WAMBO COAL
GROUNDWATER MONITORING PROGRAM

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Revisions

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9	September 2015	New management plan format and revision	WCPL/Palaris	SP	
10	October 2015	Revised following receipt of comments from DP&E on Rev 9	WCPL/Palaris	SP	
11	July 2017	Revised to address DPE comments, submitted as a component of LW11-16 EP	WCPL		
12	April 2018	Revised to address CLWD and IESC comments following MOD17 approval	WCPL		

CONTENTS

Tables

Figures

LIST OF APPENDICES

1.0 Introduction

1.1 Background

The Wambo Coal Mine (the Mine) is situated approximately 15 kilometres west of Singleton, near the village of Warkworth, New South Wales (**Figure 1**). Wambo is owned and operated by Wambo Coal Pty Limited (WCPL), a subsidiary of Peabody Energy Australia Pty Limited.

Several open cut and underground mine operations have been conducted at WCPL since mining operations commenced in 1969. Mining under the current Development Consent (DA 305-7-2003) commenced in 2004 and permits both open cut, underground operations and associated activities to be conducted.

The approved run-of-mine (ROM) coal production rate is 14.7 million tonnes per annum (Mtpa) and all product coal is transported from WCPL by rail. A summary of the approved Wambo Coal Mine is provided in **Table 1**.

Table 1: Summary of the Approved Wambo Coal Mine components

Component	Approved Wambo Coal Mine[1,2]
Life of Mine	Wambo Coal may carry out mining operations at the Wambo Mining Complex until 31 December 2039, except for open cut coal extraction, which may only be undertaken until 31 December 2020.
Open Cut Mining	Open cut mining at a rate of up to 8 Mtpa of ROM coal from the Whybrow, Redbank Creek, Wambo and Whynot Seams
	An estimated total open cut ROM coal reserve of 98 million tonnes (Mt)
	Open cut mining operations under current approved Mining Operations Plan (MOP)
	Open cut mining operations up to 31 December 2020
Underground Mining	Underground mining of up to 9.75 Mtpa of ROM coal from the Whybrow, Wambo, Woodlands Hill and Arrowfield Seams. Underground ROM coal reserves are estimated at 161.3 Mt. Underground mining operations up to 31 December 2039
Subsidence commitments and management.	The subsidence performance measures listed in Conditions 22 and 22A of the Development Consent (DA305-7-2003).
ROM Coal Production Rate	Up to 14.7 Mtpa of ROM coal
Total ROM Coal Mined	259.3 Mt
Waste Rock Management	Waste rock deposited in open cut voids and in waste rock emplacements adjacent open cut operations
Total Waste Rock	640 million bank cubic metres (Mbcm)
Rail and Train Loading Infrastructure	Construction and operation of a rail spur, rail loop, coal reclaim area, product coal conveyor and train load out bin to enable the transport of coal (DA 177-8-2004)
Coal Washing	Coal handling and preparation plant (CHPP) capable of processing approximately 1,800 tonnes per hour (tph)
Product Coal	Production of up to 11.3 Mtpa of thermal coal predominantly for export
CHPP Reject Management	Coarse rejects and tailings would be incorporated, encapsulated and/or capped within open cut voids in accordance with existing Wambo management practices
Total CHPP Rejects	Approximately 40.3 Mt of coarse rejects and approximately 24.5 Mt of tailings
Water Supply	Make-up water demand to be met from runoff recovered from tailings storage areas, operational areas, dewatering, licensed extraction from Wollombi Brook and Hunter River
Mining Tenements	Coal Lease (CL) 365, CL374, CL397, Consolidated Coal Lease (CCL) 743, Mining Lease (ML) 1402, ML1572, ML1594, Authorisation (A) 444, Exploration Licence (EL) 7211.

Note: [1] Development Consent DA305-7-2003 (as modified December 2017) [2] Development Consent DA177-8-2004

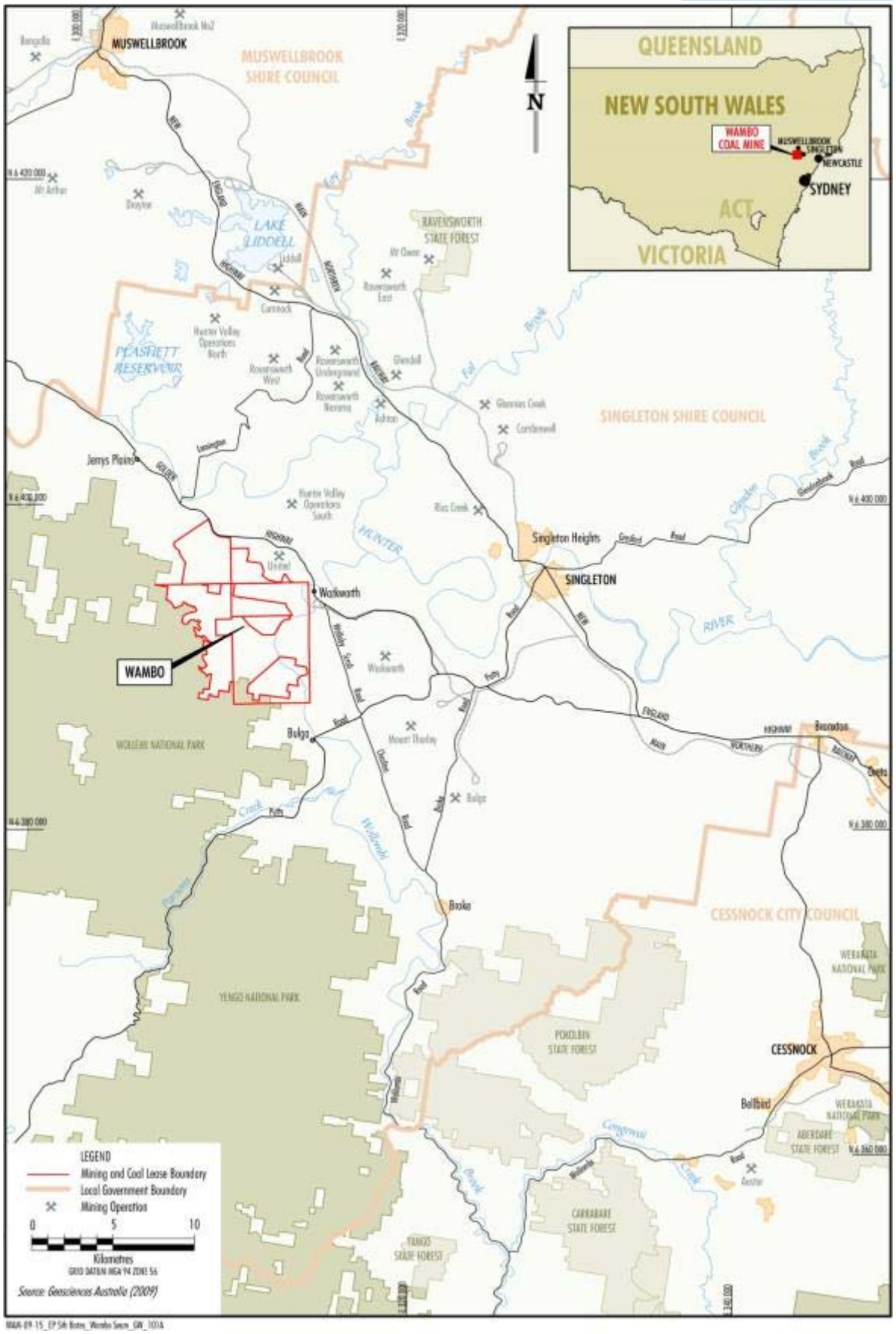


Figure 1: Wambo Coal Regional Location

In accordance with Schedule 4, Condition 30 of DA305-7-2003, WCPL are required to prepare a Site Water Management Plan (SWMP). This Groundwater Monitoring Program (GWMP) is a component of the WCPL Site Water Management Plan. **Figure 2** shows the components of the WCPL Site Water Management Plan. This GWMP should be read in conjunction with the other components of the WCPL Site Water Management Plan, in particular the Surface and Ground Water Response Plan (SGWRP).

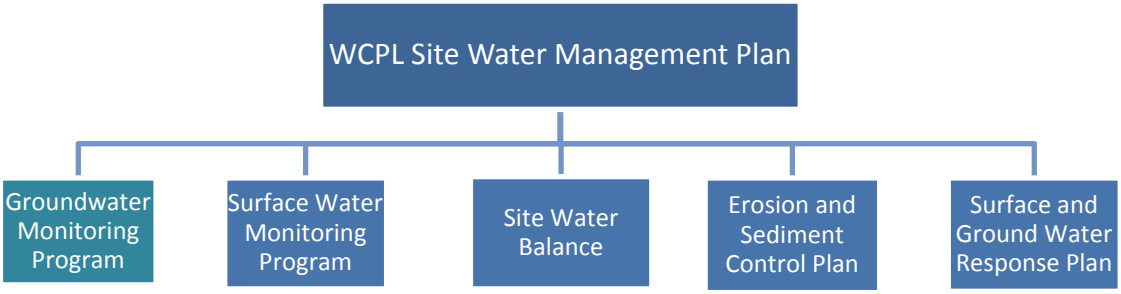


Figure 2: WCPL Site Water Management Plan

In accordance with WCPL's continuous improvement and review processes and Conditions 4 & 6, Schedule 6 of DA305-7-2003, a review of the GWMP has been undertaken to ensure that groundwater monitoring at the Mine continues to be undertaken in a manner that ensures compliance and that groundwater impacts from the Mine are minimised where possible.

1.2 Purpose

This GWMP has been developed to address the relevant requirements of DA305-7-2003. In accordance with Condition 34, Schedule 4 of DA305-7-2003, WCPL have prepared this GWMP to provide:

- Detailed baseline data on groundwater levels and quality, based on statistical analysis, to benchmark the pre-mining natural variation in groundwater levels and quality;
- Groundwater impact assessment criteria;
- A comprehensive and detailed program to monitor the volume and quality of groundwater seeping into the open cut and underground mining workings;
- A detailed program to monitor regional groundwater levels and quality in the alluvial and overburden aquifers; and
- A program to investigate and monitor potential water loss from the Chitter Dump Dam and South Wambo Dam (also known as Wambo South Water Dam), and Montrose East Dam (not yet constructed), including potential migration of stored water toward Wollombi Brook.

The GWMP has also been prepared in accordance with Schedule 6, Condition 4 of DA305-7-2003. There are no conditions relevant to groundwater monitoring in DA177-8-2004 or WCPL's Environment Protection Licence (EPL) 529.

1.3 Scope

This GWMP applies to all groundwater monitoring activities undertaken within WCPL's mining authorisations and approved mining areas (**Figure 3**) as well as regional groundwater bores. This GWMP has been prepared to monitor groundwater impacts from the Mine on local groundwater systems. This GWMP forms part of WCPL's Environmental Management System (EMS).

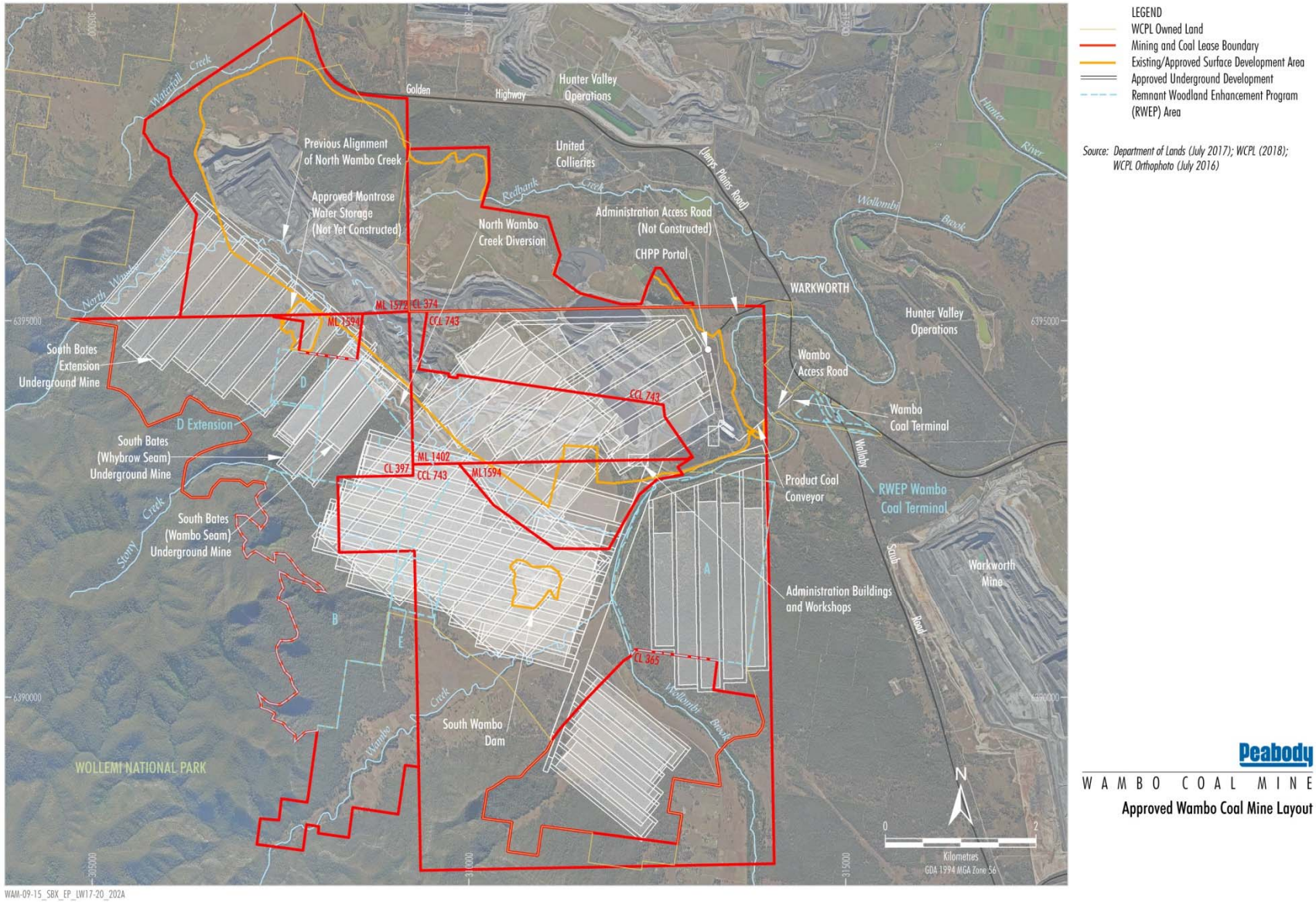


Figure 3: Approved Wambo Coal Mine Layout

1.4 Statutory Requirements

This GWMP has been prepared to fulfil the requirements of DA305-7-2003 and various groundwater licences (**Table 2** and **Table 3**). There are no conditions relevant to groundwater monitoring or management in DA177-8-2004 or WCPL's EPL 529.

1.4.1 Environmental Planning & Assessment Act 1979

WCPL received Development Consent (DA305-7-2003) in accordance with the *Environmental Planning & Assessment Act 1979* (EP&A Act) from the NSW Department of Planning and Environment (DP&E), formerly NSW Department of Planning, on 4 February 2004. Conditions within DA305-7-2003 relevant to groundwater monitoring at the Mine are summarised in **Table 2**.

Table 2: DA305-7-2003 Requirements for the Groundwater Monitoring Program

Schedule	Condition	DA 305-7-2003	GWMP Section
4	29	The applicant must: … (e) monitor regional ground water levels and quality in the alluvial and overburden aquifers during the development and at least 10 years after mining; and	**Section 4.1.1**
		(f) periodically assess groundwater pressure response in the coal measures; to the satisfaction of the EPA, CLWD and the Secretary.	**Section 4.4**
4	30	Before carrying out any development, the Applicant must prepare a Site Water Management Plan for the development in consultation with DRE and CLWD, and to the satisfaction of the Secretary. This plan must include: … (f) a Ground Water Monitoring Program;	**This GWMP**
4	34	The Ground Water Monitoring Program must include: (a) detailed baseline data on ground water levels and quality, based on statistical analysis, to benchmark the pre-mining natural variation in groundwater levels and quality;	**Section 2.0**
		(b) ground water impact assessment criteria;	**Section 2.1.7**
		(c) a comprehensive and detailed program to monitor the volume and quality of ground water seeping into the open cut and underground mining workings;	**Sections 4.1.4 and 4.1.5**
		(d) a detailed program to monitor regional ground water levels and quality in the alluvial and overburden aquifers; and	**Section 4.1.1**
		(e) a program to investigate and monitor potential water loss from the Chitter Dump Dam and South Wambo Dam, and Montrose East Dam, including potential migration of stored water toward Wollombi Brook.	**Section 4.1.6**
4	34A	Prior to submitting the first Extraction Plan for the Longwall Domains, the Applicant must revise the Groundwater Monitoring Program to: (a) include the installation of paired monitoring bores for the South Wambo Underground Mine, in consultation with CLWD, to assess potential fracture interconnections between surface water resources, alluvial and hardrock aquifers; and (b) provide detailed information on the groundwater levels within the alluvial and hardrock aquifers within the Longwall Domains.	**Table 8** (P316, P319, P320) **Prior to South Wambo Underground**
4	34B	Within 3 months of the approval of Modification 17, or as otherwise agreed with the Secretary, the Applicant must revise the Groundwater Monitoring Program, in consultation with CLWD, to include the installation of: (a) clustered monitoring bores for the South Bates Extension Area, located in proximity to the Hunter Lowland Redgum Forest along North Wambo Creek, and characterise the geological and hydrogeological systems in the vicinity of this vegetation community, including an assessment of the presence and extent of any shallow groundwater; and (b) monitoring vibrating wire piezometers, located above the South Bates Extension Area, both within and beyond the areas with potential for	**Table 8** (GW23, GW 24, GW25, GW26) **Table 8** (P317, UG139)

Schedule	Condition	DA 305-7-2003	GWMP Section
		connective cracking. The Applicant must complete the installation of the bores and piezometers required under this condition and establish a program to continually monitor them within 12 months of the Secretary's approval of the revised Ground Water Monitoring Program.	
4	36A	Within 12 months of the approval of Modification 17, or as otherwise agreed with the Secretary, the Applicant must commission and provide to the Secretary for approval, a Groundwater Dependent Ecosystem Study report. This study must: (a) be prepared by suitably qualified and experienced person/s whose appointment has been endorsed by the Secretary; (b) be developed in consultation with CLWD; (c) adopt any available data collected from the revised Ground Water Monitoring Program; (d) provide advice on the likely level of groundwater dependence of the vegetation in the South Bates Extension Area given current groundwater levels and expert knowledge of the vegetation communities in the region; (e) in the event it is considered that vegetation communities in the vicinity of the South Bates Extension Area are groundwater dependent (either entirely or partially), provide advice on the likelihood that subsidence associated with the South Bates Extension Area could cause adverse impacts and how any such impacts would manifest; (f) consider to what degree the cumulative impacts of adjacent mining operations may have already impacted groundwater dependent vegetation across the South Bates Extension Area; (g) provide any recommendations regarding the revised Ground Water Monitoring Program required under condition 34B, and in particular provide any recommendations that would assist in assessing the potential fracture interconnections between surface water resources and hard rock aquifers that may impact on groundwater dependent vegetation; and (h) include a management and/or remediation program that describes measures that could be implemented to ensure compliance with the performance measures in Table 14A for any groundwater dependent endangered ecological community.	**By December 2018**
4	36B	The Applicant must take into account the findings of the Groundwater Dependent Ecosystem Study and not less than 2 years of monitoring results obtained under condition 34B in the preparation of any Extraction Plan for Longwalls 23 – 25.	**2 years prior to the development of EP for LW23-25**
6	3	**Adaptive Management** The Applicant must assess and manage project-related risks to ensure that there are no exceedances of the criteria and/or performance measures in schedule 4. Any exceedance of these criteria and/or performance measures constitutes a breach of this consent and may be subject to penalty or offence provisions under the EP&A Act or EP&A Regulation. Where any exceedance of these criteria and/or performance measures has occurred, the Applicant must, at the earliest opportunity: (a) take all reasonable and feasible steps to ensure that the exceedance ceases and does not recur; (b) consider all reasonable and feasible options for remediation (where relevant) and submit a report to the Department describing those options and any preferred remediation measures or other course of action; and (c) implement remediation measures as directed by the Secretary, to the satisfaction of the Secretary.	**Refer SGWRP**
6	4	**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: (a) detailed baseline data; (b) a description of: - the relevant statutory requirements (including any relevant consent, licence or lease conditions); - any relevant limits or performance measures/criteria;	**Section 2.0** **Section 1.4** **Section 3.3**

Schedule	Condition	DA 305-7-2003	GWMP Section
		- the specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the project or any management measures;	**Section 3.3**
		(c) a description of the measures that would be implemented to comply with the relevant statutory requirements, limits, or performance measures/ criteria;	**Section 4.0**
		(d) a program to monitor and report on the: - impacts and environmental performance of the Wambo Mining Complex;	**Sections 4.0 and 6.0**
		- effectiveness of any management measures (see c above);	
		(e) a contingency plan to manage any unpredicted impacts and their consequences;	**Refer SGWRP**
		(f) a program to investigate and implement ways to improve the environmental performance of the Wambo Mining Complex over time;	**Section 6.2**
		(g) a protocol for managing and reporting any: - incidents;	**Section 6.4**
		- complaints;	**Section 5.0**
		- non-compliances with statutory requirements; and	**Refer SGWRP**
		- exceedances of the impact assessment criteria and/or performance criteria; and	**Refer SGWRP**
		(h) a protocol for periodic review of the plan.	**Section 6.1**

1.4.2 Water Act 1912

The *Water Act 1912* governs access, trading and allocation of licences associated with both surface and underground water for water sources where a Water Sharing Plan (WSP) has not commenced. The elements to which the *Water Act 1912* applies include extraction of water from a river, extraction of water from underground sources, aquifer interference and capture of surface runoff in dams.

The Water Sharing Plan for the North Coast Fractured and Porous Rock Groundwater Sources (NFPR WSP) commenced for the Permian and Triassic hard-rock units on 1 July 2016. WCPL's licences under the Water Act 1912 are in the process of being converted to licences under the *Water Management Act 2000*.

1.4.3 Water Management Act 2000

The *Water Management Act 2000* (WM Act) is intended to ensure that water resources are conserved and properly managed for sustainable use benefitting both present and future generations. It is also intended to provide formal means for the protection and enhancement of the environmental qualities of waterways and their in-stream uses as well as to provide for protection of catchment conditions.

An amendment to the WM Act (section 60I) came into effect on 1 March 2013. This amendment provides that it is *an offence for a person without an access licence to take, remove or divert water from a water source, or relocate water from one part of an aquifer to another part of an aquifer, in the course of carrying out a mining activity.* Various activities are captured by the provisions of the amendment including mining, mineral exploration and petroleum exploration.

The area covered by this GWMP is located within the Water Sharing Plan (WSP) area for the Hunter Unregulated and Alluvial Water Sources (HUA WSP), which commenced in August 2009 and regulates the interception and extraction of surface water and alluvium within the defined WSP area. Any interference and extraction of alluvial groundwater throughout the GWMP area generally requires a water access licence (WAL) under the WM Act.

The NFPR WSP commenced on 1 July 2016. This WSP regulates the interception and extraction of water from the Permian and Triassic hard-rock units, including coal seams. **Table 3** includes a list of groundwater entitlements held by WCPL. Surface water entitlements are outlined in the SWMP.

Table 3: WCPL Groundwater Entitlement and Licences

Licence Number	Description	Expiry Date	Entitlement	Category	Nominated Work	Expiry date	Comment
Hunter Unregulated and Alluvial Water Sources (Lower Wollombi Brook Water Source)							
WAL 23897 (20BL167737)	Well No. 2	Perpetuity	70 unit shares	Aquifer	20WA211372	31/7/2022	-
North Coast Fractured and Porous Rock Groundwater Sources (Sydney Basin - North Coast Groundwater Source)							
WAL 39735 (20BL168643)[1]	Dewatering Bore	Perpetuity	40 unit shares	Aquifer	20MW065010	-	-
WAL 39738 (20BL132753)1	Old Well No. 1	Perpetuity	243 unit shares	Aquifer	20MW065010	-	-
WAL 39803 (20BL166910)1 (20BL173032)1 (20BL173033)1 (20BL173034)1 (20BL173035)1	Dewatering (Bore No. 1)	Perpetuity	450 unit shares	Aquifer	20MW065010	-	-
WAL41494 (20BL168017)[1] (20BL172061)[#1] (20BL173040)[1]	Dewatering (Bore No. 2 and 2a)	Perpetuity	750 unit shares	Aquifer	20MW065010	-	WaterNSW to confirm conversion status and release WAL. DoI Water to confirm nominated work number.
WAL41532 (20BL172156)[1]	Dewatering	Perpetuity	98 unit shares	Aquifer	20MW065010	-	-
WAL41528 20BL167738[#1]	Dewatering Bore	11/09/15	57 ML/year	NA	20MW065010	-	-
WAL41520 20BL173844[1]	Dewatering Bore	Perpetuity	9 unit shares	Aquifer	20MW065010	-	-
20BL168997	Piezometer	Perpetuity	Groundwater monitoring	NA	-	-	DoI Water to confirm conversion status.
20BL168998	Piezometer	Perpetuity	Groundwater monitoring	NA	-	-	DoI Water to confirm

Licence Number	Description	Expiry Date	Entitlement	Category	Nominated Work	Expiry date	Comment
							conversion status.
20BL168999	Piezometer	Perpetuity	Groundwater monitoring	NA	-	-	DoI Water to confirm conversion status.
20BL169000	Piezometer	Perpetuity	Groundwater monitoring	NA	-	-	DoI Water to confirm conversion status.
20BL170638	Piezometer	Perpetuity	Groundwater monitoring	NA	-	-	DoI Water to confirm conversion status
20BL172237	Monitoring Bore (GW14, GW18, GW21)	Perpetuity	Groundwater monitoring	NA	-	-	DoI Water to confirm conversion status.
20BL172238	Monitoring Bore (GW12)	Perpetuity	Groundwater monitoring	NA	-	-	DoI Water to confirm conversion status.
20BL172240	Monitoring Bore (GW15)	Perpetuity	Groundwater monitoring	NA	-	-	DoI Water to confirm conversion status.
20BL172242	Monitoring Bore (GW16, GW17)	Perpetuity	Groundwater monitoring	NA	-	-	DoI Water to confirm conversion status.
20BL172244	Monitoring Bore (GW20)	Perpetuity	Groundwater monitoring	NA	-	-	DoI Water to confirm conversion status.
20BL172255	Monitoring Bore (GW22)	Perpetuity	Groundwater monitoring	NA	-	-	DoI Water to confirm conversion status.
20BL172256	Monitoring Bore (GW13)	Perpetuity	Groundwater monitoring	NA	-	-	DoI Water to confirm conversion status.
20BL172257	Monitoring Bore (GW19)	Perpetuity	Groundwater monitoring	NA	-	-	DoI Water to confirm conversion status.
20BL172332	Piezometer	Perpetuity	Groundwater monitoring	NA	-	-	DoI Water to confirm conversion status.
20BL173032	Monitoring		Groundwater monitoring	NA		30 Nov 2021	-
20BL173290	Monitoring Bore	Perpetuity	Groundwater monitoring	NA	-	-	DoI Water o confirm conversion status.
20BL173291	Monitoring Bore	Perpetuity	Groundwater monitoring	NA	-	-	DoI Water to confirm conversion status.
20BL173292	Monitoring Bore	Perpetuity	Groundwater monitoring	NA	-	-	DoI Water to confirm conversion status.
20BL173293	Monitoring Bore	Perpetuity	Groundwater monitoring	NA	-	-	DoI Water to confirm conversion status.
20BL173946	Monitoring	Perpetuity		NA			
20BL009818	Bore	Perpetuity	Stock	NA	-	-	DoI Water to confirm conversion status.
20BL009819	Bore	Perpetuity	Stock	NA	-	-	DoI Water to confirm conversion status.

Licence Number	Description	Expiry Date	Entitlement	Category	Nominated Work	Expiry date	Comment
20BL009820	Bore	Perpetuity	Stock	NA	-	-	DoI Water to confirm conversion status.
20BL009821	Bore	Perpetuity	Stock	NA	-	-	DoI Water to confirm conversion status.
20BL143779	Bore	Perpetuity	Stock/Domestic	NA	-	-	DoI Water to confirm conversion status.

WAL = water access licence, ML/year = megalitres per year. Former licence numbers

Renewal lodged.

1. In mid-2015, WCPL applied to the Department of Primary Industries – Water (DPI-Water) (now DoI Water) to combine all of its groundwater licences that contained an extraction entitlement into a single licence. The purpose of this licence was to streamline mining activities and simplify the reporting of extraction against licensed entitlements. As such, WCPL was licensed to extract a total of 1,647 ML from all groundwater sources under the *Water Act 1912*. This combined licence was confirmed to be active by DPI-Water in correspondence received on the 18 February 2016, the status of its' conversion to licences under the *Water Management Act 2000* is yet to be advised by DPI-Water.
   20BL prefix bore licences are no longer valid and those with allocations are being replaced with Water Access Licences (WALs).

1.4.4 Hunter Unregulated and Alluvial Water Sources Sharing Plan

The HUA WSP includes the unregulated rivers and creeks and alluvial groundwater within the Hunter region and is categorised into four extraction management units (EMUs) and further broken down into water sources. The area covered by the WSP includes 39 surface water and alluvial groundwater sources.

Wambo is located predominantly within the Lower Wollombi Brook water source. At the commencement of the WSP in August 2009, the groundwater (alluvial) entitlement within the Lower Wollombi Brook water source was 5,071 megalitres per year (ML/year) shared between 38 licences. WCPL currently holds one alluvial aquifer licence (WAL 23897, Licence 20AL211371, 70 shares) within the Lower Wollombi Brook water source of the HUA WSP as shown in **Table 3**. Surface water entitlements held by WCPL are outlined in the Surface Water Monitoring Program.

1.4.5 North Coast Fractured and Porous Rock Groundwater Sources

WCPL's licences under the *Water Act 1912* are in the process of being converted to licences under the NFPR WSP, which commenced on 1 July 2016. Although physical conversion of some of the licences has not yet occurred, DoI Water has confirmed that WCPL holds 1,647 ML of entitlements under the NFPR WSP.

1.4.6 Policies

1.4.6.1 NSW Aquifer Interference Policy

The NSW Aquifer Interference Policy (AIP) was finalised in September 2012 and clarifies the water licensing and approval requirements for aquifer interference activities in NSW, including the taking of water from an aquifer in the course of carrying out mining. Many aspects of this Policy will be given legal effect in the future through an Aquifer Interference Regulation. Stage 1 of the Aquifer Interference Regulation commenced on 30 June 2011.

This Policy outlines the water licensing requirements under the *Water Act 1912* and WM Act:

A water licence is required whether water is taken for consumptive use or whether it is taken incidentally by the aquifer interference activity (such as groundwater filling a void) even where that water is not being used consumptively as part of the activity's operation.

Under the WM Act, a water licence gives its holder a share of the total entitlement available for extraction from the groundwater source. The WAL must hold sufficient share component and water allocation to account for the take of water from the relevant water source at all times.

Sufficient access licences must be held to account for all water taken from a groundwater or surface water source as a result of an aquifer interference activity, both for the life of the activity and after the activity has ceased. Many mining operations continue to take water from groundwater sources after operations have ceased. This take of water continues until an aquifer system reaches equilibrium and must be licensed.

The AIP requires that potential impacts on groundwater sources, including their users and Groundwater Dependent Ecosystems (GDEs), be assessed against minimal impact considerations, outlined in Table 1 of the Policy. If the predicted impacts are less than the Level 1 minimal impact considerations, then these impacts will be considered as acceptable.

The Level 1 minimal impact considerations for less productive groundwater sources are relevant to the groundwater sources at Wambo and are as follows:

- **Water table**: less than or equal to 10% cumulative variation in the water table, allowing for typical climatic 'post-water sharing plan' variations, 40 m from any high priority groundwater dependent ecosystem or high priority culturally significant site listed in the schedule of the relevant WSP. A maximum of a 2 m decline cumulatively at any water supply work unless make good provisions should apply.
- **Water pressure**: a cumulative pressure head decline of not more than 40% of the 'post-water sharing plan' pressure head above the base of the water source to a maximum of a 2 m decline at any water supply work.
- **Water quality**: any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 m from the activity. For alluvial water sources, there should be no increase of more than 1% per activity in the long-term average salinity in a highly connected surface water source at the nearest point to the activity.

1.4.6.2 NSW State Groundwater Policy

The objective of the NSW State Groundwater Policy Framework Document (NSW Government 1997) is to manage the State's groundwater resources so that they can sustain environmental, social and economic uses for the people of NSW. NSW groundwater policy has three component parts:

- NSW Groundwater Quantity Protection Policy.
- NSW Groundwater Quality Protection Policy.
- NSW Groundwater Dependent Ecosystems Policy.

The principles of the NSW Groundwater Quantity Protection Policy include:

- Maintain total groundwater use within the sustainable yield of the aquifer from which it is withdrawn;
- Groundwater extraction shall be managed to prevent unacceptable local impacts; and
- All groundwater extraction for water supply is to be licensed. Transfers of licensed entitlements may be allowed depending on the physical constraints of the groundwater system.

The criteria and management plan developed as part of this document will seek to follow the principles of this policy.

The objective of the NSW Groundwater Quality Protection Policy is the ecologically sustainable management of the State's groundwater resources so as to:

- Slow and halt, or reverse any degradation in groundwater resources;
- Direct potentially polluting activities to the most appropriate local geological setting so as to minimise the risk to groundwater;

- Establish a methodology for reviewing new developments with respect to their potential impact on water resources that will provide protection to the resource commensurate with both the threat that the development poses and the value of the resource; and
- Establish triggers for the use of more advanced groundwater protection tools such as groundwater vulnerability maps or groundwater protection zones.

Groundwater triggers will be developed as part of this management plan where they will seek to follow the objectives of this policy.

The NSW Groundwater Dependent Ecosystem Policy was designed to protect ecosystems which rely on groundwater for survival so that, wherever possible, the ecological processes and biodiversity of these dependent ecosystems are maintained or restored for the benefit of present and future generations.

1.4.7 Guidelines

1.4.7.1 Draft Groundwater Monitoring Guidelines

The former NSW Department of Infrastructure, Planning and Natural Resources (DIPNR) developed the 'Draft Groundwater Monitoring Guidelines for Mine Sites within the Hunter Region' in September 2003. This draft guideline is still used by DoI Water as the benchmark for groundwater monitoring programs at mine sites within the Hunter Region.

1.5 Stakeholder Consultation

Several applications to modify DA 305-7-2003 were sought and approved by the DP&E in June and August 2009, for the construction of the Chitter Dam and Wambo South Water Dam respectively. To address additional consent requirements resulting from the recent approved modifications, a review of the GWMP was completed in May 2015. The GWMP was then revised to reflect the new WCPL management plan format in September 2015.

In accordance with Conditions 22C and 30, Schedule 4 of DA 305-7-2003, the GWMP has been prepared in consultation with DoI Water (formerly NOW, DPI-Water & CLWD), NSW Division of Resources and Geoscience (DRG, formerly the Division of Resources and Energy [DRE]) and the Environment Protection Authority (EPA), prior to submitting to the Secretary of the DP&E for approval.

Consultation on recent versions of the GWMP has included:

- Version 9 of the GWMP provided to DPI Water, DRE, EPA and DP&E as part of an Extraction Plan submission in October 2015;
- Comments received from DP&E on Version 9 of the GWMP in October 2015;
- Version 10 of the GWMP approved by DP&E in November 2015;
- Comments received from DPI Water on Version 9 of the GWMP in November 2015;
- Version 10 of the GWMP provided to DPI Water and EPA in December 2016 for consultation;
- Version 10 of the GWMP was provided to DPI Water, DRG, EPA and DP&E as part of an Extraction Plan submission in January 2017;

- Comments received from DP&E on Version 10 of the GWMP in May 2017 and July 2017. No comments were received from DPI Water, DRG or EPA on Version 10 of the GWMP.

Revision 11 of the GWMP included:

- Updating the format and layout of the GWMP, consistent with WCPL's current document management procedures and templates;
- Reflecting the latest underground mine layout; and
- Addressing comments received from DPI Water (Revisions 8 and 9) and DP&E (Revision 10) on the GWMP.

Version 11 of the SWMP was submitted to DP&E for approval as a component of the Extraction Plan for South Bates Underground LW11-16. Following receipt of the Extraction Plan in January 2017, CLWD provided comments on the SWMP in correspondence dated 17 December 2017. In addition, in providing advice on MOD 17 to DA 305-7-2003, the Independent Expert Scientific Committee (IESC) made comments on the SWMP in correspondence dated 31 July 2017. This review of the GWMP (Revision 12) addresses those comments. The Extraction Plan for LW17, which included this GWMP was approved 7 September 2018.

Correspondence in relation to the GWMP is attached as **Appendix B**. A summary of how comments from DoI Water, the IESC and DP&E have been addressed in this GWMP is also provided in **Appendix B**.

2.0 Groundwater Conditions

2.1 Baseline conditions

Baseline conditions are defined by the constant (at the timescale relevant to the project) environmental framework (geology, geomorphology etc.) and circumstances controlled by climatic conditions manifest in records up to September 2014 for rainfall and stream flows, and to April 2015 for groundwater levels and groundwater quality. Climate and borefield information included in analyses up to September 2014, while part of this categorisation, is also available for ongoing (post baseline) analyses. Given the commencement of mining operations at the Mine in 1969, and the proximity of laterally and vertically adjacent mining by other companies, no true baseline is possible in the sense of defining “pre-mining” conditions.

2.1.1 Landforms and Watercourses

Wambo is located in the Upper Hunter Valley where the landform is characterised by gently sloping floodplains of the Hunter River and its tributaries and the undulating foothills, ridges and escarpments of the Mount Royal Range and Great Dividing Range (Heritage Computing, 2012).

Elevations in the vicinity of Wambo range from approximately 60 metres (m) Australian Height Datum (AHD) at Wollombi Brook to approximately 650 m AHD at Mount Wambo within the Wollemi National Park to the west of Wambo.

Watercourses in the vicinity of Wambo Mine include Wollombi Brook, North Wambo Creek, (South) Wambo Creek, Stony Creek, Longford Creek and Doctors Creek. These creeks are tributaries of the Hunter River. North Wambo Creek has been diverted in accordance with the approved modification to its development consent (DA305-7-2003 MOD 5). The locations of these watercourses are shown in **Figure 3 (Section 2.1.4).**

2.1.2 Rainfall

A continuous daily rainfall dataset was obtained as SILO Patched Point Data from the Queensland Climate Change Centre of Excellence (QCCCE), which is based on historical data from a particular Bureau of Meteorology (BoM) station with missing data ‘patched’ in from interpolations from nearby stations. SILO data was obtained for the BoM Jerry’s Plains Post Office Station (station number 61086). Daily rainfall records from January 1901 to September 2014 were utilised.

Key statistics for the rainfall dataset are as follows:

- Minimum annual rainfall – 316.3 mm in 1957.
- Average annual rainfall – 648.5 mm.
- Median annual rainfall – 658.6 mm.
- Maximum annual rainfall – 1191.2 mm in 1950.

Monthly rainfall averages ranged from 36.9 mm in August to 76.2 mm in January.

The SILO dataset was also used to generate a Cumulative Rainfall Departure (CRD) curve. CRD is the monthly accumulation of the difference between the observed monthly rainfall and long-term average monthly rainfall.

The CRD over the period 1901 to 2014 is shown in **Figure 4**. Any increase in the CRD reflects above average rainfall while a decrease in CRD reflects below average rainfall. The CRD curve only deviates from zero due to atypical (above and below average) rainfall. The most prominent features are a severe drought from the mid-1930s to the late-1940s, with alternating wet and dry periods since 1969 when mining commenced; there is little evidence of the Millennium Drought after 2000.

While the CRD is a simple indicator of climate trends, it also provides an opportunity for conceptualising the dependence of groundwater levels on rainfall or other mechanisms. Where rainfall recharge is significant, a good correlation between a groundwater hydrograph and the CRD curve can be expected. Deviations from the correlation, over time, can be indicative of mining effects.

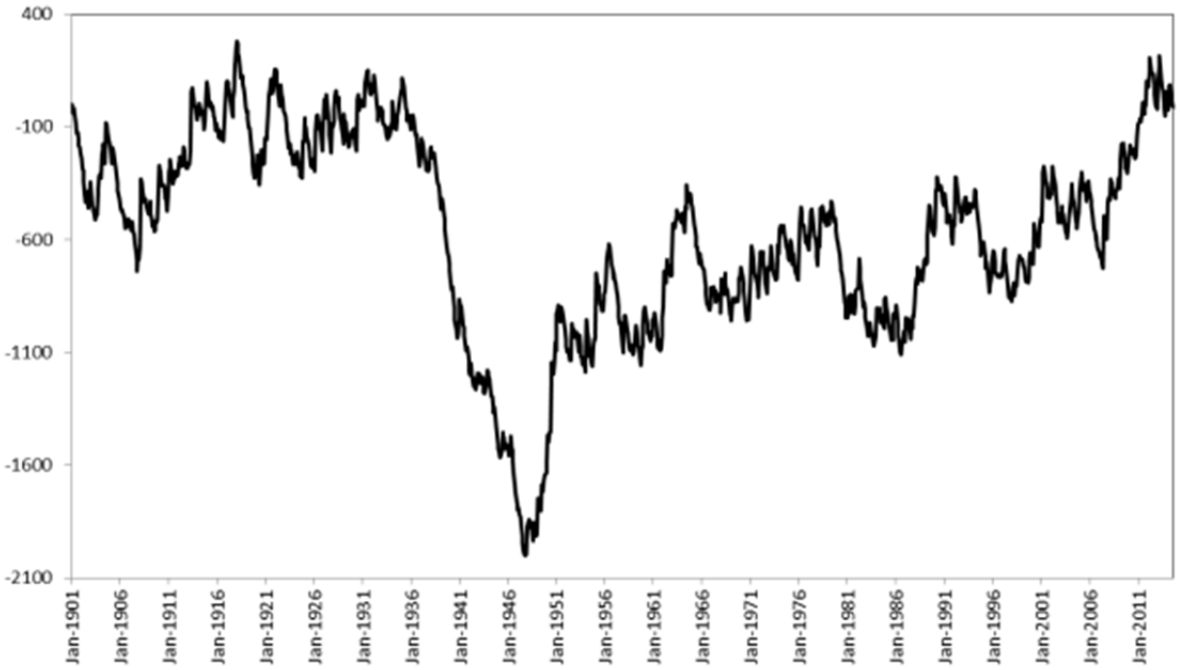


Figure 4: CRD Curve for Jerry's Plains Post Office (1901-2014)*

*(Latest available data to 17 Apr 2014)

2.1.3 Geology

Wambo is located in the Hunter Coalfield, which occupies the north-eastern portion of the Sydney Basin. The area covered by the GWMP is underlain by the Permian Singleton Coal Measures as well as Quaternary alluvial sediments along watercourses. This is underlain by the Permian Maitland Group which consists of siltstone, sandstone and conglomerate.

The stratigraphy at Wambo is summarised in **Table 4**. This information has been sourced from the Hunter Coalfield Regional Geology 1:100,000 map (NSW Department of Mineral Resources, Edition 2, 1993). The target coal seams at Wambo are all within the Jerry's Plains Subgroup of the Wittingham Coal Measures.

Table 4: Stratigraphic Sequence

Period	Supergroup	Group	Subgroup	Lithology
Quaternary				Alluvium
Permian	Singleton	Newcastle	Glen Gallic Subgroup	

Period	Supergroup	Group	Subgroup	Lithology
	Supergroup	Coal Measures (Wollombi Coal Measures)	Doyle's Creek Subgroup	
			Horseshoe Creek Subgroup	
			Apple Tree Flat Subgroup	
			Watts Sandstone	Medium to coarse-grained sandstone
		Wittingham Coal Measures	Denman Formation	Sandstone siltstone laminite
			Jerry's Plains Subgroup	Whybrow Seam Redbank Creek Seam Wambo Seam Whynot Seam Blakefield Seam Woodlands Hill Seam Arrowfield Seam Bowfield Seam
			Archerfield Sandstone	Well sorted quartz lithic sandstone
			Vane Subgroup	
			Saltwater Creek Formation	Sandstone, siltstone, minor coaly bands

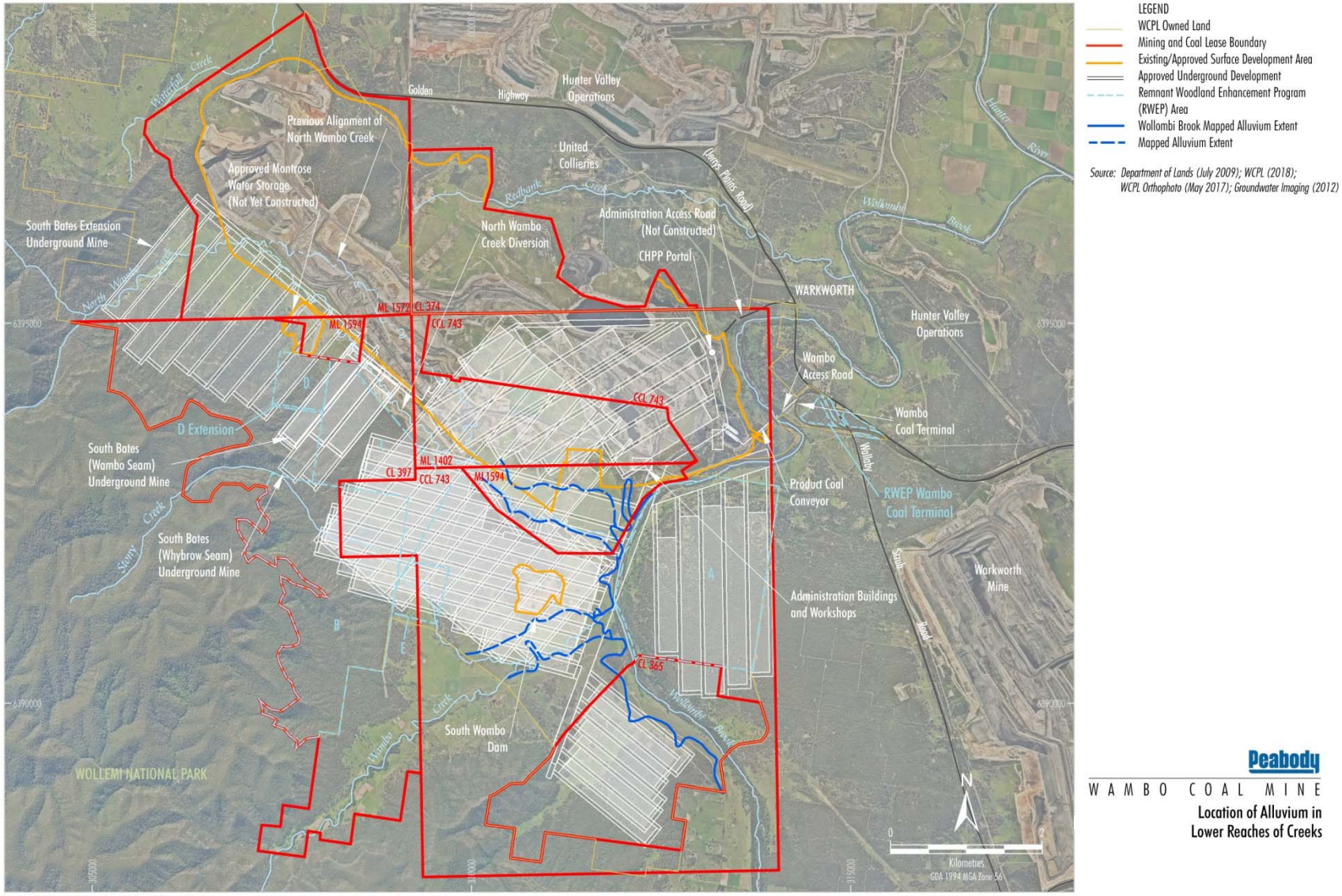
Approximate boundaries of Quaternary alluvial sediments in the vicinity of Wambo are shown in **Figure 5 (Section 2.1.4)** and have been derived from the Hunter Coalfield Regional Geology 1:100,000 map (NSW Department of Mineral Resources, Edition 2, 1993). The coal measures are overlain by the Triassic Narrabeen Group which outcrops to the south and west of Wambo but is not present within the mining lease area (Heritage Computing, 2012).

A transient electromagnetic (TEM) survey (Groundwater Imaging, 2012) was carried out to investigate the extent and thickness of alluvium along the lower reaches of (South) Wambo Creek and North Wambo Creek. The extent of alluvial sediments determined from that study is also presented on **Figure 5.**

2.1.4 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; and
  - low to moderately permeable coal seams, which are the prime water-bearing strata within the Permian measures.



WAM-09-15_Sth Bates EP_Longwalls11-16_WMP_SWMP_203B

Figure 5: Location of Alluvium in Lower Reaches of Creeks

2.1.4.1 Alluvial Water Sources

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).

A section of North Wambo Creek has been diverted to skirt the Wambo Open Cut. The alluvial flow in North Wambo Creek has been altered by the historical and existing mining operations including the removal of alluvium across the full width of the channel with consequent partial desaturation of the adjacent upstream and downstream alluvium.

Based on a review of groundwater quality and the results of the search of the NSW Bore Database (**Section 2.1.5.1**) 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.

2.1.4.2 Permian Groundwater Sources

The fractured and porous groundwater sources within the Permian strata consist of both the coal seams and the interburden layers. It is considered that pre-mining piezometric head in the Permian groundwater sources would have closely resembled topographic levels. 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, 2014).

The permeability of the Permian rock units is generally low and decreases with depth. This is due to a decrease in weathering and 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.

2.1.5 Groundwater Receptors

2.1.5.1 NSW Bore Database Search

A search of the NSW Bore Database (in 2014) was undertaken to identify registered bores within a 5 km radius of Wambo at the time of establishing baseline conditions. The search identified 72 bores, with the majority (44) registered as monitoring/test bores and located within WCPL tenement boundaries (namely ML 1402, CL 743 and ML 1594). There were 10 bores identified as mining/dewatering bores and 3 bores were of unknown use. The remainder are registered for irrigation, domestic and/or stock use (15).

Bore details are outlined in **Table 5** and approximate bore locations are shown in **Figure 6.**

Table 5: Results of NSW Bore Database Search (at 2014)

Figure 6 Ref.	Bore No.	Licence No.	Location		Use	Depth (m)	SWL (bgl)	Salinity (ppm)	Yield (L/s)	Aquifer
			mE	mN						
1	GW080963	20BL170103	315994	6397210	Monitoring	84	60		5	Gravel Clay
2	GW047240	20CA209896	316826.7	6397095	Irrigation	12.7				
3	GW200621	20BL168887	312857	6395909	Monitoring	37	24.89	5695		
4	GW200622	20BL168887	312901	6395806	Monitoring	30	29.95	4050		
5	GW200943	20BL167947	312332	6395760	Test	30	27			
6	GW200942	20BL167947	312325	6395750	Test	37	32			
7	GW200623	20BL168887	312982.1	6395319	Monitoring	31	13.84	11500		
8	GW080516	20BL168883	312898.8	6394954	Test	15	7.11	950		Sandy Clay
9	GW060750	20BL132130	314309.8	6394923	Domestic	24.4	7.8		1.25	
10	GW080952	-	314643	6394905	Unknown	1.6	1.59			Sandy Clay / Gravel / Clay
11	GW080951	-	314619	6394878	Unknown	3.1	3.14			
12	GW079060	-	314595.5	6394852	Unknown	14.6				
13	GW079059	20BL153300	314595.5	6394852	Monitoring	0		5147		
14	GW080513	20BL168880	312345	6394818	Test	10	7.53			
15	GW080515	20BL168882	313418	6394794	Monitoring	8.1	5.7	8690		
16	GW080517	20BL168884	313572.7	6394742	Monitoring	15	7.24	3600		
17	GW200835	20BL172256	308424	6394517	Monitoring	11				
18	GW005327	20BL009540	314682.9	6394498	Stock	10.4	6.1	Excellent	0.13	
19	GW200616	20BL168886	313473.4	6394446	Monitoring	8.5	5.68	8360		
20	GW080514	20BL168881	310973	6394353	Monitoring	55	42.7	6300		Coarse Sand
21	GW200615	20BL168886	313434	6394246	Monitoring	11.5	7.49	7160		
22	GW080518	20BL168885	313585.8	6394232	Monitoring	10.8	6.95	53000		
23	GW080519	20BL168885	313622.4	6394161	Test	10.5	7.42	6490		
24	GW200620	20BL168888	310489.4	6394097	Monitoring	49	39.09	4700		
25	GW200617	20BL168888	309987.4	6393974	Monitoring	9	4.75	710		
26	GW079780	-	309588.9	6393932	Monitoring	0				
27	GW037184	-	309685	6393911	Test	21				
28	GW038579	-	309737.7	6393882	Test	20.9				
29	GW060328	-	314205.2	6393534	Mining	10	7			
30	GW060327	-	314180.8	6393442	Mining	9.8	6.7	0-500		
31	GW200829	20BL172237	308641	6393376	Monitoring	36				
32	GW200625	20BL168940	310901	6393375	Mining	270				

Figure 6 Ref.	Bore No.	Licence No.	Location		Use	Depth (m)	SWL (bgl)	Salinity (ppm)	Yield (L/s)	Aquifer
			mE	mN						
33	GW060326	-	314104.3	6393348	Mining	9.8	6.7			
34	GW200828	20BL172237	310061	6393206	Monitoring	11.5				
35	GW060364	-	311636.3	6392808	Mining	5.1				
36	GW043676	-	311479.9	6392805	Test	10.6				
37	GW200830	20BL172240	313335	6392745	Monitoring	16.8				
38	GW037999	-	311481.6	6392713	Irrigation	13.7				
39	GW060365	-	311690.8	6392686	Irrigation	6.6				
40	GW200624	20BL168939	310165.9	6392650	Dewatering	260	6			
41	GW060366	-	311195.9	6392646	Irrigation	5.2				
42	GW038000	-	311457.3	6392620	Irrigation	9.4				
43	GW037998	-	311589.4	6392530	Irrigation	10.9				
44	GW043675	-	311432.9	6392527	Test	8.5				
45	GW043674	-	311302.6	6392525	Test	8.2				
46	GW060329	-	311903.5	6392474	Mining	6.4				
47	GW043673	-	311486.3	6392467	Test	9.4				
48	GW060363	20BL132753	311697.8	6392317	Mining	6.3				
49	GW200361	20BL170638	311832.9	6392209	Test	0	3.12			
50	GW060330	-	311726.7	6392163	Mining	6.2	3.8	0-500		
51	GW200827	20BL172237	312505	6391469	Monitoring	9				
52	GW017462	20BL008224	315339.2	6391460	Farming	0				
53	GW200634	20BL168999	311470	6391252	Monitoring	20		13000		
54	GW200635	20BL168999	311659	6391236	Monitoring	20		23300		
55	GW200638	20BL168999	311452	6391103	Monitoring	20	5.18			
56	GW200637	20BL168999	311662	6391094	Monitoring	15	8.45	17900		
57	GW200636	20BL168999	311749	6391078	Monitoring	20		4790		
58	GW200641	20BL168999	311761	6390921	Monitoring	20	7.01	1210		
59	GW200640	20BL168999	311638	6390920	Monitoring	50		1210		Coarse Sand
60	GW200639	20BL168999	311455	6390889	Monitoring	20				
61	GW065117	-	311153.9	6390735	Irrigation	6				
62	GW200642	20BL168999	311696	6390688	Monitoring	20	15.12	6230		
63	GW200643	20BL168999	311454	6390685	Monitoring	15				
64	GW066606	-	311207.2	6390674	Domestic	2.5				
65	GW078574	20BL167170	309174.3	6390605	Farming	12				

Figure 6 Ref.	Bore No.	Licence No.	Location		Use	Depth (m)	SWL (bgl)	Salinity (ppm)	Yield (L/s)	Aquifer
			mE	mN						
66	GW078055	-	310104.9	6390490	Test	198.5		1660	3-May	
67	GW080502	20BL168017	308897	6390160	Mining	250	105			Coarse Sand
68	GW078577	20WA208559	309968.7	6389973	Domestic	10				
69	GW078576	20BL167172	309763.7	6389784	Farming	7				Gravel, Shale Grey Siltstone, Sandstone Conglomerate
70	GW078575	20BL167171	309504.8	6389687	Farming	12				
71	GW200834	20BL172257	313695	6389546	Monitoring	15				Shale, coal, fractured, with fragments of quartz
72	GW200833	20BL172255	311340	6389530	Monitoring	54				Fractured Shale, Coal

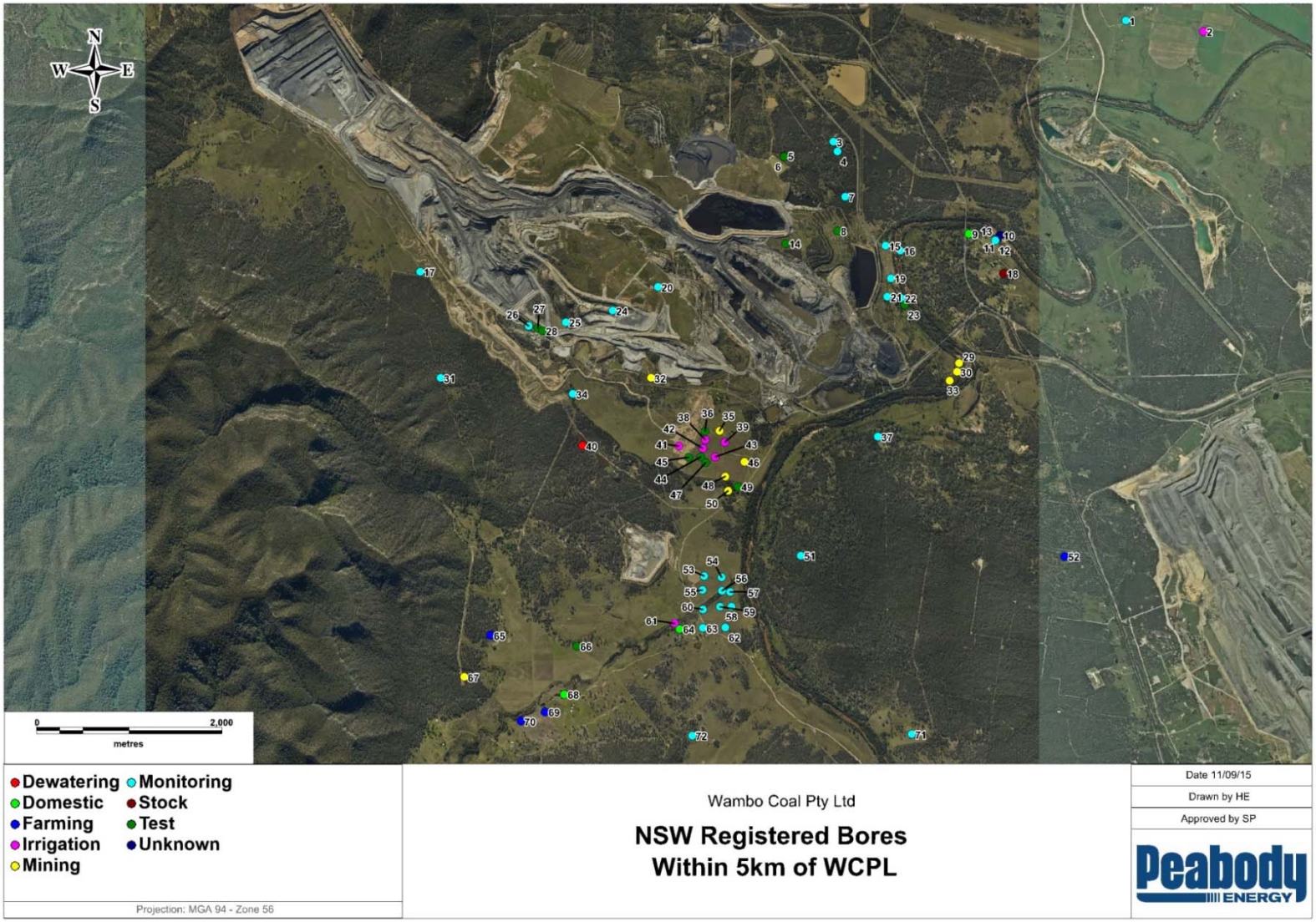


Figure 6: NSW Bore Database Search Results (at 2014)

2.1.5.2 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 surface 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.

Further investigations into the likely level of groundwater dependence of the vegetation in the South Bates Extension Area will be conducted as required under Schedule 4, Condition 36A of DA305-7-2003.

2.1.6 Mining History

Substantial coal mining activity has occurred historically and is continuing currently in the vicinity of Wambo, by a number of companies, with development across several coal seams. Coal is extracted by means of both underground and open cut mining methods. Coal mines neighbouring Wambo include United Colliery to the north and east of Wambo, Mt Thorley Warkworth to the south-east, and a number of open cut and underground mines to the north and east within the Hunter Valley Operations, as shown in **Figure 3.**

Open cut mining at Wambo commenced in 1969. During the 1970s, development consents were issued for a range of open cut and underground mining operations. The Whybrow, Redbank Creek, Wambo and Whynot Seams have primarily been mined by open cut methods at the WCPL Coal Mine. The Wambo Seam was also mined for a short period in the Wambo No. 1 Underground Mine, however was abandoned due to hydrological issues (Australian Groundwater Consultants Pty Ltd (AGC), 1989). The Whybrow Seam was also mined from the Ridge Underground in this early period.

The Wollemi Underground Mine commenced production in 1997 and was placed under care and maintenance in October 2002 after the available longwall reserves were exhausted. Open cut operations were suspended between March 1999 and August 2001. Following the closure of the Wollemi Underground Mine in October 2002, open cut operations were expanded to maintain an overall production rate of 3 Mtpa of product coal.

Development of the North Wambo Underground Mine commenced in November 2005, with longwall operations in the Wambo Seam commencing in October 2007. Longwall extraction at the North Wambo Underground Mine finished in January 2016. Underground mining previously occurred both above and below the Wambo Seam at North Wambo Underground Mine. The adjacent United Colliery mined the lower Arrowfield Seam until 2010 (United Underground Mine) directly beneath portions of the North Wambo Underground Mine.

Development of the South Bates Underground Mine commenced in October 2014 and longwall mining commenced in the Whybrow Seam (Longwalls 11 to 13) in February 2016. Mining operations progressed to the Wambo Seam (Longwalls 14 to 16) in July 2017.

Approval was granted in December 2017 (MOD17) for mining of nine additional longwall panels in the Whybrow seam at the South Bates Extension Underground (Longwalls 17 to 25), with extraction of these longwalls scheduled to commence in September 2018.

2.1.7 Review of Baseline Data

2.1.7.1 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 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 6**.

Table 6: 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/WEATHERED 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 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 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 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 7** 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 Water Dam may be attributable to these increasing trends.

At 2014, the decreasing trends in groundwater levels at a number of the alluvial bores were considered possibly attributable to mining related activities. The decreasing trends in groundwater levels within North Wambo Creek alluvium 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 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 Wollombi Brook alluvium 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. This bore 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, however this was discounted[1]. 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 P203 had been steady over the same time period. At Whybrow Seam interburden bore P202, groundwater EC increased from 3,490 µS/cm in October 2011 to 6,610 µS/cm in June 2014.

2.1.7.2 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.

2.1.7.3 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.

[1] The results of an investigation were reported in the 2016 Annual Review (HS 2016a). HydroSimulations did not find any evidence supporting the seepage of saline mine water from South Wambo Dam towards Wollombi Brook.

Table 7: 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//WEATHERED REGOLITH															
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
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
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
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
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
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
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
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
P203	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

2.2 Current Monitoring and Management

2.2.1 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 that contain a water level logger that continuously monitors groundwater levels.

Wambo has also been monitoring standing water levels and quality in a number of private bores since 2005.

The groundwater monitoring network includes a number of bores that are part of the United Colliery monitoring network. At present there are 42 sites in the Wambo groundwater monitoring network, supplemented by another seven sites from the United Colliery monitoring network. Vibrating wire piezometers (VWPs) have been installed to monitor water levels in the Permian measures at nine Wambo sites and two United sites. These piezometers are downloaded on a quarterly basis.

Four bores in the Wambo network have hydrostatic level transducers fitted to monitor water levels in real time. These data are monitored in real time by the SCADA system and any rise in level outside normal levels is communicated via alarm emails sent to distribution lists of appropriate personnel.

In November 2017 a groundwater drilling program was undertaken in the vicinity of North Wambo Creek. The program consisted of 12 drill holes at 10 sites, four of which (two shallow and two deep) were constructed as permanent monitoring bores. The site locations were determined by WCPL and provided to DoI Water for consultation. DoI Water indicated that further drill holes may be required. The lack of groundwater identified during the drilling indicates that further drilling would provide limited additional information.

In late 2017 and early 2018, two additional monitoring bores (P316 and P319) were established adjacent to shallow piezometers P114 and P116 (as requested by DoI Water), with VWPs installed. Monitoring bore P317 was established and augmented with United monitoring bore UG 139 to monitor depressurisation above South Bates Extension.

Monitoring bores P320, P321 and UG166A were included in the program to monitor the effects of the open cut to the north-west. Monitoring bore P318 was included in the program to establish baseline groundwater conditions to the south prior to the commencement of South Wambo Underground.

Details of the groundwater bores at Wambo are summarised in **Table 8** and locations are shown in **Figure 7**.

Table 8 : Groundwater Monitoring Bore Details

Bore	Lithology	Easting	Northing
Wambo Monitoring Network			
P106	Wambo Creek Alluvium	311518	6391082
P109	Wambo Creek Alluvium & Underlying Interburden	311215	6390766
P114	Wambo Creek Alluvium (or regolith)	311205	6391271
P116	Wambo Creek Alluvium (or regolith)	311511	6391292
P202	Whybrow Interburden	311854	6391262
P203[7]	Whybrow Interburden	311777	6391261
P301	Whybrow Interburden	309360	6391466
P315	Stony Creek Alluvium/Regolith	309084	6391856
P316	Ref P114_116 - 10mBGL_Alluvium, 25mBGL_Regolith, 50.63mBGL_Regolith-Overburden, 72.26mBGL_Whybrow Seam	311252	6391128
P317	Ref SBUE_17ST_15a – RDH987_35m Regolith, RDH987_100m overburden, RDH987_174m_Whybrow (WWC), RDH987_213m_Wambo(WRC), RDH987_248.5m_Wambo (WMA)	307115	6394439
P318	Ref SW28_11m Regolith, SW28_150.79m Whybrow (D2), SW28_205.25m Wambo (WMA), SW28_357m Arrowfield (AFA)	312599	6388922
P319	Ref SW64_11 Regolith (RDH988), SW64_74.9m Whybrow, SW64_161.3m Wambo, SW64_265.3m Interburden sandstone	311125	6391412
P320	Ref A444_EX11A – WJ175_VWP1_344m Middle Barrett, WJ175_VWP2_305m Lower Arties, WJ175_VWP3_263m Pikes Gully, WJ175_VWP4_217.5m Bayswater, WJ175_VWP5_191m Vaux, WJ175_VWP6_92m Warkworth	307573	6398890
P321	Ref EX06_31.8m Arrowfield(AFA, AFB, AFC piles), EX06_72.1m Warkworth (WKD ply), EX06_161.15m Vaux, EX06 187.82m Bayswater	307999.8	6399498.9
GW02[1]	Wambo Creek Alluvium	309109	6389683
GW08	North Wambo Creek Alluvium	311792	6392268
GW09	North Wambo Creek Alluvium	311641	6392564
GW11[1]	Wambo Creek Alluvium	309232	6389704

Bore	Lithology	Easting	Northing
GW12[5]	Stony Creek Alluvium / Whybrow Interburden	309841	6391000
GW13	Wollombi Brook Alluvium	313695	6389545
GW14[2]	Regolith	312507	6391479
GW15	Wollombi Brook Alluvium	313330	6392747
GW16	North Wambo Creek Alluvium	306639	6396171
GW17	North Wambo Creek Alluvium	306889	6396100
GW18[2]	North Wambo Creek Alluvium	310061	6393202
GW19[2]	Alluvium/Whybrow Interburden	308426	6394516
GW21	Whybrow Coal Interburden	308647	6393375
GW22	Whybrow Coal Interburden	311341	6389535
N2[3]	Permian Overburden, Whybrow Seam, Redbank Creek Seam, Wambo Seam	308663	6393376
N3[3]	Permian Overburden, Whybrow Seam, Redbank Creek Seam, Wambo Seam	308314	6394575
N5[3]	Permian Overburden, Whybrow Seam, Redbank Creek Seam, Wambo Seam	306755	6395963
BH2A[4]	Whybrow Seam	308868	6390096
BH2[4]	Whybrow Seam	308867	6390147
BH4C[4]	Whybrow Seam	309323	6391080
BH1F	Whybrow Seam	310144	6391552
BH1G	Whybrow Seam	310104	6391551
WAMBORE SOUTH	Wambo Seam	311812	6392555
WAMBO-03[4]	Wambo Seam	311699	6392752
GW23	North Wambo Creek – Consolidated Bedrock (Deep)	305791	6395668
GW24	North Wambo Creek - Unconsolidated sediments (Shallow)	305789	6395670
GW25	North Wambo Creek – Consolidated Bedrock (Deep)	305299	6395288
GW26	North Wambo Creek –Unconsolidated sediments (Shallow)	305297	6395291
United Colliery Monitoring Network			
P1	Coal Measure Overburden	312198.64	6395839.7

Bore	Lithology	Easting	Northing
P3	Blakefield Seam	313411.79	6395006.3
P11	Blakefield Seam	312727.99	6395461.9
P16	Wollombi Brook Alluvium	313479.53	6394654.9
P20	Wollombi Brook Alluvium	313638.76	6394166.4
UG166A	South Bates Extension Area (263 - Unnamed D Seam; 281 - Unnamed E Seam; 319 - Interburden; 329 - Glen Munro Seam; 375 - Interburden; 382 - Arrowfield Seam; 402 – interburden)	306488	6398075
UG139	130 - Unnamed D Seam; 153 - Unnamed E Seam; 183 - Blakefield Seam; 200 - Glen Munro Seam; 238 - Arrowfield Seam; 254 - Bowfield Seam; 260 - Bowfield Seam	306665	6395172

Note:

1. Private Bores
2. GW14 has been dry since December 2011. GW18 has been dry since October 2010 and GW19 has been dry since monitoring began in 2009.
3. Contains a Vibrating Wire Piezometer (VWP).
4. Contains hydrostatic level transducers (monitored by SCADA system)
5. A number of alluvial bores are also screened within the underlying interburden
6. NWC – North Wambo Creek .
7. Also known as P206.

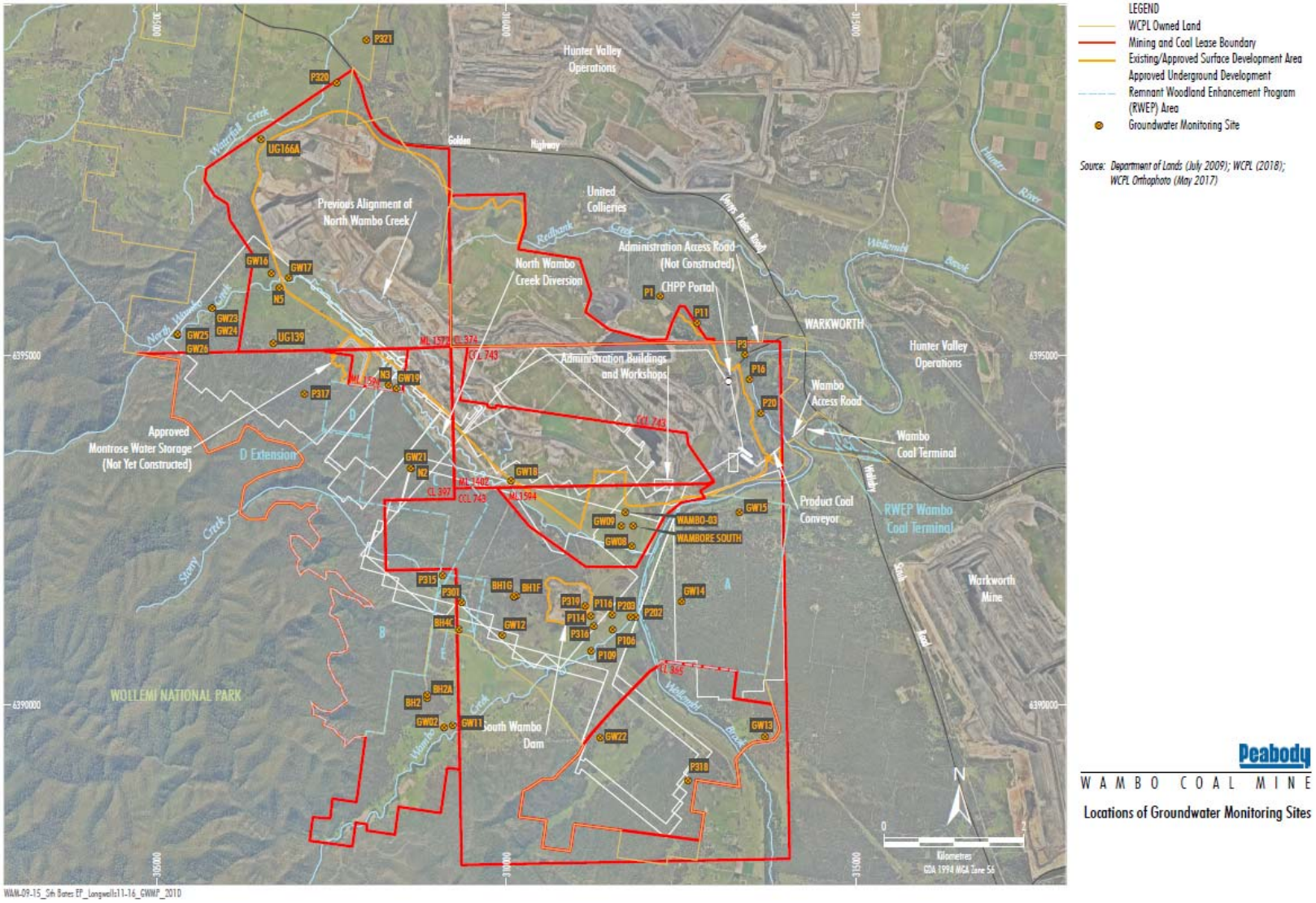


Figure 7: Wambo Groundwater Monitoring Bore Locations

2.2.2 Site Water Balance

A site water balance is undertaken annually to document the management of water at Wambo in accordance with Schedule 4, Condition 25 of DA 305-7-2003. Summary results are reported in the Annual Review report which is available on the Peabody Energy Australia website https://www.peabodyenergy.com/Operations/Australia-Mining/New-South-Wales-Mining/Wambo-Approvals,-Plans-Reports .

2.2.3 Hydrogeological Model

Recent Groundwater Assessments were completed by HydroSimulations for the South Wambo Modification (Modification 12 in April 2016) and South Bates Extension Modification (Modification 17 in July 2017) (HydroSimulations 2016a and 2017). Numerical modelling was undertaken to inform the Groundwater Assessment 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.

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.

2.2.4 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 6**). 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.

3.0 Groundwater Triggers

Groundwater triggers for both groundwater levels and quality have been developed using statistical analysis of the baseline data (**Section 2.1.7**) 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 4.0**. Reporting requirements for this GWMP are detailed in **Section 6.0**.

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

3.1 Trigger Values for Groundwater Levels

3.1.1 Alluvial Monitoring Locations

Statistical analysis of groundwater levels in shallow bores has been undertaken in **Section 2.1.7.1**. The results of this analysis indicate that shallow groundwater levels are highly responsive to rainfall.

Trigger values have been adopted for shallow bores 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 9. 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) exceed or fall below the specified depth to groundwater.

Table 9 Shallow Bores Water Level Trigger Values

Bore	Minimum (10th percentile)		Maximum (90th percentile)	
	Depth to Groundwater (mBTOC[4])	Level (m AHD)	Depth to Groundwater (mBTOC[4])	Level (m AHD)
P106	6.6	54.5	10.7	50.4
P109	4.6	57.8	6.7	55.7
P114	5.4	56.0	7.6	53.8
P116	4.8	54.2	7.3	51.7
P202	7.8	52.5	9.6	50.7
P203	16.1	44.1	21.6	38.6
P301[1]	NA	NA	NA	NA
P315	4.4	90.3	9.1	85.6
GW02	5.8	76.7	8.5	74.0
GW08[2]	NA	NA	NA	NA
GW09[2]	NA	NA	NA	NA
GW11	4.0	76.0	6.5	73.5
GW12	9.9	77.4	12.9	74.4
GW13	4.8	57.8	5.4	57.2
GW15	10.4	52.0	11.1	51.3
GW16[3]	NA	NA	NA	NA
GW17[3]	NA	NA	NA	NA

Bore	Minimum (10th percentile)		Maximum (90th percentile)	
	Depth to Groundwater (mBTOC[4])	Level (m AHD)	Depth to Groundwater (mBTOC[4])	Level (m AHD)
P16	7.1	50.4	7.8	49.7
P20	7.1	50.3	8.2	49.2

1. P301 is predicted to go dry by HydroSimulations (2014), therefore no trigger level has been established – i.e. the purpose of trigger levels is to identify unanticipated impacts.
2. WCPL will install replacement bores in the North Wambo Creek alluvium in areas that are not located above the old Wambo No 1 Seam workings. Trigger levels will be established for these bores based on modelled groundwater levels and will replace the GW08 and GW09 in this table.
3. 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 these two bores is not considered warranted. Monitoring data will be reviewed annually at these bores.
4. mBTOC = metres below top of casing

3.1.2 Chitter Dam and South Wambo Water Dam Monitoring Locations

As outlined in **Section 4.1.6**, WCPL is required to monitor impacts from the Chitter Dam and South Wambo Dam.

The Chitter Dam was drained and decommissioned by WCPL in 2016, and therefore monitoring in relation to this dam is no longer required. WCPL will monitor groundwater levels in P114, P116 and P202 (near South Wambo Water Dam). South Wambo Water Dam was constructed in August 2009 and is currently not in use.

Two additional monitoring bores have been included in the program from 2018 (P316 and P319). Data from these bores has not been included in analyses at this stage.

3.1.3 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. However groundwater levels and quality are monitored to assist in validation of the groundwater model and for review of general groundwater behaviour.

Therefore, groundwater level trigger values have not been established for Permian groundwater bores, since it is predicted by HydroSimulations (2014) that levels will fall below baseline levels. Hydrographs within these sources will be reviewed annually in combination with a review of subsidence parameters.

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 6.2**). Data will also be used to validate the groundwater model.

3.2 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). Although ANZECC and ARMCANZ (2000) 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 10**).

As described in **Section 2.1.7.1**, 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 two consecutive bi-monthly monitoring events (over a 4-month interval) (**Table 10**).

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 10: 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)
P106	941	6.7	7.9
P114	6141	6.5	7.8
P116	5972	6.6	7.5
P202	8172	6.7	7.7
P203	2630	7.3	8.1
P301[1]	NA	NA	NA
P315	552	6.0	7.4
GW02	715	6.7	7.4
GW11	592	6.8	7.5
GW13	4370	6.9	7.1
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. P301 is predicted to go dry by HydroSimulations (2014), therefore no trigger level has been established – i.e. the purpose of trigger levels is to identify unanticipated impacts.
2. 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.

3.3 Performance Indicators

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 11,** will be used to assess the performance of the Mine against the predicted impacts. North Wambo Underground operations were completed in December 2015.

Table 11: 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 9** of the GWMP
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 10** of the GWMP

Specific performance indicators have been developed also for the subsidence impact performance measures relating groundwater in Section 3.1.3 of the Extraction Plan for South Bates Underground Mine Longwalls 11 to 16 (SBU Extraction Plan). 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 12**, will be used to assess the performance of the Mine against the predicted impacts.

Table 12: 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.
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.

WCPL will report on progress against these performance indicators in the Annual Review (**Section 6.2**). In the event that a complaint is received relating to groundwater, it will be handled in accordance with the complaints management protocol (**Section 5.0**). Contingency plans for unpredicted groundwater impacts are discussed in the Extraction Plan and the SGWRP.

4.0 Groundwater Monitoring Program

The purpose of this GWMP is to monitor and manage 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. Monitoring locations, parameters, frequency and methodology of monitoring are outlined in this section.

Data collected will:

- Enable verification and refinement (where necessary) of the hydrogeological model developed for Wambo;
- Be used in the continued development of groundwater investigation triggers (**Section** 3.0); and
- Provide input to annual reviews of groundwater monitoring data (**Section 4.4**).

4.1 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.

4.1.1 Groundwater Monitoring Bores

Wambo's groundwater monitoring network consists of purpose-constructed monitoring bores (also referred to as piezometers) and water supply bores. The GWMP includes the monitoring of water levels and water quality. **Table 13** provides a summary of WCPL's proposed groundwater monitoring program. Bore locations are described in **Table 8** and shown on **Figure 7 (Section 2.2.1)**.

Table 13: Groundwater Monitoring Program

Monitoring Locations	Parameters Monitored	Lithology Monitored	Monitoring Frequency*
P1, P3, P11	• Depth to water. • EC. • pH. • Temperature.	Alluvium	Bi-monthly [from December 2005]
P16, P20	• Depth to water. • EC. • pH. • Temperature.	Alluvium	Bi-monthly [from December 2005]

Monitoring Locations	Parameters Monitored	Lithology Monitored	Monitoring Frequency*
	• TDS, Na, K, Mg, Ca, Cl, HCO_3, $CaCO_3$, SO_4 and metals (Cu, Zn, Fe, Al, Ni, Mn, Ba, Pb, As, Se).		Annually [from July 2015]
P106, P109, P114, P116,	• Depth to water. • EC. • pH. • Temperature.	Alluvium/Colluvium	Bi-monthly [from July 2003]
	• TDS, Na, K, Mg, Ca, Cl, HCO_3, $CaCO_3$, SO_4 and metals (Cu, Zn, Fe, Al, Ni, Mn, Ba, Pb, As, Se).		Annually [from July 2015]
P202, P203	• Depth to water. • EC. • pH. • Temperature.	Shallow Permian, Overburden	Bi-monthly [from July 2003]
	• TDS, Na, K, Mg, Ca, Cl, HCO_3, $CaCO_3$, SO_4 and metals (Cu, Zn, Fe, Al, Ni, Mn, Ba, Pb, As, Se).		Annually [from July 2015]
P301, P315	• Depth to water. • EC. • pH. • Temperature.	Alluvium, Shallow Permian. Overburden	Bi-monthly [from March 2004]
P316	• Groundwater Pressure.	Alluvium/Regolith, Permian Overburden, Whybrow Seam	Continuous (downloaded quarterly) [from March 2018]
P317, P318 P319, P320, P321, UG166A, UG139	• Groundwater Pressure.	Various (Refer Section 2.2.1)	Continuous (downloaded quarterly) [from March 2018]
	•		
GW02^, GW08, GW09, GW11^	• Depth to water. • EC. • pH. • Temperature.	Alluvium	Bi-monthly [from July 2005]
	• TDS, Na, K, Mg, Ca, Cl, HCO_3, $CaCO_3$, SO_4 and metals (Cu, Zn, Fe, Al, Ni, Mn, Ba, Pb, As, Se).		Annually [from July 2015]
GW12, GW13, GW15, GW16, GW17, GW21, GW22	• Depth to water. • EC. • pH. • Temperature.	Alluvium, Shallow Permian. Overburden	Bi-monthly [from December 2009]
	• TDS, Na, K, Mg, Ca, Cl, HCO_3, $CaCO_3$, SO_4 and metals (Cu, Zn, Fe, Al, Ni, Mn, Ba, Pb, As, Se).		Annually [from July 2015]
GW23, GW24, GW25 and GW26	• Depth to water. • EC. • pH. • Temperature	Alluvium and consolidated bedrock	Bi-monthly [from March 2018]

Monitoring Locations	Parameters Monitored	Lithology Monitored	Monitoring Frequency*
N2, N3, N5	• Groundwater Pressure.	Alluvium, Permian Overburden, Whybrow Seam, Redbank Seam, Wambo Seam	Continuous (downloaded quarterly)
BH2, BH2A, BH4C, Wambo-03	• Depth to Water	Whybrow Seam, Wambo Seam	Continuous (real time)
BH1G, BH1E, Wambore South	• Depth to Water	Whybrow Seam, Wambo Seam	Monthly

Notes: ^ Private Bores
* Bi-monthly = every 2 months

The overall objectives of the GWMP are to establish baseline groundwater quality and water level data and implement a program of data collection that can be utilised to assess potential impacts of mining activities on the area's groundwater resources. From a hydrogeological perspective, the Wambo region is relatively complex. This is due to the various areas of alluvium, proximity to Wollemi National Park and number of historical and current mining developments.

A key component of the GWMP is the establishment of an effective network of long-term monitoring sites that will enable any impacts on groundwater to be readily identified. Particular areas of alluvium that will require monitoring are those associated with Wollombi Brook, Wambo Creek (also known as South Wambo Creek), North Wambo Creek and Stony Creek. Significant underground mining has already been undertaken above a large portion of WCPL's underground mining areas and depressurisation has extended above the historical workings.

The GWMP 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 of an independent review of WCPL's GWMP in 2008 and the results of the 2008 Geophysical Report for the upper section of North Wambo Creek.

Additional monitoring bores may be required in the future as open cut and underground mining is undertaken in new areas. Any additional monitoring locations should target alluvial groundwater and areas where depth of cover above the seam is lowest. Any additional monitoring bores should be installed so that at least two years of monitoring data are collected prior to undermining. All new monitoring bores are to be constructed in accordance with the Minimum Construction Requirements for Water Bores in Australia (NUDLC, 2011).

4.1.2 Decommissioning of Bores

Decommissioning of monitoring bores will be undertaken in accordance with NUDLC (2011) requirements. 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.

4.1.3 Monitoring Parameters and Frequency

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.

4.1.4 Inflows to Open Cut Pits

As reported in the Site Water Balance (WorleyParsons, 2014), Wambo open cut pits receive inflows from:

- Bates North open cut pit via the old creek alluvial material whenever the adjacent creek flows;
- Seepage into Bates South open cut pit from the Homestead Pits water storage. The Homestead Pits water storage receives underground dewatering.

Metering of daily dewatered volumes from each of the Wambo open cut pits will be undertaken. These dewatered volumes will be incorporated into the site water balance on an annual basis to determine the inflows from groundwater sources, including alluvial aquifers, and to verify whether WCPL holds sufficient groundwater licence entitlements.

The water quality of inflows to the open cut 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 would be investigated by Wambo. If warranted, direct measurement of water quality at the source of inflow may be conducted.

4.1.5 Inflows to Underground Workings

The active South Bates Underground Mine workings in the Whybrow and Wambo Seams are currently being dewatered.

Dewatering volumes and underground water levels will be recorded on a daily basis during pumping. This 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 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 DoI Water.

WCPL must notify DoI 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 would be investigated by Wambo. If warranted, direct measurement of water quality at the source of inflow may be conducted.

4.1.6 Chitter Dam and South Wambo Water Dam Monitoring Program

In accordance with Consent Condition 34(e), Schedule 4 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, and therefore monitoring in relation to this dam is no longer required.

To detect potential sub-surface water loss from South Wambo Dam, WCPL will monitor existing groundwater monitoring bores P114, P116 and P202 and surface water quality of 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 bores.

South Wambo Dam has been drained as far as practical since January 2015. South Wambo Dam will only be recommissioned after further geotechnical assessment, structural repairs and following relevant consultation with NSW Dams Safety Committee and NSW Department of Resources and Geosciences.

If, once the dam is recommissioned, the monitoring data from groundwater monitoring bores P16, P20, P114, P116 and P202 indicates that the dam is potentially leaking, WCPL will:

- Notify the relevant authorities, including the NSW Dams Safety Committee;
- Drain the dam as far as practical;
- Engage a suitably qualified person to undertake a technical assessment of the dam to determine the source and nature of the leak and develop an action plan to address the issue; and
- Investigate the risk of potential impact on water quality in Wollombi Brook, including undertaking necessary water quality testing as required.

4.1.7 Montrose Dam Monitoring Program

WCPL will develop a program to investigate and monitor potential water loss from the Montrose Dam prior to construction in accordance with Consent Condition 34(e), Schedule 4 of DA305-7-2003.

4.2 Methodology

Groundwater monitoring will consider the Murray-Darling Basin Groundwater Quality. Sampling Guidelines. Technical Report No 3 (Murray-Darling Basin Commission [MDBC, 1997]).

In general, the groundwater monitoring methodology will include the following:

- Gauging of groundwater levels;
- Grab sampling techniques using a bailer in accordance with WCPL instructions;
- Measurement of groundwater field parameters (pH, EC) using a calibrated water quality meter;
- If groundwater samples are to be collected, they are to be transferred into suitably preserved laboratory supplied sample containers once field parameters have stabilised;
- All sample containers are to be clearly labelled with sample number, sample location, sample depth and sample date. The sample containers are to be transferred to a chilled esky for sample preservation prior to and during shipment to the testing laboratory. A Chain-of-Custody (CoC) form should be forwarded with the samples to the testing laboratory; and
- Decontamination of all non-dedicated sampling equipment between monitoring locations.

4.3 Data Management Procedures

Validated data from the monitoring program will be entered into a digital database by an Environmental Advisor. This renders the data in a form suitable for analysis.

WCPL will record the following details for all groundwater monitoring samples:

- The date(s) on which the sample was taken;
- The point at which the sample was taken; and
- The name of the person who collected the sample.

In the event of an apparently anomalous result, WCPL will conduct a re-test as soon as is practicable to do so.

4.4 Data Review and Investigation

Upon receipt of monitoring results, the following review processes will be undertaken:

- Data will be compared to the specific trigger values where applicable (**Section 3.0**).
- If result(s) do not meet specified trigger values the response procedure will be initiated in accordance with the SGWRP.

WCPL will undertake an annual review of monitoring data to compare groundwater levels and quality to trigger levels. Recorded groundwater levels will also be compared to rainfall to identify trends. Modelled groundwater levels will be compared to monitored data and model re-calibration will be undertaken if necessary.

The annual review of data will also assess for lines of evidence for the seepage of mine water from the Chitter Dam and South Wambo Water Dam towards Wollombi Brook. Results of the review will be included in the Annual Review (**Section 6.2**).

When monitoring results exceed specified trigger values or the annual review identifies groundwater impacts, an investigation appropriate for the situation will be launched to determine the cause. The investigation will include comparison of monitoring results, meteorological patterns, mining activities and changes to land use.

Further details outlining the response procedures for exceedance of trigger values are outlined in SGWRP.

4.4.1 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 DP&E and DoI 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 which was updated by HydroSimulations in 2015 to assess the South Bates underground operations (HydroSimulations, 2015b) was not optimised at the location of GW08 and GW09, despite being well-calibrated elsewhere. Since then, HydroSimulations (2016a) has updated and recalibrated the numerical model to better replicate shallow groundwater effects in the area around GW08 and GW09.

The status of the two bores has been reassessed in recent monitoring reviews. The simulated heads at GW08 and GW09 show a good match with the trends seen in the observed data. Although simulated initial heads are lower than observed, the drawn-down heads in 2017 were near the correct level, while overestimated. During the 2017 monitoring period, observed groundwater level at GW08 has continued to decline while modelled heads show a milder response. It should be noted that GW08 was nearly dry at the end of 2017. At GW09, the bore has gone dry due to mining related drawdown, so it is not possible to compare the performance of observed groundwater level with that modelled for 2017.

4.4.2 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 4.1.6**, 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.

In a report currently under review, HydroSimulations has made assessments relating to the leakage of saline mine water from South Wambo Dam to the Wambo Creek alluvium. These assessments found no evidence for leakage from South Wambo Dam and instead show that increases in EC are associated with periods of lower groundwater level most likely related to the interception of saline Permian groundwater at the base of the Wambo Creek Alluvium.

Two additional monitoring bores in the vicinity of P114 have been included in the program from 2018 (P316 and P319). Data collected in these bores will assist with ongoing investigations into increased salinity in P114.

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.

5.0 Community Complaint Response

All groundwater related community complaints received by WCPL will be recorded within the Community Complaints Register. The E&C Manager 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 attempt to address the complainants concerns such that a mutually acceptable outcome is achieved. However, if required, the Independent Dispute Resolution Process would be referred to (**Appendix A**).

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 E&C Manager will ensure the latest Community Complaints Register is posted on the WCPL website.

6.0 Review and Reporting

6.1 Review

The performance of the groundwater monitoring program outlined in the GWMP is to be reviewed annually by the E&C Manager. A complete review of the GWMP will occur:

- Every two years;
- When there are changes to consent or licence conditions relating to groundwater monitoring;
- Prior to new underground mining areas being developed;
- Following significant groundwater related incidents at WCPL;
- Following continual exceedance of trigger values;
- Following an independent environmental audit which requires GWMP review; or
- If there is a relevant change in technology, practice or legislation.

The revised GWMP will be re-submitted to the Secretary for approval as required by Condition 30, Schedule 4 of DA305-7-2003.

6.2 Annual Review

Prior to the end of March each year, WCPL will review the environmental performance of the Mine and submit an Annual Review report to the DP&E. This report will:

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

6.3 Website Updates

A comprehensive summary of the groundwater monitoring results will be made publicly available at WCPL website:

http://www.peabodyenergy.com/content/404/australia-mining/new-south-wales/wambo-mine)

Information on the website will be updated regularly as required by DA305-7-2003.

WCPL will also ensure that any information relevant to groundwater monitoring is uploaded to the website (and kept up to date). This includes:

- Current statutory approvals;
- Approved strategies, plans or programs required under the DA305-7-2003;
- A community complaints register;
- Minutes of Community Consultative Committee (CCC) meetings;
- Annual Reviews;
- A copy of any Independent Audits and WCPL's response to any recommendations in any audit; and
- Any other matter required by the Secretary.

6.4 Reportable Environmental Incidents

All reportable incidents will be reported via the EPA's Environmental Line on **131 555** by the E&C Manager in accordance with WCPL's Pollution Incident Response Management Plan (PIRMP).

In accordance with the PIRMP, WCPL must notify all relevant authorities of incidents causing or threatening material harm to the environment immediately after the person becomes aware of the incident in accordance with the requirements of *Part 5.7* of the *POEO Act.*

For all other incidents that do not cause threatening material harm to the environment associated with the Project, WCPL will notify the Secretary and any other relevant agencies as soon as practicable after WCPL becomes aware of the incident. This includes exceedance of the trigger levels defined in **Section 3.0.**

Within 7 days of the date of the incident, WCPL will provide the Secretary and any relevant agencies with a detailed report on the incident to include:

- The cause, time and duration of the event;
- Where possible the type, volume and concentration of every pollutant discharged as a result of the event;
- The name, address and business hours telephone number of employees or agents of the licensee who witnessed the event;
- The name, address and business hours telephone number of every other person (of whom the licensee is aware) who witnessed the event, unless the licensee has been unable to obtain that information after making reasonable effort;
- Action taken by the licensee in relation to the event, including any follow-up contact with any complainants;

- Implement remediation measures as directed by the Secretary, to the satisfaction of the Secretary;
- Details of any measure taken or proposed to be taken to prevent or mitigate against a recurrence of such an event; and
- Any other relevant matters.

7.0 RESPONSIBILITIES

Table 14 below summarises responsibilities documented in the GWMP. Responsibilities may be delegated as required.

Table 14: Groundwater Monitoring Program Responsibilities

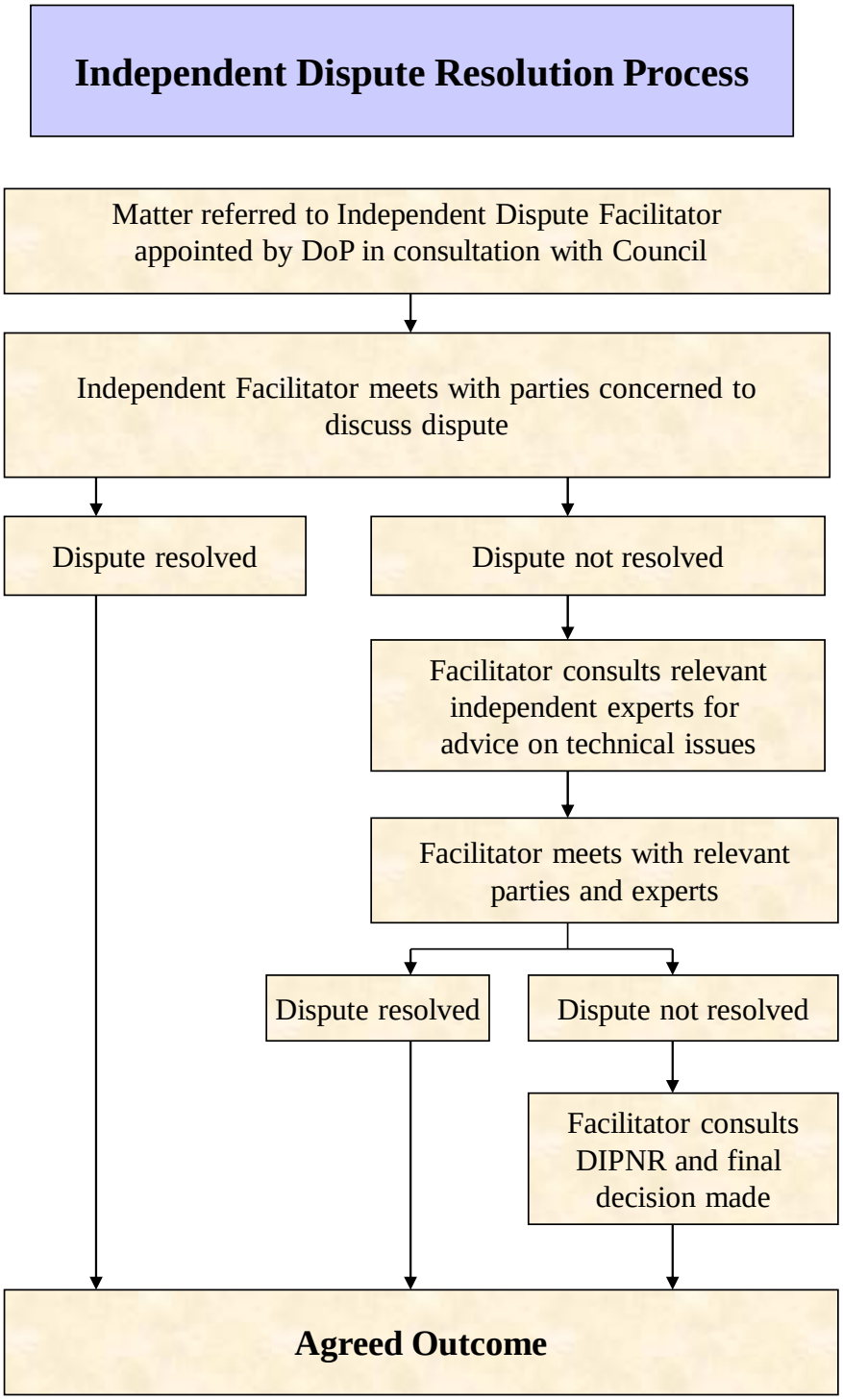
No	Task	Responsibility	Timing
1	Ensure groundwater monitoring is undertaken in accordance with **Section 4.0**.	Environmental Advisor	Bimonthly
2	Assess groundwater monitoring data against relevant trigger levels listed in **Section 3.0**	Environmental Advisor	As required
3	Review GWMP in accordance with **Section 6.0**.	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 6.4**	E&C Manager	As required
6	Submit updated GWMP to DP&E.	E&C Manager	As required
7	Groundwater related complaints to be responded to in accordance with **Section 5.0**	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 6.4**	E&C Manager	As required

8.0 References

- Development Consent (DA305-7-2003)
- Development Consent (DA177-8-2004)
- Wambo Development Project Environmental Impact Statement (EIS), July 2003
- Resource Strategies Pty Ltd (2003) Wambo Coal Mine Project Environmental Impact Statement. Report prepared for Wambo Coal Pty Ltd
- Wambo Environment Protection Licence (529)
- Bore licences 20BL173032, 20BL173033, 20BL173034 and 20BL173035
- Water Management Act 2000
- Water Act 1912
- Environmental Planning and Assessment Act 1979
- Hunter Unregulated and Alluvial Water Sources Water Sharing Plan
- North Coast Fractured and Porous Rock Groundwater Sources Water Sharing Plan
- NSW Aquifer Interference Policy
- Aquifer Interference Regulation 2011
- NSW State Groundwater Policy Framework Document 1997
- Bureau of Meteorology (2014) Atlas of Groundwater Dependent Ecosystems.
- DIPNR (2003) Groundwater Monitoring Guidelines for Mine Sites within the Hunter Region. Draft Report, Former NSW Department of Infrastructure, Planning and Natural Resources.
- Ferdowsian, R., Pannell, D., McCarron, C., Ryder, A. and Crossing, L. (2001) “Explaining groundwater hydrographs: Separating atypical rainfall events from time trends”, Australian Journal of Soil Research 39 (2001): 861-875.
- GHD Pty Ltd (2007) Report for Lower Section, North Wambo Creek Geophysical Survey.
- GHD Pty Ltd (2014) Groundwater Management Plan Monitoring Data. Wambo Coal Mine.
- 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.
- 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.
- NUDLC (2011) Minimum Construction Requirements for Water Bores in Australia. National Uniform Drillers Licensing Committee, 3rd Edition.
- Please, Patricia M & Murray-Darling Basin Commission (Australia) (1997). Murray-Darling Basin groundwater quality sampling guidelines. Murray-Darling Basin Commission, Canberra
- SLR Consulting (2017) Wambo Drilling Program – North Wambo Creek. Letter report prepared for Wambo Coal Pty Ltd. Ref 630.12300-L01-v0.1.docx
- Worley Parsons (2014) OPSIM Water Balance Model Initial Investigations – January 2014.

APPENDIX A
INDEPENDENT DISPUTE RESOLUTION PROCESS


Independent Dispute Resolution Process
Matter referred to Independent Dispute Facilitator appointed by DoP in consultation with Council
Independent Facilitator meets with parties concerned to discuss dispute
Dispute resolved
Dispute not resolved
Facilitator consults relevant independent experts for advice on technical issues
Facilitator meets with relevant parties and experts
Dispute resolved
Dispute not resolved
Facilitator consults DIPNR and final decision made
Agreed Outcome

APPENDIX B
CORRESPONDENCE WITH REGULATORY AGENCIES

Planning Services
Resource Assessments
Contact: Jessie Evans
Phone: 9274 6419
Email: jessie.evans@planning.nsw.gov.au

Mr Peter Jaeger
A/Environment & Community Manager
Wambo Coal Pty Ltd
PMB 1
SINGLETON NSW 2330

Dear Mr Jaeger

South Bates Underground Mine
Extraction Plan Longwalls 17 - 20

I refer to your correspondence of 27 April 2018 submitting an Extraction Plan (dated April 2018) and associated sub-plans for Longwalls 17 to 20 at the South Bates Underground Mine, submitted in accordance with conditions 22C and 22D of Schedule 4 of the Wambo Coal Mine development consent (DA 305-7-2003).

The Department also notes correspondence received on 4 September 2018 advising the Department that further investigation of geological structures in the area may require changes to the main headings and the finishing ends of Longwalls 18, 19 and 20. It is noted that the geological structure encountered would not result in any change to the proposed layout of Longwall 17 as originally proposed under this Extraction Plan. It is understood that Wambo Coal Pty Ltd will prepare an amended Extraction Plan for Longwalls 18, 19 and 20 for submission later in the year.

The Department has reviewed the Extraction Plan and its sub-plans as relevant to Longwall 17 and is satisfied that they generally meet the requirements of the development consent. The Department is awaiting confirmation from Natural Resources Access Regulator that the Water Management Plan and subsequent information provided by Wambo Coal has satisfactorily addressed its concerns. The Department will further liaise with Wambo Coal, if necessary, once this information is received. Nevertheless, the Water Management Plan can be considered approved and should be implemented.

The Department also acknowledges that DRG has confirmed it is satisfied with the revised Extraction Plan in accordance with condition 22C(g) of Schedule 4. Accordingly, the Secretary approves the Extraction Plan for Longwall 17 only, under conditions 22C and 22D of Schedule 4.

If you wish to discuss this matter further, please contact Jessie Evans at the details listed above.

Yours sincerely

Howard Reed 7.9.18
Howard Reed
Director Resource Assessments
as the Secretary's nominee

Summary of Comments Received from DoI Water on the WMP (Revision F) December 2017

Comment	Consideration of Comment
DoI Water (CL&W)	
…CL&W recommends the following is undertaken prior to the Department of Planning's endorsement of the WMP	
The Department of Planning and Environment engages an independent expert to advise if leakage from South Wambo Dam has resulted in contamination of the alluvial aquifer of South Wambo Creek;	Noted. HydroSimulations has prepared a report (under review) titled Update on Possibility of Mine Water Seepage to Wollombi Brook (April 2018)
In consultation with Crown Lands and Water, WCPL expands the observation bore network within and beneath the area of alluvial aquifers and mapped GDEs. This is to ensure that future groundwater model revisions can capture and predict important localised impacts;	SLR completed installation of monitoring bores in the North Wambo Creek alluvium in 2017. The lack of alluvial groundwater present during the drilling (despite recent rain at the time of the drilling) does not support further drilling.
The WMP set a requirement to measure water quality for water seeping into the open cut and underground mine workings	WCPL conducts monitoring though an extensive network of boreholes. Further investigations will be conducted in 2018 to seek improvements to the overall site water management and direct monitoring of seepage into the open cut or underground workings.
The Surface and Ground Water Trigger Action Response Plan must link to monitoring bores with defined thresholds listed in the Groundwater Monitoring Plan. Observation sites listed for North Wambo Creek alluvium have no defined triggers that hold WCPL accountable to impacts and the licensable take of water.	The Mine is approved to have an impact on North Wambo Creek alluvium and the licensable take of water has been predicted by HydroSimulations (2016a, 2017). WCPL is held account to its licensing volumes through the monitoring of inflow volumes.

Summary of Comments Received from the Independent Expert Scientific Committee (July 2017) on the GWMP

Comment	Consideration of Comment
IESC – 31 July 2017	
Groundwater quality data for contaminants such as metals and other ions (e.g. sulfate) was not provided in the EA or in the proponent's environmental reporting (from July 2015 onwards (Peabody Energy 2017)) despite the proponent's groundwater monitoring plan stating that monitoring for these parameters had commenced in July 2015 (Peabody Energy 2015a). The current sampling frequency (i.e. annual) will not provide data that is suitable for use in calculating or applying trigger values.	Water quality triggers are defined for EC and pH as sufficient indicators of potential water quality impacts in the context of beneficial use, the criterion in the Aquifer Interference Policy.
The current groundwater monitoring network does not contain any bores that are able to detect and provide early warning of potential drawdown in private bores located to the north, northwest and west of the proposed project. There are no monitoring bores located to the southwest and south of the proposed project; therefore, potential drawdown propagation in the direction of the World Heritage-listed Wollemi National Park will not be monitored. The IESC recommends that monitoring bores be installed in these areas and that the proponent commits to replace or repair any current monitoring bores which are damaged due to the proposed project such as through subsidence.	Additional groundwater monitoring bores have been and are being installed to the north and north-west of the Modification 17 area (P320, P321 and UG166A). There are no groundwater users (environmental or third-party users) to the south-west and south of the Modification 17 area, and therefore no additional groundwater monitoring to the south-west and south is proposed.
Water quality monitoring (for contaminants such as metals and ions) should be expanded to include the Permian aquifer. Sampling frequency in the Permian aquifer should be at least six-monthly, with frequency increased to a minimum of three-monthly in the alluvial aquifer where higher hydraulic conductivity and connectivity to surface water will cause more rapid changes in water quality parameters.	Water quality sampling is conducted in Permian bores P202, P203, GW12, GW21, GW22. There is limited use of the Permian aquifers and therefore further sampling is not considered warranted.
Baseline water quality data should be collected from representative reference bores in areas of the aquifers where mining impacts have not occurred.	Bore holes GW23, GW24, GW25 and GW26 were drilled late 2017 in North Wambo Creek . These bores will provide representative data prior to the commencement of mining in the South Bates Underground Extension Area (LW18-25)
The data used to calculate trigger values for both groundwater levels and quality should be provided. The IESC is concerned that data from impacted sites was used to set trigger values. Data and associated metadata (including for reference bores) should be presented to show that only pre-impact data has been used in the calculation of the trigger values.	It is noted that mining first commenced in the Wambo area in 1969. Therefore, while the use of "pre-impact" data to characterise baseline conditions is ideal, it is not feasible at Wambo. A full statistical analysis for data up to April 2015 is included as Table 7.
Trigger values should be calculated using the 20th and 80th percentiles as outlined in the ANZECC/ARMCANZ Guidelines (2000), not the less conservative 10th and 90th percentiles used by the proponent. Trigger values and associated TARPs should be initiated based on a single recorded exceedance of the 20th or 80th percentile values and not multiple exceedances over numerous months. A subsequent consecutive exceedance should initiate another level of the TARP.	As described in Section 3.2 of the GWMP, although ANZECC and ARMCANZ (2000) recommend 80th percentile values as being suitable for trigger values, a trigger would be initiated 20% of the time due to natural causes. Therefore, for the trigger to be a meaningful indicator of a possible mining effect, an investigation is to be triggered when the 90th percentile value is exceeded on two or three consecutive monitoring events.

Comment	Consideration of Comment
The groundwater management plan should include commitments from the proponent to undertake a thorough review of the groundwater model given it has been revised over a number of years to accommodate multiple modifications to mining at the Wambo Mine Site. This makes it difficult to identify the calibration and parameterisation history of the model and hence to appraise its ability to accurately predict project-specific and cumulative impacts.	The regular reviews and updates to the numerical model undertaken as part of modifications to the Wambo Coal Mine has improved the performance of the numerical model through regular re-calibration and validation. The most recent calibration of the numerical model is documented in the MOD 12 Environmental Assessment (HydroSimulations, 2016a). The most recent validation and model run is documented in the MOD 17 Environmental Assessment (HydroSimulations, 2017). Both reports are in the public domain.
The groundwater management plan should include commitments from the proponent to regularly validate the groundwater model predictions. The groundwater management plan should include commitments from the proponent to regularly update the groundwater model as recommended by the Australian Groundwater Modelling Guidelines (Barnett et al. 2012).	WCPL undertakes a comprehensive review of groundwater monitoring results annually against the groundwater model predictions in the Annual Review (Condition 5, Schedule 6 of the Development Consent DA 305-7-2003). In addition, as part of each Extraction Plan application, WCPL is required to present a revised assessment of potential impacts and environmental consequences incorporating relevant monitoring data obtained since the approval (Condition 22D, Schedule 4 of the Development Consent DA 305-7-2003).
The groundwater management plan should include commitments from the proponent to clearly define the level of variance between groundwater observations and model predictions that will trigger a review of the groundwater model.	A review of monitoring results against the numerical model predictions is undertaken annually and presented in the Annual Review. It is not considered appropriate to define a set level of variance given the complexity of the natural environment and the influence of other potential factors (e.g. climatic conditions or changes in mine progression).

NSW GOVERNMENT | Planning & Environment

Contact: Scott Brooks
Phone: 6575 3401
Fax: 6575 3415
Email: scott.brooks@planning.nsw.gov.au
Our ref: 305-7-2003

The General Manager
Wambo Mine
PMB 1
SINGLETON NSW 2330

Attention: Steve Peart

Dear Steve

Wambo Coal – Approval of Water Management Plan

Thank you for forwarding the Wambo Water Management Plan and all its parts as required under project approval DA 305-7-2003 for the Department's consideration.

The Water Management Plan is required by Condition 30 Schedule 4 and the following 5 components of the Plan were reviewed:

- Site Water Balance (30)
- Erosion and Sediment Control Plan (32)
- Surface Water Monitoring Program (33)
- Ground Water Monitoring Program (34)
- Surface and Ground Water Response Plan (35).

The Department has reviewed these plans, and is satisfied that they generally address the requirements set out in the relevant conditions of the project approval. Consequently, I would like to advise you that the Secretary has approved the plans.

These plans come into force on the 30th November 2015 and remains in force until replaced by any future updated approved Plans.

I am aware that DPI Water are expected to comment on the Extraction Plan for the South Bates U/G (Wybrow seam) LW 11-13. Should this comment require significant changes to any component of the Water Management Plan, I ask if these changes could be made and the plans resubmitted for review and approval.

Could you please forward finalised copies of the above plan (preferably in PDF format with a copy of this approval letter appended) for the Department's records by the end of November 2015.

If you require further information or clarification in this matter please contact Scott Brooks on 6575 3401 or by email to scott.brooks@planning.nsw.gov.au.

Yours sincerely

Scott Brooks
Investigations (Lead), Compliance
27-11-2015
As Nominee for the Secretary, Planning & Environment

From: Scott.Brooks@planning.nsw.gov.au [mailto:Scott.Brooks@planning.nsw.gov.au]
Sent: Wednesday, 21 October 2015 1:22 PM
To: Peart, Steven D
Subject: RE: 3 of 3

Steve,
I had no comment on the EE&SC Plan

Scott

Scott Brooks
Investigations (lead), Compliance
Planning Services, Resources Assessments
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From: Peart, Steven D [mailto:SPeart@peabodyenergy.com]
Sent: Wednesday, 21 October 2015 12:50 PM
To: Scott Brooks
Subject: RE: 3 of 3

Cheers Scott

The only other one was the Erosion and Sediment Control Plan if you had any comments on it.

Thanks again

Steven Peart
Manager: Environment & Community

Wambo Coal Pty Ltd
Peabody Energy Australia
PMB 1, Singleton NSW 2330
Phone: +61 (0)2 6570 2209
Fax: +61 (0)2 6570 2290
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Email: speart@peabodyenergy.com
www.peabodyenergy.com.au

From: Scott.Brooks@planning.nsw.gov.au [mailto:Scott.Brooks@planning.nsw.gov.au]
Sent: Wednesday, 21 October 2015 11:46 AM
To: Peart, Steven D
Subject: RE: Wambo Coal_WMP's 1 of 3

Steve,
Comments on the 3 water management plans.

Please note we will need some type of water balance, and the info for the evaporation sprays if you want to use them.

Scott

Scott Brooks
Investigations (lead), Compliance
Planning Services, Resources Assessments
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Plan	Section	DP&E Comment
Surface and Ground Water Response Plan (WA-ENV-MNP-509.4) Version 8	2.7 North Wambo Creek Diversion Performance Criteria	Given the problems with the NWCD this section should refer to other management plans of have a section referring to erosion and the potential for sediment generation and loss from the system.
Surface Water Monitoring Program (WA-ENV-MNP-509.2) Version 8	1.4.1 Environmental Planning & Assessment Act 1979 (Table 3)	(NOW) Currently called DPI Water
	2.2.3.2 Stream Flow (Table 7)	(No flow data available) Is this because the SWC never runs?
	4.1 Monitoring Network, Parameters and Frequency	(Mine water monitoring is undertaken for operational management purposes only. This data is not reported publicly). This would appear to conflict with Schedule 6 Condition 12 requiring the publishing of monitoring results.
	4.1.5 Riparian Vegetation and Creek Bed Stability	The NWCD has its own rehab management plan. This management plan should refer to it and it may need to be updated.
	4.1.6 Monitoring of Discharge Flows in the North Wambo Creek Diversion	What did NOW ask for. This should be included.
	6.1 Review	(Review every two years) Usually 3 years
Groundwater Monitoring Program (WA-ENV-	2.2.3.1 Alluvial Water Sources	(Investigation into increase in EC) This will need to be reported in the AEMR

Plan	Section	DP&E Comment
MNP-509.1) Version 9	3.1.3 Permian Monitoring Locations	Need to discuss why we monitor if the results cannot result in action.
	3.2 Trigger Values for Groundwater Quality	(Bi-monthly monitoring) This will need to be defined. Twice a month or every 2 months
	4.1.6 Chitter Dam and Wambo South Water Dam Monitoring Program	Need some comment here if the dam will be recommissioned if it is found to be leaking.
	6.1 Review	(Review every two years) Review is normally every 3 years.

From: Joanna Webster [mailto:jwebster@ResourceStrategies.com.au]
Sent: Wednesday, 17 June 2015 1:05 PM
To: Jessie Evans; Brendan Liew
Cc: Joshua Hunt; Howard Reed; Alexander, Micheal G; Peart, Steven D
Subject: RE: Wambo 10A Extraction Plan - NOW comments
Importance: High

Hi Jessie/Brendan,

On behalf of Wambo Coal, please find attached a response to the recommendations made by NSW Office of Water.

Also attached is a revised Groundwater Monitoring Program that has been updated to address the recommendations made by the Office of Water.

Please consider Attachment 3 of the Water Management Plan for North Wambo Underground Mine Longwalls 8 to 10A Extraction Plan to be replaced by the attached revised Groundwater Monitoring Program.

Please don't hesitate to call if you would like to discuss.

Regards

Joanna Webster
Senior Environmental Manager
e jwebster@resourcestrategies.com.au
m 0414 664 532

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Suite 2 Level 3, 24 McDougall Street
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t 07 3367 0055 f 07 3367 0053
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From: Jessie Evans [mailto:Jessie.Giblett@planning.nsw.gov.au]
Sent: Thursday, 4 June 2015 8:42 AM
To: Joanna Webster

Cc: Joshua Hunt; Howard Reed; Brendan Liew
Subject: RE: Wambo 10A Extraction Plan - NOW comments

Hi Joanna,

The Department has received comments from NOW in regards to the Wambo LW 8-10A Extraction Plan. I have attached these for your careful consideration and response. NOW has raised a number of issues, and in particular has concerns regarding the Groundwater Management Plan.

Could you please provide a response to NOWs concerns at your earliest possible convenience.

Thanks
Jessie

North Wambo Underground Mine Extraction Plan Longwalls 8 to 10A
Response to NSW Office of Water Comments (Dated 3 June 2015)

NOW Recommendation	Response
Groundwater Management It is recommended with respect to the exceedance of groundwater level triggers: • WCPL must investigate the drivers for declining water levels (rather than omitting bores from the monitoring program when bores go dry). Notification to the Office of Water is required as part of the response procedure within 3 months of such an event.	Five bores are proposed to be removed from the groundwater monitoring program (GW14, GW18, GW19, P5 and P6). Only two samples (August 2011 and December 2011) have been obtained from GW14 since its installation in 2011 (these samples may have been associated with groundwater levels stabilising following drilling). This bore is located to the east of Wollombi Brook and is far removed from mining activities associated with the Wambo Coal Mine. Only one sample (August 2010) has been obtained from GW18. GW19 has been consistently dry since installation and no valid samples have been obtained from this bore. GW18 and GW19 are located immediately downstream and upstream of the North Wambo Creek Diversion, respectively. The alluvial flow in North Wambo Creek has been altered by the historical and existing mining operations including the removal of alluvium across the full width of the channel with consequent desaturation of the adjacent upstream and downstream alluvium associated with the approved and constructed North Wambo Creek Diversion. Bores P5 and P6 have been covered by the approved Wambo Coal Mine waste rock emplacement. WCPL considers removal of these five bores from the groundwater monitoring program is justified as outlined above. Trigger levels are not proposed for a further four bores along North Wambo Creek (GW08, GW09, GW16 and GW17). WCPL has initiated an investigation for bores GW08 and GW09 as outlined further below. Trigger levels will not be developed for these bores until this investigation is complete. 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 these two bores is not considered warranted.

NOW Recommendation	Response
• Where the driver for declining shallow bore water levels exceeding trigger levels can not be linked to the prevailing climatic influence or miscellaneous sampling error, additional groundwater modelling is required to re-assess if there is a change in the predicted take of water from the Lower Wollombi Brook Water Source from mining related activities. As part of WCPL's response procedure, a report summarising the assessment is to be submitted to the Office of Water.	WCPL has initiated an investigation into the monitored declining water levels in GW08 and GW09. As described in Section 6.1.3 of the revised GWMP, a preliminary investigation report will be provided to the DP&E and NOW by 30 September 2015. This report will include preliminary conclusions regarding the potential licensing implications and a process and timetable for any further investigation work (including potential additional numerical hydrogeological modelling work).
• Where the updated modelled aquifer interference take of water from the Lower Wollombi Brook Water Source (encapsulating Wambo and North Wambo Creek) exceeds the estimates as predicted in WPCL's Groundwater Impact Assessment by 100% or more, WCPL must re-evaluate the associated ecological impacts and any influence on a low flow cease to pump criteria specified in the relevant WSP. The reference value triggering this response procedure must be clearly documented in the GWMP.	As described in Section 6.1.3 of the revised GWMP, Where the investigation for GW08 and GW09 indicates a revised predicted take from alluvial water sources that exceeds the previous estimates by more than 100%, WCPL would consider other potential associated impacts (e.g. on ecology) and any influence on a low flow cease to pump criteria specified in the HUA WSP.
• The trigger levels in Table 11 of the GWMP outlines a minimum and maximum depth to water level. These values, plus any new bores added to the list, and the bores proposed to be dropped, must be presented in Australian Height Datum.	Table 11 of the GWMP has been revised to include trigger levels presented in Australian Height Datum.
<u>It is recommended with respect to the exceedance of groundwater quality triggers</u> • Appropriate water quality baseline data has not been captured and presented in way that can be used for before and after impact. Salinity data for a number of bores has fluctuated considerably which is not consistent with a more stable groundwater environment. The use of major ion analysis and QA/QC procedures should be reviewed to inform if the salinity measurements reported are accurate and if so the drivers to cause such variability in the results.	The GWMP has been revised to include annual comprehensive analysis of major ions standpipe bores. A description of data management procedures has been included in Section 5.3.2.
• Due to the concerns with the potential for cross aquifer interconnection, water quality performance measures are essential to the impact assessment. Water quality performance measures should be defined and added to the GWMP.	The GWMP has been revised to include groundwater quality trigger levels in Section 5.4.
<u>It is recommended with respect to the exceedance of predicted mine inflows</u> • There is a discrepancy between the GWMP which outlines a monthly measurement and annual assessment of mine inflows, whilst the 'Subsidence Response Strategy' indicates metering of weekly dewatered volumes. It should be consistently reported weekly, in the GWMP as this will improve the understanding of inflow and assist with groundwater management and the triggers for exceedance.	Section 5.2.5 of the GWMP has been updated to clarify that dewatering values are recorded internally on a daily basis (during active pumping). As outlined in the North Wambo Creek Subsidence Response Strategy, these values are reviewed weekly for any indication that pumping rates are higher than normal (which would trigger an investigation). Dewatering values are also reviewed annually (as outlined in the GWMP) to determine the inflows from groundwater sources and to verify whether WCPL holds sufficient groundwater licence entitlements.

NOW Recommendation	Response
• Where the annual assessment for mine inflows exceeds the peak estimate as predicted in WCPL's Groundwater Impact Assessment by 50% or more, WCPL shall: – 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 relevant WSP. – define the mine inflow volume value triggering this response procedure within the GWMP. – As part of WCPL's response procedure, a report summarising the assessment is to be submitted to the Office of Water.	Section 5.2.5 of the GWMP has been updated to include the recommended response procedure. The mine inflow volume that would response procedure has been defined in the GWMP (563 ML/annum, which is 50% more than the peak estimate predicted by HydroSimulations (2014) [375 ML/annum] for the North Wambo Underground Mine).
• WCPL must notify the Office of Water as soon as practicable on become aware of any take of water in excess of its licensed entitlement	Section 5.2.5 of the GWMP has been updated to include this statement.
<u>It is recommended with respect to monitoring leakage from dams</u> • The closest bore to South Dam is Piezometer 114 representative of Wambo Creek alluvium. South Dam contains produced water from the mine and P114 shows a sharp rise in salinity to a level on par with water in the dam. This indicates probable leakage occurring from the dam that warrants further investigation. However, as the proponent proposes not to utilise water quality as a performance measures, no direct response is proposed. Significant leakage to the nearby alluvial aquifer could risk a change in the beneficial use of the aquifer. Trigger levels with regard to salinity must be set to investigate and determine if remediation is required.	WCPL has initiated an investigation into the monitored increasing salinity levels in P114. Wambo South Water Dam is currently not in use for the period of secondary extraction for Longwall 9, Longwall 10 and Longwall 10A at the North Wambo Underground Mine. Wambo South 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.
A report summarising any special assessment for the above recommendations should be provided within 6 months.	As described in Section 6.1.4 of the revised GWMP, a preliminary investigation report will be provided to the DP&E and NOW by 30 November 2015.
<u>Surface Water Management</u> • The Office of Water recommends the proponent and the Department of Planning and Environment develop a consultation process with affected landholders to address existing and potential degradation which occurs as a result of mining subsidence. This should focus on incorporating natural processes for channel recovery particularly using large timber controls to maintain bed level (bed sills), bank toe protection (timber bank revetment) and creation of scour pools by using 'forced' controls such as engineered log jams as an adjunct to revegetation of both banks of both watercourses.	All land above the North Wambo Underground Mine is owned by WCPL. Therefore there are no other affected landholders associated with the North Wambo Underground Mine Extraction Plan for Longwalls 8 to 10A. Advisian (2015) concluded it is unlikely Wambo Creek and Stony Creek would experience adverse impacts from the North Wambo Underground Mine, and mitigation measures are unlikely to be required. In the unlikely event that any mitigation measures are required, these would be developed in consultation with the Department of Planning and Environment and the NSW Office of Water, and would aim to incorporate natural processes for channel recovery.

Summary of Comments Received on the GWMP

Comment	Consideration of Comment
Department of Planning and Environment – 25 May 2017 and 5 July 2017	
Update the GWMP to reflect the modified layout for LWs 14-16 and the most up-to-date and recommended monitoring regime provided in Technical Report 2.	The GWMP has been revised to reflect the latest layout for LWs 14-16 (e.g. see Figure 3). There was no additional monitoring recommended by Technical Report 2 of the Extraction Plan for the South Bates Underground mine. It is noted that this report describes some sites that have been removed from the program due to disturbance by open cut operations (e.g. P5 and P6).
Replace Figure 3 with the approved longwall layout for LWs 11-16 (as approved by the Extraction Plan on 16 May 2017).	Figure 3 has been revised.
Provide evidenced of consultation with DRG and DPI-Water in relation to this version of the GWMP, and indicate how many matters raised have been addressed.	Section 1.5 and this Appendix have been revised to include further detail on consultation.
Replace Figure 5 with the location of the approved longwall layout for LWs 11-16.	Figure 5 has been revised to show the location of mapped alluvium in the lower reaches of the creeks over the latest approved underground mine layout.
Update Section 2.2.1 to include a discussion of the latest approved mining operations in the South Bates Underground Mine.	Section 2.2.1 has been revised to discuss the latest status of mining at Wambo.
Update Section 2.2.2 to describe the current groundwater monitoring network. Replace Figure 7 with Figure 4 in Technical Report 2.	Section 2.2.2 has been revised with the latest groundwater monitoring network.
Update the data summaries in Section 2.2.3 (including Table 8) to include the last 3 years of data.	The data in Table 8 (HARTT Analysis Results for Shallow Monitoring Bores) was used to generate the groundwater impact assessment criteria. It is not considered appropriate to continue to update baseline data during mining operations, as it may skew the impact assessment criteria. Monitoring results during operations are presented in Annual Reviews.
Update the discussion on the hydrogeological model in Section 2.2.5.	Section 2.2.5 has been revised to refer to the latest hydrogeological model for the approved mine.
Update the ground water triggers in Section 3.0 to reflect the latest data for the South Bates Underground.	The trigger levels in Section 3.0 are for bores with a broad spatial extent and are designed for all open cut and underground mining operations at Wambo. It is not considered appropriate to revise trigger levels to incorporate mine affected data.
Update Section 4.1.5 to reflect inflow estimates and triggers for South Bates Underground Mine inflows (based on 2015 HydroSimulations estimates). Liaise with DPI-Water in relation to the inflow "trigger", procedures for exceedances and licence implications.	Section 4.1.5 has been revised for the South Bates Underground Mine based on the same methodology that was used for North Wambo Underground Mine. This methodology was developed in consultation with DPI Water.
Update Section 4.0 and Table 12 to reflect the most up-to-date and current groundwater monitoring regime.	Table 12 reflects the latest groundwater monitoring network. Note that Table 6 includes a note that GW14 has been dry since December 2011, GW18 has been dry since October 2010 and GW19 has been dry since monitoring began in 2009.
Update Section 4.1.6 to reflect the current status of mining and monitoring results in the vicinity of these structures.	Section 4.1.6 has been revised to reflect that the Chitter Dam has been decommissioned.
DPI Water – 6 November 2015	
DPI Water recommended that the groundwater monitoring program be revised to address the loss of bores from the North Wambo Creek alluvium.	WCPL is installing additional groundwater monitoring locations in 2017.

Comment	Consideration of Comment
DPI Water noted that groundwater trigger levels in the GWMP are not referenced in Australian Height Datum (AHD).	Section 3.1.1 of the GWMP has been amended to include absolute trigger levels in m AHD.
DPI Water requested that P114 and P116 of the Wambo Creek alluvial trigger bores within the subsided area be nested or paired with deeper interburden bores to assess the direction of flow between Permian and alluvial aquifers during the post mining period.	WCPL is installing additional piezometers in this area in 2017.
DPI Water noted that Table 3 of the GWMP should be updated to reflect that: • the combined extraction limit of 20BL166910, 20BL173032, 20BL173033, 20BL173034 and 20BL173035 is 450 ML; • the combined extraction limit of 20BL173040, 20BL168017 and 20BL172061 is 750 ML; and • 20BL166906 has been cancelled.	The GWMP has been updated with the latest groundwater licence information.
DPI requested that Table 3 of the GWMP is updated to include all Water Access Licences (including regulated river access licences). DPI Water recommends that WCPL provide clarification regarding which licences relate to the operation of Wambo mine and which are used to account for passive water take.	Table 3 of the GWMP lists groundwater entitlements. Section 1.4.2 of the GWMP has been revised to include a reference to the SWMP for a list of surface water entitlements.
DPI Water indicated that the GWMP should address its previous comment that where the updated modelled aquifer interference take of water from the Lower Wollombi Brook Water Source exceeds the estimates as predicted in WPCL's Groundwater Impact Assessment by 100% or more, WCPL must re-evaluate the associated ecological impacts and any influence on a low flow cease to pump criteria specified in the relevant WSP. The reference value triggering this response procedure must be clearly documented in the GWMP.	This comment has been addressed in the SGWRP.
DPI Water referred to the Assessment of Groundwater Trends in GW08 and GW09 prepared by HydroSimulations (29 September 2015) and commented that vertical connection with North Wambo Creek and Wambo Creek is more significant than modelled. DPI Water recommended that an appropriate timeframe be set where the groundwater conceptualisation and numerical model will be updated.	The groundwater conceptualisation was reviewed as a result of monitoring results in GW08 and GW09. The numerical model was recalibrated to capture the monitoring data in GW08 and GW09 and reported in HydroSimulations (2016a).

APPENDIX C
SUMMARY OF COMMITMENTS

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

GWMP Section	Commitment	Timing
Groundwater Monitoring Program		
2.2.1	Quarterly download of the four vibrating wire piezometers, monitoring water levels in the Permian measures (Bores N2, N3, N5 and GW20).	Quarterly
2.2.1	Quarterly download of the four hydrostatic level transducers monitoring water levels in real time (Bores BH2A, BH2, BH4C and WAMBO-03, Bore 2 and 2A).	Quarterly
2.2.2	Undertake annual site water balance and present summary in the Annual Review.	Annually in February
2.2.3	Periodic re-calibration of the hydrogeological model, based on observed piezometric heads and groundwater inflow data	As required
3.0	Utilise trigger values outlined in Table 9 and Table 10, to determine if groundwater impact investigation procedure or Trigger Action Response Plan (TARP) in the SGWRP should be initiated	Monthly or following quarterly downloads
3.1.2	Monitor groundwater levels in P114, P116 and P202 (South Wambo Water Dam) against the trigger levels in Table 9 and Table 10.	Monthly or as data is available
3.1.3	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
3.3	Report on progress against the performance indicators in Table 11 in the Annual Review	Annually
4.0	Utilise data collected in the continued development of groundwater triggers and provide input into annual reviews of groundwater monitoring data	Annually
4.1.1	Install additional monitoring bores so that at least two years of monitoring data is collected prior to undermining.	2 years prior to mining
4.1.1	Construct all new monitoring bores in accordance with the Minimum Construction Requirements for Water Bores in Australia (NUDLC, 2011).	As required
4.1.2	Decommissioning of monitoring bores will be undertaken in accordance with NUDLC (2011) requirements.	As required
4.1.4	Metering of dewatered volumes from each of the Wambo open cut pits will be undertaken. Dewatered volumes will be incorporated into the annual site water balance to determine the inflows from groundwater sources, including alluvial aquifers, and to verify WCPL groundwater licence entitlements.	Annually
4.1.5	Dewatering volumes and underground water levels will be recorded on a daily basis during pumping.	Daily, during pumping
4.1.5	Data collected from the underground dewatering volumes will be incorporated into the site water balance on an annual basis	Annually

GWMP Section	Commitment	Timing
4.1.5	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 DoI Water.	Annually
4.1.5	Notify DPI Water as soon as practicable on becoming aware of any take of water in excess of the licensed entitlement.	As required
4.1.6	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
4.1.6	South Wambo Dam will only be recommissioned after further geotechnical assessment, structural repairs and following relevant consultation NSW DSC and DRG.	If required
4.2	Groundwater monitoring methodology will consider the Murray-Darling Basin Groundwater Quality. Sampling Guidelines. Technical Report No 3 (Murray-Darling Basin Commission [MDBC, 1997]) and the Methodology outlined in Section 4.2.	Bi-monthly and as required
4.3	Validated data from the monitoring program will be entered into a digital database by an Environmental Advisor.	Monthly and as required
4.4	Upon receipt of monitoring results: • Data will be compared to the specific trigger values ; and • If result(s) do not meet specified trigger values the response procedure will be initiated in accordance with the SGWRP.	Monthly and as data is available
4.4	When monitoring results exceed specified trigger values or the annual review identifies groundwater impacts, an investigation will be launched to determine the cause.	As required
5.0	All groundwater related community complaints will be recorded within the Community Complaints Register.	As received
5.0	The Monthly Environment Monitoring Report will include details of all community complaints	Monthly
6.0	The performance of the groundwater monitoring program is to be reviewed annually by the E&C Manager.	Annually
6.2	Review the environmental performance of the Mine and submit an Annual Review to the DP&E prior to the end of March each year.	Annually
6.4	Groundwater monitoring results will be made publicly available on the WCPL website.	Monthly
6.4	All reportable incidents will be reported via the EPA's Environmental Line on 131 555 by the E&C Manager.	As required