WATER MANAGEMENT PLAN

Ashton Coal Project

Version 11

Date: September 2020

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1. PURPOSE

This Water Management Plan (WMP) describes the management measures to be implemented by Ashton Coal Operations Ltd (ACOL) to manage and mitigate potential mine related impacts on water resources, for the Ashton Coal Project (ACP).

This document has been prepared to satisfy Schedule 3, Condition 26 and Schedule 5, Condition 2 of the ACP Development Consent DA 309-11-2001 i, June 2016 (as modified) (DA), in consultation with the Environmental Protection Authority (EPA), Natural Resource Access Regulator (NRAR), NSW Resources Regulator (RR), Department of Regional NSW - Division of Resources and Geoscience (DRG), Department of Planning, Industry and Environment - Environment, Energy and Science (EES) and Singleton Council (SC). The WMP has been endorsed by the NRAR and submitted to the Secretary of NSW Department of Planning, Industry and Environment (DPIE).

2. INTRODUCTION

The ACP is located in the Upper Hunter Valley of New South Wales, approximately 14 kilometres (km) north-west of Singleton (refer to

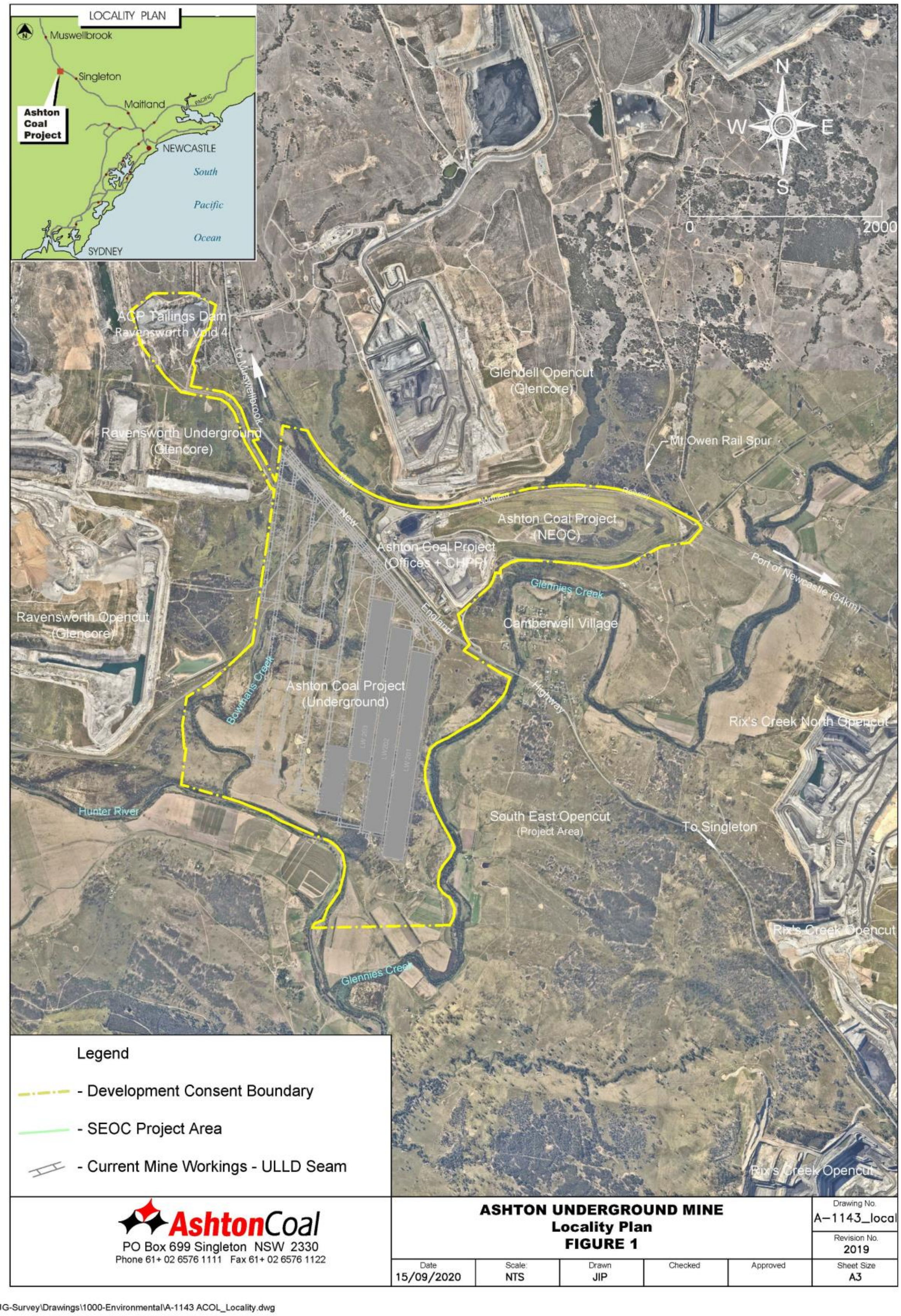

Figure 1). Ashton Coal Operations Pty Limited (ACOL) are the site operators and are a wholly owned subsidiary of Yancoal Australia Limited (Yancoal).

The key elements of the ACP include:

- An open cut pit (North East Open Cut - NEOC) that has now been completed, with the final void remaining for the storage of coarse and fine reject;
- A four seam descending underground mine with approval to extract up to 5.45 Million Tonnes Per Annum (Mtpa) of Run of Mine (ROM) coal;
- Surface mine infrastructure associated with the underground Mine, including gas drainage bores, ventilation fans, mine dewatering and water supply infrastructure;
- Coal handling and preparation facilities including rail siding and rail loading bin;
- Reject and tailings emplacements; and
- Administration, bathhouse and workshop buildings.

The DA was initially granted for the ACP by the Minister for Planning in October 2002. The approval has been subsequently modified on several occasions.

In April 2015, the Land and Environment Court approved a major project application (PA 08_0182) for the South East Open Cut (SEOC) Project. This approved project includes (among other things) extraction of up to 3.6 Mtpa of ROM coal from a new open cut operation (the SEOC). Development of the SEOC Project has not yet commenced and is beyond the scope of this Management Plan.

In June 2016, DA 309-11-2001-i was modified (MOD 5) to allow for integration with the SEOC Project, including (among other things):

- Changes to the ACP Coal Handling and Preparation Plant (CHPP) and associated facilities to allow conveyors and pipelines for coal processing and reject disposal from the SEOC;
- An increase in total production rates to 8.6 Mtpa of ROM coal, to account for production from the SEOC; and
- Fine rejects (tailings) to be piped from the ACP CHPP to the SEOC for disposal.

In amending DA 309-11-2001-i the consent conditions were updated to be consistent with the project approval conditions for the SEOC Project (PA 08_0182), including contemporising consent conditions as well as administrative and other changes. Following the approval of MOD 5, ACOL updated all strategies/ plans / programs to reflect the amended conditions of consent. This included updating the WMP to reflect the administrative changes within the DA (as modified), whilst still meeting the requirements for water management within the development consent that applied prior to the approval of the modification.

Schedule 5, Condition 6 of the DA requires the review (and where necessary the revision) of the Plans within 3 months of the submission of an incident report, Annual Review or Audit (as specified within the DA). This WMP has been reviewed and revised following the submission of the 2019 Independent Environmental Audit (Barnett & May, 2020).

This Water Management Plan (WMP) is specifically required by and has been prepared in accordance with Condition 26, Schedule 3 of the Development Consent.

Table 1 provides a summary of the specific requirements of the development consent and groundwater licences held by ACOL (under Part 5 of the Water Act 1912) and where these are addressed within the WMP.

This WMP was most recently approved by the NSW Department of Planning, Industry and Environment (DPIE) on 1 March 2018. A copy of the correspondence is included in **Appendix A**.

Table 1 Summary of WMP Development Consent and Aquifer Water Access Licence conditions

Condition	Requirements	Where Addressed in WMP
26	The Applicant must prepare a Water Management Plan for the Ashton Mine Complex to manage potential impacts of the development. This plan must:	This document
26 (a)	Be prepared in consultation with OEH, EPA, DRE, and Council, and be endorsed by DPI Water and then submitted to the Secretary for approval;	Section 1
26 (b)	Include detailed performance criteria and describe measures to ensure that the Applicant complies with the Water Management Performance Measures (see Table 8)	This document Sections 4.5, 6.2 and 7.2
26 (c)	A Site Water Balance, which must: • include details of: - sources and security of water supply; - water use on site; - water management on site; - any off-site water transfers, and • investigate and implement all reasonable and feasible measures to minimise water use by the Ashton Mine Complex	Sections 2.2, 3.2 and 3
23 (d)	A Bowmans Creek Diversion Management Plan for the proposed creek diversions in the underground mining area, which must: • be submitted to the Secretary for approval; • be consistent with any related requirements in future Extraction Plan(s); and • include: - a vision statement for the creek relocations; - an assessment of the surface water and groundwater quality, ecological, hydrological and geomorphic baseline conditions within the creek; - detailed design specifications for the creek relocations; - a construction program for the creek relocations, describing how the work would be staged, and integrated with mining operations; - a revegetation program for the relocated creeks using a range of suitable native species; - water quality, ecological, hydrological and geomorphic performance and completion criteria for the creek relocations based on the assessment of baseline conditions; and - a program to monitor and maintain surface water and groundwater quality, ecological, hydrological and geomorphic stability of the creek diversions	Section 4
26 (d)	An Erosion and Sediment Control Plan which must: • identify activities that could cause soil erosion, generate sediment or affect flooding; • describe measures to minimise soil erosion and the potential for the transport of sediment to downstream waters, and manage flood risk; • describe the location, function, and capacity of erosion and sediment control structures and flood management structures; and • describe what measures would be implemented to maintain the structures over time	Section 5
26 (e)	A Surface Water Management Plan, which must include: • detailed baseline data on surface water flows and quality in creeks and other waterbodies that could potentially be affected by the development; • surface water and stream health impact assessment criteria including trigger levels for investigating any potentially adverse surface water impacts (for existing creeks and reinstated/rehabilitated creeks); • a program to monitor and assess: - surface water flows and quality; - impacts on water users;	Section 6

Condition	Requirements	Where Addressed in WMP
	- stream health; and - channel stability	
26 (f)	A Groundwater Management Plan, which must include: • detailed baseline data of groundwater levels, yield and quality in the area, particularly for privately-owned groundwater bores that could be affected by the development; • groundwater impact assessment criteria including trigger levels for investigating any potentially adverse groundwater impacts; and • a program to monitor and assess: - groundwater inflows to the mining operations; - impacts on regional aquifers; - impacts on the groundwater supply of potentially affected landowners; - impacts on the Bowmans Creek, Glennies Creek and the Hunter River alluvial aquifers; and - impacts of groundwater dependent ecosystems and riparian vegetation.	Section 7
26 (g)	A Surface and Groundwater Response Plan, which must include: • a response protocol for any exceedances of the surface water and groundwater assessment criteria, including provisions for independent investigation by a suitably qualified hydrogeologist whose appointment has been approved by the Secretary; • measures to offset the loss of any baseflow to watercourses caused by the development; • measures to compensate landowners of privately-owned land whose water supply is adversely affected by the development; and • measures to mitigate and/or offset any adverse impacts on groundwater dependent ecosystems or riparian vegetation.	Section 8
25 (Table 8)	Water Management – General: • Maximise water sharing with the other mines in the region • Minimise the use of clean water on site Construction and operation of infrastructure: • Design, install and maintain erosion and sediment controls generally in accordance with the series *Managing Urban Stormwater: Soils and Construction* including *Volume 1, Volume 2A – Installation of Services* and *Volume 2C – Unsealed Roads* • Design, install and maintain all new infrastructure within 40 m of watercourses generally in accordance with the *Guidelines for Controlled Activities on Waterfront Land* (DPI 2007), or its latest version • Design, install and maintain creek crossings generally in accordance with the *Policy and Guidelines for Fish Friendly Waterway Crossings* (NSW Fisheries 2003) and *Why Do Fish Need To Cross The Road? Fish Passage Requirements for Waterway Crossings* (NSW Fisheries 2003), or their latest versions	Section 3 Section 4 and Section 5
3 & 4 of bore licence 20BL173716 [1] (Converted to WAL 41552) and 5 of bore licence 20BL169508 (Converted to	The licence holder must develop and implement a methodology to estimate the annual volume of water that will be intercepted and/or taken from any alluvial or regulated river water source as defined in the relevant water sharing plan (called a "water budget"). The methodology must be incorporated within the water management plan required under the development consent within 6 months of the date of issue of this licence. A finalised water budget must be submitted to the Office of Water as part of the Groundwater Management Report required to be prepared on an annual basis under the Development Consent, or in accordance with any other similar reporting requirements under the development consent should the AEMR cease to be required under the development consent. Breakdown	Section 7.3.2

[1] 20BL173716 and 20BL169508 have been converted to WAL; however, conditions governing water take recording are still being devised, so conditions from previous bore licences are applicable in the interim.

Condition	Requirements	Where Addressed in WMP
WAL 41501	of water budget should be in six monthly periods to coincide with the water year.	
6 of bore licence 20BL173716 (Converted to WAL 41552) and 7 of bore licence 20BL169508 (Converted to WAL 41501	The licence holder must review and, if necessary, revise the groundwater management plan and the surface and groundwater response plan required under the development consent to consider the works authorised by the licence in consultation with the office of water within six months of the date of issue of this licence.	Sections 7 and 8
11 of bore licence 20BL173716 (Converted to WAL 41552)	An extraction measurement device must be installed and maintained on each bore used for extraction of water under this licence. Each extraction measurement device must meet a type and standard, and must be maintained in a manner that is consistent with any metering guidelines that have been published or notified by the office of water.	Sections 6.3 and 7.3.1
10 of bore licence 20BL169508 (Converted to WAL 41501)	The licence holder must install to the satisfaction of the NSW Office of Water in respect of location, type and construction an appliance(s) to measure the quantity of water extracted from the works. The appliance(s) to consist of either a measuring weir or weirs with automatic recorder, or meter or meters of the Dethridge type, or such other class of meter or means of measurement as may be approved by NSW Office of Water. The appliance(s) must be maintained in good working order and condition. A record of all water extracted from the works must be kept and supplied to the Department upon request. The licensee when requested must supply a test certificate as to the accuracy of the appliance(s) furnished either by the manufacturer or by some person duly qualified.	Sections 6.3 and 7.3.1

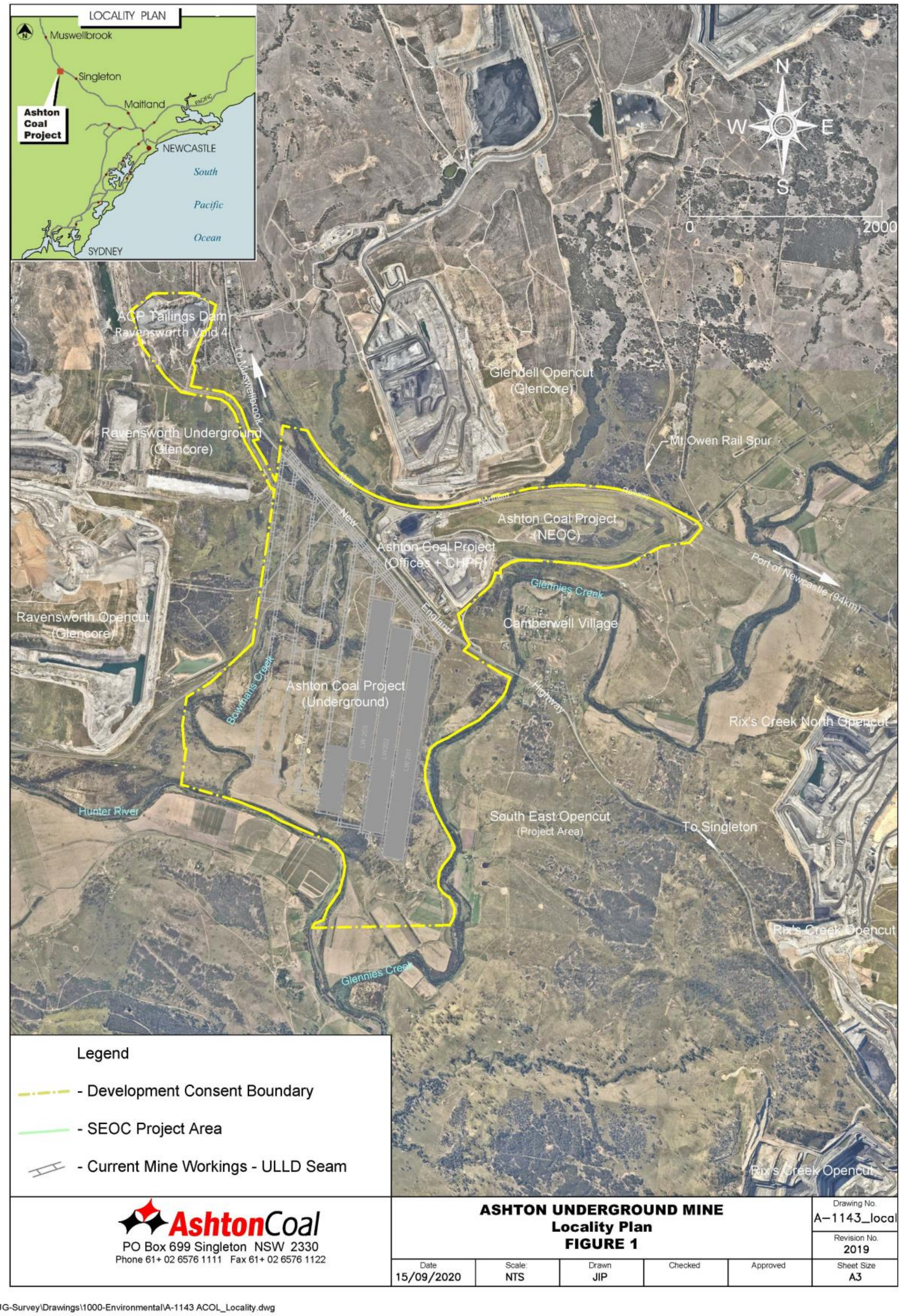

Figure 1 Site Location and Locality

2.1. Water Management System Description

Figure 2 shows the mine layout and surface facilities in relation to surface features including watercourses. Existing and future underground operations extend southwards and are located between Bettys Creek (to the north), the Hunter River (to the south), Glennies Creek (to the east) and Bowmans Creek (to the west). Glennies Creek and Bowmans Creek are tributaries of the Hunter River while Bettys Creek is a tributary of Bowmans Creek. Glennies Creek is a heavily modified stream with a regulating storage (Glennies Creek Dam) located upstream. Glennies Creek drains southwards joining the Hunter River immediately south-east of the ACP. Bowmans Creek has a largely unmodified catchment in its middle and upper reaches and also flows southwards joining the Hunter River 3 km upstream of the confluence with Glennies Creek.

Open cut mining at the ACP ceased on September 2011. The current underground mine extracts coal using longwall mining methods, with the area of mined panels (Pikes Gully seam, Upper Liddell seam) and current/near future panels (Upper Lower Liddell seam, Lower Barrett seam) shown on **Figure 2**. Two reaches of Bowmans Creek have been relocated in order to mitigate the effects of mining subsidence resulting from direct hydraulic connection between the Bowmans Creek alluvium and the underground workings. The Eastern and Western reaches of the Bowmans Creek Diversion (BCD) are shown on **Figure 2**. Construction has been completed, except for permanent block banks, which will be constructed twelve months prior to mining LW 106B or as triggered by subsidence monitoring (in the ULD Seam) (refer **Section 4**).

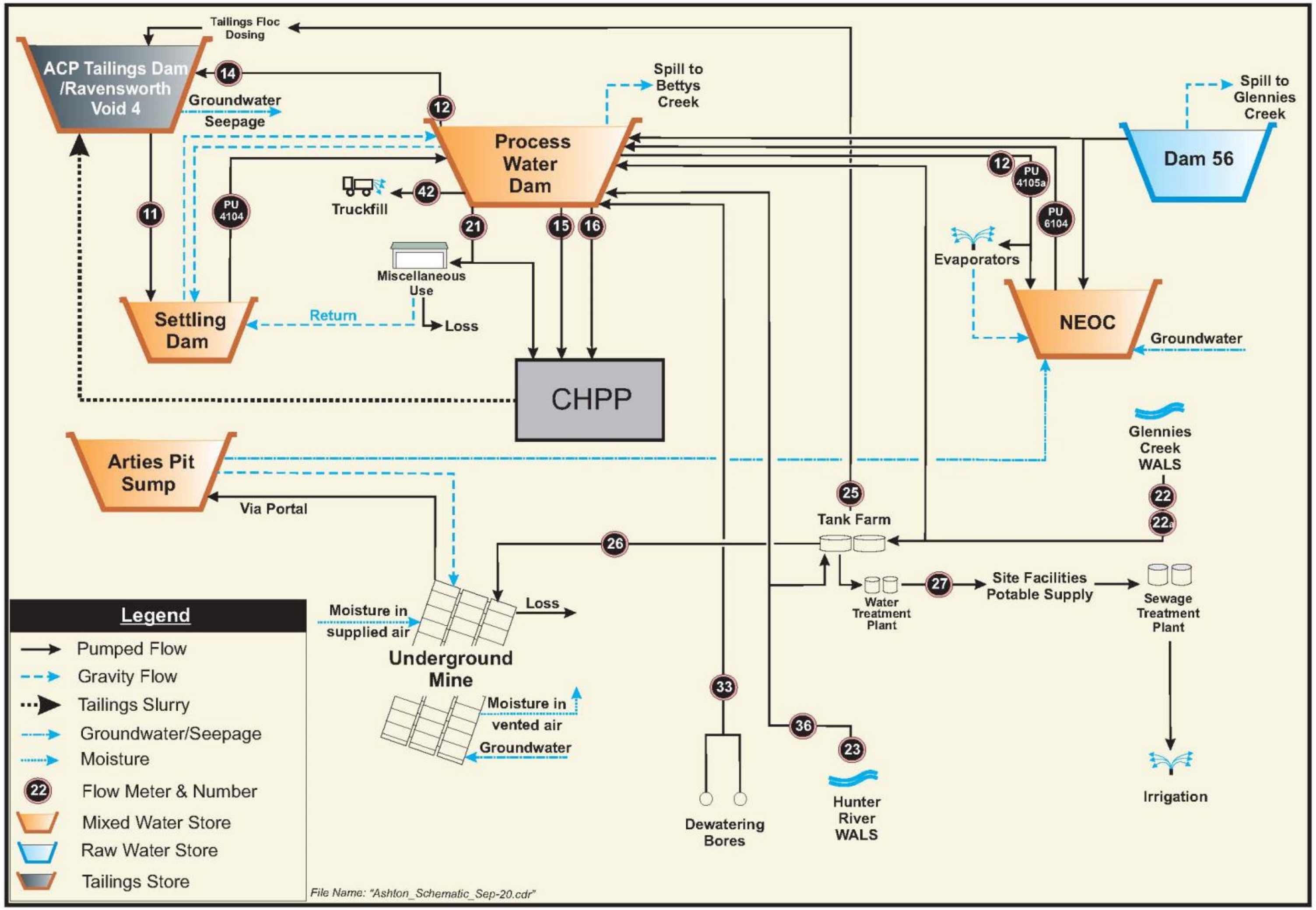

Figure 3 **Water Management Schematic**

The key components of the mine water management system at the ACP are shown in schematic form in. The catchment area and capacity of each water storage is given in **Table 2**.

Table 2 ACP Mine Water Storages

Storage	Catchment Area (ha)	Capacity (ML)
North-East Open Cut	159	18,500*
Process Water Dam	14	60
Settling Dam	25	34
Dam 56	35	61
Arties Pit Sump	10	31

* Capacity slowly reducing with continued rejects placement –approximate estimate at start of 2020.

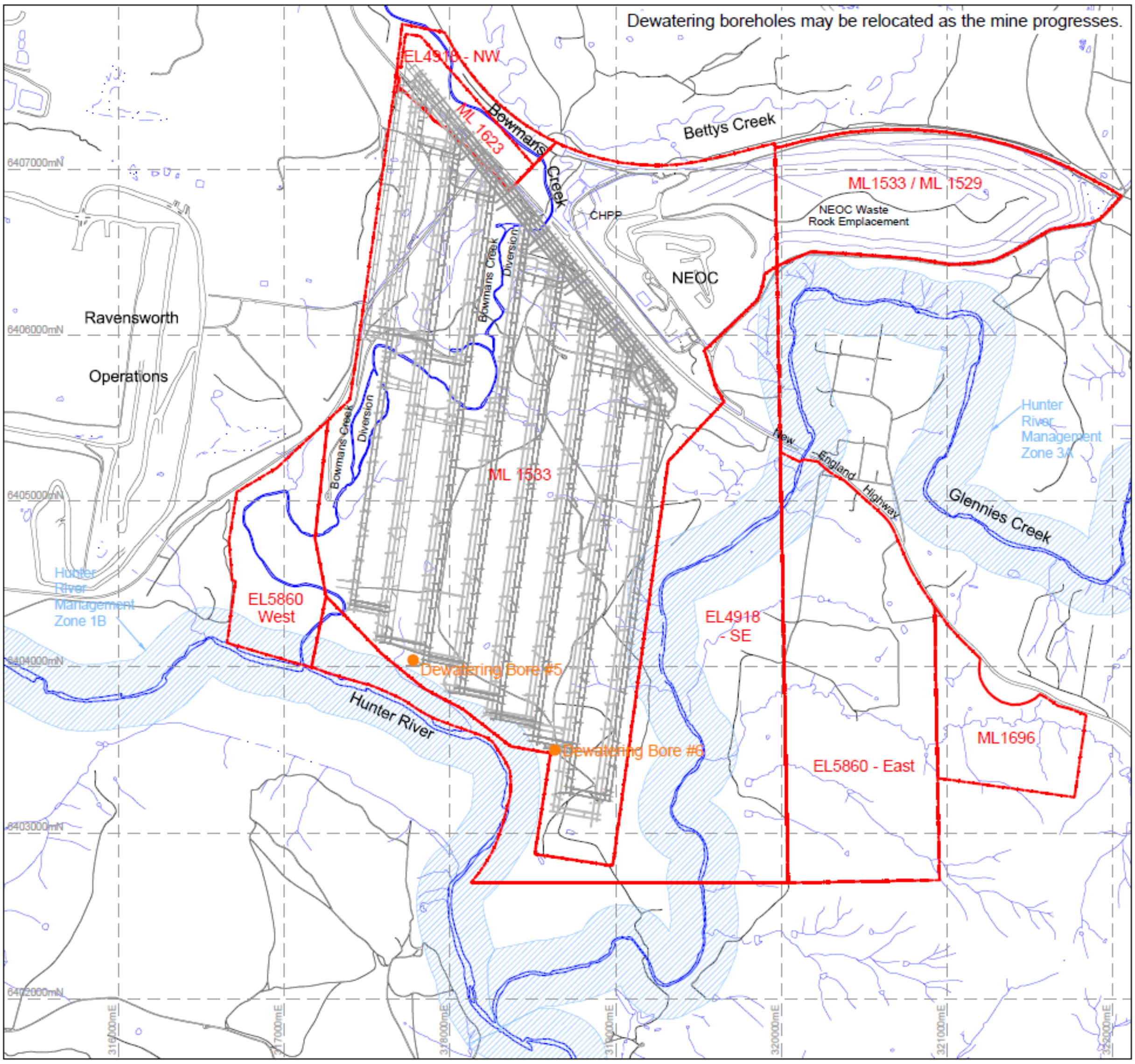

Figure 2 Mine Area Layout

The Process Water Dam (PWD) supplies water to the CHPP for road dust suppression (truckfill) and miscellaneous CHPP usage. The north-east open cut (NEOC) is the former open cut pit which is now in the process of being progressively backfilled with coarse rejects and, in terms of available capacity, it is the main water storage at the ACP. Rejects disposal to the NEOC was approved under Section 100 of the *Coal Mine Health & Safety Act (2002)* on 1st March 2012. The Section 100 Application Report (Cardno, 2012) states that to meet geotechnical and stability requirements, the groundwater level within the rejects emplacement must not rise to within 3 m of any coarse rejects surface.

Tailings disposal occurs to the Ravensworth Final Void No. 4 East (Ravensworth Void 4). ACOL is responsible for the management of Ravensworth Void 4 which is owned by Macquarie Generation and is a remnant of previous open cut mining operations. ACOL is responsible for the management of a defined area within the Macquarie Generation owned land for the duration of tailings emplacement and rehabilitation operations. Ravensworth Void 4 has an estimated catchment area of 32 ha. Water is reclaimed by pumping from Ravensworth Void 4 to the ACP Settling Dam which is pumped or overflows to the PWD for CHPP re-use (refer Figure 3).

The CHPP is the largest consumer of water on site while dust suppression usage (i.e. of haul roads and stockpiles) and water for CHPP sprays and washdown is also a significant component (refer **Section 3.1**). The underground mine requires a water supply for various uses such as operation of underground mining equipment and dust suppression. Other demands for water usage on site are water for tailings secondary flocculant dosing and potable usage. Demand is supplied by site runoff, underground dewatering, tailings reclaim and water sourced from the Hunter River and Glennies Creek via WALs and purchase of potable water trucked to site. Make-up is provided from water held in storages on site, including surface facilities dams, which collect runoff from the approximately 274 ha catchment area of the site and groundwater as well as water return from underground mining operations.

Supply of potable water to offices, workshops, bathhouses and underground workings is sourced from the Tank Farm. The Tank Farm also provides supply to secondary flocculant dosing at the Ravensworth Void 4 tailings storage, and receives inflows from Glennies Creek or the Hunter River accessed using WALs. Sewage treatment is provided by three Sewage Treatment Plants (STPs). Effluent from the STPs is irrigated on dedicated land located within the mine water management system.

A bank of evaporator sprays was commissioned in the NEOC void in July 2014. During periods when the site water balance identifies increasing water inventory as an issue, water is pumped from the PWD to these evaporators to increase system losses and mitigate the water inventory increase. Unevaporated water from the irrigators reports to the NEOC.

No discharge of surface water occurs from the ACP. All mine affected water is stored in mine water storages (refer **Table 2**) for use on site.

2.2. Water Licences

ACOL currently holds WALs under the Water Management Act 2000 for groundwater extraction from the *North Coast Fractured and Porous Rock Groundwater Sources* Water Sharing Plan (WSP) and surface water extraction under the *Hunter River Regulated Water Source* WSP. The reach of the Hunter River and Glennies Creek adjacent to the ACP comprise management zones 1B and 3A of the WSP. Groundwater monitoring bores are approved under the Water Act 1912 by bore licence 20BL173735. This licence permits up to 224 monitoring bores across the ACOL project area. A summary of WALs held by ACOL for both surface and groundwater is provided in **Table 3**.

Groundwater and rainfall runoff are extracted from the NEOC via a large diameter well ('caisson') constructed within the backfilled coarse rejects and equipped with a pump, for pumped transfer to the PWD. Groundwater and return water from the underground operations is extracted via the mine access portal and dewatering bores to the Arties Pit Sump and PWD respectively. **Figure 2** shows the location of the existing dewatering bores.

Table 3 Summary of Water Access Licences

Water Access Licence Number	NRAR Reference	Water Sharing Plan, Source, Management Zone and Reliability	Entitlement
984	20AL201282	Hunter Regulated Water Sharing Plan, surface water, zone 3A (Glennies Creek), General Security	9
997	20AL201311	Hunter Regulated Water Sharing Plan, surface water, zone 3A (Glennies Creek), High Security	11
1120	20AL201624	Hunter Regulated Water Sharing Plan, surface water, Hunter Regulated River Water Source, High Security	3
1121	20AL201625	Hunter Regulated Water Sharing Plan, surface water, zone 1B (Hunter River from Goulburn River Junction to Glennies Creek Junction), General Security	335
1358	20AL203056	Hunter Regulated Water Sharing Plan, surface water, Hunter Regulated River Water Source, Supplementary	4
6346	20AL203106	Hunter Regulated Water Sharing Plan, surface water, Hunter Regulated River Water Source, Supplementary	15.5
8404	20AL200491	Hunter Regulated Water Sharing Plan, surface water, zone 3A (Glennies Creek), High Security	80
15583	20AL204249	Hunter Regulated Water Sharing Plan, surface water, zone 3A (Glennies Creek), General Security	354
19510	20AL211015	Hunter Regulated Water Sharing Plan, surface water, zone 1B (Hunter River from Goulburn River Junction to Glennies Creek Junction), High Security	130
23912	20AL211423	Hunter Unregulated and Alluvial Water Sources 2009, surface water, Whole Water Source (Jerrys Water Source) (Bowmans Creek), Unregulated	14
29566	20AL212287	Hunter Unregulated and Alluvial Water Sources 2009, aquifer, Jerrys Management Zone (Jerrys Water Source), Unregulated	358
36702	20AL212975	Hunter Unregulated and Alluvial Water Sources 2009, surface water, Jerrys Management Zone (Jerrys Water Source) (Bowmans Creek), Unregulated	116
36703	20AL212976	Hunter Unregulated and Alluvial Water Sources 2009, surface water, Jerrys Management Zone (Jerrys Water Source) (Bowmans Creek), Unregulated	150
41501	20AL216955	North Coast Fractured and Porous Rock Groundwater Sources, Sydney Basin – North Coast Groundwater Source, aquifer (NEOC)	100
41552	20AL219014	North Coast Fractured and Porous Rock Groundwater Sources, Sydney Basin – North Coast Groundwater Source, aquifer (U/G)	511
20BL173735	20BL173735	Monitoring bore, Water Act 1912 Groundwater Licence	Nil - Monitoring Only
TOTAL			**2190.5**

2.3. Works Approvals

ACOL holds Works Approvals under the *Water Management Act 2000* for surface water extraction works (pump sites) on the Hunter River (20CA201626) and Glennies Creek (20CA201565), used to supply operational water for the ACP. Works approval 20CA211424 is held to allow interception of water from Bowmans Creek and associated alluvial water sources. ACOL also holds 13 works approvals associated with Camberwell properties, used for *Stock & Domestic* water use.

The levee that separates the Process Water Dam from Bettys Creek is a licenced flood control work (20FW213279) and, as a project approved under the Environmental Planning and Assessment Act 1979, the ACP has been designated the miscellaneous works approval number 20MW065006, to allow linkage with associated surface and aquifer WALs.

3. SITE WATER BALANCE

3.1. Recorded Water Use on Site

Metered water usage and supply volumes between January 2015 and May 2020 provide data on water usage on site over this period. **Table 4** provides average monthly totals for this period.

No spills were recorded from site storages during this period.

Table 4 Summary of Metered Water Usage Volumes (January 2015 to May 2020)

Description	Source	Average Rate (ML/month)
CHPP Supply	PWD*	32.7
Underground Supply	Tank Farm‡	15.7
Potable Supply	Tank Farm‡	0.4
Supply to Tailings Storage Secondary Flocculant Dosing	Tank Farm‡	0.64
Haul Road Dust Suppression and CHPP Miscellaneous Use (sprays, washdown)	PWD*	47.0†
Total		96.4

* PWD water sourced from combination of mine area runoff, tailings reclaim, CHPP return, underground dewatering, bores, supply from Glennies Creek Mine and WALs.

‡ Tank Farm water sourced from WALs.

† A portion of this water is returned to the PWD from the CHPP. Although not metered, this return volume has been estimated from the water balance model to be approximately 14.7 ML/month average.

3.2. Site Water Balance Model

A life-of-mine water balance model of the ACP has been developed by Hydro Engineering & Consulting Pty Ltd (HEC). The structure of the model is generally per the schematic in Figure 3. The model operates on a sub-daily time-step and has been setup to simulate the forward planning period from mid-2019 to the end of December 2030.

3.2.1 Data

Surface catchment areas of the mine were simulated using supplied plans and were constant over the forward planning period with the exception of rehabilitation progression. Total catchment area reporting to the ACP water management system is 274 ha. The majority of this catchment area reports to the NEOC (refer **Table 2**) and comprises most of the NEOC overburden emplacement area (refer **Figure 2**), much of which has been rehabilitated.

Annually, varying ROM coal tonnages (which affect CHPP water demand) are expected to be between 1.6-4.2 Mtpa over the simulated period. The ACP is approved to produce up to 5.45 Mtpa of ROM coal up to February 2024. Projected ROM coal tonnages, yields and moistures (feed, product, rejects and tailings) were used to calculate CHPP demand.

Underground mine groundwater inflow rates were obtained from groundwater modelling by AGE (2016) and vary from approximately 1.01 ML/d to 1.14 ML/d over the forward planning period. Groundwater inflow rates to the NEOC were assumed constant at 0.1 ML/d (estimate developed from water balance model calibration by HEC).

Underground demand was calculated based on historical pumping records, with an average demand during mining of 0.56 ML/d, while during longwall change-outs this drops to 0.26 ML/d. For water quality reasons, this water is sourced only from WALs.

The water balance model was calibrated by comparing model estimates of total water volume stored in all monitored water storages (NEOC, Arties Pit Sump, PWD, Settling Dam and Dam 56) against water volumes estimated from monthly monitoring records for the period late 2012 to mid-2019.

The Australian Water Balance Model (tony) (Boughton, 2004) was used to simulate runoff from rainfall on the various catchments and landforms across the mine area. Model rainfall-runoff parameters have been taken from studies conducted at similar mining operations and then adjusted as part of model calibration. Seven different sub-catchment types were modelled.

The model simulates 121, 12 year mine life "realizations", derived using the climatic record from 1892 to 2012. The first realization uses climatic data from 1892-1904, the second 1893-1905 the third 1894-1906 and so on. The results from all realizations are used to generate water storage volume estimates and other relevant water balance statistics. This method effectively includes all recorded historical climatic events in the water balance model, including high, low and median rainfall periods.

The water balance model has been linked to output from the Hunter River Integrated Quantity and Quality Model (IQQM). The IQQM is the model used by WaterNSW to make available water determinations in the Hunter Valley, in accordance and in conjunction with the WSP for the Hunter Regulated River Water Source. The IQQM was run using climatic data from 1892 to 2013 to generate predictions of general security available water determinations and periods of off-allocation.

Simulation of evaporator sprays in the NEOC was included in the model. The model simulates pumping from the PWD to these evaporators at a rate of 2.81 ML/d in summer and 1.87 ML/d in winter (as advised by ACOL). Operation was simulated only on days with less than 5 mm rain, with 30% of the water pumped assumed lost and the balance (unevaporated water) reporting to the NEOC. Operation was undertaken only when the stored NEOC water volume rose above a low trigger volume.

3.2.2 Results

The average predicted water balance (averaged over the simulation period) for median, wet (90th percentile) and dry (10th percentile) rainfall sequences is summarised in **Table 5**.

[2] Data was sourced from 'Data Drill' generated climatic data for the mine location. The Data Drill is a system which provides synthetic data sets for a specified point by interpolation between surrounding point records held by the Bureau of Meteorology (refer Queensland Government, 2014). Both rainfall and pan evaporation data were obtained from this source. Additional climate data after 2012 was generated by "wrapping" data from the beginning of the climate record to after 2012. In this way, the drought period of 2005/06 and the wet period of 2007 could be simulated as occurring at varying times through the mine life.

Table 5 Summary of Simulated Annual Inflows and Outflows (ML/annum)

	10th Percentile Rainfall Realization	Median Rainfall Realization	90th Percentile Rainfall Realization
Inflows			
Rainfall Runoff	366	411	506
Hunter River WALs	66	65	25
Glennies Creek WALs	174	242	296
Groundwater	453	453	453
Tailings Bleed* Water	453	454	459
CHPP Miscellaneous Use Return	69.8	75	82
TOTAL	**1,582**	**1,699**	**1,820**
Outflows			
Evaporation	52	54	53
Evaporator Spray Loss	0	0	0
CHPP Supply	985	1082	1189
Underground Loss	142	142	142
Truckfill (Dust Suppression)	25	28	27
Potable Supply	4	4.5	5
Tailings Floc Dosing Supply	9	11	13
Spill	0		1
Spoil Loss	468	476	492
TOTAL	**1,685**	**1,796**	**1,922**

* Tailings 'bleed' refers to water liberated from tailings as settling occurs.

Table 5 shows that the main system inflows over the forward planning period comprise rainfall runoff, groundwater inflows and tailings bleed water. Water supplied to the CHPP dominates the outflows from the system water balance.

Water supply security can be described in terms of water supply reliability. Predicted average supply reliability is expressed as total water supplied over the simulation period divided by total demand (i.e. a volumetric reliability). Average supply reliability over all climatic realizations, as well as the lowest reliability in any one realization, for the CHPP, underground supply, haul road dust suppression and potable usage are summarised in **Table 6**.

Table 6 Summary of Modelled Water Supply Reliability

	CHPP	Underground	Truckfill	Potable Use
Average	93.1%	81.1%	92.0%	81.6%
Minimum	69.2%	31.5%	65.5%	30.2%

Forecast average supply reliability for the CHPP and truckfill is relatively high. Forecast average and minimum supply reliability for underground and potable supply is lower because of the reliance of these supplies on WALs. In extended drought periods, available water determinations would likely fall to zero for extended periods of time. In these circumstances, and using the water balance model to forecast their likelihood, ACOL will seek alternative supply sources (e.g. purchase of additional WALs on the open market or import potable water).

The forecast total stored water volume in all storages (water inventory) is shown in **Figure 3** for different risk levels.

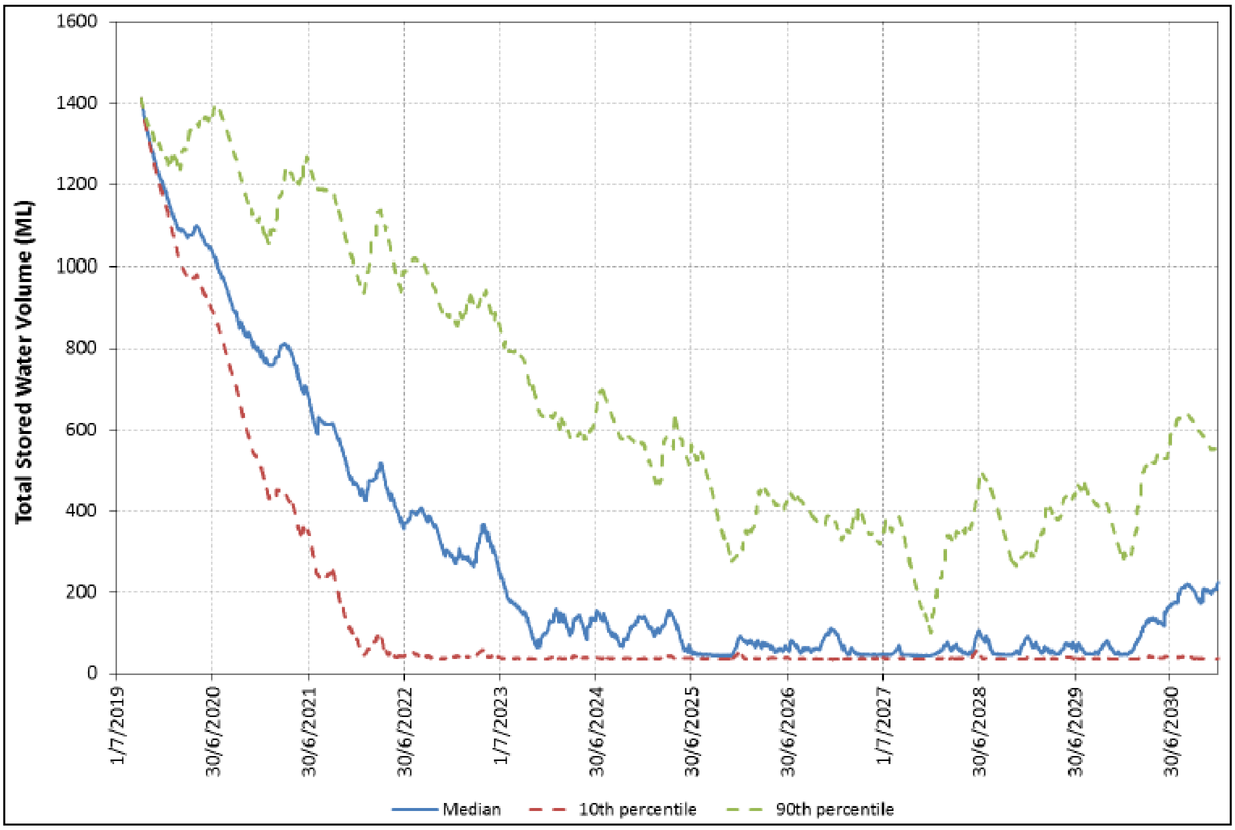

Figure 3 Forecast Water Inventory

3.3. Reporting

An annual retrospective site water balance for the reporting period is documented in the Annual Review.

3.4. Measures to Minimise Clean Water Use

Measures to minimise clean water use include:

- Recovery of tailings bleed water and use of this as a priority for CHPP and truckfill demand on site instead of WALs.
- Storage and use of runoff from disturbed areas in preference to using WALs.
- Use of water reclaimed from underground operations in preference to using WALs.
- Maintenance of water management infrastructure to ensure efficient operation and minimisation of wastage.

Although there is no current imperative to reduce water inventory, ACOL are investigating the feasibility of diverting the rehabilitated surface catchment of the NEOC overburden emplacement to adjacent non-mine catchments (once suitable water quality has been demonstrated), in order to minimise runoff captured in the water management system, should this be required in the future.

4. BOWMANS CREEK DIVERSION MANAGEMENT PLAN

The two reaches of the BCD (Eastern and Western) have been constructed in the underground mining area as shown in **Figure 4**. Construction commenced on the Eastern diversion in March 2011 and on the Western diversion in February 2012. Both were commissioned with direction of flow through each diversion in November 2012. Temporary low level block banks have been constructed across the original channel of Bowmans Creek, directing low flows into the diversion reaches. High (flood) flows are designed to overtop the temporary block banks in order that such flows not pass through the diversion until full vegetation establishment. The construction program has been completed (engineering sign off obtained) with the exception of permanent block banks which will be constructed prior to mining of the Upper Liddell Seam in LW106B or as triggered by subsidence monitoring. Remnant stockpiles of soil or alluvium may be used for re-spreading into future subsidence areas on the floodplain.

4.1. Vision Statement

The vision for the diversions is to establish an ecologically healthy riparian corridor between the New England Highway and the Hunter River, on land owned by ACOL. Fulfilment of this vision includes the construction, landscaping and ongoing monitoring and management which, compared to the characteristics and conditions of the pre-diverted creek, will provide:

- Flow channels that mimic the hydraulic and geomorphic characteristics and provide similar resilience;
- For fish passage and a diversity of aquatic habitat;
- An enlarged area of ecologically diverse, naturally vegetated, riparian corridor; and
- A free draining floodplain that is vegetated to a standard consistent with the final intended land use.

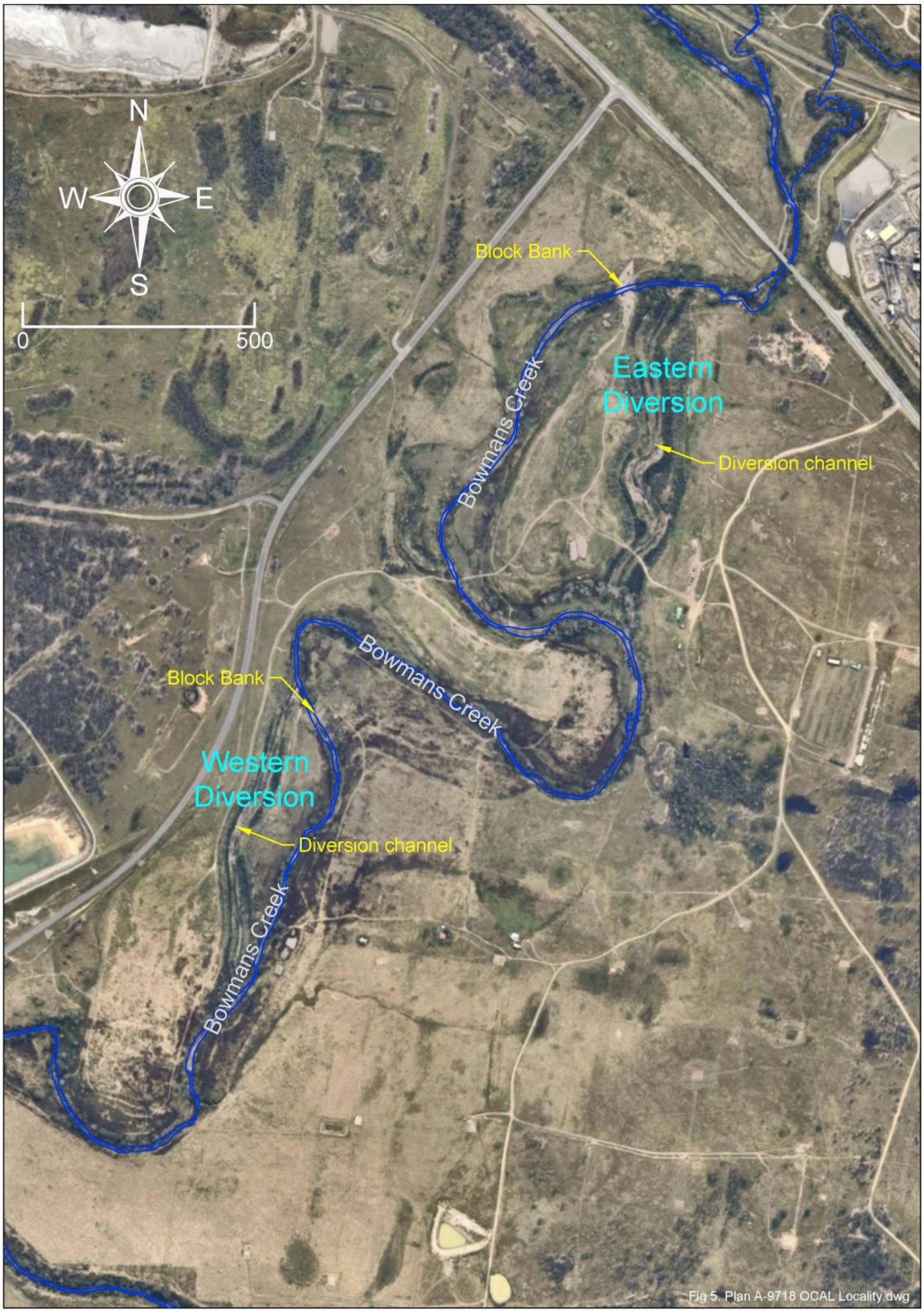

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Figure 4 Bowmans Creek Diversion Layout

4.2. Design Specifications

The key design objectives or the BCD are summarised in **Table 7**.

Table 7 Key Design Specifications

Design Specification	Design Criterion/Strategy	Features
Conveyance		
Divert flows up to 5 year ARI	152 m^3/s	152 m^3/s
Minimise seepage losses in 80th – 100th percentile low flow range	Seal under low flow channel (80th percentile flow = 2 ML/d = 0.023m^3/s)	Seal under channel to convey flow up to 10 m^3/s (865 ML/d)
Channel Morphology and Stability		
Channel shear stress	Comparable to existing	Comparable to existing
Low flow channel cross section and longitudinal profile	Mimic existing	Channel sections copied. Longitudinal profile with similar variation.
Floods inundate low level floodplain	Inundation at least once per year	Low level floodplain inundated once per year
Channel Alignment and Geometry		
Maximise channel length with sinuosity within defined corridor	Existing E channel grade 0.17% Existing W channel grade 0.39%	E channel grade 0.24% W channel grade 0.40%
Batter slopes comparable to existing channel	1:3.5 – 1:11 (V:H)	Typical batter slopes 1:4 – 1:7
Maintain comparable lower active floodplain	Range 21 – 35 m width	Channel sections copied
Maintain comparable width of incised creek corridor	Range 50 – 100 m width	Channel sections copied
Sinuosity	Mimic existing channel sinuosity as far as possible	Comparable channel alignment
Flood Levels and Flood Storage		
100 year ARI flood level at Highway	No increase	No increase
Flow velocity at Highway	Peak 100 year ARI velocity 4.3 m/s	Peak 100 year ARI velocity 4.5 m/s
Floodplain storage	No significant loss of storage	Increased flood storage
Fish Passage and Aquatic Habitat		
Fish passage when creek flowing	Passage possible in moderate flows	Flow conditions similar
Provide appropriate pool and riffle sequence	Mimic existing channel	Pool and riffles mimic existing creek
Maximum bed slope of riffles	Approximately 5%	Approximately 5%
Maintain comparable pool area	0.9 ha	1.1 ha
Riparian and Low Active Floodplain Ecology		
Maintain area of lower active floodplain area inundated in 1 year ARI flood	6.7 ha	6.4 ha
Improve habitat value of lower active floodplain	Revegetate and exclude domestic stock	Establish plant communities characteristic of those present prior to European colonisation
Ecosystem resilience	Create robust, relatively self-sustaining ecosystem	

4.3. Baseline Conditions

An assessment of the surface water and groundwater quality, ecological, hydrological and geomorphic baseline conditions within Bowmans Creek was included in the Environmental Assessment prepared in support of the development consent modification application (Evans & Peck, 2009). Updated surface water and groundwater quality baseline data as well as hydrological baseline conditions are detailed in **Sections 6.1** and **7.1** respectively. Updated ecological and geomorphic baseline conditions, including baseline site pollution sensitivity indices, are detailed in the Flora and Fauna (Biodiversity) Management Plan (FFMP).

4.4. Rehabilitation

The Bowmans Creek Diversion Rehabilitation Strategy (BCDRS) (ACOL, 2010) provides a consolidated account of the overall design and rehabilitation strategy for the BCD. Progression of rehabilitation is ongoing and ahead of the schedule outlined in the BCDRS (ACOL, 2010). Phase 1 (Bank Stabilisation) is finalised with Phase 2 (Community Structure) in progress and Phase 3 (Species Diversity) commenced.

4.5. Performance and Completion Criteria

Performance and completion criteria for channel geomorphology and stability, stream health and rehabilitation are summarised in **Table 8** below (taken from and further detail provided in the BCDRS [ACOL, 2010]). Rehabilitation performance and completion criteria for the BCD rehabilitation will be included in the FFMP.

Table 8 Bowmans Creek Diversion Performance and Completion Criteria

Functional Aspect	Assessment Method	Performance Criteria	Corrective Action
Geomorphology and Channel Stability			
Absence of permanent channel scouring	Visual inspection after minor floods during first three years.	No visible scouring.	Repair any significant scour and revegetate as necessary.
Geometry of diversion channels	Establish ten permanent survey sections in each diversion channel. Survey these cross and long section (along the channel thalweg) at the following times after completing construction of the diversion channels: • 6 months; • 1 year; • 2 years; • 5 years; • 10 years; • After floods with peak flow* > 150 m^3/s. Compare channel sections against earlier surveys and any changes in reference sites to assess trajectory towards long-term stability (assessment by qualified fluvial geomorphologist).	Evident trend towards long-term stability (by qualified fluvial geomorphologist).	As recommended by qualified fluvial geomorphologist.
Channel geometry at existing reference sites	Re-survey cross sections in remaining active sections of channel every 5 years and after floods with peak flow* > 150 m^3/s.	None (for comparison with diversion channel sections).	-
Bed load transport	At same time as above surveys, sample channel bed at four locations in each diversion channel (two pools and two riffles) and at eight comparable representative sites in the remaining active sections of the creek. Undertake particle size distribution analyses on samples.	Statistics of data from the diversion channels within 20% of that from the existing channel.	Review by qualified fluvial geomorphologist to assess trend and recommend corrective actions.
Stream Health			
Fish passage and aquatic ecology of diversion sections	Macro-invertebrate sampling of diversion reaches using AusRivAS protocols, fish sampling, habitat diversity assessment, water quality sampling and assigning site scores for Macroinvertebrate diversity, site SIGNAL index, site fish lists and site RCE aquatic habitat condition and comparing against baseline site mean ± SD scores. Baseline sites comprise: • corresponding sites within the creek sections excised (pre-excision); and • reference sites in the existing creek.	New site scores are consistently within or above the range (Baseline Excised Site Mean – SD) score and consistent with trend in reference sites.	Review by aquatic ecologist to assess trend, whether change is natural expected change or otherwise and recommend corrective actions.
Rehabilitation			
Community Structure (Phase 2** – vegetation elements that provide habitat niches)	Annual surveys to record growth rates, species abundance as well as percentage cover to determine a final structural complexity index.	Quantitative data compared with data sets from reference sites to assess success of this phase.	Feedback to planting program and modification thereof

* Flow measured at the WaterNSW gauging station on Bowmans Creek – GS 210130.

** Current rehabilitation phase

Water quality and hydrological completion criteria are defined based on the impact assessment criteria detailed in **Section 6.2**. For the criteria to be achieved, the impact assessment criteria for the Bowmans Creek monitoring locations must not be triggered over a 12 month period due to causes attributable to the BCD.

4.6. Monitoring Program

Surface water quality and groundwater quality monitoring for the BCD are carried out in accordance with the Surface Water Monitoring Program (refer **Section 6.3**) and Groundwater Monitoring Program respectively (refer **Section 6.3**). In addition, ACOL will undertake monthly review of streamflow data in Bowmans Creek at the streamflow gauging station on Bowmans Creek (refer **Section 6.1.1** and **Section 6.2** for relevant surface water impact assessment criteria).

Subsidence monitoring of Bowmans Creek (including BCD and creek section excised by BCD) is completed by ACOL surveyors in accordance with the program outlined in the current approved Extraction Plan(s). As at May 2020, two Extractions Plans (LW105-107 and LW 201 to 204) were on foot, and the Extraction Plan for LW205 to 208 was in preparation.

Ecological monitoring is carried out in accordance with procedures outlined in the FFMP.

Monitoring of the geomorphic stability of the BCD is detailed in the BCDRS (ACOL, 2010) and summarised in **Table 8** above.

5. EROSION AND SEDIMENT CONTROL PLAN

The objective of this Erosion and Sediment Control Plan (ESCP) is to set out strategies to control soil erosion and sediment generation close to the source and thereby minimise the potential for mine activities to adversely affect downstream water quality. Minimal surface disturbance occurs at the ACP with most of the site rehabilitated. The two main areas of disturbance are:

- The remnant NEOC void which is used for coarse reject emplacement and will ultimately be self-draining and integrated into the final landform; and
- The Ravensworth Void 4 area which is also self-draining, used for fine reject emplacement and will ultimately be integrated into the final landform.

Activities that could cause soil erosion and generate sediment have been identified as:

- Mine-induced subsidence and cracking (and crack repair works);
- NEOC overburden emplacement, much of which is completed and rehabilitated;
- Contained reject emplacement in the NEOC void;
- Stockpiling in the CHPP area;
- Gas drainage, exploration, de-watering and service bores (drill pad, bore construction);
- Surface disturbance at the gas drainage plant area;
- Failure of the BCD; and
- Rehabilitation of the BCD.

The following principles, which have been taken from the Landcom (2004) guidelines, underpin the approach to erosion and sediment control for the mine site:

- Minimising surface disturbance and restricting access to undisturbed areas;
- Progressive rehabilitation/stabilisation of mine infrastructure areas;
- Separation of runoff from disturbed and undisturbed areas where practicable;
- Construction of surface drains to control and manage surface runoff; and
- Construction of sediment dams or use of existing/modified water storages to contain runoff up to a specified design criterion.

These principles have been implemented to minimise soil erosion and the potential for transport of sediment off site. Specific measures used at the ACP include:

- Inclusion of disturbance management and rehabilitation conditions on Ground Disturbance Permits;
- Contour drains and rock-armoured drop structures on the NEOC overburden emplacement (refer **Figure 5**);
- Collection drains at the toe of the NEOC overburden emplacement and around the perimeter of the NEOC and administration areas (refer **Figure 5**);
- Direction of runoff from disturbed areas to mine water storages (refer **Section 2.1**);
- A levee bank constructed between the Settling Dam / PWD and Bettys Creek;

- Repair of subsidence induced surface cracking or instability implemented in a timely fashion following occurrence by regrading, ripping or infilling followed by revegetation, using equipment suitably sized for the task;
- Coal stockpiling on prepared / stabilised pads;
- Drill sumps are contained on site and not allowed to spill;
- Drill pads will have silt fence established around the downslope perimeter, with the pads themselves sheeted with road base material (low fines fill);
- Sealing of high-traffic roads;
- Maintenance of unsealed roads to avoid erosion, with table drain outlets directed to well grassed areas;
- Use of downslope / downstream silt fences hay bale filters or natural grass filters (Landcom, 2004) associated with loose material stockpiles and new surface excavation or disturbance;
- Upslope diversions and downslope sediment dam used to divert and collect runoff around the gas drainage plant (refer **Figure 5**); and
- Shaping and revegetation of stockpiles at the BCD.

No additional broadscale surface disturbance (other than mining induced subsidence) is planned in the near future at the ACP. Erosion and sediment control is therefore focussed on maintenance of existing controls, managing surface water drainage and controlling minor disturbance associated with surface infrastructure projects.

The design criteria for sediment control structures are summarised in **Table 9**.

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Figure 5 NEOC and CHPP Area Drainage and Water Storages

Table 9 Design Criteria for Sediment Control Structures

Sediment Control Structure	Function	Design Capacity
Upslope diversion drains	Reduce runoff from undisturbed areas onto disturbed areas	Peak flow calculated for 1 in 20 year* critical duration rainfall event (Department of Environment and Climate Change [DECC], (2008), Table 6.1)
Downslope collection drains	Intercept and convey disturbed area runoff water to sediment dams/sumps	Peak flow calculated for 1 in 20 year* critical duration rainfall event (DECC, (2008), Table 6.1)
Sediment dams	Containment of sediment-laden runoff from disturbed areas with more than 150 m^3/yr estimated soil loss (Landcom (2004), Section 6.3.2(d))	**Settling Zone:** Capacity to store the runoff produced from the 90th percentile*, 5-day rainfall event (DECC (2008), Table 6.1)
		Sediment Storage Zone: Either: Two months calculated soil loss estimated using RUSLE** (Landcom (2004), Section 6.3.4 (i)) Or: Half the Settling Zone Capacity†
Sediment fences and/or straw bale filters	Retention/filtration of suspended sediments	Peak flow limited to less than 50 L/s in the design 1 in 10 year critical duration rainfall event (Landcom (2004), Section 6.3.7(e))††

* Assuming a duration of disturbance greater than 3 years with a standard, not sensitive, receiving environment.

** Revised Universal Soil Loss Equation (RUSLE)

† Only on land of low erosion hazard (Landcom (2004) Section 4.4.1).

†† Assuming a duration of disturbance between 1 and 3 years with a standard sensitivity receiving environment.

The 90th percentile 5-day rainfall event, used in determining the sediment dam settling zone capacity, was calculated to be 39.4 mm from the average of values for Scone and Cessnock[3] as given in Table 6.3a in Landcom (2004).

Based on the methodology and parameters contained in Landcom (2004) and DECC (2008), the settling zone capacity and sediment storage zone capacity and hence required dam capacity are calculated using Equations 1, 2 and 3 below respectively:

$$\text{Settling Zone Capacity } (m^3) = V_{settling} = 251.8 \times A \quad (1)$$

$$\text{Sediment Zone Capacity } (m^3) = V_{sediment} = 0.5 \times V_{settling} \quad (2)$$

$$\text{Required Dam Capacity } (m^3) = V_{total} = V_{settling} + V_{sediment} \quad (3)$$

Where;

$V_{settling}$ = settling volume

$V_{sediment}$ = sediment volume

V_{total} = total volume

A = catchment area of the sediment dam (ha)

[3] Table 6.3a of Landcom (2004) gives 90th percentile 5-day rainfall depths for Cessnock and Scone of 42.8 mm and 35.9 mm respectively

Mine water storages (refer **Table 2**) at the ACP serve both as water management structures and sediment dams. The locations of these storages are shown in **Figure 5**.

Table 10 summarises the minimum sediment dam capacity requirements in comparison to existing surveyed capacities.

Table 10 Comparison of Sediment Dam Requirements to Existing Dam Capacities

Storage	Capacity (ML)	Required Settling Zone Volume (ML)	Required Sediment Zone Volume (ML)	Minimum Required Total Volume (ML)
NEOC	22,000*	40	20	60
Process Water Dam	60	3.5	1.8	5.3
Settling Dam	34	6.3	3.1	9.4
Dam 56	61	8.8	4.4	13.2
Arties Pit Sump	31	2.5	1.3	3.8

* Prior to rejects placement, gradually reducing with time.

Monthly inspections of sediment control structures, as well as inspections following significant rainfall events (more than 25mm in 24 hours), are conducted by ACOL personnel. During these inspections, sediment control structures are inspected for capacity, structural integrity and effectiveness.

Where inspections indicate substantial accumulation of sediment in a storage, clean-out is undertaken so as to reinstate the minimum required volumes given in **Table 10**. Silt fences and straw bale filters are inspected and trapped sediment removed or straw bales replaced as necessary. Removed sediment is placed in areas upslope of existing sediment control structures, mine water storages or tailings storages.

Monthly inspections of the NEOC overburden emplacement are undertaken to identify areas of erosion of water management infrastructure (i.e. dams, drains, contour banks) degradation / failure that will require remediation.

Block banks, stabilised areas and vehicle creek crossings at the BCD are routinely inspected and monitored to ensure that the risk of erosion has been effectively reduced. Any repairs or remedial measures are implemented as required.

5.1. Flooding

Schedule 3, Condition 26 (d) requires the ESCP to consider potential flooding which could affect infrastructure or properties external to the mine, or the environment. Flood assessments were completed as part of the ACP EIS (2001) and BCD (MOD 6) EA. Activities that could affect flooding have been identified as:

- Mine-induced subsidence;
- Stockpiling in the CHPP area;
- Failure of the BCD;
- Failure of the drainage infrastructure on the NEOC; and
- Any construction works in flow paths.

The following principles underpin the approach to management of flood risk for the mine site:

- Construction, monitoring and maintenance of a licenced flood works levee (20FW213279) to separate natural flows in Bettys Creek and the mine water management footprint;

- Stockpiling and construction works are not carried out in flow paths or potential flood-prone areas unless detailed assessment has been completed; and
- The BCD and NEOC drainage infrastructure have been constructed to be stable up to the required flood design criteria and regular monitoring and maintenance is carried out.

5.2. Creek Crossings

Schedule 3, Condition 25 requires creek crossings at the ACP to be designed, installed and maintained in accordance with the following two documents:

- *Fisheries NSW Policy and Guidelines for Fish Habitat Conservation and Management* (2013 update) (NSW Department of Primary Industries 2013); and
- *Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings* (Fairfull & Witheridge, 2003).

Seven existing creek crossings have been identified at the ACP as shown on **Figure 6** and summarised in **Table 11** As no new crossings are proposed, recommendations regarding design and installation are not applicable to the ACP, and only maintenance recommendations in the guideline documents above have been considered.

Table 11 Summary of Creek Crossings

Number	Creek	Location	Description
1	Bettys Creek	Downstream of railway, upstream of confluence with Glennies Creek	Pipe culvert under road, no flow observed in the creek
2	Swamp Creek	Downstream of railway, upstream of confluence with Glennies Creek	Pipe culvert under road, no flow observed in the creek
3	Bowmans Creek	Downstream of confluence with Bettys Creek, upstream of New England Highway crossing	Concrete causeway
4	Bowmans Creek	Block bank for Eastern Diversion of BCD	Complete blockage of low flows, redirected to BCD
5	Bowmans Creek	Eastern Diversion of BCD	No structure, drowned gravel track crossing
6	Bowmans Creek	Excised section (Eastern) of Bowmans Creek	No structure, drowned gravel track crossing
7	Bowmans Creek	Block bank for Western Diversion of BCD	Complete blockage of low flows, redirected to BCD

All seven of these crossings are inspected during the erosion and sediment control inspection following heavy rainfall events (>25mm in 24 hours) to assess their hydraulic capacity and utility for fish passage, as well as to assess the need to remove debris and sediment deposits or repair bed and bank erosion as needed. As recommended in the above documents, wherever possible, in-stream maintenance activities will be programmed for those times of the year that minimise overall environmental harm (e.g. low or no flow periods) with appropriate consideration to anticipated critical periods of fish passage and seasonal high flows (Fairfull & Witheridge, 2003).

6. SURFACE WATER MANAGEMENT PLAN

The objective of the Surface Water Management Plan (SWMP) is to provide baseline data for creeks potentially affected by the ACP, nominate surface water impact assessment criteria for investigating any potentially adverse impacts and provide details of the monitoring program used to monitor the effects of the ACP on existing surface water bodies, in order to assist in detecting if any significant off-site impacts occur as a result of ACP operations and to trigger response plans to adverse impacts.

6.1. Baseline Data

Glennies Creek has been modified by the construction of the Glennies Creek Dam in its upper reaches. Bettys Creek has been modified with its upper reaches diverted around the Mt Owen Complex operations. Bowmans Creek has been modified in its lower reaches by the construction of the BCD and overlies the underground mining operations. Flows in the Hunter River are affected by releases from Glenbawn Dam and by controlled releases from mining operations in accordance with the Hunter River Salinity Trading Scheme.

Historical data relating to water quality and flows in the above watercourses are summarised in the sections to follow. This data is used as a baseline for on-going monitoring of the impacts of mining activities on surface water in these watercourses. For the purposes of developing impact assessment criteria, the water quality baseline data end date has been assumed as December 2011.

6.1.1 Streamflow

Streamflow monitoring is focussed on Bowmans Creek which has the greatest potential to be impacted by the ACP. Additional gauging stations exist on the Hunter River in the vicinity of the ACP, however given the large catchment area of the Hunter River (13,590 km2 at Bowmans Creek), the effect of releases from Glenbawn Dam and licensed extraction from and releases to the river by others, any effects on streamflow by the ACP are likely to be indiscernible. Similarly, direct monitoring of flow in Glennies Creek is obviated by the effects of regulated flow releases from Glennies Creek Dam and licensed extraction by others.

Streamflow gauging station GS 210130 on Bowmans Creek is maintained by WaterNSW. This station is located between the Eastern and Western reaches of the BCD (refer **Figure 6**). Therefore, the data from this station forms a valuable baseline in any future assessment of impact of the ACP on streamflow. Available streamflow data is summarised in Error! Reference source not found.**.** Data indicates that (except during drought periods) Bowmans Creek at GS 210130 has been persistent, with zero flow recorded on 8.4% of days (and 99% of those no-flow days being recorded since March 2018).

Table 12 Summary of Recorded Baseline Bowmans Creek Streamflow Monitoring Data

Catchment Area:	240 km^2
Period of Record:	28/10/1993 to present
No. Missing Days:	791
No. Zero Flow Days:	805 (784 post-March-2018)
Max. Daily Flow (ML/d):	23,045 (June 2007 flood)
Mean Annual Flow (ML/year):	14,181

* Data source: WaterNSW (https://realtimedata.waternsw.com.au/)

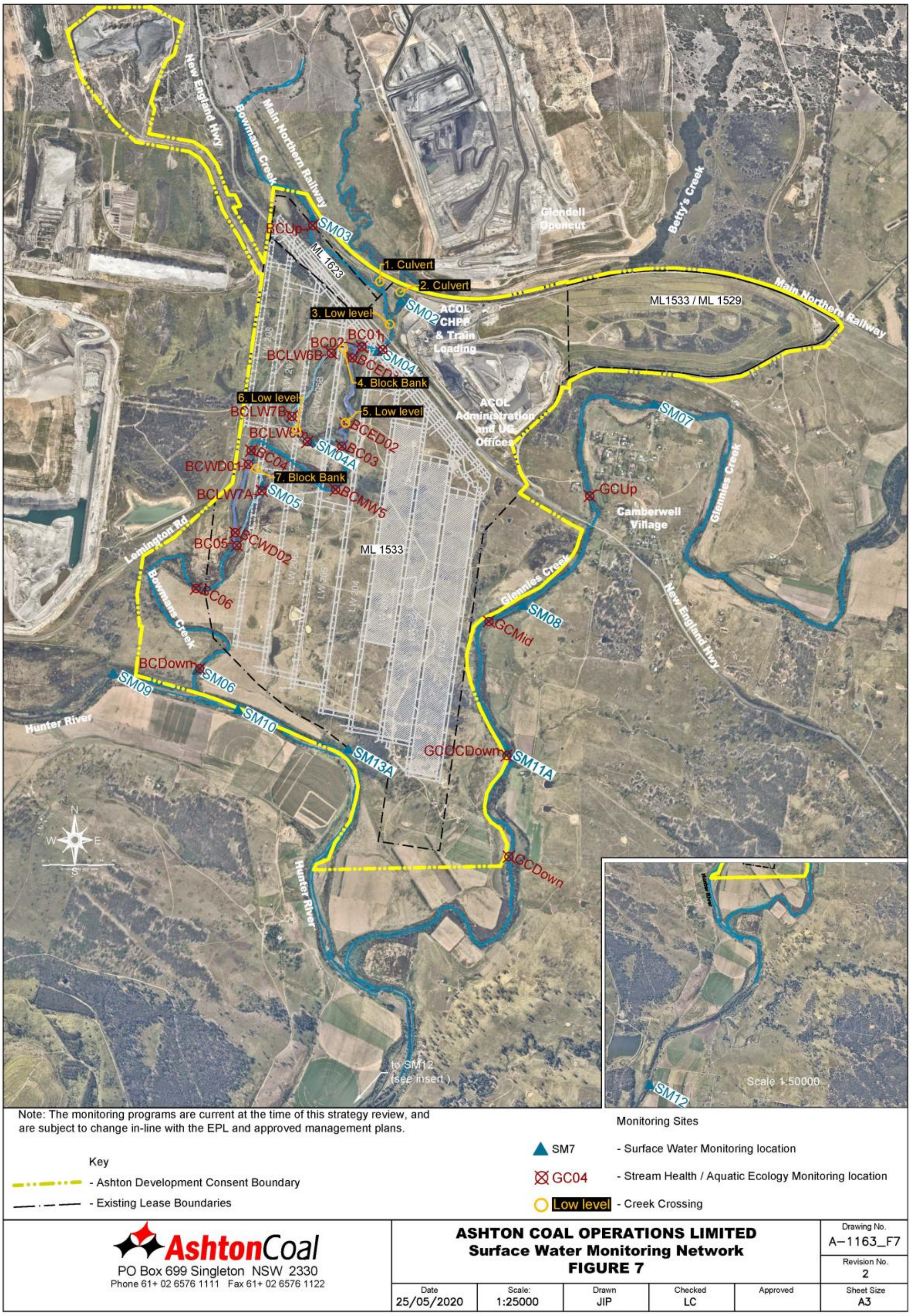

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Figure 6 ACP Surface Water Monitoring Network

6.1.2 Water Quality

Water quality monitoring has been carried out since 2003 at the sites shown in **Figure 6**. Routine monitoring occurs for pH, electrical conductivity (EC), total dissolved solids (TDS) and total suspended solids (TSS). Baseline water quality data are summarised in **Table 13** to **Table 16** for the four watercourses (Bowmans Creek, Bettys Creek, Glennies Creek and the Hunter River).

In addition, quarterly sampling of the site STPs commenced in 2019, with testing for pH and faecal coliforms in accordance with Condition M2.3 of EPL 11879.

Table 13 Summary of Baseline Surface Water Quality Monitoring Data – Bowmans Creek

	Site Name	SM3	SM4	SM4a	SM5	SM6
	Description	Upstream Bettys Creek	Upstream Eastern Diversion	Former Channel (Eastern Diversion)	Former Channel (Western Diversion)	Upstream Hunter River
	Baseline Period	12/9/03 – 16/12/11	12/9/03 – 16/12/11	5/12/06 – 16/12/11	22/9/03 - 16/12/11	22/9/03 - 10/11/11
pH	No.	406	422	249	100	99
	Min	6.79	6.66	6.79	6.90	6.84
	Max.	8.94	9.16	8.54	8.28	8.46
	Mean	7.66	7.91	7.83	7.80	8.01
	Median	7.66	7.90	7.84	7.79	8.05
	5th %ile	7.20	7.40	7.40	7.50	7.60
	20th %ile	7.42	7.71	7.67	7.66	7.84
	80th %ile	7.88	8.09	8.01	7.97	8.23
	95th %ile	8.10	8.40	8.30	8.10	8.40
EC (µS/cm)	No.	406	422	249	100	99
	Min	283	82	289	381	367
	Max.	3720	14700	4620	2040	2000
	Mean	1147	2797	1030	1223	970
	Median	1115	1795	981	1190	958
	5th %ile	598	589	543	610	605
	20th %ile	879	909	824	927	764
	80th %ile	1440	3656	1140	1542	1108
	95th %ile	1620	10790	1796	1831	1424
TSS (mg/L)	No.	406	421	247	100	99
	Min	1	1	1	1	2
	Max.	996	592	140	98	163
	Mean	21	32	15	14	21
	Median	10	19	10	10	14
	5th %ile	5	8	5	6	8
	20th %ile	5	8	5	6	8
	80th %ile	20	37	19	20	26
	95th %ile	62	104	44	31	60
TDS (mg/L)	No.	406	422	248	100	99
	Min	194	212	227	294	294
	Max.	2150	9070	2530	1160	1080
	Mean	678	1673	597	707	540
	Median	653	1030	562	681	514
	5th %ile	361	364	339	360	334
	20th %ile	500	514	474	513	397
	80th %ile	878	2270	653	891	642
	95th %ile	965	6331	1067	1031	810

Table 14 Summary of Baseline Surface Water Quality Monitoring Data – Bettys Creek

Site Name		SM1	SM2
Description		Upstream ACP	Upstream Bowmans Creek
Baseline Period		24/11/03 – 8/12/11	24/11/03 – 8/12/11
pH	No.	40	47
	Min	6.42	6.15
	Max.	8.12	8.14
	Mean	7.34	7.23
	Median	7.28	7.16
	5th %ile	6.60	6.60
	20th %ile	6.97	6.87
	80th %ile	7.70	7.63
	95th %ile	8.00	7.90
EC (µS/cm)	No.	40	47
	Min	113	119
	Max.	2490	2100
	Mean	656	651
	Median	338	405
	5th %ile	148	142
	20th %ile	202	222
	80th %ile	1198	1144
	95th %ile	1811	1803
TSS (mg/L)	No.	40	47
	Min	7	5
	Max.	504	330
	Mean	83	71
	Median	41	46
	5th %ile	7	6
	20th %ile	14	16
	80th %ile	122	116
	95th %ile	273	213
TDS (mg/L)	No.	40	47
	Min	198	184
	Max.	1670	1180
	Mean	591	541
	Median	548	500
	5th %ile	246	222
	20th %ile	326	302
	80th %ile	794	732
	95th %ile	1193	1105

Table 15 Summary of Baseline Surface Water Quality Monitoring Data – Glennies Creek

	Site Name	SM7	SM8	SM11
	Description	Upstream ACP	Adjacent LW Panels	Upstream Hunter R.
	Baseline Period	22/9/03 – 16/12/11	22/9/03 – 16/12/11	22/9/03 – 16/12/11
pH	No.	100	100	100
	Min	7.15	7.18	7.10
	Max.	8.40	8.28	8.45
	Mean	7.83	7.78	7.88
	Median	7.82	7.77	7.88
	20^{th} %ile	7.66	7.62	7.74
	80^{th} %ile	8.03	7.96	8.02
EC (µS/cm)	No.	100	100	100
	Min	207	219	208
	Max.	903	887	888
	Mean	415	413	417
	Median	352	347	353
	20^{th} %ile	270	265	269
	80^{th} %ile	577	562	564
TSS (mg/L)	No.	100	100	100
	Min	2	1	2
	Max.	226	120	86
	Mean	17	18	16
	Median	12	14	13
	20^{th} %ile	6	8	8
	80^{th} %ile	19	22	20
TDS (mg/L)	No.	100	100	100
	Min	131	125	126
	Max.	460	474	466
	Mean	243	241	242
	Median	206	201	204
	20^{th} %ile	163	160	160
	80^{th} %ile	342	334	332

Table 16 Summary of Baseline Surface Water Quality Monitoring Data – Hunter River

	Site Name	SM9	SM10	SM13	SM14	SM12
	Description	Upstream Bowmans Creek	Downstream Bowmans Creek	Down-stream LW Panels	Upstream Glennies Creek	Downstream Glennies Creek
	Baseline Period	22/9/03 – 10/11/11	22/9/03 - 6/12/11	22/9/03 - 6/12/11	23/8/06 -	22/9/03 – 10/11/11
pH	No.	99	100	100	65	97
	Min	7.54	7.66	7.69	7.61	7.62
	Max.	8.52	8.52	8.68	8.53	8.39
	Mean	8.16	8.18	8.17	8.18	8.03
	Median	8.20	8.21	8.20	8.18	8.06
	20th %ile	8.00	8.00	8.02	8.01	7.84
	80th %ile	8.32	8.32	8.32	8.39	8.24
EC (µS/cm)	No.	99	100	100	65	97
	Min	304	319	293	266	239
	Max.	1270	1290	1260	1260	982
	Mean	775	772	760	797	565
	Median	744	742	713	802	552
	20th %ile	619	629	605	629	375
	80th %ile	942	942	927	985	728
TSS (mg/L)	No.	99	100	100	65	97
	Min	1	2	1	5	2
	Max.	204	160	226	209	184
	Mean	27	30	33	36	26
	Median	22	25	24	26	16
	20th %ile	10	12	12	13	10
	80th %ile	34	42	41	47	36
TDS (mg/L)	No.	99	100	100	65	97
	Min	236	255	142	167	150
	Max.	722	672	750	666	640
	Mean	426	426	420	445	320
	Median	400	406	390	424	314
	20th %ile	330	332	329	348	214
	80th %ile	541	526	516	544	415

6.2. Surface Water Impact Assessment Criteria

Impact assessment criteria can be described as trigger levels, which, if triggered, would lead to a response in terms of more intensive monitoring, investigation and ultimately, if required, remedial action. The Surface and Groundwater Response Plan (SGRP – **Section 8**) contains details of responses. Surface water impact assessment criteria are related to water quality in local watercourses. **Table 17** shows a summary of the impact assessment criteria.

Table 17 Surface Water Quality Impact Assessment Criteria

Parameter	Trigger
pH EC TSS TDS	*Either* If recorded value at a monitoring site is greater than the x^{th} percentile of baseline data* for 3 consecutive readings or, for pH, less than the y^{th} percentile of baseline data for 3 consecutive readings, where: x = 80 during periods of flow x = 95 during periods of no, trickle or low flow† y = 20 during periods of flow y = 5 during periods of no, trickle or low flow† *Or* If a recorded value at a monitoring site differs extremely from the preceding 3 readings at that location and there are no unusual events that could have caused the difference

* Refer **Table 13** to **Table 16**

† Only occurs Bowmans and Bettys Creeks. Refer **Table 18**

The above triggers will be revised in future revisions of the WMP, if analysis of additional data (including other monitoring sites) demonstrates that improvement(s) to triggers and their associated assessment methods would result from such a revision.

Table 18 shows predicted average yearly reductions in baseflow obtained from the most recent revision of the groundwater model (AGE, 2016).

Table 18 Predicted Average Annual Creek Baseflow Reduction

	Baseflow Reduction in:					
	Glennies Creek		Bowmans Creek		Hunter River	
Year	*Avg. m³/d*	*ML*	*Avg. m³/d*	*ML*	*Avg. m³/d*	*ML*
2017	43.5	15.9	51.4	18.8	17.4	6.34
2018	48.2	17.6	55.7	20.3	18.5	6.78
2019	52.1	19.0	59.0	21.6	19.6	7.17
2020	55.6	20.3	62.2	22.7	20.7	7.55
2021	58.6	21.4	64.8	23.7	21.6	7.87
2022	61.5	22.5	67.3	24.6	22.4	8.20
2023	63.9	23.3	69.7	25.5	23.3	8.51
2024	66.6	24.3	72.2	26.4	24.2	8.83
2025	69.3	25.3	74.4	27.2	24.9	9.08
2026	71.7	26.2	76.7	28.0	25.6	9.3.4
2027	73.6	26.9	79.0	28.8	26.2	9.59
2028	75.6	27.6	81.4	29.7	27.0	9.85

Baseflow impacts cannot be measured directly from seepages underground. Instead, a sudden drawdown in the alluvium that is greater than the predicted drawdown may indicate a baseflow impact that is greater than predicted. The impact assessment criteria for monitoring baseflow impacts as a result of groundwater drawdown is provided in **Section 7.2**.

The predicted average annual baseflow reductions given in **Table 18** are used by ACOL each year to 'reserve' a volume of water from their WALs (**Table 3**) – i.e. the effective annual WAL volume is reduced by the predicted baseflow reduction.

6.3. Monitoring Program

The SWMP for the ACP involves the monitoring of all data relevant to surface water impact assessment criteria (refer **Table 17**). A summary of the monitoring locations and parameters monitored is provided in **Table 19** and **Figure 6**.

Table 19 Summary of Surface Water Monitoring Program

Watercourse / Location	Site	Parameters	Frequency
Bowmans Creek	SM3, SM4, SM4A, SM5, SM6	pH, EC, TSS, TDS, flow (qualitative)[†].	Monthly
		Tot. Hardness, Oil & Grease, turbidity, Ca, Mg, Na, K, Cl, SO_4, HCO_3, CO_3, Al, As, Cd, Cr, Cu, Fe, Pb, Mn, Hg, Ni, Se, Zn, NH_3, NO_4, F.	Annual
	BCUp, BC1, BC2, BCED1, BCLW6b, BCLW6B, BCLW7B, BCED2, BC3, BCMW5, BC4, BCWD1, BCLW7A, BCWD2, BC5, BC6, BCDown[*]	Aquatic ecology sampling and stream health assessment: field observations of aquatic habitat, macroinvertebrate sampling, macrophyte sampling, fish trapping, selective 'edge' and riffle habitat sampling, field water quality, taxonomic identifications and diversity assessment, SIGNAL index calculations, site condition index (RCE).	Annual
	BCED1, BCED2, BCWD1, BCWD2	Photo point assessment and comparison or erosion and deposition features	Annual
Bettys Creek	SM1, SM2	pH, EC, TSS, TDS, flow (qualitative)[†].	Monthly
		Tot. Hardness, Oil & Grease, turbidity, Ca, Mg, Na, K, Cl, SO_4, HCO_3, CO_3, Al, As, Cd, Cr, Cu, Fe, Pb, Mn, Hg, Ni, Se, Zn, NH_3, NO_4, F.	Annual
Glennies Creek	SM7, SM8, SM11A	pH, EC, TSS, TDS, flow (qualitative)[†].	Monthly
Hunter River	SM9, SM10, SM12, SM13A	pH, EC, TSS, TDS, flow (qualitative)[†].	Monthly
		Tot. Hardness, Oil & Grease, turbidity, Ca, Mg, Na, K, Cl, SO_4, HCO_3, CO_3, Al, As, Cd, Cr, Cu, Fe, Pb, Mn, Hg, Ni, Se, Zn, NH_3, NO_4, F.	Annual
Sewage Treatment Plants	Admin / Underground (EPL Site 17) CHPP (EPL Site 18) Open cut / Workshop (EPL Site 19)	pH, Faecal Coliforms	Quarterly

[†] Data logged every 10 minutes.

[†] Qualitative flow assessment at the time and location of sampling involves the designation of either zero flow (i.e. a stagnant pool), trickle, low, moderate or high flow.

* A number of these sites were brought into the monitoring program sequentially as the staged diversion works proceeded and other sites are to be brought in sequentially as mining proceeds. These latter sites will be introduced into the aquatic ecology monitoring program on a staged basis, that is, relative to the progression of the respective longwall mining. Sampling of each of these short-term longwall sites will be scheduled into the regular sampling program to incorporate a before, and at least two after samples from each site, according to the scheduled mining program. Not all sites are to be sampled for the full stream health monitoring program but will be sampled for fish passage and/or field water quality as appropriate.

In accordance with Schedule 3 Condition 26 (e) of the Development Consent, the impacts of the operation on private water users will be monitored, assessed and responded to in accordance with the SGRP (**Section 8**). There are 10 private water users on Bowmans Creek with 13 extraction licenses (Industry & Investment NSW, 2012), with 4 users located downstream of the confluence with Bettys Creek. The surface water monitoring network shown in **Figure 6** will be used to monitor and assess any impacts on these users.

The results of surface water quality monitoring are reported in the Annual Review. This includes an assessment of results in terms of off-site impacts as a result of mining.

ACOL undertake routine monitoring of water usage, water imported to and extracted from the mine and volumes of water stored on site, as part of a program of monitoring to verify the mine site water balance. The data is used to:

- monitor trends in water use and efficiency;
- assess mine water inflows;
- check stored water inventory;
- validate or re-calibrate the mine water balance; and
- assist in future mine water supply and management planning.

Flow meters are shown on Figure 3 and are typically recorded on a monthly basis. Flow metering at ACP is conducted to ensure accurate accounting and water balance data. Flow meters are installed on all water extraction devices that are used to take water from water sources. Records are kept onsite of flow meter readings to account for water take.

Water levels in all mine water storages (**Table 2**) are also typically recorded on a monthly basis. Site water balance reviews are undertaken on at least an annual basis as part of the Annual Review.

7. GROUNDWATER MANAGEMENT PLAN

The objective of the Groundwater Management Plan (GMP) is to provide baseline data for the area that could possibly be affected by the ACP, nominate groundwater impact assessment criteria for investigating any potentially adverse impacts and provide details of the monitoring program used to monitor the effects of the ACP on surrounding groundwater aquifers, in order to assist in detecting if any significant off-site impacts occur as a result of ACP operations and to trigger response plans to adverse impacts.

Two distinct main aquifer systems occur within the ACP area:

- a semi-confined, porous fractured rock aquifer system in the consolidated Permian age sedimentary strata (Permian coal measures); and
- a shallow, unconfined, granular aquifer system in the unconsolidated sediments of the alluvium associated with Bowmans Creek, Glennies Creek and Hunter River.

The alluvium is hydraulically connected with a layer of weathered rock / regolith and colluvium (colluvium is defined as sediment/detritus accumulated in drainage lines at the surface). Whilst these units are not constantly saturated, they can contribute to the recharge of the alluvium and fractured rock aquifer.

The main aquifers are the alluvial deposits, which extend along the low-lying areas of the watercourses. Except during periods of high flow in the watercourses, water discharges from the alluvium into the watercourses, providing baseflow. Mining activities that reduce the water table have the potential to reduce the contribution of baseflow from the alluvial aquifers and to affect licensed bores in the alluvium.

7.1. Baseline Data

7.1.1 Groundwater Levels

The baseline groundwater level range for selected monitoring bores in the Bowmans Creek, Glennies Creek and Hunter River alluvium are summarised in **Table 20** and the bore locations are shown in **Figure 7**. The baseline data spans the period from November 2000 to August 2011. It is important to note that baseline levels fluctuate according to natural seasonal, and longer-term cyclical, climatic variations.

Baseline monitoring location co-ordinates are included in **Appendix B**.

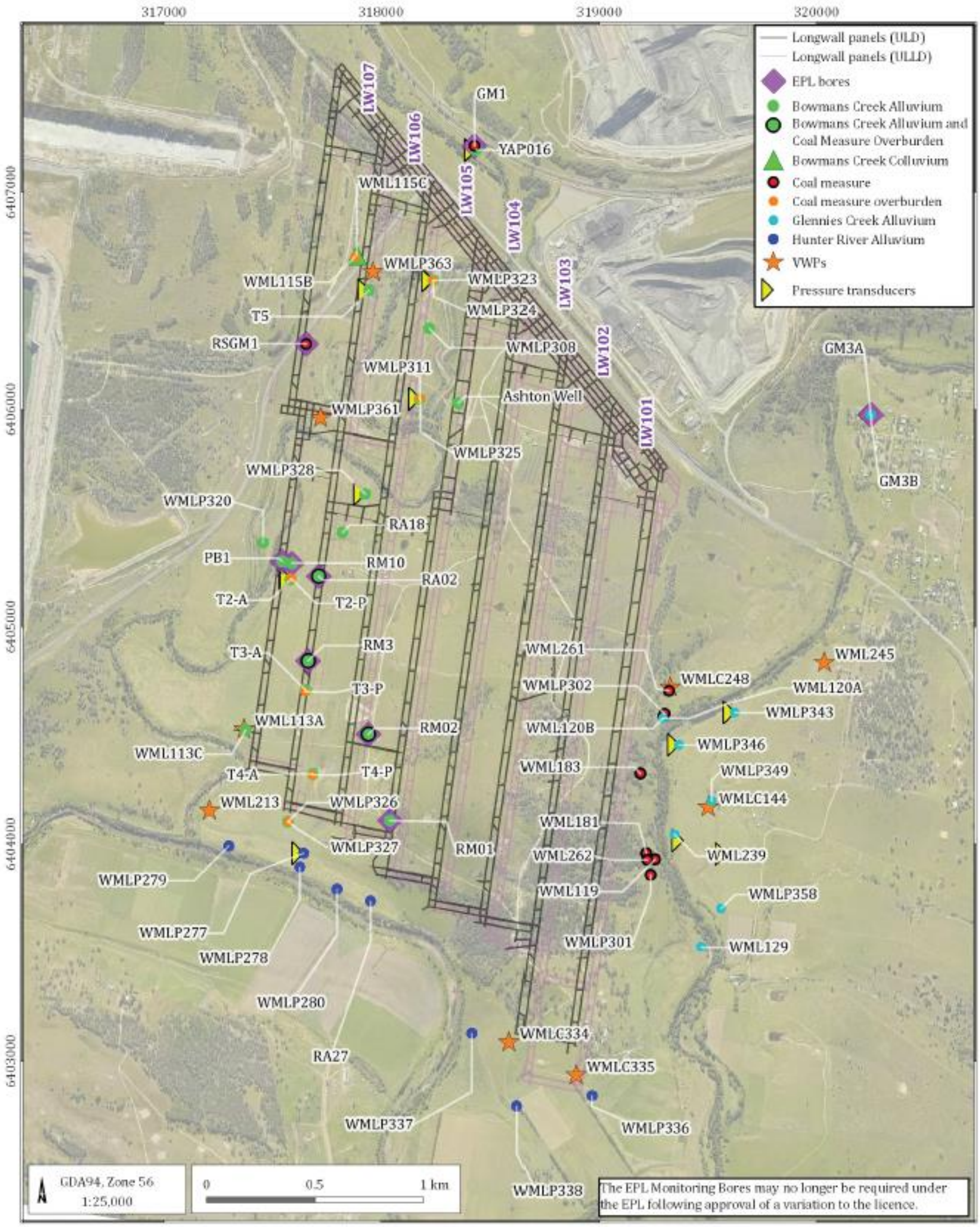

Figure 7 Groundwater Level Baseline and Trigger Level Monitoring Bores

Table 20 Alluvium Monitoring Bore Baseline Water Levels

Alluvial Area	Bore	Highest Recorded Level (m AHD)	Mean Level (m AHD)	Lowest Recorded Level (m AHD)
Bowmans Creek	RM6	56.8	55.7	55.11
	RM7	57.2	56.08	55.33
	RM9	57.26	56.74	55.3
	RA30	62.59	61.01	59.95
	RA18	56.84	56.41	55.98
	T2-A	56.02	55.43	55.12
	T3-A	60.37	50.98	50.35
	T4-A	50.57	49.92	49.26
Glennies Creek	WML129	51.95	50.79	43.14
Hunter River	RA27	50.51	49.48	48.89

7.1.2 Groundwater Quality

Groundwater quality varies in different aquifers. Alluvial groundwater in the floodplains of Bowmans Creek, Glennies Creek and the Hunter River is generally of a quality suitable for stock and, in areas, suitable for domestic use. Colluvial groundwater and some of the alluvial groundwater is brackish to saline in quality and is not used for consumptive use. Groundwater in coal measures is saline and is not suitable for consumption, nor is it used for consumptive purposes apart from mining demands. A summary of the baseline groundwater quality, from representative bores over the available period of data prior to longwall mining (2007 to 2011) is given in **Table 21**.

Table 21 Summary Baseline Groundwater Quality

Aquifer	pH		EC (µS/cm)	
	Mean	*Range*	*Mean*	*Range*
Bowmans Creek Alluvium	7.23	6.44 - 10.04	1,622	722 – 9,920
Hunter River Alluvium	6.97	6.76 - 7.14	2,091	1,375 – 2,540
Glennies Creek Alluvium	7.05	6.53 - 7.79	3,202	300 – 16,300
Colluvium	6.91	6.52 - 7.87	6,682	1,300 – 13,860
Coal measures (Pikes Gully Seam)	6.87	5.29 - 7.78	2,088	86 – 8,820

7.1.3 Groundwater Users

There are no non-ACOL registered bores in surrounding areas that will be impacted by the underground mine. The reason for this is that most of the drawdown due to the underground mine occurs in close proximity to the mined area. In the most recent update to the groundwater model, AGE (2016) stated that modelled impact to groundwater levels are, in general, less than that predicted in the Bowmans Creek Diversion Impact Assessment (Aquaterra, 2009).

Based on groundwater model predictions (AGE, 2016) and monitoring observations during longwall mining to date, drawdown impacts due to the underground operation are not expected to propagate over long distances towards private registered bores in surrounding regions.

7.1.4 Groundwater Dependent Ecosystems

Two small stands of River Red Gums (RRGs) are commonly identified as a groundwater dependent ecosystem (GDE) located in the vicinity of the ACP (refer **Figure 7**). These stands of RRGs are located on the lower reaches of Bowmans Creek, within 1 km of the Hunter River confluence, and the lower reaches of Glennies Creek. However, these RRG were determined not to be completely dependent on groundwater, drawing water opportunistically from multiple sources (Marine Pollution Research, 2009). Nor are these RRG stands mapped on the High Priority Groundwater Dependent Ecosystem Map (NSW Department of Water and Energy, 2009). Nonetheless, the RRG are not predicted to be impacted by approved underground mining at the ACP.

7.2. Groundwater Impact Assessment Criteria

Impact assessment criteria can be described as trigger levels, which, if triggered, will lead to a response in terms of further, more intensive monitoring, investigation and ultimately, if required, remedial action. The SGRP (**Section 8**) contains details of all responses relating to each impact assessment criterion. Groundwater impact assessment criteria focus on particular areas and each area may contain more than one criterion.

Impact assessment criteria have been defined based on a statistical analysis of the baseline and operational groundwater data collected across all hydrogeological units at the ACP and consideration of guideline water quality values for slightly to moderately disturbed ecosystems as given in ANZECC/ARMCANZ (2000).

7.2.1 Groundwater Levels

Groundwater levels within the alluvium can provide an indication of the potential for impacts on watercourse baseflow. Groundwater levels can also indicate induced leakage from alluvial aquifers to underlying hydrogeological units in response to subsidence impacts. Triggers have been developed based on observed natural variations in monitored bores and predicted mining-induced drawdowns at alluvium monitored bores (AGE, 2016). Predicted drawdown in alluvium (AGE, 2016), by the end of mining in LW204 (Upper Lower Liddell seam), ranges from 0.02 m to 1.12 m in Bowmans Creek alluvium monitoring bores, from 0.08 m to 1.1 m in Glennies Creek alluvium monitoring bores and from 0.01 m to 0.13 m in Hunter River alluvium monitoring bores. A summary of the observed and modelled drawdown (AGE, 2016) compared to the approved impacts is included in **Table 22**. Both the observed and modelled impacts are within the limits of the approved impacts.

Table 22 Comparison of 2016 modelled drawdown to 2001 EIS and 2009 EA modelled drawdown (AGE 2016)

Location	Observed	2016 AGE model	2009 EA	2001 EIS
	Impact to May 2020 (to end of-LW203 ULLD)	***Impact to end of LW204 – ULLD (March 2020)***	***Completed mine modelled impact***	***Completed mine modelled impact***
BCA	No mining-related drawdown observed in WMP bores (WMLP311, WMLP323, WMLP328, T2A), but significant water level decrease due to prolonged dry climatic conditions	Generally < 1 m (>1m - <2 m in a very small and localised area)	< 3 m	No significant drawdown
GCA	No drawdown observed in WMP bores (WML120B, WML129, WML239)	Generally < 1 m (>1m - <2 m in a very small and localised area)	< 2 m	2.5 m
HRA	Slight drawdown observed in	< 1 m	< 1 m	No significant

	WMP bores (WMLP279, WMLP280, WMLP337) due to prolonged low river levels due to dry climatic conditions			drawdown

To account for natural variation, trigger levels are derived by interpreting the variation observed in recent years (2011 to 2019), the approved impacts (Aquaterra 2009) and the predicted drawdown (AGE, 2016) – refer **Table 22**. The result is a practical trigger level that accounts for both model predictions and natural influences (**Table 23**).

The compliance bores water level trigger values have been derived by subtracting the model predicted drawdown (AGE, 2016) from the minimum water level observed in recent and measured natural variation. A contingency of 0.2 m has also been applied to allow for the conservative nature of the updated model relative to the approved impacts as detailed in Aquaterra (2009). Trigger levels are given for bore locations shown in **Figure 7**. A recorded water level below the defined trigger level at a monitoring bore at any time between now and the end of mining of LW204 in the ULLD, sustained for three consecutive months, will trigger a response (refer **Section 8**).

Table 23 Trigger Levels for Alluvial Piezometers

Aquifer and Monitoring Piezometer	Ground Elevation (m AHD)	Base of Bore Elevation (m AHD)	Base of Alluvium Elevation (m AHD)	Lowest Recorded Water Level (m BGL)	Modelled Drawdown to End of LW204 (m)	Assigned Groundwater Level Trigger Value at End of Mining of in LW204 (Upper Lower Liddell Seam) (m AHD)
Bowmans Creek Alluvium*						
WMLP311	63.64	56.04	55.64	58.55	0.85	**57.50**
WMLP323	64.47	56.59	59.47	60.21	0.81	**59.20**
WMLP328	61.52	49.47	49.42	55.58	0.23	**55.15**
T2A	59.69	50.79	49.69	54.61	0.24	**54.17**
Glennies Creek Alluvium						
WML120B	60.12	51.12	51.12	51.66	0.01	**51.45**
WML129	54.94	45.94	45.44	50.63	0.63	**49.80**
WML239	58.82	45.32	50.82	51.03	1.05	**49.78**
WMLP343	61.0	49.14	50.00	52.13	0.60	**51.33**
WMLP346	60.68	48.18	49.18	52.08	0.53	**51.35**
WMLP349	58.34	48.34	48.84	51.96	0.94	**50.82**
WMLP358	59.66	48.46	50.16	51.66[$]	0.67	**50.79**[$]
Hunter River Alluvium						
WMLP279	61.6	44.2	45.10	49.03	0.01	**48.82**
WMLP280	59.92	43.92	44.92	48.85	0.02	**48.63**
WMLP337	59.85	46.35	48.05	47.94	0.01	**47.73**
WMLP336	60.37	44.94	47.87	48.48	0.13	**48.15**

[*] Bowmans Creek alluvium is approved to be dewatered in areas above the mine plan by end of mining of the Upper Liddell seam (Aquaterra 2009). Trigger values are therefore intended as a guide representing updated, more conservative, impact predictions from the updated groundwater model (AGE, 2016).

[$] This water level trigger is based on the second lowest water level measured, as the lowest measured water level is an outlier in the dataset.

It is noted that, in accordance with the approved groundwater impact predictions (Aquaterra, 2009), the sections of Bowmans Creek alluvium that overly the mine plan were anticipated to be dewatered by the end of mining in the Upper Liddell seam. The updated predictions (AGE, 2016) and subsequently assigned trigger values for water level in the Bowmans Creek alluvium piezometers show a level of saturation remaining.

This indicates that the approved ACP impacts are conservative in nature, in that observed mining-related impacts are within the limits of the approved impacts. Trigger levels have been assigned to the Bowmans Creek alluvium using updated predictions however, these should be considered in the context that the ACP is approved to induce dewatering in these areas (Aquaterra, 2009).

Baseline, trigger and monitoring bore location co-ordinates are included in **Appendix B**.

7.2.2 Groundwater Quality

In a similar fashion to observed water levels, groundwater quality exhibits a degree of natural variation. Based on the baseline and recently recorded water quality data, water quality impact assessment criteria have been refined for the alluvial aquifers. The following trigger values for specific monitoring bores represent an observed value outside of expected natural variation for those bores. Natural variation has been determined using the 5th and 95th percentile of the historical data.

A maintained 'trend', regarded as three consecutive measurements outside of these percentiles (trigger values), will trigger a response (refer **Section 8**). In addition, if a recorded value at a monitoring bore differs extremely from the preceding three readings at that location and there are no unusual events that could have caused the difference, a response will be triggered.

Table 24 Trigger Levels for Alluvial Piezometers

Aquifer and Monitoring Piezometer	pH								
	No. of records[@]	Min	Max	Mean	Median	Standard Deviation	Range	Groundwater pH Trigger - Lower (5th Percentile)	Groundwater pH Trigger - Upper (95th Percentile)
Bowmans Creek Alluvium									
WMLP311	51	6.3	8.2	7.1	7.0	0.40	1.9	**6.5**	**8.0**
WMLP323	50	6.5	8.1	7.2	7.1	0.39	1.7	**6.5**	**8.1**
WMLP328	50	6.6	8.4	7.2	7.1	0.44	1.8	**6.6**	**8.2**
T2A	37	6.6	7.8	7.1	7.1	0.24	1.2	**6.7**	**7.7**
WML113C	12	6.6	7.4	7.1	7.0	0.28	0.9	**6.6**	**7.4**
WMLP326	14	6.6	7.5	7.1	7.1	0.27	0.9	**6.6**	**7.5**
Glennies Creek Alluvium									
WML120B	118	6.1	8.8	6.9	6.8	0.41	2.7	**6.4**	**7.7**
WML129	114	6.5	8.5	7.2	7.1	0.42	2.0	**6.7**	**8.0**
WML239	61	6.2	7.7	6.9	6.8	0.32	1.5	**6.3**	**7.4**
WMLP343	2	7.0	7.6	7.3	7.3	0.28	0.6	**6.7**	**7.2**
WMLP346	2	6.9	7.3	7.1	7.1	0.18	0.4	**6.5**	**7.1**
WMLP349	2	7.0	7.7	7.4	7.4	0.37	0.7	**6.5**	**6.8**
WMLP358	2	6.7	7.4	7.1	7.1	0.36	0.7	**6.2**	**6.9**
Hunter River Alluvium									
WMLP279	27	6.3	7.5	6.8	6.8	0.28	1.2	**6.3**	**7.5**
WMLP280	73	6.5	8.9	7.2	7.1	0.41	2.4	**6.6**	**7.9**
WMLP337	88	6.7	8.5	7.2	7.1	0.31	1.8	**6.8**	**7.8**
WMLP336	29	6.1	8.9	6.9	6.8	0.51	2.9	**6.2**	**8.2**

[*] Data reviewed includes historical data to June 2017.

Table 25 Trigger Levels for Alluvial Piezometers

Aquifer and Monitoring Piezometer	EC (µS/cm)							
	No. of records@	Min	Max	Mean	Median	Standard Deviation	Range	Groundwater EC Trigger (95th Percentile)
Bowmans Creek Alluvium								
WMLP311	51	790	1400	1090	1080	117	610	**1289**
WMLP323	50	796	1481	1060	1072	137	685	**1241**
WMLP328	50	844	1298	1030	1029	83	454	**1175**
T2A	40	346	1680	1046	1036	193	1334	**1422**
WML113C	13	902	1450	1111	1120	162	548	**1445**
WMLP326	15	1420	2080	1735	1720	196	660	**2078**
Glennies Creek Alluvium								
WML120B	121	438	1930	775	676	275	1492	**1387**
WML129	121	227	1080	459	428	142	853	**740**
WML239	63	637	1000	812	800	79	363	**984**
WMLP343	3	651	859	731	684	91	208	**994**
WMLP346	3	684	805	734	713	52	121	**750**
WMLP349	3	1150	2700	1780	1490	665	1550	**983**
WMLP358	2	294	400	347	347	53	106	**401**
Hunter River Alluvium								
WMLP279	27	906	1375	1014	1014	94	469	**1276**
WMLP280	73	1130	2250	1723	1751	185	1120	**2034**
WMLP337	88	1840	5690	2791	2819	447	3850	**3254**
WMLP336	29	627	1747	1007	892	305	1120	**1708**

@ Data reviewed includes historical data to June 2017.

7.2.3 Groundwater Inflows

Groundwater inflows to the underground mining operations have been forecast by AGE (2016). Monitoring of water supplied to and extracted from the underground operations is undertaken using portal and de-watering bore flow meters, with volumes recorded typically monthly.

7.3. Monitoring Program

7.3.1 Bores and Piezometers

The groundwater monitoring program is tailored to current operations and some sites will be monitored more or less frequently depending on where mining is taking place at the time. Bores and VWP installations can be damaged through planned subsidence and may be deleted from the monitoring network if no longer necessary or functional.

The current groundwater monitoring network consists of 64 monitoring bores and VWP installations that monitor the alluvial and fractured rock aquifers on site.

The groundwater monitoring program includes the monitoring of:

- water levels;
- piezometric pressure;
- field water quality parameters – pH and EC;
- groundwater sampling for a minor chemical analysis suite, comprising Lab pH, Lab EC and cation/anions;
- groundwater sampling for comprehensive chemical analysis, comprising Lab pH, Lab EC, temperature, TDS, Turbidity, Na, K, Ca, Mg, F, Cl, SO_4 HCO_3, NO_3, Total N, Total P, Cu, Pb, Zn, Ni, Fe, Mn, As, Se, Cd, Cr, Total Alkalinity, Total Cyanide;
- monitoring of water level and EC required by EPL 11879; and
- dewatering bore / portal pumped volumes.

Monitoring frequency/parameters are as follows:

- Monthly campaign
  - Water levels at all WMP monitoring bores shall are measured at monthly intervals. Bores equipped with pressure transducers are downloaded monthly.
  - Monthly monitoring at selected alluvium and fractured rock aquifer piezometers (refer **Table 26)** is undertaken of water level and field water quality.
  - Monthly monitoring of piezometric pressure occurs at selected vibrating wire piezometer installations.
- Quarterly campaign

  In addition to the monthly monitoring campaign, the quarterly campaign also includes:
  - Quarterly monitoring at selected monitoring bores (refer **Table 26)** is undertaken of water level and field water quality (EC and pH).
  - Quarterly sampling at selected monitoring bores (refer **Table 26)** is undertaken for minor suite of chemical analysis (laboratory analysis of pH, EC and cation/anions).
- Six-monthly monitoring at EPL 11879 monitoring bores for water level and field EC only.
- Annual campaign

  In addition to the quarterly monitoring campaign, the annual campaign also includes:
  - Annual sampling at selected monitoring bores (refer **Table 26)** for minor suite of chemical analysis (laboratory analysis of pH, EC and cation/anions).
  - Annual sampling at selected monitoring bores (refer **Table 26)** for comprehensive chemical analysis (laboratory analysis of pH, EC, temperature, TDS, Turbidity, Na, K, Ca, Mg, F, Cl, SO_4 HCO_3, NO_3, Total N, Total P, Cu, Pb, Zn, Ni, Fe, Mn, As, Se, Cd, Cr, Total Alkalinity, Total Cyanide).

A summary of the monitoring locations and parameters monitored is provided in **Table 26** and **Figure 7**. Monitoring location co-ordinates are included in **Appendix B**.

Table 26 Summary of Groundwater Monitoring Program (Monthly, Quarterly and Annual Campaigns)

ID	Type	Data Recording Method	Targets	Monthly	Quarterly	Annually
Ashton Well	Monitoring bore	-	BCA	Water level only	Monthly plus field parameters	Quarterly plus minor lab analysis
GM1	EPL Monitoring bore	-	197-203m deep (BAR seam)	Water level only	Monthly plus field parameters and minor lab analysis	Quarterly plus field parameters and **comprehensive** analysis
GM3A	Monitoring bore	-	GCA	Water level only	Monthly plus field parameters	Quarterly plus minor lab analysis
GM3B	Monitoring bore	-	GCA	Water level only	Monthly plus field parameters	Quarterly plus minor lab analysis
PB1	Monitoring bore	-	BCA	Water level only	Monthly plus field EC only	Quarterly plus minor lab analysis
RA02	Monitoring bore	-	BCA + CMOB	Water level only	Monthly plus field EC only	Quarterly plus field parameters and **comprehensive** analysis
RA18	Monitoring bore	-	BCA	Water level only	Monthly plus field parameters	Quarterly plus minor lab analysis
RA27	Monitoring bore	-	HRA	Water level only	Monthly plus field parameters	Quarterly plus **comprehensive** analysis
RM01	Monitoring bore	-	BCA	Water level only	Monthly plus field EC only	Quarterly plus minor lab analysis
RM02	Monitoring bore	-	BCA + CMOB	Water level only	Monthly plus field EC only	Water level and field EC only
RM03	Monitoring bore	-	BCA + CMOB	Water level only	Monthly plus field EC only	Quarterly plus minor lab analysis
RM10	Monitoring bore	-	BCA + CMOB	Water level and field parameters	Monthly plus minor lab analysis	Quarterly plus minor lab analysis
RSGM1	Monitoring bore	-	Coal measure (BWS)	Water level only	Monthly plus field EC only	Quarterly plus field parameters and **comprehensive** analysis

ID	Type	Data Recording Method	Targets	Monthly	Quarterly	Annually
T2-A	Monitoring bore	Pressure transducer	BCA	Water level and field parameters	Monthly plus minor lab analysis	Quarterly plus **comprehensive** analysis
T2-P	Monitoring bore	Pressure transducer	CMOB	Water level only	Monthly plus field parameters and minor lab analysis	Quarterly plus **comprehensive** analysis
T3-A	Monitoring bore	-	BCA	Water level only	Monthly plus field parameters	Quarterly plus **comprehensive** analysis
T3-P	Monitoring bore	-	CMOB	Water level only	Monthly plus field parameters	Quarterly plus **comprehensive** analysis
T4-A	Monitoring bore	-	BCA + BWS	Water level only	Monthly plus field parameters and minor lab analysis	Quarterly plus **comprehensive** analysis
T4-P	Monitoring bore	-	CMOB	Water level only	Monthly plus field parameters and minor lab analysis	Quarterly plus **comprehensive** analysis
T5	Monitoring bore	Pressure transducer	BCA	Water level only	Monthly plus field parameters	Quarterly plus **comprehensive** analysis
WML113C	Monitoring bore	-	BCA	Water level and field parameters	Monthly plus minor lab analysis	Quarterly plus **comprehensive** analysis
WML115B	Monitoring bore	-	CMOB & Lem3-4	Water level only	Monthly plus field parameters	Quarterly plus minor lab analysis
WML115C	Monitoring bore	-	BCA	Water level only	Monthly plus field parameters	Quarterly plus minor lab analysis
WML119	Monitoring bore	-	PG	Water level only	Monthly plus field parameters and minor lab analysis	Quarterly plus **comprehensive** analysis
WML120A	EPL Monitoring bore	-	PG	Water level only	Monthly plus field parameters and minor lab analysis	Quarterly plus **comprehensive** analysis
WML120B	EPL Monitoring bore	-	GCA	Water level and field parameters	Monthly plus field parameters and minor lab analysis	Quarterly plus **comprehensive** analysis
WML129	EPL Monitoring bore	-	GCA	Water level and field parameters	Monthly plus field parameters and minor lab analysis	Quarterly plus **comprehensive** analysis

ID	Type	Data Recording Method	Targets	Monthly	Quarterly	Annually
EPL WML181	Monitoring bore	-	PG	Water level only	Monthly plus field parameters and minor lab analysis	Quarterly plus **comprehensive** analysis
EPL WML183	Monitoring bore	-	PG	Water level only	Monthly plus field parameters and minor lab analysis	Quarterly plus **comprehensive** analysis
WML213	Vibrating wire piezometer	-	BWS, Lem 8-9, Lem 15, Lem 19, PG, ULD, ULLD, LB	Pressure head	Pressure head	Pressure head
WML239	Monitoring bore	-	GCA	Water level and field parameters	Monthly plus minor lab analysis	Quarterly plus **comprehensive** analysis
WML245	Vibrating wire piezometer	-	ULD, MLD, LB, LB-HEB int	Pressure head	Pressure head	Pressure head
WML261	Monitoring bore	-	ULD	Water level only	Monthly plus field parameters and minor lab analysis	Quarterly plus **comprehensive** analysis
WML262	EPL Monitoring bore	-	ULD	Water level only	Monthly plus field parameters and minor lab analysis	Quarterly plus **comprehensive** analysis
WML269	Vibrating wire piezometer	-	Lem 5, Lem 7, Lem 8-9, Lem 11-12, Lem 15, Lem 19	Pressure head	Pressure head	Pressure head
WMLC144	Vibrating wire piezometer	-	ULD, MLD1, MLD2, ULLD, LLLD, UBS, LB	Pressure head	Pressure head	Pressure head
WMLC248	Vibrating wire piezometer	-	ULLD, ULLL, LB, HEB	Pressure head	Pressure head	Pressure head
WMLP334	Vibrating wire piezometer	-	Lem 13, Lem 15, Lem 18/19, Art, ULD, ULLD, UB, LB	Pressure head	Pressure head	Pressure head
WMLP335	Vibrating wire piezometer	-	Lem 15B, Lem 17, PG Upper, Art, ULDB, LLLD, UB, LB	Pressure head	Pressure head	Pressure head
WMLP277	Monitoring bore	Pressure transducer	HRA	Water level only	Monthly plus field parameters	Quarterly plus **comprehensive** analysis

ID	Type	Data Recording Method	Targets	Monthly	Quarterly	Annually
WMLP278	Monitoring bore	-	HRA	Water level only	Monthly plus field parameters	Quarterly plus **comprehensive** analysis
WMLP279	EPL Monitoring bore	-	HRA	Water level and field parameters	Monthly plus field parameters and minor lab analysis	Quarterly plus **comprehensive** analysis
WMLP280	EPL Monitoring bore	-	HRA	Water level and field parameters	Monthly plus field parameters and minor lab analysis	Quarterly plus **comprehensive** analysis
WMLP301	Monitoring bore	-	Arties Seam	Water level only	Monthly plus field parameters and minor lab analysis	Quarterly plus **comprehensive** analysis
WMLP302	Monitoring bore	-	Arties Seam	Water level only	Monthly plus field parameters and minor lab analysis	Quarterly plus **comprehensive** analysis
WMLP308	Monitoring bore	-	BCA	Water level only	Monthly plus field parameters	Quarterly plus **comprehensive** analysis
WMLP311	Monitoring bore	Pressure transducer	BCA	Water level and field parameters	Monthly plus minor lab analysis	Quarterly plus **comprehensive** analysis
WMLP320	EPL Monitoring bore	-	BCA	Water level only	Monthly plus field parameters	Quarterly plus **comprehensive** analysis
WMLP323	Monitoring bore	Pressure transducer	BCA	Water level and field parameters	Monthly plus minor lab analysis	Quarterly plus **comprehensive** analysis
WMLP324	Monitoring bore	Pressure transducer	CMOB	Water level only	Monthly plus field parameters and minor lab analysis	Quarterly plus **comprehensive** analysis
WMLP325	Monitoring bore	Pressure transducer	CMOB	Water level only	Monthly plus field parameters	Quarterly plus **comprehensive** analysis
WMLP326	Monitoring bore	-	BCA	Water level only	Monthly plus field parameters	Quarterly plus minor lab analysis
WMLP327	Monitoring bore	-	CMOB	Water level only	Monthly plus field parameters	Quarterly plus minor lab analysis
WMLP328	Monitoring bore	Pressure transducer	BCA	Water level and field parameters	Monthly plus minor lab analysis	Quarterly plus **comprehensive** analysis

ID	Type	Data Recording Method	Targets	Monthly	Quarterly	Annually
WMLP336	EPL Monitoring bore	-	HRA + CMOB	Water level and field parameters	Monthly plus field parameters and minor lab analysis	Quarterly plus **comprehensive** analysis
WMLP337	Monitoring bore	-	HRA	Water level and field parameters	Monthly plus minor lab analysis	Quarterly plus **comprehensive** analysis
WMLP338	Monitoring bore	-	HRA	Water level only	Monthly plus field parameters	Quarterly plus **comprehensive** analysis
WMLP343	Monitoring bore	Pressure transducer	GCA	Water level and field parameters	Monthly plus minor lab analysis	Quarterly plus **comprehensive** analysis
WMLP346	Monitoring bore	-	GCA	Water level and field parameters	Monthly plus minor lab analysis	Quarterly plus **comprehensive** analysis
WMLP349	Monitoring bore	-	GCA	Water level and field parameters	Monthly plus minor lab analysis	Quarterly plus **comprehensive** analysis
WMLP358	Monitoring bore	-	GCA	Water level and field parameters	Monthly plus minor lab analysis	Quarterly plus **comprehensive** analysis
WMLP361	Vibrating wire piezometer	VWP datalogger	Lem 5, Lem 8, Lem 15A, Art, ULD	Pressure head	Pressure head	Pressure head
WMLP363	Vibrating wire piezometer	VWP datalogger	CMOB, Lem 8, Lem 9-10 int, Lem 12, Lem 14, Lem 15, PG roof, ULD	Pressure head	Pressure head	Pressure head
YAP016	EPL Monitoring bore	Pressure transducer	BCA	Water level and field parameters	Monthly plus field parameters and minor lab analysis	Quarterly plus **comprehensive** analysis

Selected alluvial piezometers are located in the alluvial aquifers between the watercourses and the underground mine and provide detailed spatial coverage. Additional site bores may be maintained and monitored by ACOL for internal purposes.

A comprehensive review of groundwater quality and water level monitoring results are reported in the Annual Review. Results are compared to relevant statutory requirements, previous year's results and relevant predictions in relevant Environmental Assessments and updates to the Groundwater Model.

The following quality assurance/quality control measures form part of the GMP:

- Groundwater quality monitoring and sample collection, storage and transportation are undertaken in accordance with the procedures outlined in the relevant sections of the Australian Standard for Water Quality Sampling AS/NZS5667.1-1998 and by a suitably qualified and experienced contractor. This includes the use of proforma field sheets and chain of custody records.

- Laboratory analysis is undertaken by a laboratory which has relevant accreditation by the National Association of Testing Authorities (NATA), Australia or equivalent.

- Results of all water quality monitoring that is required under EPL 11879 is reviewed internally each month by ACOL prior to the data being uploaded to the Ashton Coal website.

7.3.2 Underground Mine Inflows

Routine (typically monthly) monitoring of pumped transfer of mine water and water imported to the ACP is undertaken using a network of flow meters (refer Figure 3). Undertaking a calculated balance on inflows to and outflows from the underground and the volume stored in the underground provides an estimate of total groundwater inflows each month. These are then partitioned into inflows from the three alluvial sources and the coal measures using the relative proportions of inflows rates predicted by the groundwater model (AGE, 2016). This inflow partitioning may be adjusted if there is an obvious disparity between monitored data and model predictions – e.g. if the majority of monitored inflow is monitored from dewatering bore #3, which is located close to Glennies Creek and Hunter River alluvium, whereas the model may be predicting the majority of inflow from Bowmans Creek alluvium.

Water balance calculations undertaken as part of the annual water balance review (**Section 6.2**) for the NEOC use monitored flow rates, water levels and modelled estimates of rainfall runoff, to estimate groundwater inflows to the open cut void.

8. SURFACE AND GROUNDWATER RESPONSE PLAN

8.1. Objective

The objective of this SGRP is to present a set of protocols to be followed and actions for implementation should the surface or groundwater impact assessment criteria be exceeded.

8.2. Protocol for Exceedance of Surface Water Trigger Values

In the event of a surface water assessment criterion (**Table 17**) being exceeded, the following protocol will be followed:

1. Check and validate the data which indicates an exceedance of the criterion, including whether the exceedance is ongoing.
2. A preliminary investigation will be undertaken to establish the cause(s) and determine whether changes to the water management system or operations are required. This will involve the consideration of the monitoring results in conjunction with:
    a) site activities being undertaken at the time;
    b) baseline monitoring results;
    c) predictive modelling;
    d) surface water monitoring at nearby locations and upstream (including WaterNSW stations);
    e) the prevailing and preceding meteorological and streamflow conditions;
    f) available data indicating releases from upstream regulating storages or other sites;
    g) changes to the land use/activities being undertaken in the contributing catchment area; and
    h) hydrological conditions.
3. If the preliminary investigation shows that the impact is linked to activities undertaken by ACOL, a report will be emailed to the DPIE and any other relevant department. Causal factors will be addressed and rectified if possible. Contingency measures will be developed in consultation with the DPIE and any other relevant department and implemented in response to the outcomes of the investigation.
4. Remedial/compensatory measures will be developed in consultation with DPIE and any other relevant department and implemented in response to the outcomes of the investigations.
5. Monitoring will be implemented as required to confirm the effectiveness of remedial measures.
6. Where required, an independent hydrologist will be engaged to conduct investigations. ACOL will seek the Secretary of DPIE's approval in selecting a hydrologist.

Any loss of baseflow in excess of predictions will be further offset against ACOL's WALs. ACOL could purchase additional WALs if required.

Any exceedances and responses taken to ameliorate these exceedances will be reported in the Annual Review.

8.3. Protocol for Exceedance of Groundwater Trigger Values

In the event of a groundwater assessment criterion (**Table 23** and **Section 7.2**) being exceeded, the following protocol will be followed:

1. Check and validate the data which indicates an exceedance of the criterion, including whether the exceedance is ongoing.
2. A preliminary investigation will be undertaken to establish the cause(s) and determine whether changes to the water management system or operations are required. This will involve the consideration of the monitoring results in conjunction with:
   a) site activities being undertaken at the time;
   b) activities at nearby operations (cumulative affects);
   c) groundwater extraction by others;
   d) baseline monitoring results and natural fluctuations;
   e) predictive modelling;
   f) groundwater monitoring at nearby locations;
   g) the prevailing and preceding meteorological and streamflow conditions; and
   h) changes to the land use/activities being undertaken nearby.
3. If the preliminary investigation shows that the impact is linked to activities undertaken by ACOL, a report will be emailed to the DPIE and any other relevant department. Causal factors will be addressed and rectified if possible. Contingency measures will be developed in consultation with the DPIE and any other relevant department and implemented in response to the outcomes of the investigation.
4. Remedial/compensatory measures will be developed in consultation with DPIE and any other relevant department and implemented in response to the outcomes of the investigations.
5. Monitoring will be implemented as required to confirm the effectiveness of remedial measures.
6. Where required, an independent hydrogeologist will be engaged to conduct investigations. ACOL will seek the Secretary of DPIE's approval in selecting a hydrogeologist.

Any exceedances and responses taken to ameliorate these exceedances will be reported in the Annual Review.

8.4. Protocol for Impacts on the Water Supply of Private Landowners

No privately owned groundwater bores exist in surrounding areas that are expected to be impacted by the underground mine (refer **Section 7.1.3**), hence an impact on the groundwater supply of private landowners is not expected. There are no privately-owned surface water storages within the ACP colliery holding boundary and hence impacts on the surface water supply of private landowners are not expected. If a complaint is received, this will be handled in accordance with ACOL procedures, which includes recording the details of the complaint, providing feedback to the complainant (including corrective actions) and reporting of investigation outcomes and corrective actions. Compensation will be developed in consultation with the private landowner where it can be demonstrated that the ACP has adversely affected the water supply. To date, no complaints have been received in relation to groundwater or surface water supply of private landowners.

If it was established that ACOL's activities have adversely affected flows in Bowmans Creek, thereby affecting licensed private water users in the lower reaches of the creek (refer **Section 6.2**), ACOL will negotiate provision of an alternative water resource with the affected users.

8.5. Protocol for Impacts on Riparian Vegetation

Whilst not considered GDEs (refer to Section 7.1.4), the stands of RRGs on the downstream reaches of Bowmans Creek and Glennies Creek are identified as high importance remnant vegetation communities, and RRG monitoring and response requirements are described in the FFMP (ACOL, 2016).

The potential for impact on riparian vegetation has been identified in Bowmans Creek and **Section 4.4** outlines vegetation rehabilitation assessment, performance criteria and corrective actions. In addition, the FFMP (ACOL, 2016) contains further details of riparian vegetation monitoring, triggers and response.

Any impacts on the RRG will be investigated, with corrective actions implemented where the impact is determined as attributable to the ACP.

8.6. Roles and Responsibilities

The roles and responsibilities assigned to water management on site under this WMP are outlined in **Table 27**.

Table 27 Roles and Responsibilities for Site Water Management

Water Management Component	Responsible Person
Provide resources required to implement the WMP	General Manager
Review and update of WMP	Environment and Community Relations Superintendent
Management and maintenance of water management infrastructure	CHPP Superintendent and Technical Services Manager
Environmental Monitoring	Environment and Community Relations Superintendent
Investigation of water-related incidents	Environment and Community Relations Superintendent
Reporting (including Annual Review and incident reporting)	Environment and Community Relations Superintendent

9. REFERENCES

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10. REVISION HISTORY

Water Management Plan Version History

Version	Issue Date	Section/s Modified	Reason for Modification (including whether review or minor amendment)	Modified By
1	25/9/2014	Revised from existing WMP	Document revised and submitted to DPE for review	Gilbert & Associates, J Barben
2	7/11/2014	1-6	Following DPE review	A.Marszalek (G&A), J Barben
3	22/4/2015	6	Following DPE second review	J Barben
4	1/5/2015	1	DPE Approval granted 27.4.2015	J Barben
5	14/5/2015	1.2, 6	Revised in accordance with DA309-11-2001i (Condition 1.21), 20BL173716 (Condition 6), 20BL169508 (Condition 7) and updates made to the Groundwater Section	J Barben, C Conte (Australasian Groundwater and Environment)
6	1/4/2016	1, 5.3, 6	Revised for Extraction Plan for LW 105-107 in the Upper Liddell Seam (updated in Nov 2015)	A Marszalek, C Conte. J Barben
7	9/5/2016	6.3	Following DPE comments	C Conte, J Barben
8	11/5/2016	-	Review and approval by DPE	J Barben, C Knight
9	18/7/2017	Revised from existing WMP	Update for DA Mod 5, submission of Annual Review and approval of LW201-204 Extraction Plan	A Marszalek, C Conte, J Barben
10	01/03/2018	-	Review and approval by DPE	L.Crawford
11	15/09/2020	Revised from existing WMP	Update for Independent External Audit	P Brown

11. APPENDICES

APPENDIX A CONSULTATION AND APPROVAL RECORDS

Organistaion	Date	Fomat	Topic
Ashton Community Consultative Committee (ACCC)	9.07.2020	ACCC meeting https://www.ashtoncoal.com.au/page/sustainability/community/community-consultative-committee/ccc-meeting-minutes/2020-july-ccc-minutes/	WMP

APPENDIX B BASELINE, TRIGGER AND MONITORING BORE LOCATION COORDINATES

Table B-1 Summary of Baseline and Trigger Level Monitoring Bore Locations

Bore ID	Easting (GDA94 Z56)	Northing (GDA94 Z56)	Top of Casing (mAHD)	Depth (m)
RA18	317821.7	6405434.4	62.61	8.50
RA27	317952.1	6403738.0	62.71	15.50
RA30	317810.6	6406500.9	65.19	9.00
RM6	317871	6405888	63.95	10.20
RM7	318073	6405761	63.70	9.80
RM9	318166	6406380	65.55	8.80
T2-A	317583.3	6405217.4	60.80	8.90
T3-A	317654.2	6404708.0	59.85	10.80
T4-A	317685.8	6404323.1	58.58	10.70
WML129	319468.4	6403527.8	55.34	7.00

Table B-2 Summary of Monitoring Bore Locations

ID	Type	Easting (GDA94 Z56)	Northing (GDA94 Z56)	Top of Casing (mAHD)	Depth (m)
Ashton Well	Monitoring bore	318355.0	6406029.0	62.0	-
GM1	EPL Monitoring bore^	318431.0	6407214.0	67.0	203.0
GM3A	EPL Monitoring bore^	320246.5	6405976.9	59.0	16.2
GM3B	EPL Monitoring bore^	320250.9	6405976.7	59.0	7.5
PB1	EPL Monitoring bore^	317545.0	6405301.0	61.1	7.8
RA02	EPL Monitoring bore^	317712.8	6405233.0	55.2	11.3
RA18	Monitoring bore	317821.8	6405434.2	62.6	8.5
RA27	Monitoring bore	317952.1	6403738.0	61.6	15.5
RM01	EPL Monitoring bore^	318041.0	6404109.5	69.4	10.8
RM02	EPL Monitoring bore^	317942.0	6404506.0	61.1	12.9
RM03	EPL Monitoring bore^	317667.0	6404844.5	62.1	11.0
RM10	Monitoring bore	317589.0	6405292.0	61.6	10.8
RSGM1	EPL Monitoring bore^	317655.0	6406302.0	65.6	8.5
T2-A	Monitoring bore	317583.3	6405217.4	60.8	8.9
T2-P	Monitoring bore	317587.0	6405222.0	60.7	14.9
T3-A	Monitoring bore	317654.2	6404708.0	59.9	10.8
T3-P	Monitoring bore	317650.0	6404702.0	59.8	30.5
T4-A	Monitoring bore	317685.8	6404323.1	58.6	10.7
T4-P	Monitoring bore	317683.0	6404319.0	58.5	31.9
T5	Monitoring bore	317946.1	6406549.4	65.3	8.8
WML113C	Monitoring bore	317377.0	6404526.0	60.2	50.0
WML115B	Monitoring bore	317881.0	6406704.0	66.4	40.0

ID	Type	Easting (GDA94 Z56)	Northing (GDA94 Z56)	Top of Casing (mAHD)	Depth (m)
WML115C	Monitoring bore	317888.0	6406710.0	66.2	6.2
WML119	Monitoring bore	319255.3	6403930.1	61.5	35.0
WML120A	Monitoring bore	319292.0	6404579.6	60.4	20.0
WML120B	Monitoring bore	319293.6	6404587.5	60.1	9.0
WML129	Monitoring bore	319468.4	6403527.8	55.3	7.0
WML181	Monitoring bore	319215.0	6403958.3	64.3	32.0
WML183	Monitoring bore	319188.2	6404325.2	76.7	45.5
WML213	Vibrating wire piezometer	317210.0	6404154.0	61.5	316.0
WML239	Monitoring bore	319345.0	6404044.8	58.8	13.5
WML245	Vibrating wire piezometer	320035.0	6404835.0	64.9	101.0
WML261	Monitoring bore	319320.2	6404705.9	58.7	39.0
WML262	Monitoring bore	319220.1	6403927.7	63.2	60.3
WML269	Vibrating wire piezometer	317850.0	6404073.0	65.5	65.5
WMLC144	Vibrating wire piezometer	319500.0	6404170.0	59.3	132.0
WMLC248	Vibrating wire piezometer	319326.0	6404721.0	58.5	144.6
WMLP334	Vibrating wire piezometer	318589.0	6403088.0	75.9	218.5
WMLP335	Vibrating wire piezometer	318892.0	6402936.0	64.5	200.5
WMLP277	Monitoring bore	317643.2	6403958.5	59.0	13.0
WMLP278	Monitoring bore	317626.3	6403894.2	62.3	12.5
WMLP279	Monitoring bore	317298.9	6403991.8	62.7	17.4
WMLP280	Monitoring bore	317797.6	6403793.4	62.5	16.0
WMLP301	Monitoring bore	319235.0	6403858.0	60.2	10.0
WMLP302	Monitoring bore	319299.6	6404600.2	59.7	10.5
WMLP308	Monitoring bore	318222.7	6406373.0	65.7	9.1
WMLP311	Monitoring bore	318178.9	6406047.9	63.6	7.6
WMLP320	Monitoring bore	317457.2	6405388.0	61.5	8.0
WMLP323	Monitoring bore	318242.2	6406594.7	64.5	7.3
WMLP324	Monitoring bore	318240.0	6406594.0	64.5	14.1
WMLP325	Monitoring bore	318181.0	6406050.0	63.7	14.6
WMLP326	Monitoring bore	317571.0	6404103.2	59.3	11.2
WMLP327	Monitoring bore	317573.0	6404103.0	59.4	18.0
WMLP328	Monitoring bore	317927.3	6405611.6	62.8	12.1
WMLP336	Vibrating wire piezometer	318965.4	6402841.9	60.6	15.5
WMLP337	Vibrating wire piezometer	318418.0	6403129.0	59.9	13.5
WMLP338	Monitoring bore	318624.7	6402794.0	58.8	12.9
WMLP343	Monitoring bore	319623.0	6404606.0	61.0	11.9
WMLP346	Monitoring bore	319366.5	6404457.23	60.68	12.5
WMLP349	Monitoring bore	319516.0	6404198.0	58.3	10.0
WMLP360	Monitoring bore	319560.0	6403704.0	59.66	11.2
WMLP361	Monitoring bore	317722.0	6405962.0	62.9	191.0

ID	Type	Easting (GDA94 Z56)	Northing (GDA94 Z56)	Top of Casing (mAHD)	Depth (m)
WMLP363	Monitoring bore	317963.0	6406634.0	66.0	164.0
YAP016	Vibrating wire piezometer	318438.0	6407195.0	66.8	7.3

^ EPL monitoring requirements will be removed after discussion with the EPA in the coming months. Some of the EPL bores may continue to be monitored as part of the WMP.

Mr Phillip Brown
Environment & Community Superintendent
Ashton Coal Operations Pty Limited
PO Box 699
SINGLETON NSW 2330

16/11/2020

Dear Mr Brown

Ashton Coal Project (DA309-11-2001-i)
Water Management Plan

I refer to the *Water Management Plan* which was submitted in accordance with Condition 26 of Schedule 3 of the consent for the Ashton Coal Project (DA309-11-2001-i).

The Department has carefully reviewed the document and is satisfied that it meets the requirements of the consent conditions and has also addressed the Department's issues raised on 14 September 2020.

I also refer to your letter of 09 October 2020 seeking the Secretary's agreement to waive the consultation requirements for this management plan due to the minor nature of the update following the recommendations of the Independent Environmental Audit completed on 05 March 2020 and the findings of the 2019 Annual Review submitted on 06 March 2020. The Department has reviewed your request and considers it acceptable. Consequently, in accordance with condition 5 of Schedule 5 of DA309-11-2001-i, the Secretary agrees that the consultation requirements for the *Water Management Plan* is not required for this update.

Accordingly, the Secretary has approved the *Water Management Plan* (Revision 11, dated September 2020). Please ensure that the approved plan is placed on your website as soon as possible.

If you wish to discuss the matter further, please contact Nagindar Singh on 8289 6873.

Yours sincerely

Matthew Sprott
Director
Resource Assessments (Coal & Quarries)

as nominee of the Secretary