between decreasing water level trends and extended dry periods. •If decreasing trends are maintained and eventually exceed 2m below modelled statistical trends then go to Level 2 Response.	•Initiate consultation with the affected Landowner/s of the Private Bore to commence preliminary investigations on receipt of complaint. •Maintain monitoring of Private Bore to identify if decreasing trend has stabilised and displays signs of increasing trend. •Review recent rainfall data to identify potential correlation between decreasing water level trend and extended dry periods. •If decreasing trend is maintained and remains 2m below statistical trends for three consecutive monitoring events, initiate consultation with affected owner of Private Bore. •Undertake preliminary investigation as soon as possible and engage groundwater specialist for a review of relevant groundwater monitoring results in conjunction with site activities being undertaken at the time, baseline groundwater monitoring results, groundwater observations at nearby locations, the prevailing and preceding meteorological conditions and changes to the landuse/ activities being undertaken in the contributing hydrogeological regime. Notify DPIE and DPIE Water of contingency response.

TARP Code	Level 1 Response Management Measures	Level 2 Response Contingency Phase
Plan		•If preliminary or subsequent investigations indicate that compensatory water supplies are to be initiated, as a direct result from WCPL's operations, then WCPL will commence consultation with the affected Landowners to establish an agreed suitable compensatory supply of water, until further monitoring can establish these are no longer required. •Review and update the WMP and resubmit to DPIE within 3 months, or as otherwise agreed.

7.3.1.2 Impacts on North Wambo Creek Alluvium

WCPL has developed a TARP that must be implemented in the event that:

- Groundwater monitoring of standing water levels in the proposed replacement bores within the North Wambo Creek alluvium, identifies standing water trigger levels, beyond predicted modelled impacts; and/or
- Monitoring of aquatic ecosystems in accordance with the ***BMP*** identifies a potential or actual decline in aquatic health, beyond natural fluctuations; and/or
- Monitoring of Land Function Analysis (LFA) of riparian areas in accordance with the ***BMP*** identifies a potential or actual decline in creek stability, beyond natural fluctuations.

This TARP is summarised in **Table 18.** This TARP is also supported by the TARP in the ***SWMP***

Table 18: TARP for Impacts on North Wambo Creek Alluvium

TARP Code	Level 1 Response Management Measures	Level 2 Response Contingency Phase
Trigger	•Groundwater monitoring of standing water levels the proposed replacement bores within the North Wambo Creek alluvium, identifies a groundwater level below the minimum observed groundwater level during the first 12 months of monitoring; and/or •Monitoring of aquatic ecosystems in accordance with the ***BMP*** identifies a potential decline in aquatic health, beyond natural fluctuations; and/or •Monitoring of Land Function Analysis (LFA) of riparian areas in accordance with the ***BMP*** identifies a potential decline in creek stability, beyond natural fluctuations.	•Groundwater monitoring of standing water levels in the proposed replacement bores within the North Wambo Creek alluvium, identifies more than two consecutive groundwater levels below the minimum observed groundwater level during the first 12 months of monitoring; and/or •Monitoring of aquatic ecosystems in accordance with the ***BMP*** identifies a decline in aquatic health in consecutive monitoring events, beyond natural fluctuations; and/or •Monitoring of Land Function Analysis (LFA) of riparian areas in accordance with the ***BMP*** identifies a decline in creek stability in consecutive monitoring events, beyond natural fluctuations.
Action	•Maintain monitoring of bores within the North Wambo Creek alluvium, for standing water levels, to identify if decreasing trends have stabilised and bores display signs of increasing trends. •Review recent rainfall data to identify potential correlation between	•Maintain monitoring of bores within the North Wambo Creek alluvium, for standing water levels to identify if decreasing trends have stabilised and bores display signs of increasing trends. •Continue annual LFA and aquatic ecosystems monitoring to determine if decline trends have stabilised and displaying signs of improving trends in consecutive monitoring periods. •If decreasing standing water level trends are maintained and/or LFA and aquatic ecosystems are in decline and/or a

TARP Code	Level 1 Response Management Measures	Level 2 Response Contingency Phase
	decreasing water level trends and extended dry periods. •Continue annual LFA and aquatic ecosystems monitoring to determine if decline trends have stabilised and displaying signs of improving trends in consecutive monitoring periods. •If standing water levels exceed standing water trigger values (consecutively) as provided in the GWMP, then go to Level 2 Response. •If consecutive LFA and aquatic ecosystems monitoring events show continued decline trends and are displaying no signs of improving trends, then go to Level 2 Response.	significant increase of alluvium flows into the open cut has been identified, WCPL will undertake a preliminary investigation, including: -An investigation and engage groundwater specialist to review relevant groundwater monitoring results in conjunction with site activities being undertaken at the time, baseline groundwater monitoring results, groundwater results at nearby locations, the prevailing and preceding meteorological conditions and changes to the landuse/ activities being undertaken in the contributing hydrogeological regime; -Review the site water balance and groundwater model; -An investigation and engage ecologist to review LFA and aquatic monitoring results in conjunction with site activities being undertaken at the time, the prevailing and preceding meteorological conditions and changes to the landuse/ activities being undertaken. -Develop corrective/preventative actions based on the outcomes of the investigation.
Plan		•If confirmation of a results above and investigations confirms impacts to alluvium are greater than modelled, WCPL will notify the relevant government agencies and in consultation develop appropriate remedial measures. •Develop corrective/preventative actions based on the outcomes of the investigation for example: -Secure additional water licences to account for the estimated future inflows (if applicable). • Review and update the GWMP[1] and resubmit to DPIE within 3 months, or as otherwise agreed.

Notes to **Table 18:**
1. SWMP and United Wambo Water Management Plans may also require review/revision and resubmission to DPIE.

7.3.1.3 Groundwater Leakage from Wollombi Brook

WCPL has developed a TARP that must be implemented in the event that:

- Groundwater monitoring of standing water levels in bores P106, P109, P114, P116 within the Wambo Creek alluvium and GW13 and GW15 within the Wollombi Creek alluvium, identifies a decreasing trend, beyond natural fluctuations and predicted modelled impacts.

This TARP is summarised in **Table 19.**

Table 19: TARP for Wollombi Brook and Wambo Creek Alluvium

TARP Code	Level 1 Response Management Measures	Level 2 Response Contingency Phase
Trigger	•Groundwater monitoring of standing water levels in bores P106, P109, P114, P116 (within the Wambo Creek alluvium) and GW13 and/or GW15 (within the Wollombi Creek alluvium), identifies a decreasing trend, beyond natural fluctuations and predicted modelled impacts	•Groundwater monitoring of standing water levels in bores P106, P109, P114, P116, GW13 and/or GW15, exceed the standing water trigger values as provided in **Table 11**, beyond natural fluctuations, for more than two consecutive monitoring events.

TARP Code	Level 1 Response Management Measures	Level 2 Response Contingency Phase
Action	•Maintain monitoring of bores within the Wollombi and Wambo Creek alluvium, for standing water levels, to identify if decreasing trends have stabilised and bores display signs of increasing trends. •If standing water levels exceed standing water trigger values as provided in **Table 11**, then go to Level 2 Response.	•Maintain monitoring of P106, P109, P114, P116 within the Wambo Creek alluvium and GW13 and GW15 within the Wollombi Creek alluvium, for standing water levels to identify if decreasing trends have stabilised and bores display signs of increasing trends. •If decreasing standing water level trends are maintained, WCPL will undertake preliminary investigation as soon as possible, including: -An investigation and engage groundwater specialist to review relevant groundwater monitoring results in conjunction with site activities being undertaken at the time, baseline groundwater monitoring results, groundwater observations at nearby locations, the prevailing and preceding meteorological conditions and changes to the landuse/ activities being undertaken in the contributing hydrogeological regime. -Review the site water balance and groundwater model; -Develop corrective/preventative actions based on the outcomes of the investigation.
Plan		•If confirmation of results and investigations from above confirms impacts to alluvium are greater than modelled, WCPL will notify the relevant government agencies and in consultation develop appropriate remedial measures. •Develop corrective/preventative actions based on the outcomes of the investigation for example: -Secure additional water licences to account for the estimated future inflows (if applicable). -Measures to offset the potential groundwater leakages. •Review and update the WMP and resubmit to DPIE within 3 months, or as otherwise agreed.

7.3.2 Compensatory Water Supply

WCPL is required to provide a compensatory water supply to any landowner of privately-owned land whose rightful water supply is adversely and directly impacted (other than an impact that is minor or negligible) as a result of the development, in consultation with DPIE Water, and to the satisfaction of the Planning Secretary.

Compensatory water supply arrangements will be negotiated in consultation with the affected landowner(s) and DPIE Water as required, in accordance with Conditions B56 – B59 of DA305-7-2003.

7.3.3 Impacts on Groundwater Dependent Ecosystems or Riparian Vegetation

An aquatic ecosystem and GDE monitoring program has been developed to detect any potential changes in aquatic biology in accordance with the ***BMP,*** within North Wambo Creek, Wambo Creek, Stoney Creek and the North Wambo Creek Diversion.

Annual channel stability surveys are also undertaken to monitor the quantity and quality of riparian vegetation along North Wambo Creek and North Wambo Creek Diversion to determine the need for any maintenance and/or contingency measures. This program and the development of stream health triggers (for water quality, stability and alluvium) are discussed above and within the ***BMP*** and ***SWMP***.

In the event that deterioration is identified in GDEs during stream health monitoring or annual channel stability surveys, the processes outlined below will be implemented.

7.3.4 Unforeseen Impacts

In the event that any unforeseen surface water or groundwater impacts are detected, the following general response procedure will be initiated:

- Check and validate the data/information which indicates an unforeseen impact;
- Notify DPIE, EPA and other relevant agencies immediately after becoming aware of the impact;
- In the event of a suspected anomalous monitoring result, conduct a resample/retest where possible;
- Review the unforeseen impact, including consideration of:
    - Any relevant monitoring data; and
    - Current mine activities and land management practices in the relevant catchment, including other mining activities;
- Commission an investigation by an appropriate specialist into the unforeseen impact;
- Provide a preliminary investigation report to DPIE, EPA and relevant agencies within 7 days of identifying the unforeseen impact;
- Implement appropriate contingency/remedial measures;
- Implement additional monitoring to measure the effectiveness of the mitigation measures, where necessary;
- Communicate results of investigation and subsequent contingency and remedial measures to government agencies as required; and
- Review and update the WMP and resubmit to DPIE.

7.4 Failure to Comply with Other Statutory Requirements

Statutory requirements relating to this GWMP are summarised in **Section 2.0**. WCPL monitors compliance with these statutory requirements on an ongoing basis, including during regular reviews and reporting of monitoring data and as part of Annual Reviews and compliance audits (e.g. Independent Environmental Audits).

In the event that WCPL identifies a failure to comply with a statutory requirement (other than those relating to unpredicted impacts – refer **Section 7.3.4**), WCPL will:

- Undertake an investigation into the failure;
- Identify suitable strategies or actions to be implemented to address the failure (and avoid a recurrence of the failure); and
- Report the non-compliance in accordance with the requirements of the development consents.

Reporting of non-compliances will be undertaken in accordance with Section 9.2.5 of the ***WMP***.

8.0 Community Complaint Response

All groundwater related community complaints received by WCPL will be recorded within the Community Complaints Register. The WCPL Environment and Community (E&C) Manager (or delegate) will investigate the complaint, which will include, where possible, contacting the complainant within 24 hours to discuss the complaint. A review of the effectiveness of the corrective or preventative actions will be conducted within a month of the complaint and the relevant work procedures updated if required.

Preliminary investigations will commence as soon as practicable upon receipt of a complaint to establish if WCPL is responsible. All efforts will be made to determine the likely causes contributing to the complainant's concerns.

WCPL will address the complainant's concerns such that a mutually acceptable outcome is achieved. If a mutually beneficial outcome cannot be reached, WCPL may refer the matter to the Planning Secretary for resolution.

Details of all community complaints will be included in the Monthly Environment Monitoring Report. WCPL will retain a copy of the Community Complaints Register for at least four years. The Community Complaints Register is posted on the WCPL website.

9.0 Review and Reporting

9.1 Review

9.1.1 Environmental Performance

The performance of the groundwater monitoring program outlined in the GWMP will be reviewed annually as part of the Annual Review (see **Section 9.2.1**).

9.1.2 Validation of Predictions

Every year the site water balance, surface water take and groundwater model will be validated by comparing predicted results to monitoring results collected over the life of the development. This will be undertaken as part of the Annual Review process (see **Section 9.2.1**).

Every five years the validity of the model predictions will be assessed and if the data indicates significant divergence from the model predictions, an updated groundwater model will be constructed for simulation of mining. Further detail on the groundwater model is included in **Section 3.6.**

9.1.3 Management Plan Review

This GWMP will be reviewed, and if necessary revised, with any review of the ***WMP*** (refer Section 9.1 of the ***WMP***).

The GWMP will reflect any changes in environmental requirements, technology, and operational procedures.

The revised GWMP will be re-submitted to the Secretary for approval as required by Condition B66 of DA305-7-2003.

9.2 Reporting

9.2.1 Annual Review

The WCPL E&C Manager will be responsible for reporting any significant findings regarding the implementation of this GWMP in the WCPL Annual Review. The Annual Review report will include details of:

- water level and quality results from the monitoring network;
- water extracted or discharged from the site, including water taken under each water licence;
- predictions, actual and licensing requirements; and
- any additional monitoring sites that may be required, or if optimisation of the existing monitoring sites, frequency of sampling and analytical suites should be undertaken.

Further detail on reporting for the Annual Review is included in Section 9.1 of the ***WMP***.

9.2.2 Reporting of Incidents

Reporting of environmental incidents will be undertaken in accordance with Section 9.2.4 of the ***WMP***.

9.2.3 Reporting of Results

A comprehensive summary of the groundwater monitoring results will be made publicly available at WCPL website (refer Section 9.2.7 of the ***WMP***).

10.0 Responsibilities

Table 20 below summarises responsibilities documented in the GWMP. Responsibilities may be delegated as required.

Table 20: GWMP Responsibilities

No	Task	Responsibility	Timing
1	Ensure groundwater monitoring is undertaken in accordance with **Section 6.0** and the ***WMProg***	Environmental Advisor	As required
2	Assess groundwater monitoring data against relevant trigger levels listed in **Section 4.0.**	Environmental Advisor	As required
3	Review GWMP in accordance with **Section 9.1.3**.	Environmental Advisor	Annually
4	Undertake internal bi-monthly groundwater reporting.	Environmental Advisor	Bimonthly
5	Notify government departments if an incident occurs in accordance with **Section 9.2.2**.	E&C Manager	As required
6	Submit updated GWMP to DPIE.	E&C Manager	As required
7	Groundwater related complaints to be responded to in accordance with **Section 8.0**.	E&C Manager	As required
8	Annual Review to include groundwater monitoring results, complaints, mitigation measures undertaken and a review of the monitoring undertaken.	E&C Manager	Annually
9	Regulator review to be undertaken of the GWMP.	E&C Manager	As required
10	Prepare investigation reports and implementation of corrective actions in accordance with **Section 7.0**	E&C Manager	As required

11.0 References

- AGE (2019): Wambo Coal Mine Alluvial Drilling and Monitoring Bore Installation Report - Phase Two
- AGE (2018): Wambo Coal Mine Alluvial Drilling and Monitoring Bore Installation Report - Phase One
- AGE (2016) Report on United Wambo Open-Cut Coal Mine Project Groundwater Impact Assessment, Prepared for Umwelt Australia Pty Ltd, Project No. G1733 July 2016
- Development Consent (DA305-7-2003)
- Development Consent (DA177-8-2004)
- Wambo Development Project Environmental Impact Statement (EIS), July 2003
- Wambo Environment Protection Licence (529)
- Bore licences 20BL173032, 20BL173033, 20BL173034 and 20BL173035
- Bureau of Meteorology (2014) Atlas of Groundwater Dependent Ecosystems.
- Hunter Eco Pty Ltd (2019) South Bates Extension Underground - Groundwater Dependent Ecosystems Vegetative Assessment. Report prepared for Wambo Coal Pty Ltd.
- Glen, R.A. and Beckett, J. (1993) Newcastle Coalfields Regional Geology 1:100,000 map, (Second Edition), NSW Department of Mineral Resources, Sydney.
- Groundwater Imaging Pty Ltd (2012) A Transient Electromagnetic Investigation of the Extent of the Wollombi Brook Alluvium at the Wambo Coal Mine Site.
- Hansen Bailey (2018). Independent Environmental Audit Report for Wambo Coal Pty Ltd, September 2018.
- Heritage Computing (2012) North Wambo Underground Mine Modification Environmental Assessment: Appendix B Groundwater Assessment.
- HLA-Envirosciences Pty Ltd (1999) Effect of Longwall Panel 9 Mining on Surface and Groundwater – Homestead Underground Mine Warkworth NSW.
- HydroSimulations (2014) North Wambo Underground Longwall 10A Modification Groundwater Assessment. Report prepared for Wambo Coal Pty Limited.
- HydroSimulations (2015a) Assessment of Groundwater Trends in GW08 and GW09. Report prepared for Wambo Coal Pty Ltd. Report No. HC2015/39.
- HydroSimulations (2015b) South Bates (Wambo Seam) Underground Mine Modification Groundwater Assessment. Report for Wambo Coal Pty Ltd. Report No. HC2015/026.
- HydroSimulations (2016a) South Wambo Underground Mine Modification Groundwater Assessment. Report for Wambo Coal Pty Ltd Report No..HS2016/01.
- HydroSimulations (2016b) Wambo Annual Review Groundwater Analysis. Report for Wambo Coal Pty Ltd. Report No. HS2016/26
- HydroSimulations (2017) South Bates Underground Extension Modification Groundwater Assessment. Report for Wambo Coal Pty Ltd Report No. HS2016/51.

- HydroSimulations (2018) Update on the Possibility of Mine Water Seepage to Wollombi Brook– Report for Wambo Coal Pty Ltd. Report No. HS2018/10
- HydroSimulations (2019a) Wambo Annual Review Groundwater Analysis – Report for Wambo Coal Pty Ltd. Report No. HS2019/13
- HydroSimulations (2019b) Groundwater Knowledge to inform GDE Study. Report for Wambo Coal Pty Ltd Report No. HS2018/50
- NUDLC (2012) Minimum Construction Requirements for Water Bores in Australia. National Uniform Drillers Licensing Committee, 3rd Edition.
- SLR Consulting (2017) Wambo Drilling Program – North Wambo Creek. Letter report prepared for Wambo Coal Pty Ltd. Ref 630.12300-L01-v0.1.docx
- SLR (2020a) SBE LW21-24 Groundwater Technical Review. Report for Wambo Coal Pty Ltd. Report No.665.10008.R02
- SLR (2020b) Wambo 2018 Annual Review: Groundwater. Report for Wambo Coal Pty Ltd. Report No 665.10008.00006-R01
- SLR (2020c) Glen Munro Seepage Investigation. Report for Wambo Coal Pty Ltd. Report No. 665.10008.00009-L01
- Umwelt (2016) United Wambo Open Cut Coal Mine Project Environmental Impact Statement
- Worley Parsons (2014) OPSIM Water Balance Model Initial Investigations – January 2014.

APPENDIX A: Evidence of Consultation

Planning, Industry & Environment

Nicole Dobbins
Senior Environmental Advisor
Wambo Coal Mine
PMB 1
Singleton NSW 2330

20/11/2020

Dear Ms Dobbins

Wambo Coal Mine (DA 305-7-2003-i)
Water Management Plan

I refer to the Wambo Water Management Plan (WMP), submitted in accordance with condition B66 of the approval for the Wambo Coal Mine (DA 305-7-2003-i). I understand that revisions to the WMP are required prior to Phase 2 of operations between the Wambo Coal Mine and United Wambo Joint Venture, which are scheduled to start on 1 December 2020.

I note that the WMP includes the following sub – plans:
- Site Water Balance;
- Salt Balance;
- Erosion and Sediment Control Plan;
- Surface Water Management Plan (including the North Wambo Creek Diversion Management Plan);
- Groundwater Management Plan; and
- Water Monitoring Plan.

The Department notes that the Site Water Balance, Salt Balance and Water Monitoring Program cover both the Wambo Coal Mine and United Wambo Joint Venture operations.

The Department has carefully reviewed the WMP and is satisfied that it adequately addresses the relevant requirements of the approval. Accordingly, the Planning Secretary has approved the WMP (Revision 2, November 2020) for Phase 2 of the operations. Please continue to operate in accordance with the previously approved WMP until Phase 2 commences.

Please also ensure that the approved plan is placed on the project website at the earliest convenience. If you wish to discuss the matter further, please contact Melanie Hollis on 8217 2043.

Yours sincerely

Matthew Sprott
Director
Resource Assessments (Coal & Quarries)

as nominee of the Planning Secretary

Planning, Industry & Environment

Nicole Dobbins
Senior Environmental Advisor
Wambo Coal Pty Ltd
PMB 1
Singleton NSW 2330

28/05/2020

Dear Ms Dobbins

Wambo Coal Mine (DA 305-7-2003)
Approval of Experts

I refer to your correspondence of 23 April, requesting the Secretary's approval of suitably qualified persons to prepare the following environmental management plans for the Wambo Coal Mine (DA 305-7-2003):

- Air Quality and Greenhouse Gas Management Plan, required by condition B46; and
- Groundwater Management Plan required by condition B66(v).

The Department has reviewed the nominations and information you have provided and is satisfied that the following experts are suitably qualified and experienced:

- Shane Lakmaker (Jacobs) – Air Quality; and
- Claire Stephenson (SLR Consulting) – Groundwater.

I note that the Department recently approved the following experts to prepare the Wambo Extraction Plan for Longwalls 21 – 22:

- Dr Noel Merrick, (SLR Consulting) – Groundwater;
- Mr Rohan Lucas, (Alluvium) – Surface water;
- Mr Peter Kuskie, (South East Archaeology) – Aboriginal Cultural heritage; and
- Mr Martin Sullivan, (Eco Logical Australia) – Biodiversity.

The Department is satisfied that these experts are also suitably qualified and experienced to assist in the preparation of site environmental management plans in their field of expertise.

If you wish to discuss the matter further, please contact Melanie Hollis on 8217 2043.

Yours sincerely

Matthew Sprott
Director
Resource Assessments (Coal & Quarries)
as nominee of the Secretary

Planning, Industry & Environment

Mr Peter Jaeger
Environment and Community Manager
Wambo Coal Pty Limited
PMB 1
Singleton NSW 2330

28/02/2020

Dear Mr Jaeger

Wambo Coal Project (DA 305-7-2003)
Endorsement of Experts

I refer to your letter dated 11 February 2020, requesting the Secretary's approval of suitably qualified persons to prepare the Extraction Plan for Longwalls 21 to 24 for the Wambo Coal Project (DA 305-7-2003).

The Department has reviewed the nominations and information you have provided and is satisfied that these experts are suitably qualified and experienced. Consequently, I can advise that the Secretary approves the appointment of the following experts to prepare the Extraction Plan for Longwalls 21 to 24:

- Mr Joshua Hunt (Resource Strategies) - Extraction Plan preparation;
- Mr James Barbato (Mine Subsidence Engineering Consultants) - Subsidence;
- Mr Rohan Lucas (Alluvium) - Surface Water;
- Dr Noel Merrick (SLR Consulting) - Groundwater;
- Mr Martin Sullivan (Eco Logical Australia) – Biodiversity; and
- Mr Peter Kuskie (South East Archaeology) - Aboriginal cultural heritage.

In relation the upcoming revisions of complex-wide management plans, to align with the commencement of United Wambo Phase 2, it is recommended that the Department's Water Group is consulted on this approach.

If you wish to discuss the matter further, please contact Melanie Hollis on 8217 2043.

Yours sincerely

Matthew Sprott
A/Director
Resource Assessments (Coal & Quarries)

as nominee of the Planning Secretary

Planning, Industry & Environment

Planning and Assessment
Energy and Resource Assessments
Contact: Melanie Hollis
Phone: 8217 2043
Email: melanie.hollis@planning.nsw.gov.au

Ms Nicole Dobbins
Senior Environmental Advisor
Wambo Coal Pty Ltd
PMB 1
Singleton, NSW 2330

Dear Ms Dobbins

Wambo Coal Mine (DA 305-7-2003)
Groundwater Dependent Ecosystem Study

I refer to your recent correspondence submitting the revised Groundwater Dependent Ecosystem Study (Study), in accordance with condition B64 of Schedule 2 of the Wambo Coal Mine development consent (DA 305-7-2003).

The Department has reviewed the revised Study and considers that it adequately addresses the requirements of DA 305-7-2003. Consequently, the Secretary approves this Study.

If you have any questions in relation to the above matters, please contact Melanie Hollis on 8217 2043.

Yours sincerely,

05/02/2020

Matthew Sprott
Director
Resource Assessments
as nominee of the Secretary

Summary of Historic Stakeholder Consultation i.e. for WCPL's Groundwater Monitoring Program (versions 8 to 12)

GWMP Version	Consultation
8	• Version 8 provided to DPI Water, Resource Regulator (formerly DRE), EPA and DPIE as part of an Extraction Plan submission in October 2015. • Comments were received from DPIE in October 2015. • Comments were received from DPI Water in November 2015.
9	• Version 9 provided to DPI Water, DRE, EPA and DPIE as part of an Extraction Plan submission in October 2015. • Comments received from DPIE in October 2015 and DPI Water in November 2015. • Version 9 was approved by DPIE in November 2015.
10	• Version 10 was provided to DPI Water and EPA in December 2016 for consultation. • Version 10 was provided to DPI Water, Resource Regulator, EPA and DPIE as part of an Extraction Plan submission in January 2017. • Comments were received from DPIE in May 2017 and July 2017. • No comments were received from DPIE Water, Resource Regulator or EPA.
11	• Version 11 was submitted to DPIE for approval as a component of the Extraction Plan for South Bates Underground LW11-16. • DPIE Water provided comments in correspondence dated 17 December 2017. • In providing advice on MOD 17 to DA 305-7-2003, the Independent Expert Scientific Committee (IESC) made comments in correspondence dated 31 July 2017.
12	• Version 12 of the GWMP, which addressed IESC and DPIE comments following MOD17 approval and included a Summary of Commitments, was submitted to DPIE for approval in March 2018, as a component of the Extraction Plan for South Bates Underground Extension LW17-20. • Version 12 was approved on 4 June 2019.

Consultation for this GWMP (for Phase 2 Activities at the Wambo Coal Mine)

Stakeholder	Consultation
DPIE	Copy of draft Version 1, prepared for the commencement of Phase 2 activities at the Wambo Coal Mine provided 26 August 2020 via the DPIE - Major Projects Planning Portal. Minor comments received 18 November 2020 which have been addressed in Version 2.
EPA	Copy of draft Version 1, prepared for the commencement of Phase 2 activities at the Wambo Coal Mine provided to the EPA 26 August 2020 via the DPIE - Major Projects Planning Portal. The EPA provided correspondence dated 4 September 2020 advising that it is not the role of the EPA to review management plans. No further comments received.
DPIE Water	Copy of draft Version 1, prepared for the commencement of Phase 2 activities at the Wambo Coal Mine provided to the DPIE Water via the DPIE - Major Projects Planning Portal 26 August 2020. DPIE requested the WMP be sent directly to nrar.servicedesk.@industry.com.au. A copy of the WMP was sent to NRAR 31 August 2020. No comments have been received.

DOC20/707501-2

Wambo Coal Pty Ltd
134 Jerrys Plains Road
WARWORTH NSW 2330

Returned via the Major Projects Portal

4 September 2020

Dear Sir/Madam

Wambo Open Cut Coal Mine Draft Water Management Plan (DA305-7-2003-i-PA-26)

Reference is made to your request on 28 August 2020 via the Department of Planning, Industry and Environment's major projects portal requesting the Environment Protection Authority (EPA) to review and comment on the draft Wambo Coal Mine Water Management Plan (WMP), Doc No. WA-ENV-MNP-509 incorporating Site Water Balance, Wambo erosion and sediment control plan, surface water management plan and groundwater management plan.

The EPA encourages the development of such plans to ensure that licensees have determined how they will meet their statutory obligations and designated environmental objectives.

Being a regulatory authority, the EPA's role is to set environmental management objectives rather than being directly involved in the development of strategies to achieve those objectives. Accordingly, the EPA has not reviewed this management plan.

If you have any questions about this matter, please contact Jenny Lange on 02 4908 6891 or by email to hunter.region@epa.nsw.gov.au

Yours sincerely

JOCK DUNCAN
Acting Unit Head
Regulatory Operations Regional North

Phone 131 555
Phone 02 9995 5555
(from outside NSW)

TTY 133 677, then
ask for 131 155

Locked Bag 5022
PARRAMATTA
NSW 2124

4 Parramatta Square
12 Darcy Street
PARRAMATTA NSW
2150

info@epa.nsw.gov.au
www.epa.nsw.gov.au
ABN 43 692 285 758

APPENDIX B: GWMP Summary of Commitments

Groundwater Management Plan (GWMP) Version 1 - Summary of Commitments

Note: The list of commitments in this appendix is in addition to those explicitly required by Development Consent conditions.

GWMP Section	Commitment	Timing
3.5	The site water balance will be recalculated on an annual basis and reported in the Annual Review.	Annually
3.6 and 5.3	Periodic re-calibration of the hydrogeological model, based on observed piezometric heads and groundwater inflow data.	As required
4.0	Triggers will be used to determine if the groundwater impact investigation procedure or Trigger Action Response Plan (TARP) in **Section 7.0** should be initiated.	Ongoing
4.1.1	Establish trigger levels for replacement bores (for GW08 and GW09) based on modelled groundwater levels.	Once sufficient data is available
4.1.1 and 4.2	Review monitoring data annually at bores GW16 and GW17.	Annually
4.1.2	Initiate further investigation of the Permian monitoring bores if: • An adjacent landholder complains about declining groundwater levels in their bore; or • Higher than predicted inflows are recorded; or • The groundwater drawdown is greater than predicted. (Note - specific groundwater trigger values have not been established for the Permian monitoring bores).	As required
	Groundwater monitoring data from the Permian monitoring bores will be assessed and reviewed as part of the Annual Review.	Annually
4.3	Report on progress against the performance indicators in **Table 13** in the Annual Review.	Annually
	In the event that a complaint is received relating to groundwater, it will be handled in accordance with the complaint's management protocol (**Section 8.0**).	As required
4.4	Report on progress against the performance indicators in **Tables 14** and **15** in the Annual Review.	Annually
5.1 and 5.2	Use actual monitoring data in the annual Site Water Balance and groundwater model validation.	As required
5.3	Organise an independent review of the model every 3 years.	3 yearly
5.4	Decommissioning of monitoring bores will be undertaken in accordance with NUDLC (2012) requirements.	As required
5.5	Permanently seal all exploration drill holes not required for monitoring purposes.	As required
5.6	Generic training on the aspects of the GWMP will be provided to all employees and contractors through the WCPL Site Induction process.	Ongoing
	Selected site personnel whose duties directly involve the management of water at Wambo will undertake specific training with respect to site Operational Procedures which incorporate water management measures.	As required
5.7	Audits (both internal and external) will be undertaken to assess the effectiveness of environmental controls, compliance with this GWMP, consent conditions, and other relevant approvals, licenses, and guidelines. Audit requirements are detailed in the **EMS**.	As per **EMS**

GWMP Section	Commitment	Timing
6.0	Data collected will: • Enable verification and refinement (where necessary) of the hydrogeological model developed for Wambo (**Section 5.3**); • Be used in the continued development of groundwater investigation triggers (**Section 4.0**); and • Provide input to annual reviews of groundwater monitoring data (**Section 9.1.1**).	As required
6.1.1	Install additional monitoring bores so that at least two years of monitoring data is collected prior to undermining.	2 years prior to mining
	Construct all new monitoring bores in accordance with the Minimum Construction Requirements for Water Bores in Australia (NUDLC, 2012).	As required
	Bi-monthly monitoring of groundwater levels, pH and EC will be undertaken at all standpipe bores in the groundwater monitoring program.	Bi-monthly
	Comprehensive analysis of major ions will occur at each standpipe bore annually.	Annually
	VWPs, which continuously record groundwater levels, are downloaded quarterly.	Quarterly
6.1.2	Dewatering volumes and underground water levels will be recorded.	As required (during pumping)
	Data collected from the underground dewatering volumes will be incorporated into the site water balance on an annual basis	Annually
	Where the annual assessment for mine inflows to the South Bates Underground Mine exceeds the peak estimate predicted by HydroSimulations (2017) (316 ML/year) by 50% or more (that is more than 474 ML/year), WCPL will: • Investigate if there is a change in the predicted take of water from the Lower Wollombi Brook Water Source from mining related activities; • Where there is an increased take from the Lower Wollombi Brook Water Source, investigate any influence on a low flow cease to pump criteria specified in the HUA WSP; • Define the mine inflow volume value triggering this response procedure; and • Submit a report summarising the assessment to DPIE Water.	Annually
	Notify DPIE Water as soon as practicable on becoming aware of any take of water in excess of the licensed entitlement.	As required
	Investigate an unexpected increase in water make or change in water quality of mine water storages.	As required
6.1.3	Monitoring bores P114, P116 and P202 and surface water quality from Wambo South Water Dam will be analysed to detect potential sub-surface water loss. Water quality analysis will include major cations and major anions (annually) in addition to pH and EC (bi-monthly).	Bi-monthly and annually
	South Wambo Dam will only be recommissioned after further geotechnical assessment, structural repairs and following relevant consultation NSW DSC and NSW DPIE Resources Regulator.	If required
6.1.4	Develop a program to investigate and monitor potential water loss from the Montrose Dam prior to construction.	Prior to construction
6.1.5	Install GW36 in the channel of North Wambo Creek, near the River Oak riparian grassy tall woodland, to monitor potential impacts.	2020
7.3	Following the receipt of groundwater monitoring results, a data review will be undertaken.	On receipt of results

GWMP Section	Commitment	Timing
	In the event that a trigger level is exceeded, or a complaint is received in relation to loss of groundwater supply, an investigation will be undertaken as soon as possible. The investigation will include a detailed review of monitoring data trends and climatic information along with operational activities and surrounding land uses, to determine if the impact on groundwater is a result of Wambo's activities.	As required
	If the investigation identifies actual groundwater impacts and attributes those impacts to Wambo's activities, WCPL will implement the adaptive management process in **Section 7.1**. Appropriate remediation measures will be developed and implemented in consultation with relevant government agencies and affected landowners, as required.	As required
	The outcomes of this process will be reported in the Annual Review.	Annually
	WCPL will notify and report to DPIE and any other relevant government departments in accordance with **Section 9.2.2**.	As required
7.3	WCPL will respond to identified groundwater impacts in accordance with the procedures and TARPs and processes described in **Section 7.3**.	As per TARPs
7.4	In the event that WCPL identifies a failure to comply with a statutory requirement, WCPL will: • Undertake an investigation into the failure; • Identify suitable strategies or actions to be implemented to address the failure (and avoid a recurrence of the failure); and • Report the non-compliance in accordance with the requirements of the development consents.	As required
8.0	All groundwater related community complaints will be recorded within the Community Complaints Register.	As received
	The Monthly Environment Monitoring Report will include details of all community complaints.	Monthly
9.1.1	Review Wambo's performance against management measures outlined in the GWMP as part of the Annual Review.	Annually
9.1.2	Every year the site water balance, surface water take and groundwater model will be validated by comparing predicted results to monitoring results collected over the life of the development. This will be undertaken as part of the Annual Review process.	Annually
	Every five years the validity of the model predictions will be assessed and if the data indicates significant divergence from the model predictions, an updated groundwater model will be constructed for simulation of mining.	5 yearly
9.1.3	Review and, if necessary, revise the GWMP with any review of the WMP. Resubmit to DPIE as required.	As required
9.2.1	Report any significant findings regarding the implementation of this GWMP in the WCPL Annual Review.	Annually
	Report details of any incidents or non-compliances relating to groundwater in the WCPL Annual Review.	Annually
	Report on water extracted or discharged from the site each year (direct and indirect) in the Annual Review, including water taken under each water licence.	Annually
	Yearly reporting of the water level and quality results from the monitoring network will be included in the Annual Review. An experienced hydrogeologist will review measured water levels and determine when water levels deviate significantly from that predicted by the groundwater model and determine the reason for this deviation. The review will consider the impact of mining, and other factors that could result in declining water levels including climatic conditions, rainfall recharge and pumping from private (and mine owned) bores.	Annually
	The Annual Review will also identify if any additional monitoring sites are required, or if optimisation of the existing monitoring sites, frequency of sampling and analytical suites should be undertaken.	Annually
9.2.2	Report incidents as per the **WMP**.	As required

GWMP Section	Commitment	Timing
9.2.3	Groundwater monitoring results will be made publicly available on the WCPL website.	Monthly