The Bloomfield Group

5 August 2021

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Bloomfield Mining Operations WMP

Water Management Plan

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Water Management Plan

Client: The Bloomfield Group

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Quality Information

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Previously reviewed by	Amanda Kerr, Gabriel Wardenburg

Revision History

Rev	Revision Date	Details	Authorised	
			Name/Position	Signature
A	18-Dec-2018	Draft for Review	Simon Murphy Project Manager	
B	14-Mar-2019	Draft for Client Comments	Simon Murphy Project Manager	
C	29-Mar-2019	DPE Review	Simon Murphy Project Manager	
0	26-Jul-2019	Final	Simon Murphy Project Manager	
1	10-Aug-2020	Revised following DPIE Review	Gabriel Wardenburg Project Manager	
2	5-Aug-2021	Updated to include the "Bloomfield Site" under Abel Approval PA 05_0136	Chris Knight Environmental Manager	

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Abbreviations

Ca	calcium
CHPP	Coal Handling Preparation Plant
Cl	chloride
CO_3	carbonate
DoI	Department of Industry – Lands and water
EC	electrical conductivity
EPA	Environmental Protection Agency
EP&A Act	*Environmental Planning & Assessment Act 1979*
EPL	Environment Protection Licence
HCO_3	bicarbonate
K	potassium
MAW	mine affected water
Mg	magnesium
Na	sodium
ROM	run of mine
SO_4	sulfate
TDS	total dissolved solids
WMS	water management system

1.0 Part A – Water management plan

1.1 Overview

This water management plan (WMP) has been prepared in response to Project Approval (Approval) 07_0087 granted under section 75J of the *Environmental Planning and Assessment Act 1979* (EP&A) and a modification (MOD 4) to the Approval was granted on 16 August 2018 in accordance with section 75W of the EP&A Act.

This WMP also includes the area known as the "Bloomfield site" as defined in the Abel Coal Project Approval MP 05_0136 which includes the Bloomfield Coal Handling and Preparation Plant, the Bloomfield Rail Loading Facility, Rail Loop and Rail Spur, and the Bloomfield Colliery open-cut pits which are used to emplace coal reject and tailings from the Abel Coal Project.

PA 07_0087, Condition 19 of Schedule 3 (Specific Environmental Conditions) requires the Proponent to prepare and implement a WMP (this document) for the project to the satisfaction of the Secretary. This plan must:

a. *Be prepared in consultation with EPA (Environment Protection Agency) and DoI (Department of Industry – Lands and water) and be submitted to the Secretary for approval within 6 months of the date of this approval.*

b. *Be prepared by suitably qualified expert/s whose appointment/s have been approved by the Secretary.*

c. *Include:*

- *a site water balance*
- *an erosion and sediment control plan*
- *a surface water monitoring plan*
- *a ground water monitoring program*
- *a surface and ground water response plan.*

The Proponent must implement the water management plan as approved by the Secretary.

In accordance with Condition 19(a) the WMP has been prepared in consultation with the EPA and DoI. Copies of consultation correspondence from both agencies is attached at **Error! Reference source not found.**.

In accordance with Condition 19(b) the WMP has been prepared by a suitable qualified consultant as approved by the Department. Refer to approval correspondence at Appendix F.

The water management plan takes into consideration the Environmental Management Strategy (EMS) for the site, commitments stated in the Part 3A Environmental Assessment, and the various conditions outlined in schedules 2 to 5 of the Approval granted under Section 75 J of the *EP&A Act 1979*.

1.2 Background to the Project

Bloomfield Colliery is an open cut mining operation located to the north of John Renshaw Drive, Buttai and east of Buchanan Road, Buchanan, approximately 20 km northwest of Newcastle (refer Figure 1).

Mining has occurred on the site for approximately 180 years. The approved Project Area includes approximately 576 hectares of land which the majority has been disturbed by mining and mining related activities. It is located within the Cessnock Local Government Area, and zoned 1(a) Rural 'A' under the Cessnock Local Environmental Plan 1989.

Mining is currently a multi-seam truck and excavator or face shovel operation, conducted in sequential mining blocks. It is proposed to continue this existing method using the same or similar equipment.

Run of Mine (ROM) coal is trucked to the ROM coal stockpile at the Bloomfield washery for processing, which occurs under the Abel Project Approval. The colliery has approval to operate 7 days per week, 24 hours per day.

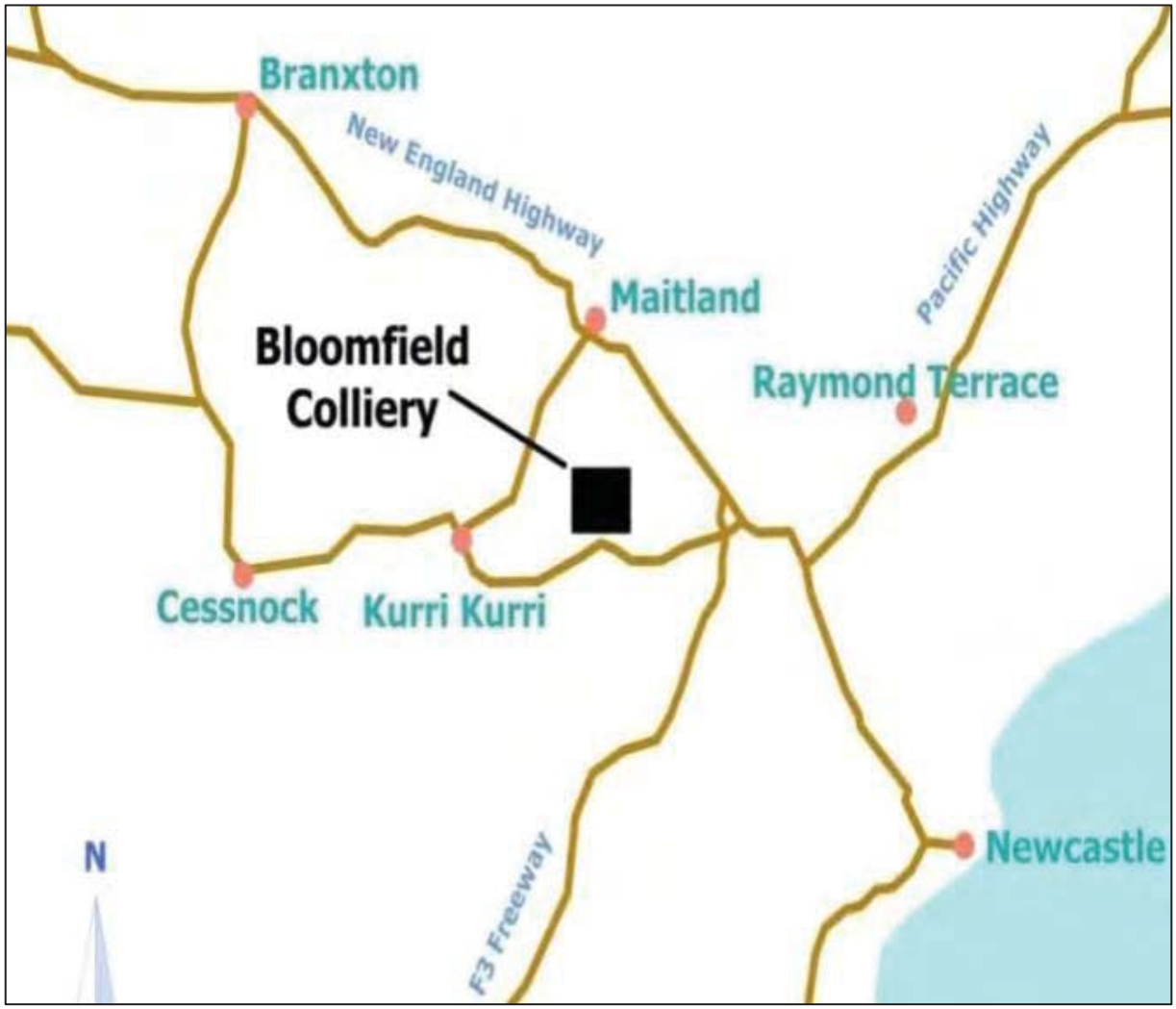


Figure 1 Locality Plan

The Project Approval has since been modified on four separate occasions:

- Modification No. 1 – Amending overburden placement, rehabilitation works, constructing a new haul road and amending a powerline easement
- Modification No. 2 – Seeking an extension of the date for the submission of certain management plans required by the Project Approval
- Modification No. 3 – Approval to modify approved vegetation clearing and biodiversity offset area
- Modification No. 4 – Approval to extend mining operations until 31st December 2030.

Pursuant to Schedule 2, Condition 5 of the current Project Approval, mining may take place until 31 December 2030.

1.2.1 Modification 4

Mine scheduling to support the Project Approval previously identified that the resource would be exhausted by the end of 2021. However, Bloomfield now predicts mining to extend beyond 2021 as:

- Actual run of mine (ROM) production levels have been lower than the predicted ROM production rates of 1.3 Mtpa, over the life of the project to-date.
- Changes to the mine fleet have allowed access to, and extraction of seams that were not previously considered to be a recoverable resource as part of the Environmental Assessment for Project Approval 07-0087 (Business Environment 2008).
- Further exploration has identified other previously unrecoverable resources that the new fleet can now access.

Bloomfield has therefore identified up to 13 million tonnes of ROM coal remaining inside the approval area that could be recovered. Based on annual mining rates of approximately 1 million tonnes per annum (Mtpa) of ROM coal, mining will now extend beyond 2021. The intention of the consent modification (MOD 4) is to align the Bloomfield mining operations consent limit to coincide with the adjoining Abel Underground Mine ('Abel') consent limit of 31 December 2030. Rehabilitation will continue past this limit to allow for the rehabilitation of the tailings emplacement area. Maximum annual production levels will continue at 1.3 Mtpa of ROM coal.

1.3 Scope and objectives

The WMP addresses water management issues within the Project Area covered by the Environmental Assessment (Evans and Peck 2008) (refer to Figure 2). The Approval allows for continued mining and operation of mine infrastructure including:

- current and proposed open cut mine areas
- workshop
- the road between the open cut pit areas and the ROM coal stockpile at the washery
- the road that links the workshop, open cut pits and washery.

Modification (MOD 4) allows for:

- extension of mining operations up until to 31 December 2030
- approval of an amended mine schedule to access previously unrecoverable resource and final landform.

This will enable Bloomfield to complete mining and rehabilitation of the site. Figure 2 shows the approved Project Area.

The purpose of the WMP is to:

- address the relevant conditions of the Approval as modified
- address relevant commitments made in the Environmental Assessment (Business Environment 2008)
- address statutory requirements and relevant guidelines.

The WMP aims to minimise the impact on water quality and quantity that exits in the Project Area and the "*Bloomfield Site*" and protect groundwater users and water bodies off site. The plan includes a strategy to manage waters including erosion and sediment controls, a ground and surface water monitoring program and develops a response program to mitigate potential impacts on surface and ground water.

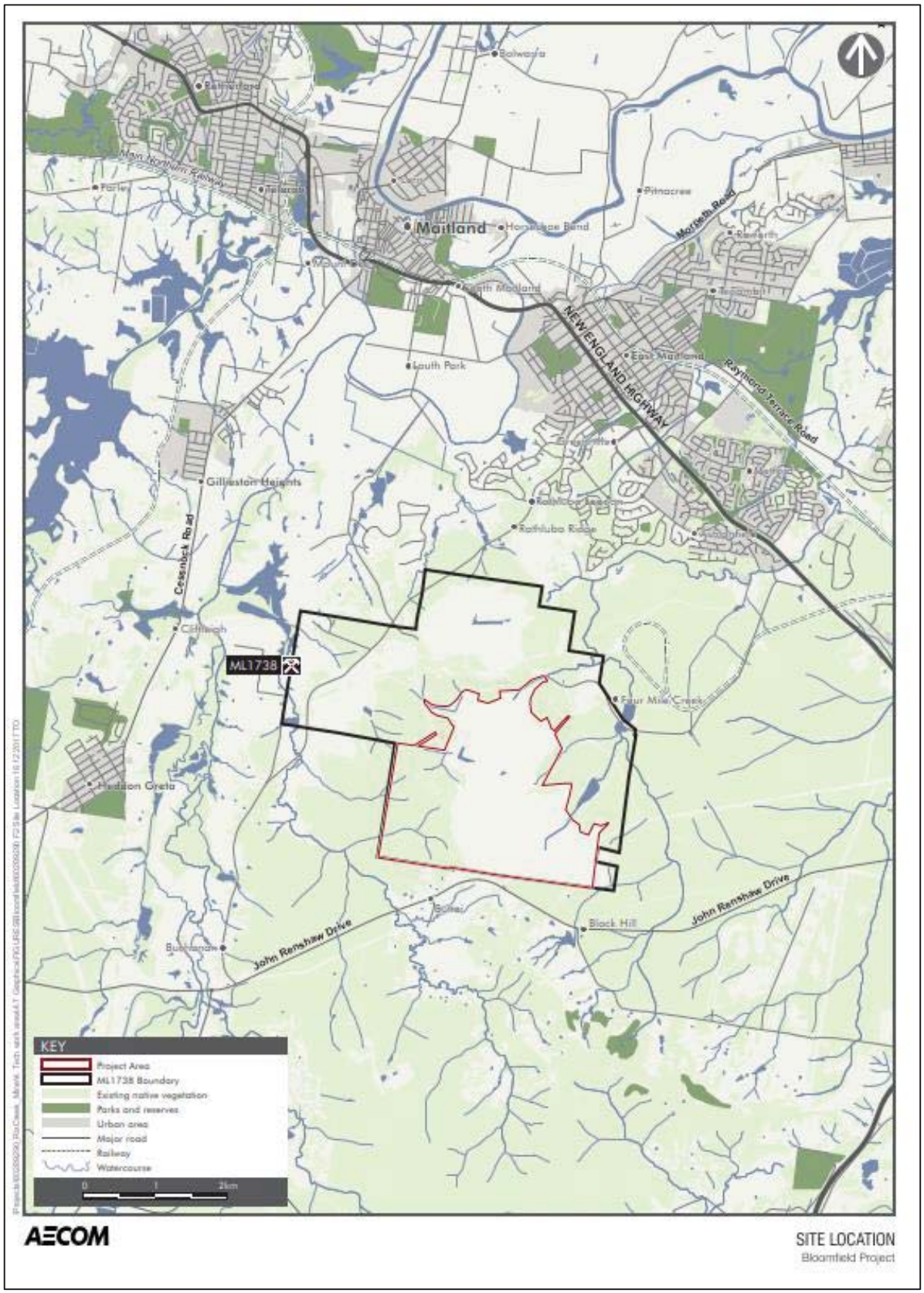


Figure 2 **Bloomfield Mining Lease and Project Approval (PA 07_0087) Area.**

1.4 Relationship with other plans

The EMS for the site establishes a framework for environmental monitoring. The WMP is an integral component of the EMS and supports the overall environmental objectives for the site.

1.5 Report structure

The water management plan is an integrated document that addresses water management within the project area and the "*Bloomfield Site*". The document has been designed to address the requirements of Condition 14, Schedule 3 of the Approval and the structure of the Plan is summarised in Figure 3.

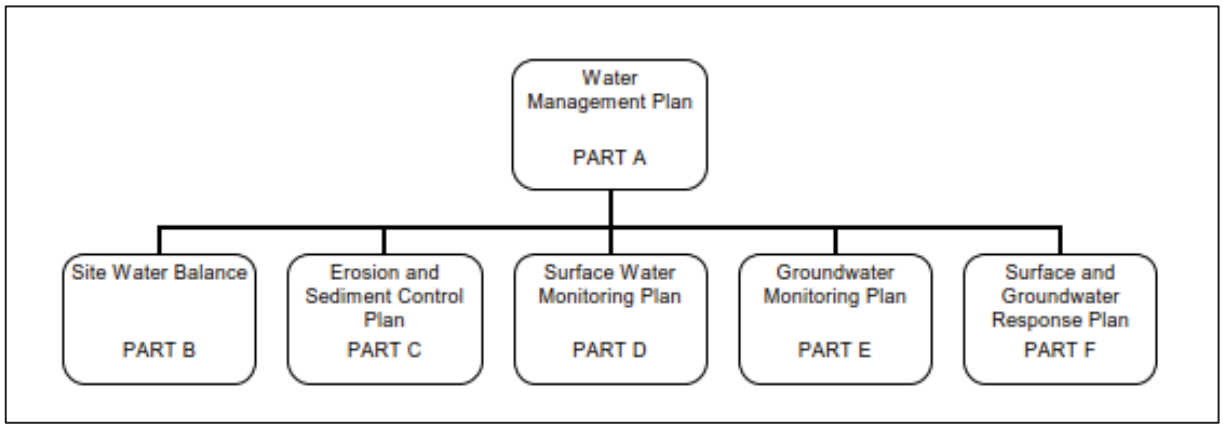


Figure 3 Structure of the water management plan

In accordance with Condition 19 of Schedule 3 of the Approval, AECOM Australia Pty Ltd (AECOM) were previously engaged to update the WMP including development of a revised site water balance. Since then a number of changes have been made to this plan and the surface monitoring plan as summarised in Table 1.

Table 1 Water management plan modification 4 revision summary

Aspect	Document reference	Revisions
Project Approval	Appendix A	Revised to include the "Bloomfield Site" as defined in PA 05_0136 Abel Coal Project.
Site water balance	Appendix B	Revised for MOD4
Erosion and sediment control management	Appendix C	Revised for MOD4
Surface water monitoring, and surface response plan prepared	Appendix D	Revised to include the "Bloomfield Site" as defined in PA 05_0136 Abel Coal Project.
Groundwater monitoring and groundwater response plan	Appendix E	Revised for MOD4

1.6 Roles and responsibilities

The company directors are responsible for the overall environmental performance of Bloomfield Colliery. Senior operational managers have direct responsibility for their areas of control while the environmental officer provides direction and advice to ensure that site environmental conformance is maintained. The principal environmental and operational managers are shown in Table 2.

Table 2 Management team

Position	Name
CEO	Brett Lewis
Mine Manager	Brad Donoghue
Manager Technical Services	Simon Grassby
Environmental Officer	Greg Lamb

1.7 Meteorological monitoring

In accordance with the Project Approval, a meteorological station is installed on site. The station is located near the active mining areas adjacent to an existing communications tower. The meteorological station monitors:

- rainfall
- temperature
- relative humidity
- wind speed
- wind direction.

2.0 Part B – Site water balance

A detailed report on the site water balance prepared by AECOM is provided in Appendix B and should be referred to for further detail. The key findings are summarised in the following section of the WMP.

Appendix B provides a detailed water balance for the site. The assessment concluded that the impact from the project would have a negligible impact on the approved integrated water management system for the three adjoining mines of Bloomfield, Abel and Donaldson. The water balance presented in this report relates specifically to the project area (outlined in black in Figure 2) covered by the modified Approval.

2.1 Condition of Approval

Condition 20 of Schedule 3 addresses the specific requirements for the site water balance. It is specified that the site water balance must:

a. Include details of:
   - sources and security of water supply
   - water use and management on site
   - any off-site water transfers or discharges
   - reporting procedures

b. describe measures to minimise water use by the project.

2.2 Sources of water

The water balance addresses areas and activities within the project area that comprise the mine affected water management system and includes:

- groundwater inflow to the mine pits
- various catchment areas and processes that contribute to the generation of mine affected water
- representation of the different runoff characteristics associated with the different land uses within the mine while mining progresses (existing natural conditions, mine pit, haul roads, placed overburden and rehabilitated overburden)
- reuse of mine affected water for dust suppression and use in the coal handling and preparation plant (CHPP).

2.3 Water use

A schematic diagram of the water balance for the site is provided in Figure 4. The water balance analysis shows that the site has a positive (surplus) water balance and that generation of mine affected water within the mine water management system WMS provides sufficient supply of water to meet all demands for reuse of mine affected water MAW without reliance on an external source of raw water.

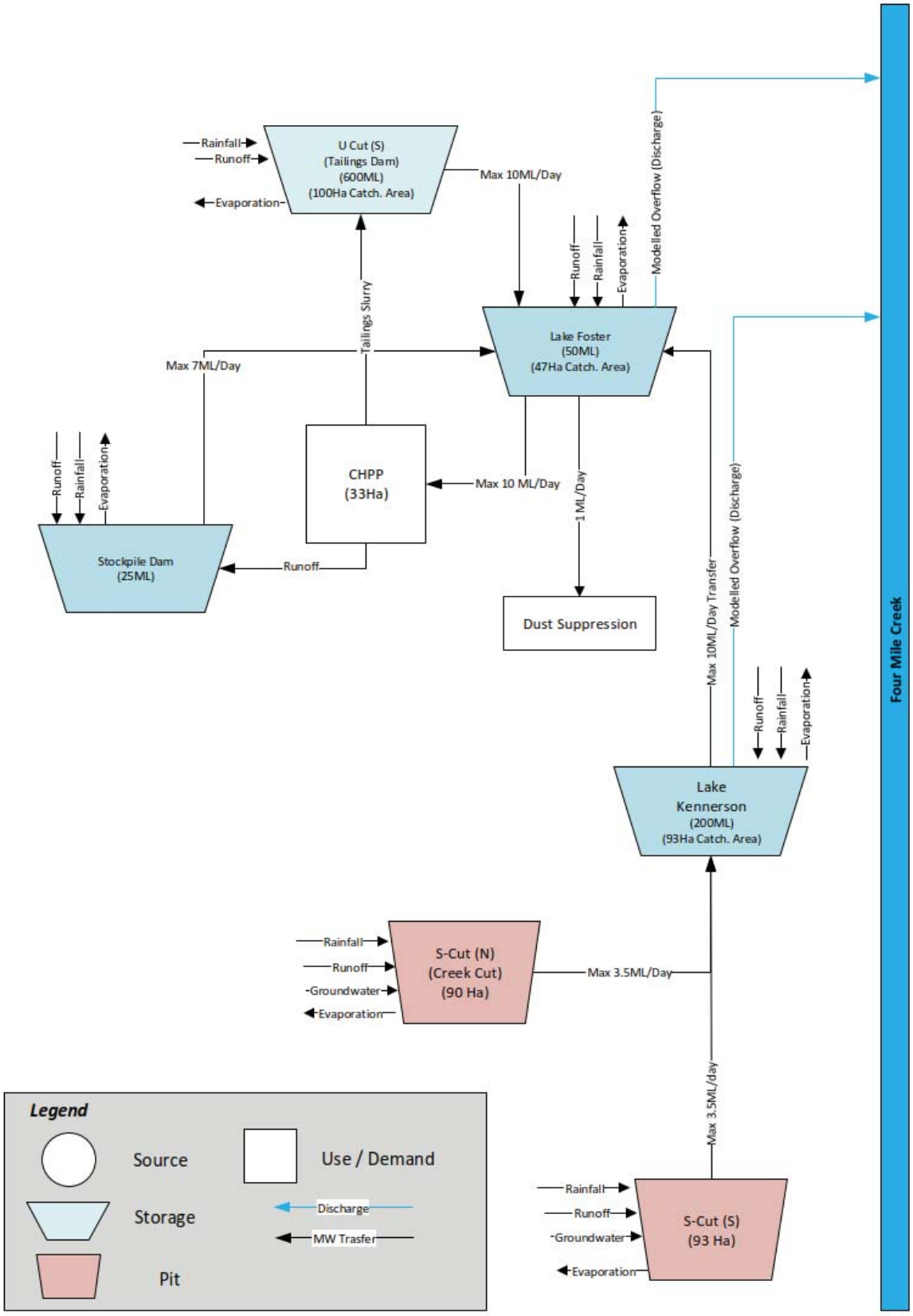


Figure 4 Schematic diagram of flows and transfers within the Project Area and "Bloomfield Site".

2.4 Water balance outputs

Summary water balance statistics are presented in Table 3. The outputs show:

- Annual water inputs exceed outputs and that there is an annual excess of water that will need to be discharged offsite as per the conditions outlined in the Environment Protection Licence (EPL).
- There is a significant variation in the amount of inflow predominately resulting from the variable rainfall experienced at the site and the resultant variability in surface runoff.
- Sufficient volumes of mine affected water are available for reuse such that import of water is not required.

Table 3 Summary water balance

	Annual				
	Units	Mean	Median	10th	90th
WMS Inputs					
Direct rainfall	ML/d	142	137	118	174
Total runoff	ML/d	2,389	2,306	1,429	3,591
Total groundwater inflow	ML/d	447	447	447	447
Total water input	**ML/d**	**2,978**	**2,890**	**1,993**	**4,211**
WMS Outputs					
Total storage loss	ML/d	513	499	407	624
Dust suppression	ML/y	353	357	338	360
Consumptive losses CHPP	ML/d	535	542	510	542
External discharge	ML/d	1,051	1,015	563	1,702
Total water output	**ML/d**	**2,452**	**2,413**	**1,818**	**3,228**

The difference in input and output is due to an increase in storage.

2.5 Use and on-site management

It is noted that while the CHPP is accounted for under the Abel approval, it is under the control of the Bloomfield Group and is part of the "Bloomfield Site" as noted in the Abel Project Approval. The CHPP and associated storages have been included in the water balance assessment as operations at the Abel site are currently under care and maintenance. Supply of water to the CHPP presents the largest single demand for water from the Bloomfield site. It provides a significant draw down on the stored inventory of mine affected water contained in the water management system allowing capacity for containment of future inflows to be maximised. Water is also used for dust suppression within the active area of mining and haul roads.

Wherever practical, passive measures have been adopted to divert the flow of clean water around the mine water management system. Opportunities to minimise raw water use have been incorporated within the operation (such as reuse of mine water for CHPP process use and dusts suppression) and future opportunities will be incorporated as they arise.

2.6 Conclusion

The water balance model concludes that the project will:

- be capable of meeting all water needs for CHPP uses and dust suppression from the groundwater inflows and surface runoff into the mine pits
- provide a net surplus of water that could contribute to supplying potential additional future demands.

3.0 Part C – Erosion and sediment control plan

The objective of the erosion and sediment control plan (ESCP) (Appendix C) is to ensure that the discharge of all water from the site is managed and that it meets appropriate quality standards. The ESCP covers the Project approval area and "Bloomfield Site".

The ESCP for the site is presented in full in Appendix C. Key elements of the plan are summarised in the following sections of the WMP.

3.1 Conditions of Approval

Condition 21 of Schedule 3 specifies the requirements for the preparation of the erosion and sediment control which are reproduced as follows:

The erosion and sediment control plan must:

a. be consistent with the requirements of 'Managing Urban Stormwater: Soils and Construction (Volume 2E – Mines and Quarries) Manual (DECC 2008)', or its latest version

b. identify activities that could cause soil erosion and generate sediment

c. describe measures to minimise soil erosion and the potential for transport of sediment downstream

d. describe the location, function and capacity of erosion and sediment control structures

e. describe what measures would be implemented to maintain the structures over time.

3.2 Erosions and sediment management principles

To minimise the potential for the generation of sediment the following key principles are applied to the site:

- coordination of mining to minimise exposure of disturbed soils
- separation/diversion of 'clean' water catchments from disturbed areas to minimise sediment-laden and mine water volumes for management
- collection and management of runoff sediment control devices
- appropriate storage and handling of topsoil materials
- revegetation of disturbed areas following site disturbance
- effective maintenance program for the site.

3.3 Potential sources of sediment

The activities associated with the workshop area and active mining areas have been identified as having the greatest potential for erosion and sediment generation on the site. Whilst the ESCP focuses on these key areas, consideration is also given to the runoff and maintenance of haul roads, clearing and rehabilitation of disturbed areas.

3.4 Erosion and sediment control measures

The regular inspection and maintenance of permanent structures ensures that the water management system and erosion controls remain effective. Measures to minimise erosion and sediment generation include:

- identification and review of surface activities that may change surface water flows and result in erosion
- minimising the clearing of vegetation ahead of mining activities
- regular monitoring of rehabilitated areas

- installation of temporary and/or additional permanent controls to manage locations that have been identified as requiring attention
- diversion of surface and road runoff away from disturbed areas
- regular inspection and cleaning of catch drains and structures following storm events or other activities such as vehicle movements that may result in damage
- clearing of excessive vegetation and weeds along drainage lines.

The ESCP provides for long term permanent controls and short term structures that may be required in areas that are disturbed for short periods.

The location of permanent controls is provided in Appendix C and should be referred to for details. Sediment dams vary in desirable location, dam shape and size and will be designed and constructed with regard to the contributing catchment area, erosivity of the soil, storm intensities and average recurrence intervals. In sizing sediment basins on site, the recommended minimum design criteria for temporary erosion and sediment control measures outlined in Table 6.1 from Managing Urban Stormwater Soils and Construction Vol 2 Mines and Quarries will be followed. Sediment dams will be constructed, where practical, in accordance with the sediment dam standard drawings (SD6-4) of the 'Blue Book' (Managing Urban Stormwater: Soils and Construction (4th ed.), NSW Office of Environment and Heritage, 2004).

The plan provides details for the current stage of mining and will be reviewed and revised as mining and rehabilitation progresses.

3.5 Maintenance and monitoring of erosion and sediment controls

The ESCP requires regular monitoring and management of controls to ensure runoff is managed appropriately. A summary of the regular monitoring schedule is provided in Table 4.

Table 4 ESCP monitoring schedule

Element	Management/monitoring strategy	Frequency
CHPP haul road drainage	Inspect status of erosion along the side of haul road to ensure the toe of the rehabilitated batter is stable and not undercutting. Grader maintenance of the haul road will be undertaken as required.	Weekly and following high intensity storm events.
Sediment ponds/dams (as marked on ESCP Figure 1)	Inspect sediment build-up and integrity of structures. De-silt dams as required.	Quarterly
Constructed drainage lines (as marked on ESCP Figure 1)	Inspect drainage lines to ensure stable, not actively eroding and has adequate capacity. Clean out or repair as required.	Quarterly
Natural drainage lines in southwest corner of the mine boundary	Inspect drainage lines for sedimentation from upstream catchment.	Quarterly
Pipe outflow from pit sumps	Inspect pipe outflow sites for erosion and scouring. Implement protection as required.	Monthly and following relocation
Rehabilitation areas and drainage lines on rehabilitated slopes	Inspect rehabilitation and drainage lines for adequate surface protection; ensuring sediment build-up in drainage lines is not adversely affecting drain capacity.	Within 12 months of establishment and then every 2 years
Proposed clearing activities ahead of mining	Inspect sites to be cleared ahead of mining, ensuring adequate sediment controls are established prior to surface disturbance.	Prior to clearing activities

Element	Management/monitoring strategy	Frequency
Temporary sediment controls (silt fence, sandbag weirs etc.)	Inspect sediment control structures for sediment build up and clean out as required to maintain adequate capacity.	Monthly and following high intensity storm events
Review of this ESCP	Undertake review and update of this ESCP to ensure all aspects associated with the site are captured.	Following any modification of the conditions of the approval or significant changes to the mine plan
Reporting of ESCP findings and inspections	Results of ESCP inspections, maintenance activities and construction of erosion and sediment control structures are to be reported to mine management.	Monthly

4.0 Part D – Surface water monitoring

The surface water monitoring plan (Appendix D) is an integral component of the WMP. The plan identifies locations and schedule for monitoring of surface water. The surface water monitoring plan for the site is presented in full in Appendix D. Key elements of the plan are summarised in the following sections of the WMP.

4.1 Conditions of Approval

Condition 22 of Schedule 3 specifies the requirements for the preparation of the surface water monitoring program control which are reproduced as follows:

The surface water monitoring program must include:

a. detailed baseline data on surface water flows and quality in creeks and other waterbodies that could potentially be affected by the project

b. surface water and stream health impact assessment criteria

c. a program to monitor the impact of the project on surface water flows, water quality and stream health

d. reporting procedures for the results of the monitoring program.

4.2 Environment Protection Licence

The WMP takes into consideration the Environment Protection Licence (EPL) (No. 396) which allows for the discharge of water under certain conditions. When sufficient rainfall is recorded and the quality of water meets the criteria specified in the licence, discharge is permitted from the licenced discharge point.

The requirements of the EPL in relation to the discharge of water are provided in Table 5.

Table 5 Environment Protection Licence 396 conditions

	Condition
L1	**Pollution of waters**
L 1.1	Except as may be expressly provided in any other condition of this licence, the licensee must comply with section 120 of the *Protection of the Environment Operations Act 1997.*
L3	**Concentration limits**
L2.1	For each monitoring/discharge point or utilisation area specified in the table\s below (by a point number), the concentration of a pollutant discharged at that point, or applied to that area, must not exceed the concentration limits specified for that pollutant in the table.
L2.2	Where pH quality limit is specified in the table the specified percentage of samples must be within the specified ranges.
L2.3	To avoid any doubt, this condition does not authorise the pollution of waters by any pollutant other than those specified in the tables/s. Point 1- Lake Forster Outlet • Conductivity – 6000 uS/cm • pH – 6.5-8.5 • Total suspended solids -30 mg/L • Filterable iron – 1 mg/L.
	Volume and mass limits
L3.1	For each discharge point or utilisation area specified below (by a point number), the volume/mass of: a. liquids discharged to water b. solids or liquids applied to the area must not exceed the volume / mass limit specified for that discharge point or area.

	Condition
	Point 1 – Lake Forster 40000 kL/day only permitted in the following conditions: • In wet weather conditions following a 10 mm or greater 24 hours rainfall event in the catchment in the first 24 hour period following the rainfall event. • In wet weather conditions following a 15 mm or greater 24 hours rainfall event in the catchment in the second 24 hour period following the rainfall event. • In wet weather conditions following a 20 mm or greater 24 hours rainfall event in the catchment in the third 24 hour period following the rainfall event.

The licensed discharge of water from the site is covered in the Abel Consent and is covered by the approval.

4.3 Hydrology and baseline data

A summary of baseline conditions for Elwells Creek and Buttai Creek at Buchanan Road is provided in Appendix D.

4.4 Surface water impact assessment criteria

The proposed water quality trigger values for Buttai and Elwells Creeks have been based on historic data collected over a number of years. The upper and lower limit thresholds have been based on the 10th and 90th percentiles of collected baseline data as per ANZECC guidelines (rounded figures).

The trigger values as shown in Table 6 provide an appropriate level of protection for the waterway and are reflective of the community values for the catchment areas. The results of monitoring will be reviewed annually. If required, the trigger values will be reviewed in consultation with the EPA and will be revised if found necessary.

Under Environment Protection Licence (EPL) 396 Bloomfield is licensed to discharge waters to Four Mile Creek under wet conditions and to concentration limits for conductivity, filterable iron, pH and total suspended solids as per the EPL. Therefore no trigger values are provided for Four Mile Creek.

Table 6 Trigger values

Water quality parameter	Source	
	Elwells Creek (WM5)	Buttai Creek at Buchanan Road (W13)
pH	5.2 – 8.0	6.4 – 7.8
EC (µS/cm	430 - 4,000	380 – 1,100
TSS (mg/L)	4 – 85	5 - 45

4.5 Surface water monitoring program

Appendix D provides the locations of surface water monitoring and ground water monitoring locations. The location of surface water monitoring points are shown on **Error! Reference source not found.**. The monitoring schedule outlines the frequency and analysis required at each location.

Table 7 Surface water monitoring

Location	Frequency	Parameter
Elwells Creek at Haul Road Buttai Creek - Immediately upstream of Buchanan Rd *	**Monthly** field monitoring at all listed sites for the range of parameters listed	Temperature pH EC Turbidity Oil and Grease (Visual observation)

Location	Frequency	Parameter
		Flow (Visual observation)
	Quarterly grab sample at all listed sites and laboratory analysis for the range of parameters listed	TSS TDS pH EC DO
	Six monthly grab sample at all listed sites and laboratory analysis for the range of parameters listed	Chlorides Sulfates Alkalinity (Bicarb) Alkalinity (Carb) Calcium Magnesium Sodium Potassium

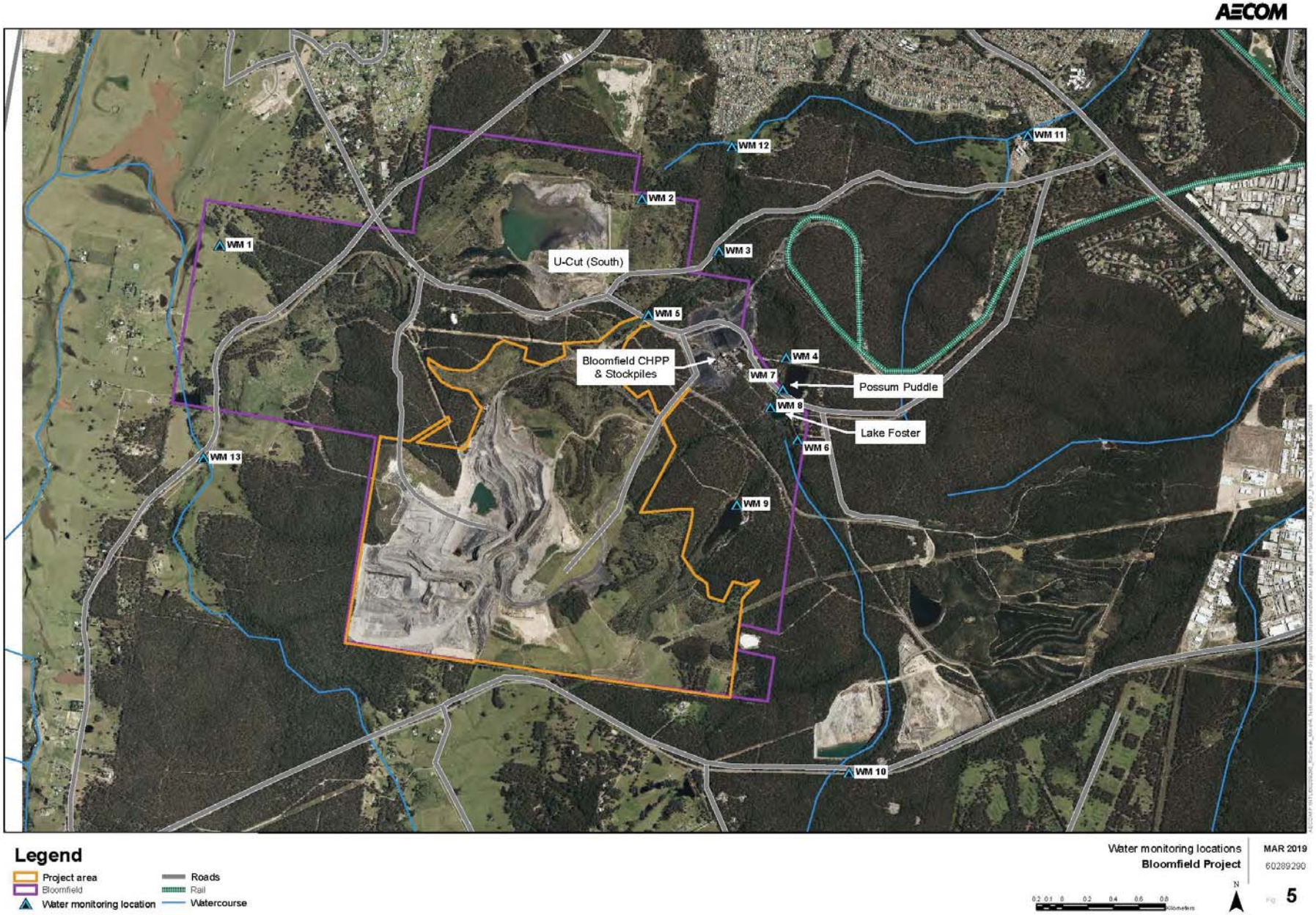
Aquatic ecology surveys of Four Mile Creek will continue to be undertaken every five years to:

- assess the quality of aquatic ecology and riparian vegetation in sites upstream and downstream of the EPL discharge point;
- identify measurable differences in these attributes between upstream and downstream pools and determine whether these differences are attributable to the EPL discharge point;
- assess whether the aquatic resources provide suitable and sustained aquatic habitat for fish and other aquatic biota and whether the streams continue to provide suitable fish passage; and
- identify protected or threatened aquatic species or communities residing within the study area.

4.6 Reporting of monitoring results

Surface water monitoring results will be included in the Annual Review Report in accordance with Schedule 5, Condition 3 of the Project Approval and will include the following:

- a summary of the monitoring results for the project during the past year
- analysis of these monitoring results against the relevant:
  - statutory requirements, limits or performance measures / criteria
  - monitoring results from previous years
  - predictions made in the Environmental Assessment
- Identification of any trends in the monitoring data over the life of the Project.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WM 1
WM 2
WM 3
WM 4
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WM 7
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WM 10
WM 11
WM 12
WM 13
U-Cut (South)
Bloomfield CHPP & Stockpiles
Possum Puddle
Lake Foster
Legend
Project area
Bloomfield
Water monitoring location
Roads
Rail
Watercourse
Water monitoring locations
Bloomfield Project
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Fig. 5

5.0 Part E – Groundwater monitoring

The groundwater monitoring plan (Appendix E) is an integral component of the WMP. The plan identifies locations and schedule for monitoring.

Groundwater levels in the project area show the accumulated effects of long-term mining. Due to the long period of time mining has occurred on the site (~180 years), there is no evidence to suggest what pre-mining groundwater levels might have been. However, the influence of mining on water levels is apparent by the marked differences in groundwater levels between shallow and deeper coal measures.

5.1 Conditions of Approval

Condition 23 of Schedule 3 specifies the requirements for the preparation of the surface water monitoring program control which are reproduced as follows:

a. further development of the regional and local groundwater model

b. detailed baseline data to benchmark the natural variation in groundwater levels, yield and quality (including at any privately owned bores in the vicinity of the site)

c. groundwater impact assessment criteria

d. a program to monitor the impact of the project on groundwater levels, yield, quality, groundwater dependent ecosystems and riparian vegetation

e. procedures for the verification of the groundwater model

f. reporting procedures for the results of the monitoring program and model verification.

5.2 Baseline data

Due to the long history of mining on the site and areas surrounding the site, pre mining baseline groundwater level and quality information is not available.

The Mod 4 Groundwater Impact Assessment AECOM (2018) noted groundwater drawdown as a result of mining activities are expected to reach a maximum in 2025, at which time mining activities are scheduled to cease in the southern end of the approved extraction area and groundwater levels would start to recover. A drawdown of 10m is predicted in the surficial aquifer in the Bloomfield approved extraction area of the final mine void. Drawdown is generally less than 0.5 m outside the Bloomfield lease area apart from the south-west corner where the 2 m drawdown contour extends outside the lease approximately 600 m beneath Buttai Creek. The predicted drawdowns are not expected to negatively impact GDE's as historical mining in the area has lowered levels far below the ground surface. The final void will remain a sink and will have a wide spread effect of lowering water levels in the vicinity of the mine in the long term. A hypothetical monitoring point within the final void is predicted to only recover 15 m after 100 years Groundwater Impact.

5.3 Further development of the groundwater model

The Bloomfield Coal groundwater model by HydroSimulations (2017) was developed to assess an extension to the life of mine modification (mod 4),to assess the groundwater impacts associated with completion of mining and rehabilitation.

The current regional model that includes Bloomfield, Donaldson, Abel and Tasman Mines was modified and partially recalibrated by HydroSimulations in 2016, with emphasis on the Abel Mine.

Several modifications have been made to the current model to improve its suitability for assessing the effects of mining at Bloomfield. The following changes were made by HydroSimulations:

- re-build of the model geometry in the Bloomfield area only
- inclusion of old Big Ben underground works (not in current Abel Model)
- inclusion of a dyke in the Bloomfield Area (not in the current Abel model)

- Contraction of the southern extent of the model from northing 6350000 to 6357420. This reduced the very large number of model cells which exceed the industry benchmark of 1 million cells. This contraction does not affect the results of interest
- extension of model calibration from December 2015 to April 2017

No changes were considered necessary for the following features:

- position of the northern boundary at northing 6374000
- cell sizes (maximum 100m x 100m at Bloomfield)
- inclusion of Donaldson, Abel, Tasman mines for cumulative impact assessment.

The following circumstances would trigger further development or refinement of the groundwater model:

- a significant change to the mine plan
- acquisition of new hydrogeological information, such as groundwater levels and aquifer properties (i.e. hydraulic conductivity) which are different to calibrated values used in the model
- groundwater drawdown and inflows which significantly exceed model predictions for that stage of mining.

5.4 Groundwater impact assessment criteria

Impact assessment criteria (detailed in Section 2.3 of Appendix E) are recommended for:

- mine inflow rate
- mine inflow water quality
- near surface groundwater levels, in particular groundwater levels near Buttai and Wallis Creek
- impacts on surficial groundwater levels and/or creek base flows
- impacts on existing licensed users.

5.5 Groundwater monitoring plan

The groundwater monitoring program will include:

- Quarterly measurement of water levels in the existing network of piezometers located on company land to be monitored through the life of the project
- Six monthly sampling of all standpipe piezometers for analysis of electrical conductivity (EC), total dissolved solids (TDS) and pH
- Annual collection of water samples from standpipe piezometers for laboratory analysis of a broader suite of parameters:
  - physical properties (EC, TDS and pH)
  - major cations and anions (Calcium (Ca), Magnesium (Mg), Sodium (Na), Potassium (K), Chloride (Cl), Sulfate (SO4), Bicarbonate (HCO3) and Carbonate (CO3))
  - nutrients
  - dissolved metals
- Record pump time from the pit to estimate the volume of mine water pumped from the open cut mine.

In addition, aquatic ecology surveys of Four Mile Creek are undertaken every five years to assess the quality of aquatic ecology and riparian vegetation in sites up- and down-stream of the EPL discharge point, as described in Section 4.5 of this WMP.

5.6 Reporting of monitoring results

Groundwater monitoring results will be included in the Annual Review Report in accordance with Schedule 5, Condition 3 of the Project Approval and will include the following:

- a summary of the monitoring results for the project during the past year
- analysis of these monitoring results against the relevant:
  - statutory requirements, limits or performance measures / criteria
  - monitoring results from previous years
  - predictions made in the Environmental Assessment
- Identification of any trends in the monitoring data over the life of the Project.

6.0 Part F - Surface and groundwater response plan

In the event of unexpected adverse impacts or water quality degradation an assessment of the causes will be undertaken and if required an approach developed to mitigate the impacts.

6.1 Conditions of Approval

Condition 24 of Schedule 3 specifies the requirements for the preparation of the surface and groundwater response program control which are reproduced as follows:

The surface and groundwater response plan must describe the measures and/or procedures that would be implemented to:

a. Investigate, notify and mitigate any exceedances of the surface water, stream health and ground water impact assessment criteria

b. compensate landowners of privately-owned land whose water supply is adversely affected by the project

c. mitigate and/or offset any adverse impacts on groundwater dependent ecosystems or riparian vegetation.

6.2 Surface and groundwater response plan

In the event the monitoring results show an exceedance of the adopted water quality trigger values or adverse impact to aquatic or riparian environments, an investigation into the potential sources and/or causes will be undertaken. If the company is found that it could be responsible for the exceedance further actions will be taken to address the matter.

The response actions listed below will be initiated. An action plan will be prepared to reflect these actions:

- Once an exceedance is detected the circumstances of the event will be immediately investigated including a review of relevant monitoring data, meteorological conditions.
- An assessment will be made to determine the reason for the exceedance, the potential magnitude of the impact and the level of future risk.
- If assessed as being caused by the mining operation, and it is further assessed to be likely to cause an adverse impact on an existing beneficial or environmental use of surface water or aquatic/riparian environment, then an appropriate preventative and/or remedial strategy will be prepared for discussion with relevant authorities including the Department of Planning, Industry and Environment - Resource Regulator and the EPA, which may comprise:
  - additional monitoring including assessment of ecological aspects
  - rehabilitation measures such as revegetation or bank and channel stabilisation
  - modification of mine water management procedures
  - modification to mine water management facilities
  - (If appropriate) no change to operations
- A response/mitigation plan will be implemented to the satisfaction of the relevant authorities such as EPA
- If it is found that downstream water users have been adversely impacted, a compensation strategy would be developed in consultation with the landholder(s). This may include the provision of an alternative water supply, adequate compensation made available or some other appropriate agreement negotiated between the parties (for example, installation of an irrigation system, dam or stock watering point). The timeframe for implementation of the compensation strategy would be agreed with the landholder(s). In the event that agreement cannot be reached regarding the compensation to be provided, the matter may be referred to the Department of Planning, Industry and Environment for resolution.

6.3 Investigation and reporting of exceedances

In the situation where an exceedance is detected and investigated, a report will be prepared and provided to Department of Planning, Industry and Environment and relevant agencies. The report will:

a. describe the date, time and nature of the exceedance / incident

b. identify the cause (or likely cause) of the exceedance / incident

c. describe what action has been taken to date

d. describe the proposed measures to address the exceedance / incident.

6.4 Complaints

Bloomfield's EMS details the procedures for addressing complaints including water related issues that may be raised by the community. All complaints from the community and/or government agencies are recorded. Details for each are kept including:

- date and time of complaint
- method by which the complaint was made
- personal details of the complainant which were provided by the complainant or, if no such details were provided, a note to that effect
- nature of the complaint
- the action(s) taken in relation to the complaint, including any follow up contact with the complainant
- if no action was taken, the reason why no action was taken.

The complainant will be followed up to explain the outcome of the investigations.

6.5 Audit and review

The ongoing effectiveness and efficiency of this management system is monitored as part of the operation's day to day management. Feedback from this and other more formal reviews and/or following special occurrences, form the basis for system improvement and re-design.

6.6 General conditions of review

In general management systems are reviewed and up-dated conditional as follows:

- every three years, or
- whenever there is a significant change to relevant legislation
- if required to do so by the regulations
- whenever there is a significant change to the operations
- if required (in writing) to do so by government department
- whenever control measures are found to be ineffective either through:
  - changes to the working environment
  - changes to operating systems
  - subsequent risk assessments
  - the findings of an audit
  - following a fatality or dangerous incident that could reasonably have been expected to result in a fatality
  - following an assessment of a related safety alert.

6.7 Document management

Copies of this document are managed under the group document management, management system. This document and other relevant documents are kept on site and are available to all employees.

7.0 References

The Australian and New Zealand Environment Conversation Council (2000) *ANZECC Guidelines*

Business Environment Pty Ltd. (2008). *Bloomfield Colliery Completion of Mining and Rehabilitation: Part 3A Environmental Assessment Project Application 07_0087.*

Evans and Peck. (2008). *Completion of Mining and Rehabilitation Project. Surface Water Assessment.*

Appendix A

Project approval

Appendix A Project approval

A copy of the Bloomfield Open Cut Project Approval (PA 07_0087) is available on the Bloomfield website at:

https://www.bloomcoll.com.au/sustainability/environmental-management/bloomfield-assessments/project-approval

A copy of the Abel Coal Project, Project Approval (PA 05_0136) which covers the "*Bloomfield Site"* is available on the Bloomfield website at:

https://www.bloomcoll.com.au/sustainability/environmental-management/bloomfield-assessments/project-approval

Appendix B

Site water balance

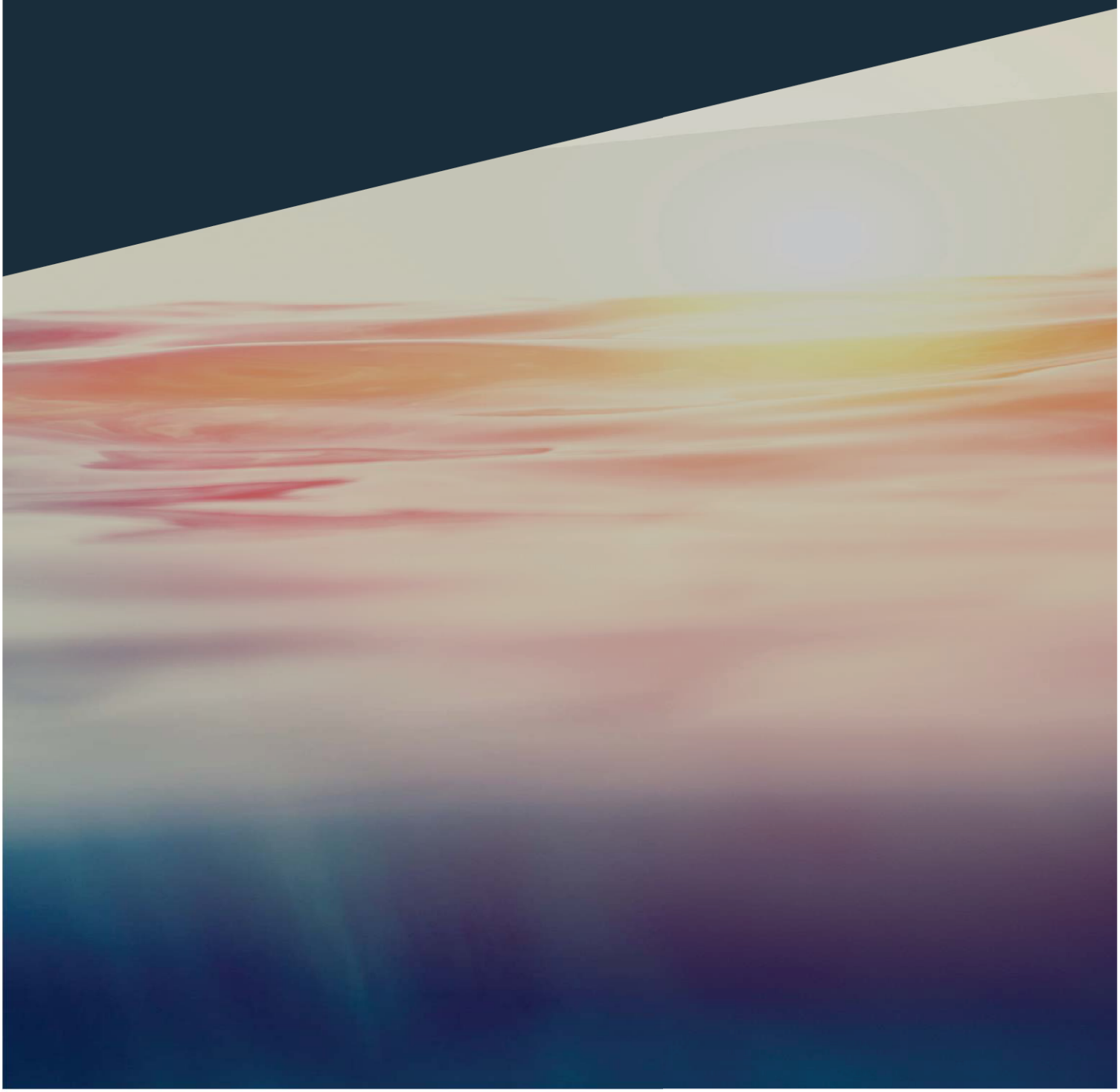
Appendix B Site water balance

AECOM Imagine it. Delivered.

The Bloomfield Group
05 August 2021
Doc No. Appendix B

Bloomfield Mining Operations Water Management Plan

Site Water Balance



Bloomfield Mining Operations Water Management Plan

Site Water Balance

Client: The Bloomfield Group

ABN: 25 003 824 244

Previously Prepared by

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05 August 2021

Job No.: 60289290

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Quality Information

Document	Bloomfield Mining Operations Water Management Plan
Ref	60289290 – Appendix B
Date	05-Apr-2019
Previously Prepared by	Steven Voss
Previously Reviewed by	Dr Mohand Amghar

Revision History

Rev	Revision Date	Details	Authorised	
			Name/Position	Signature
A	18-Dec-2018	Draft	Simon Murphy Project Manager	
B	14-Mar-2019	Draft for client review	Simon Murphy Project Manager	
C	29-Mar-2019	DPE Review	Simon Murphy Project Manager	
D	05-Apr-2019	DPE Review	Simon Murphy Project Manager	
E	5 August 2021	Updated to include the "Bloomfield Site" under Abel Approval PA 05_0136	Chris Knight Environmental Manager	

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Abbreviations

EPA	Environment Protection Agency
DoI	Department of Industry – Lands and water
ROM	run of mine
MAW	Mine Affected Water
EPL	Environment Protection License
TSF	Tailings Storage Facility
WBM	Water Balance Model
LOM	Life of Mine
EC	Electrical Conductivity
CHPP	Coal Handling Preparation Plant
BoM	Bureau of Meteorology
WMS	Water Management System
FSL	Full Supply Level
AEMR	Annual Environmental Management Report

1.0 Background

This site water balance has been prepared in response to Project Approval (Approval) 07_0087 granted under section 75J of the *Environmental Planning and Assessment Act, 1979* (EP&A Act) and a modification (MOD 4) to the Approval granted in accordance with section 75W of the EP&A Act.

This Site Water Balance Plan also includes the area known as the "Bloomfield site" as defined in the Abel Coal Project Approval MP 05_0136 which includes the Bloomfield Coal Handling and Preparation Plant, the Bloomfield Rail Loading Facility, Rail Loop and Rail Spur, and the Bloomfield Colliery open-cut pits which are used to emplace coal reject and tailings from the Abel Coal Project.

In accordance with Condition 19 of Schedule 3 of the Approval, AECOM Australia Pty Ltd (AECOM) was engaged by The Bloomfield Group (Bloomfield) to update the water management plan (WMP) including development of a revised site water balance (this report).

Condition 19 of Schedule 3 (Specific Environmental Conditions) of the Project Approval requires the Proponent to prepare and implement a water management plan for the project to the satisfaction of the Secretary. This plan must:

a. Be prepared in consultation with EPA (Environment Protection Agency) and DoI (Department of Industry – Lands and water) and be submitted to the Secretary for approval within 6 months of the date of this approval

b. Be prepared by suitably qualified expert/s whose appointment/s have been approved by the Secretary

c. Include:

- a site water balance [this report]
- an erosion and sediment control plan
- a surface water monitoring program
- a surface and ground water response plan.

The Proponent must implement the water management plan as approved by the Secretary.

1.1 Conditions of approval

Condition 20 of Schedule 3 addresses the specific requirements for the site water balance. It is specified that the site water balance must:

a. Include details of:

- sources and security of water supply
- water use and management on site
- any off-site water transfers or discharges
- reporting procedures

b. describe measures to minimise water use by the project.

1.2 Modification 4

Mine scheduling to support the Project Approval did previously identify that the resource would be exhausted by the end of 2021. However, Bloomfield currently predicts mining to extend beyond 2021 as:

- Actual run of mine (ROM) production levels have been lower than the predicted ROM production rates of 1.3 Mtpa, over the life of the project to-date.
- Changes to the mine fleet have allowed access to, and extraction of seams that were not previously considered to be a recoverable resource as part of the Environmental Assessment for Project Approval 07-0087 (Business Environmet Pty Ltd, 2008)
- Further exploration has identified other previously unrecoverable resources within the approved mining area that the new fleet can now access.

Bloomfield has therefore identified up to 13 million tonnes of ROM coal remaining inside the approval area that could be recovered. Based annual mining rates of approximately 1 million tonnes of ROM per year, mining will now extend beyond 2021. The intention of the consent modification (MOD 4) is to align the Bloomfield mining operations consent limit to coincide with the adjoining Abel Underground Mine ('Abel') consent limit of 31 December 2030. Rehabilitation will continue past this limit to allow for the rehabilitation of the tailings emplacement area. Maximum annual production levels will continue at 1.3 Mtpa of ROM coal per year.

1.3 Site description

Bloomfield Colliery is an existing open cut mining operation located to the north of John Renshaw Drive, Buttai, and east of Buchanan Road, Buchanan, approximately 20 km north-west of Newcastle. Mining has occurred on the site for over 180 years. The open cut operations commenced in 1966 and the site produces mainly thermal coal with some semi-soft coking coal, principally for the Asian export market. In addition to the open cut operations, the site has also been subject to underground workings, which ceased in 1992.

A number of former or inactive mining operations are located adjacent to or partially integrated with Bloomfield Colliery as detailed below:

- Donaldson Open Cut Mine (former mine site, being rehabilitated)
- Abel Underground Mine (under care and maintenance since June 2016)
- Tasman Underground Mine (former mine site, rehabilitated in 2014).

Mine water management has previously been integrated across the Abel and Bloomfield sites however, since the Abel Underground Mine was placed into care and maintenance, operations at Bloomfield Colliery represent the only active mining activity. For the purpose of this assessment, it has been assumed that Abel Underground Mine will remain in care and maintenance for the remaining consent limit (through 31 December 2030). Consequently, potential integrated operation of Abel and Bloomfield mine water management infrastructure has not been considered and the site water balance has considered Bloomfield operations in isolation. Should the Abel Underground Mine recommence operations it is recommended that the site water balance be updated to reflect the likely changes to sources of mine affected water (MAW), water demands and mine water management.

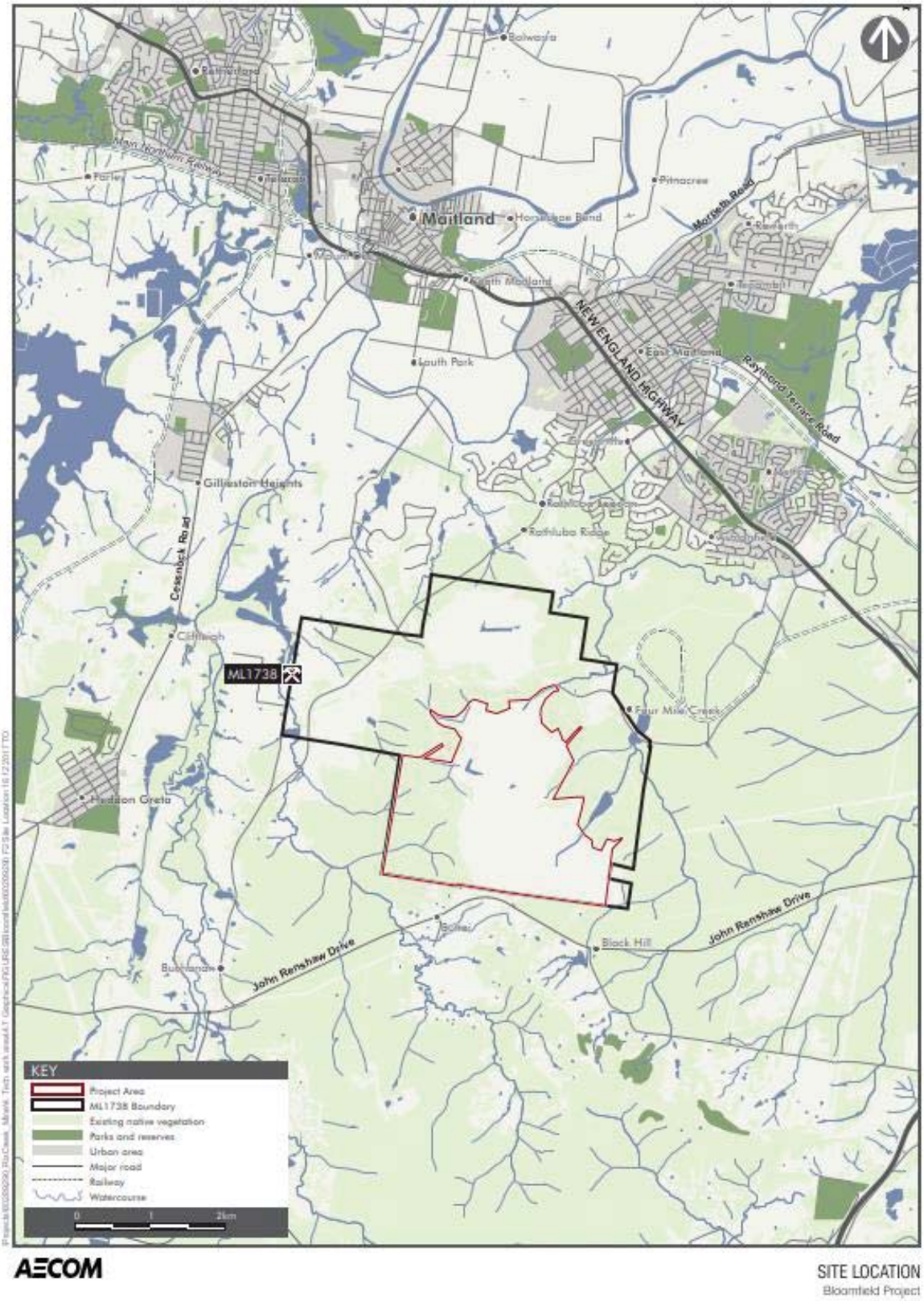


Figure 1 Site location

1.4 Mine water management system overview

Mine affected water (MAW) is any water produced during the completion of mining operations that may have levels of key contaminants or poor water quality (typically salinity, measured as electrical conductivity) that make it unsuited for discharge to the receiving environment except under specific conditions outlined under an Environment Protection Licence (EPL). Sources of MAW at the Bloomfield site include open cut pit dewatering (groundwater, rainfall and runoff), reclaim of water from the tailings storage facility (TSF) and stormwater runoff collected from key operational areas including high wall, haul roads, overburden dumps awaiting rehabilitation and stockpile areas (run-of mine (ROM) and product coal).

The MAW management system comprises the following key storages (

Figure 2):

- **Lake Kennerson** which receives dewatering from the two open cut pits, S-Cut (south) and S-Cut (north). S-Cut north is also known as the Creek Cut and reports to the storage via open drains. Runoff from disturbed areas, including high wall, haul roads, overburden dumps awaiting rehabilitation, has the potential to carry suspended solids and is directed to Lake Kennerson for primary settlement of suspended material. The storage has a catchment of approximately 93 Ha comprised of raw and rehabilitated overburden (refer to Table 5). Lake Kennerson has a valve-controlled discharge pipe which, when opened, transfers water to Lake Foster.
- **Lake Foster** receives decant water from the TSF (U-Cut) and water from the stockpile dam, which collects the runoff from the Coal Handling Preparation Plant (CHPP) and coal stockpile pads. Mine water is pumped from Lake Foster to the CHPP for use in coal processing and for dust suppression of the coal stockpiles . Lake Foster also receives return water from the TSF. Lake Foster also receives top up water from Lake Kennerson if required. The storage has a catchment of approximately 47 Ha comprised of raw and rehabilitated overburden as well as some undisturbed areas (refer to Table 5).
- **Stockpile Dam** receives runoff from the CHPP, stockpile and rail loadout areas. Runoff is collected in a number of minor dams around the CHPP area which collectively drain to the Stockpile Dam which subsequently transfers to Lake Foster.
- **Tailings Storage Facility.** Coarse and fine tailings are currently disposed of via in-pit storage in the U-Cut (south) open cut pit. Reclaim of decant water from the TSF is transferred via a pump to Lake Foster for subsequent reuse.

Discharge of excess MAW is via lockable valve pipes, into an open drain that flows to Four Mile Creek. Discharges are undertaken in accordance with the conditions of EPL 396. Water sampling is undertaken during discharge, and a monitoring station continuously monitors electrical conductivity (EC) and water level.

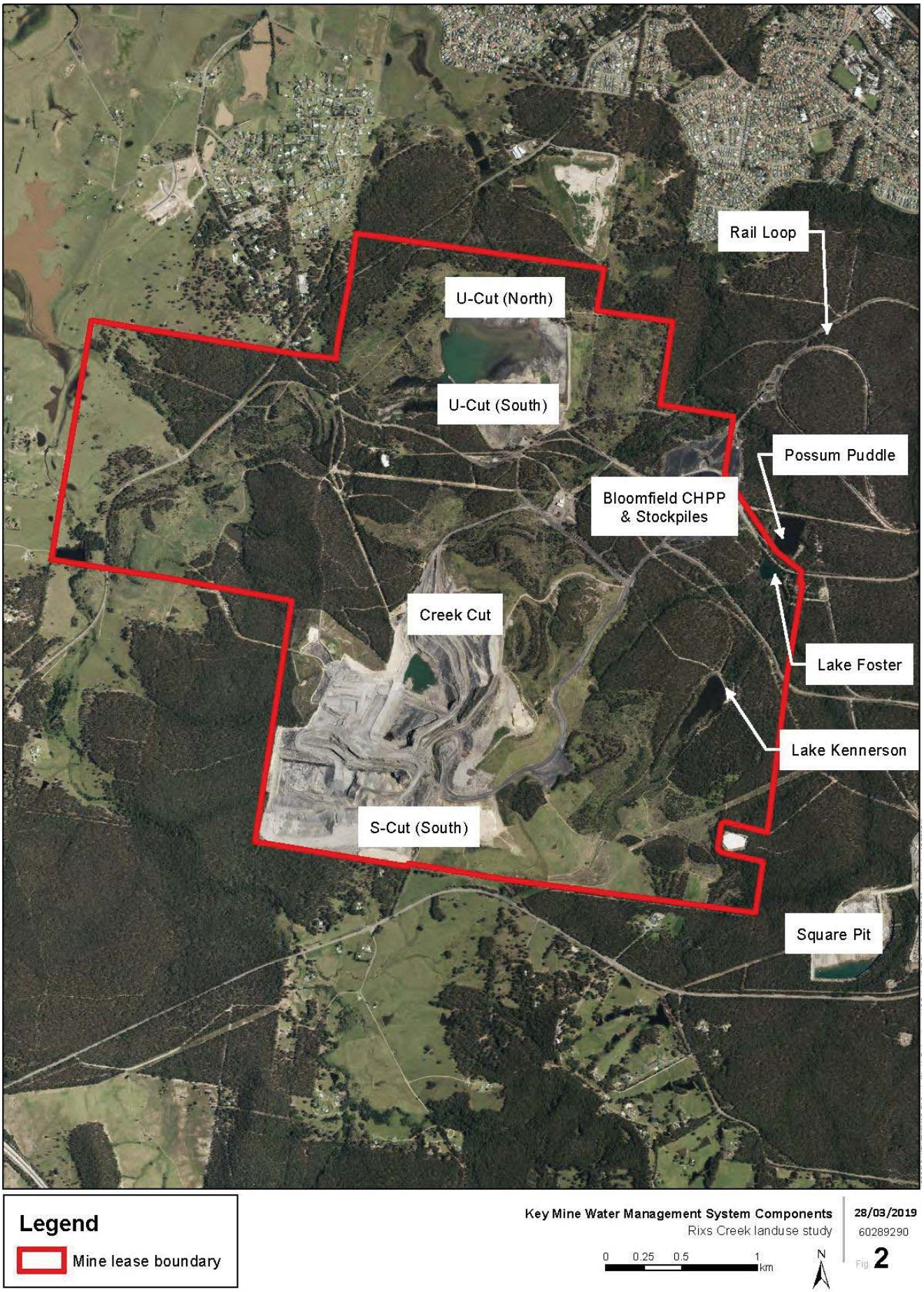


Figure 2 Key mine water management system components

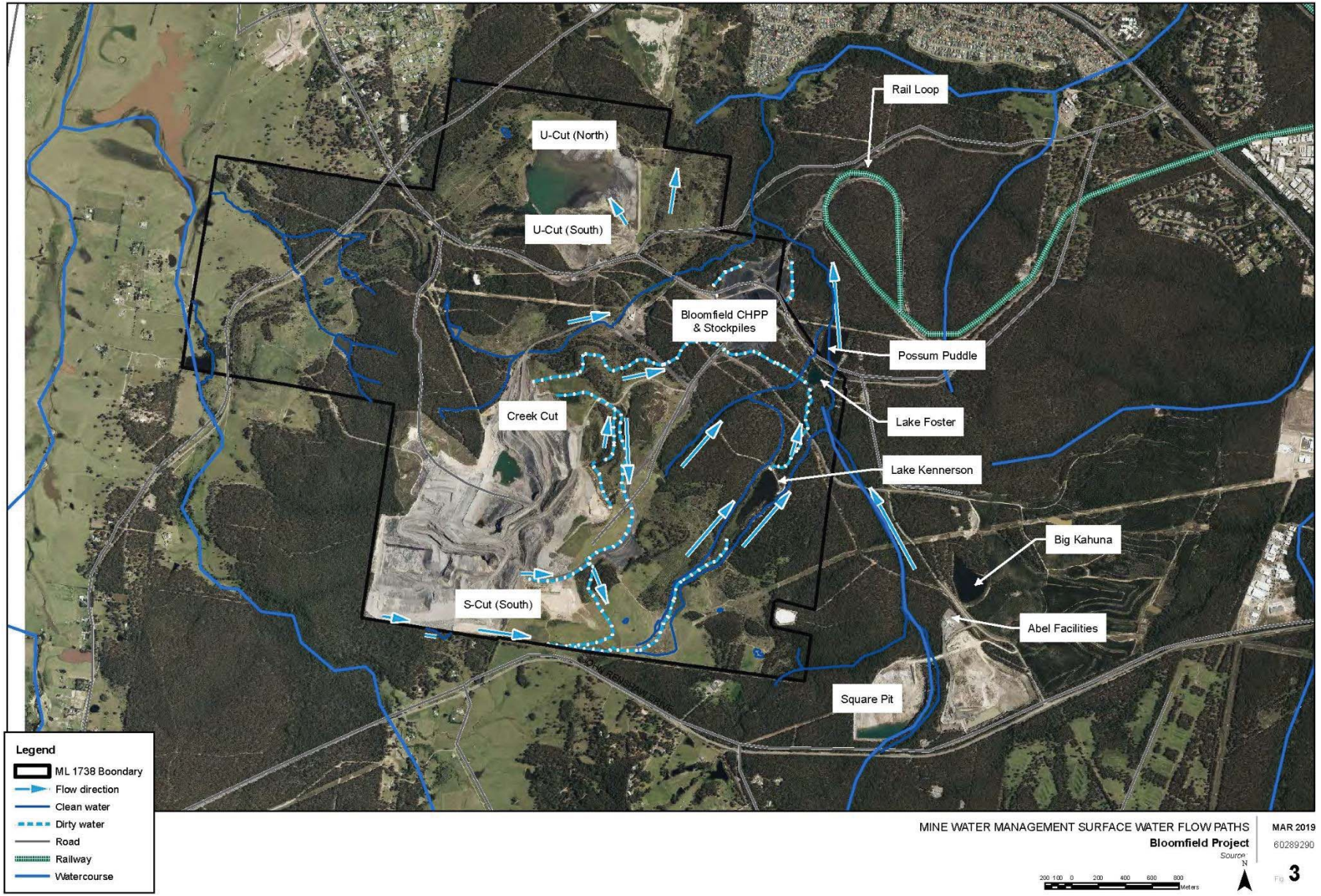


Figure 3 Mine water management surface water flow paths

2.0 Water balance model

2.1 Scope

Development of the revised site water balance included the following key steps:

- review of existing documentation including:
  - existing site water management plan (WMP), (Bloomfield Mining Operations, 2013)
  - previous site water balance (Evans and Peck, 2010)
  - previous surface water assessment (Evans and Peck, 2008)
  - current (MOD 4) surface water assessment (AECOM, 2018)
  - annual environmental management reports, 2012 through 2017 (The Bloomfield Group, 2012-2017)
- review of existing site spreadsheet water balance model as provided by Bloomfield
- update the model schematic, assumptions and key inputs
- development of GoldSim water balance model, model simulation and reporting.

Except where stated otherwise, all assumptions, data and information used in the site water balance were provided by Bloomfield.

2.2 Model development

The site water balance model (WBM) has been developed using GoldSim probabilistic modelling software. GoldSim is a Monte Carlo simulation software package that is commonly used in the mining industry for water balance modelling. The model has been used to validate the site mine water management system under a range of historical climatic conditions and to identify any off-site water transfers or discharges.

2.3 Model description and simulation approach

The WBM has been developed to simulate the proposed 7 year extended life of mine (LOM) as per Modification 4 (Section 1.2). The model (refer to Figure 5) has been developed to simulate relevant onsite process including key water demands, transfers and generation and containment of runoff from mine affected catchment areas through to 31st December 2025.

In order to assess the performance of the mine water management system under a range of historical climatic conditions, multiple simulations (known as realisations) of the LOM were performed. The only difference between each realisation was the input climate data (rainfall and evaporation) which consists of 128 years (1889 to 2017) of data obtained from the Bureau of Meteorology (BoM) SILO data drill (refer to Section 2.6.1). This method of simulation is commonly referred to as 'bootstrapping'

Running on a daily timestep, the first model realisation simulates the 7 year LOM utilising climate data from 1889 to 1895. The second realisation then utilises climate data from the period 1890 to 1896, the third from 1891 to 1897, and so on. This process allows for a total of 129 model realisations (known as a Monte Carlo simulation) to be run from the available climate data and the development of probability distributions for key results. In this manor, the response of the mine water management system (WMS) to a wide range of historical climatic conditions is considered in a single simulation. This allows for the development of probability distributions for key results (e.g. estimated discharge water) and the probability of occurrence e.g. the 90th percentile annual water discharge over the LOM.

Key simulation assumptions are shown below in Table 1.

Table 1 Key simulation assumptions

Aspect	Assumption
Length of simulation	Remaining life of mine (LOM), 7 years, 1/1/2019 through 31/12/2025
Simulation type	Probabilistic (bootstrapped)
Number of realisations	128

2.4 Key modelling assumptions and limitations

The following key assumptions and limitations were applied to the development of the site water balance model:

- The water balance has considered the MOD 4 mine plan, based on catchment area and land use data provided by Bloomfield (refer to Table 5).
- Mine water management has considered operation of the Bloomfield Colliery in isolation with no transfer of water to or from infrastructure associated with the Abel Underground Mine (assumed to continue in care and maintenance status).
- The site water balance has considered water quantity only, no modelling of water quality has been completed.
- Modelled pumped transfers occur 'instantly' within each water balance model timestep (i.e. daily) and are based on pump transfer rules and capacities provided by Bloomfield (refer to Table 9).
- Mine Water Management System (WMS) dam data (capacities, catchment areas and land use; and water surface areas) have been provided by Bloomfield (refer to Table 5 and Table 6).
- No allowance is made for the time taken for water to actually move from one location to the next and pump availability is assumed to be 100 % of potential capacity for 100 % of the time.
- Pump capacity remains fixed irrespective of head differential in dams due to draw down.
- No quality restrictions have been placed on the reuse of MAW for either CHPP or dust suppression use.
- Model inputs for mine water demands have been based on rates provided by Bloomfield.
- Performance of the mine WMS was assessed on the basis of historical climate data however potential changes to climatic extremes resulting from climate change have not been considered.
- An evaporation pan factor of 0.75 or 75% was applied to the evaporation loss from all dams.
- No seepage losses from mine WMS have been considered.
- Potential loss of dam storage capacity over time due to sedimentation has not been considered.
- Modelled releases of water to the receiving environment have not considered the discharge licence conditions outlined in the EPL (396) and estimated discharge volumes simply represent the uncontrolled release of water via spillway discharge when the dam storage capacity is exceeded.
- Operating rules provided by Bloomfield were incorporated into the water balance model (refer to Table 9).

2.5 Rainfall-runoff submodel

In order to estimate the potential volumes of runoff entering the mine WMS, the WBM utilises the Australian Water Balance Model (Boughton, 1993) which is consistent with the approach adopted by (Evans and Peck, 2010). The AWBM is commonly selected for this purpose due to its simplicity, widespread usage in many similar applications and ease of parameterisation and calibration. This conceptual rainfall-runoff model uses three independently balanced surface stores to simulate partial areas of rainfall excess. The excess rainfall is then divided into surface and baseflow stores which are then allowed to discharge at rates governed by their respective recession constants.

In order to reflect the differences in land use, potential for contamination and runoff depth within the Bloomfield site, the WBM utilises a number of different land use types previously defined and parameterised by (Evans and Peck, 2010) and detailed in Table 2. Each land use type has been modelled utilising the AWBM to simulate the different volumes of runoff generated by each land use and is managed within the mine WMS according to its assumed quality.

Table 2 AWBM land use types

Landuse[1]	Proposed runoff management
Natural	Dependent upon location, primarily excluded/diverted from mine water system, however some capture in dam catchments.
Raw overburden	Contained onsite and managed within the mine WMS
Rehabilitated overburden	Contained onsite and managed within the mine WMS
Pit and haul roads	Contained onsite and managed within the mine WMS

Adopted AWBM parameters for each AWBM land use have been taken from the Evans and Peck (2010) water balance model and are shown in Table 3 below.

Table 3 Adopted AWBM land use parameters (Evans and Peck, 2010)

Parameter	Description	Land use			
		Natural	Raw overburden	Rehabilitated overburden	Roads and pits
A1	Partial area	0.115	0.1	0.1	0.1
A2	Partial area	0.596	0.9	0.9	0.9
A3	Partial area	0.286	0.0	0.0	0.0
C1	Surface storage capacity	15	1.7	27.5	6.6
C2	Surface storage capacity	70	5.4	85.5	66
C3	Surface storage capacity	160			
BFI	Base flow index	0.182	0	0.7	0.15
K_b	Base flow recession constant	0.78	1	0.85	0.98
K_s	Surface flow recession constant	0	0	0	0

[1] As characterised by (Evans and Peck, 2010)

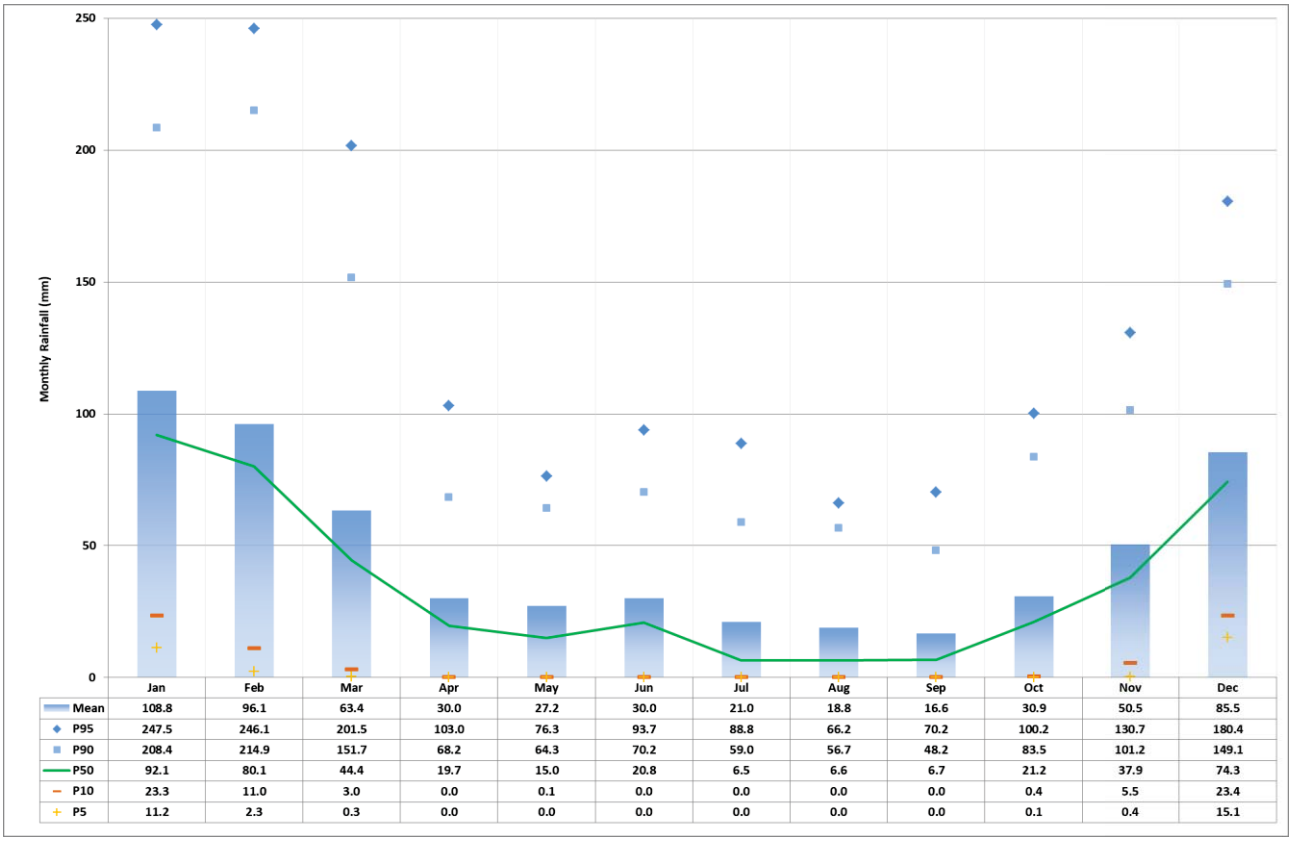
2.6 Model input data

2.6.1 Climate data

Input climate data for the WBM consists of daily rainfall and evaporation records which were sourced from the BoM SILO data drill. This fully synthetic data set is derived from the BoMs extensive database of recorded observations taken from its network of weather recording stations. The WBM utilises 129 years of data representing the period 1889 to 2018.

Rainfall data is used by the AWBM to estimate runoff depths and consequent runoff volumes entering the mine WMS. Rain falling directly over the impounded water surface within each dam is also added to the mine WMS but without any loss. Figure 4 shows monthly rainfall for the site derived from the SILO data drill. From the figure it can be seen that rainfall is subject to a seasonal distribution with a notable wet season occurring from November through March. Also of note is the significant variability associated with monthly rainfall as exhibited by the deviation of extreme values (such as P5 and P95 values) from the mean.

Potential evapotranspiration is used to inform the AWBM rainfall-runoff model and pan evaporation is used to estimate dam evaporative water losses. In recognition of the potential for reduced evaporation rates from large bodies of water and water containing elevated salinity levels, the daily pan evaporation rate was reduced to 75% of the input Class A pan rate when estimating evaporation from each dam. Dam evaporative losses are calculated daily with each time step and are applied to an area representative of the dam's maximum water surface area.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean	108.8	96.1	63.4	30.0	27.2	30.0	21.0	18.8	16.6	30.9	50.5	85.5
P95	247.5	246.1	201.5	103.0	76.3	93.7	88.8	66.2	70.2	100.2	130.7	180.4
P90	208.4	214.9	151.7	68.2	64.3	70.2	59.0	56.7	48.2	83.5	101.2	149.1
P50	92.1	80.1	44.4	19.7	15.0	20.8	6.5	6.6	6.7	21.2	37.9	74.3
P10	23.3	11.0	3.0	0.0	0.1	0.0	0.0	0.0	0.0	0.4	5.5	23.4
P5	11.2	2.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.4	15.1

Figure 4 Monthly rainfall statistics at site (SILO data drill, 1889-2018)

Table 4 Climate data – key assumptions

Aspect	Assumption
Data source	SILO data drill obtained for Lat, Long: -32.80, 151.55 (decimal degrees)
Length of record	1 January 1889 to the current year
Time increment	Daily
Rainfall	Daily total
Evaporation (class A pan)	Daily total
Evaporation pan factor	0.75 or 75 % (applied to evaporation from all dams)
Evaporation (potential evapotranspiration)	FAO56[2] (used by AWBM model)

2.6.2 Mine catchment areas

Mine catchment areas are based upon information provided by Bloomfield and catchment land use has been assigned on the basis of the classification previously defined by (Evans and Peck, 2010) (refer to Section 2.5). Table 5 summarises adopted model catchment areas and land use.

Table 5 Modelled mine catchment areas – adopted values (Bloomfield)

Mine Affected Catchment	Catchment area by AWBM land use (ha)				
	Natural	Raw Overburden	Rehabilitated Overburden	Roads & Pits	Total
Reporting to Lake Foster	20	2	25	0	47
Reporting to Lake Kennerson	0	23	70	0	93
Coal handling and preparation plant (CHPP) dam	0	0	0	33	0
Pit: U-Cut (s) – tailings storage facility (TSF)	0	100	0	0	100
Pit: S-Cut (N) (Creek Cut) – not currently being actively worked.	0	90	0	0	90
Pit: S-Cut (S)	0	93	0	0	93

[2] Potential evapotranspiration calculated using the FAO Penman-Monteith formula as in FAO Irrigation and Drainage paper 56, http://www.fao.org/docrep/X0490E/X0490E00.htm

2.6.3 Storage details

As previously described in Section 1.4, the WMS is comprised of four key water storages: Lake Foster, Lake Kennerson, Stockpile Dam, and the TSF. Data provided by Bloomfield for each storage is summarised in Table 6.

Table 6 Storage details (Bloomfield)

Parameter	Lake Foster	Lake Kennerson	Stockpile Dam	U-Cut (s) (TSF)
Capacity at spillway (ML)	50	200	25	> 5000
Volume at full supply level (ML)	40	200	25	600
Ponded area at full supply level (FSL) (ha)	2	7	0.6	30
Catchment (ha)	47	93	33	100

2.6.4 Open cut pits

There are two open cut pits at the Bloomfield site, S-Cut (S) and S-Cut (N) – Creek Cut. All water which drains to the pits collect in sumps which have been assumed to have a capacity of 1000 ML. Only the S-Cut (S) is currently active and is therefore given priority to be dewatered to Lake Kennerson. This results in the periodic storage of significant volumes of water in the S-Cut (N).

2.6.5 Groundwater

Groundwater modelling previously conducted for the site (HydroSimulations, 2017) established a range of groundwater inflow rates for the life of mine (Table 7). The values predicted for the remaining life of mine (2019-2025) have been adopted within the water balance model. A daily groundwater inflow has been adopted dependent upon the year of simulation, as shown in Table 7.

Table 7 Predicted mine inflows (HydroSimulations, 2017)

Mine year		Mine inflow (ML/d)	Mine inflow (ML/year)
Calibration	2006	0.88	322
	2007	0.82	300
	2008	0.85	312
	2009	0.87	318
	2010	0.92	336
	2011	1.18	430
	2012	1.4	513
	2013	1.57	572
	2014	1.51	551
	2015	1.4	511
	2016	1.2	440
	2017	1.24	455
Prediction	2018	1.42	520
	2019	1.42	520
	2020	1.54	561
	2021	1.53	559
	2022	1.16	423
	2023	0.69	253
	2024	1	367
	2025	1	367

2.6.6 Mine affected water demands

Fulfilling water demands through use of MAW where suitable minimises the requirement to import and use raw water. Furthermore, it provides a continual drawdown on stored inventories of MAW throughout the MWS which allows capacity for containment of future flows. Sources of water consumption and estimated demands are listed in Table 8.

Operation of the CHPP is currently not continuous and processing of ROM coal occurs periodically throughout the year. When operating at capacity (700 tonnes per hour) the CHPP requires approximately 10 ML/d (process losses, fine and coarse rejects) however, for the purpose of modelling a pro-rata daily rate of 2.12 ML/d has been adopted[3].

The rate of return for decant water is not currently well understood. For the purpose of modelling, a recovery rate of 30 % has been applied to the total CHPP demand of 2.12 ML/d. This represents the rate of return water from the TSF as a percentage of the total demand (and is therefore inclusive of any losses associated with coarse rejects, process losses, seepage from the TSF and any interstitial losses associated with entrainment in the tailings material). It is also noted that additional inflows of direct rainfall and runoff and evaporative losses from the decant pond are also applied to the modelled TSF.

Table 8 Water demand sources

Water Demand	Quality Restrictions	Requested Rate (ML/d)	Source
CHPP (pro-rated daily demand)	None	2.12	Lake Foster
Dust suppression	None	1.0	Lake Foster

2.6.7 Water transfer rules

Model operating rules have been incorporated into the WBM based on information provided by Bloomfield. Model water transfer rules dictate when transfers occur, where water is transferred to and at what rate the transfer should take place. Table 9 summarises the transfer rules as modelled by the WBM. In addition to the transfer rules shown in Table 9, rainfall, runoff and evaporation is also taken into account for each mine water storage element.

Table 9 Model water transfer rules

From	To	Operating Rules	Rate (ML/d)
S-Cut (N) Creek Cut	Lake Kennerson	Transfer occurs while water is available until Lake Kennerson is 90% full.	3.5
S-Cut (S)	Lake Kennerson	Transfer occurs while water is available until Lake Kennerson is 90% full.	3.5
Lake Kennerson	Lake Foster	Transfer occurs whenever water is required to top up lake foster to enable CHPP demands to be met.	10
Lake Foster	CHPP	Consistent Daily CHPP demand.	2.12
Tailings Dam	Lake Foster	Transfer occurs while water is available until Lake Foster is 90% full.	10
Stockpile Dam	Lake Foster	Transfer occurs if volume of stockpile dam is greater than 5ML.	7

[3] Email communication dated 3/12/2018

2.6.8 Project water storage data

Storage data is not available for any of the water storages on the site. Therefore estimation of daily evaporative losses and direct rainfall inflows were based on fixed water surface area estimations provided by Bloomfield for Lake Kennerson, Lake Foster and the Stockpile Dam. These storages were noted by Bloomfield to have relatively consistent water surface areas.

For the TSF and both open cut pits it was observed through historic aerial imagery that their water surface areas are subject to significant variability. In order to assess model sensitivity to the potential impact of water surface area variability on potential evaporative losses and direct rainfall inflows storage curves and storage-area curve were developed assuming trapezoidal prism storage. The curves were developed based upon the following assumptions:

- base area of 0.5 ha
- constant batter slopes.

The batter slopes were estimated based upon aligning the volume at FSL to the surface area at FSL, both of which are values which were provided by Bloomfield.

Sensitivity analysis indicated that the model was not particularly sensitive to variations in the stage-storage and storage-area curves however the derived curves were retained in the model.

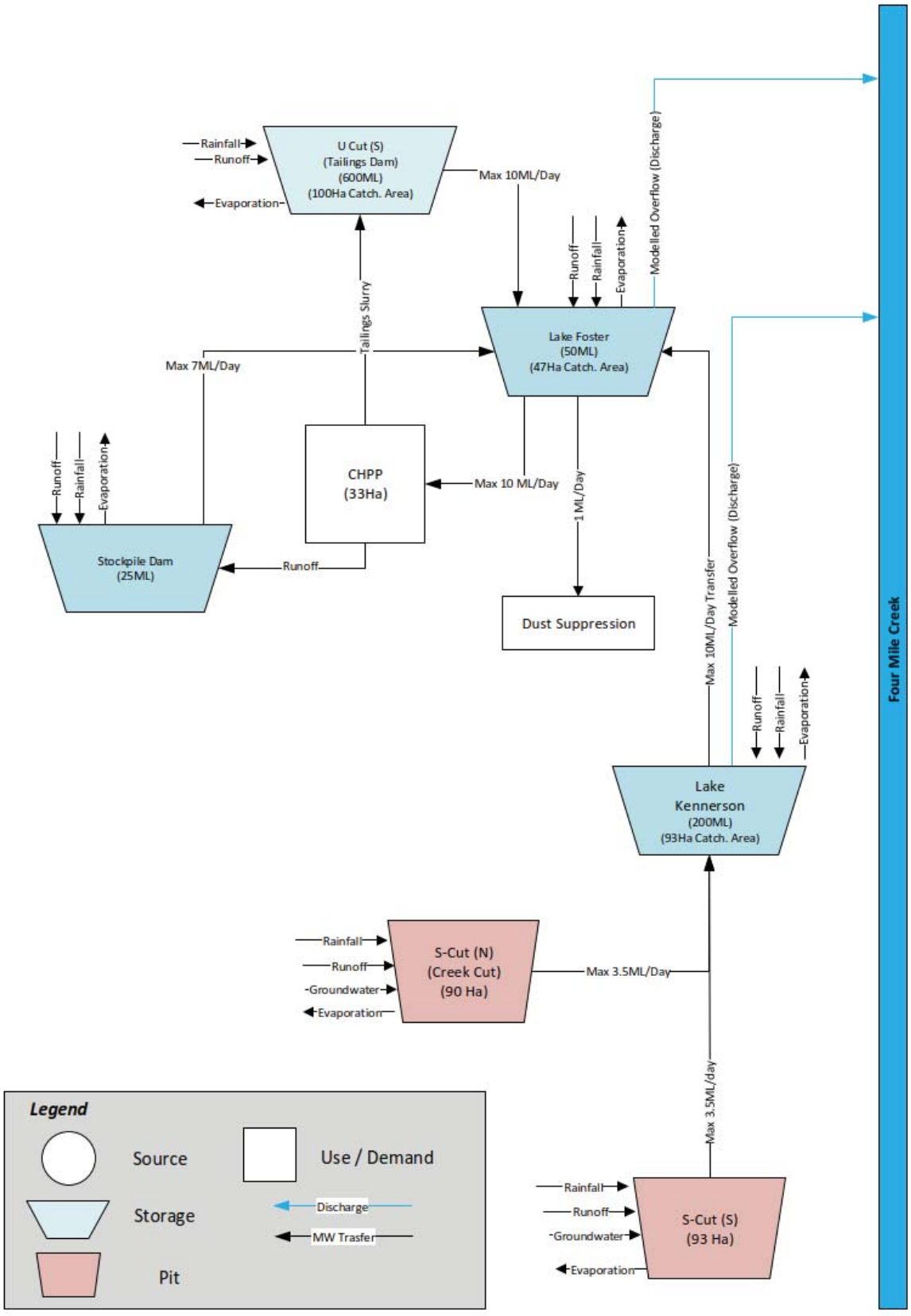


Figure 5 Site water management process flow diagram

3.0 Modelling results

3.1 Overview

Results from the water balance modelling indicate that the Bloomfield site has an overall positive (surplus) water balance. Generation of mine affected water within the mine WMS provides sufficient supply of water to meet all demands for which reuse of MAW is suitable, without reliance on an external source of raw water. Modelling also indicates that surplus water will need to be released from the site in accordance with conditions outlined in the site EPL.

3.2 Model overflow volumes

Insufficient data is available to calibrate the water balance model, however a high level validation of the model was completed by comparing estimated model discharges (which were modelled as an uncontrolled overflow of water from both Lake Foster and Lake Kennerson) with discharge volumes previously reported by Bloomfield (The Bloomfield Group, 2012-2017) for the period of 2012 and 2017.

Table 10 provides summary statistics on both the recorded discharges and the estimated discharges for the 2012 through to 2017. It is noted that there is a degree of uncertainty regarding a number of elements within this comparison such as:

- representation of CHPP operation within the WMS unquantifiable transfers between Abel site and Bloomsfield Site
- Assumed storage data (volume –level-surface area)
- Lack of recorded data within which to calibrate AWBM runoff parameters.

Table 10 Estimated modelled overflow statistics

Statistic	Recorded Discharges (ML/yr)	Available Discharge Capacity (ML/yr)**	Estimated Discharge* (ML/yr)	Difference (%)
Mean	1390	2320	1051	24%
Median	1513	2360	1017	33%
10th Percentile	920	2100	564	39%
90th Percentile	1736	2320	1703	2%

*Modelled as uncontrolled overflow from Lake Kennerson and Lake Foster

**Available discharge capacities have been provided by the Bloomfield Group. The data represents the total volume that could have been released throughout the year, based upon meeting the trigger conditions and relevant conditions of EPL396.

As shown above in Table 10, the data provided by the Bloomfield Group indicate that there is typically more than enough available discharge capacity within a yearly period to enable sufficient releases from the Bloomfield water storages. This is supported by an assessment of a number of realisations within the water balance model. The analysis of the various realisations indicate that under EPL396 there are typically enough trigger events to allow the entire external discharge volume shown in Table 10 to be released. It is noted that from the WBM results, there were realisations where the daily rainfall depths were not significant enough to trigger controlled discharges, however it is understood that there isn't representation of the Abel storages within the WBM, and as such there is potential to store additional volumes of water when EPL396 cannot be met.

3.3 Mine water balance summary

Summary water balance fluxes for the WBM are presented in Table 11 and Table 12. All dams within the WBM as well as the entire model have been subjected to water and mass balance checks to confirm model continuity and mass balance.

Referring to Table 11 for Life of Mine results and Table 12 for annual results:

- Runoff represents the largest single input to the mine WMS, with a median value of 13,840 ML over the LOM (Table 11) or 2,306 ML/yr (Table 12).
- Runoff input is highly variable with the 10th and 90th percentile total annual runoff volumes ranging from 1,429 ML/yr. to 3,591 ML/yr. respectively, and
- Estimated median discharges to the receiving environment are 1,015ML/yr.

Table 11 Mine water balance summary for the life of mine

	Life of Mine (7 Years)				
	Units	Mean	Median	10th	90th
WMS Inputs					
Direct rainfall	ML	852	823	706	1,042
Total runoff	ML	14,336	13,840	8,576	21,549
Total groundwater inflow	ML	2,682	2,682	2,682	2,682
Total water input	**ML**	17,870	17,345	11,963	25,272
					WMS Outputs
Total storage loss	ML	3,076	2,995	2,441	3,743
Dust Suppression	ML	2,120	2,141	2,030	2,158
Total water demand	ML	3,211	3,253	3,059	3,253
External discharge	ML	6,309	6,093	3,378	10,214
Total water output	**ML**	**14,716**	**14,482**	**10,908**	**19,368**

Table 12 Mine water balance summary on annual basis over the life of mine

	Annual				
	Units	Mean	Median	10th	90th
WMS Inputs					
Direct rainfall	ML/yr	142	137	118	174
Total runoff	ML/yr	2,389	2,306	1,429	3,591
Total groundwater inflow	ML/yr	447	447	447	447
Total water input	**ML/yr**	**2,978**	**2,890**	**1,993**	**4,211**
WMS Outputs					
Total storage loss	ML/yr	513	499	407	624
Dust suppression	ML/yr	353	357	338	360
Consumptive losses CHPP	ML/yr	535	542	510	542
External discharge	ML/yr	1,051	1,015	563	1,702
Total water output	**ML/yr**	**2,452**	**2,413**	**1,818**	**3,228**

The difference in input and output is due to an increase in storage.

4.0 Reporting procedures

4.1 Annual reporting

The following information relating to water management will be included in the Annual Environmental Management Report in accordance with Schedule 5, Condition 3 of the Project Approval:

a. describe the works that were carried out in the past year, and the works that are proposed to be carried out over the next year

b. include a comprehensive review of the monitoring results and complaints records of the mine complex over the past year, which includes a comparison of these results against:

- the relevant statutory requirements, limits or performance measures/criteria
- the monitoring results of previous years
- the relevant predictions in the documents listed in condition 2 of Schedule 2

c. identify any non-compliance over the last year, and describe what actions were (or are being) taken to ensure compliance

d. identify any trends in the monitoring data over the life of the project

e. identify any discrepancies between the predicted and actual impacts of the project, and analyse the potential cause of any significant discrepancies

f. describe what measure will be implemented over the next year to improve the environmental performance of the project.

4.2 Incident reporting

Incident reporting will be undertaken in accordance with Condition 6 of Schedule 5 for the Project. Any incidents will be notified to the secretary and any other relevant agencies of any incident associated with Project as soon as practical after the incident is identified. A detailed report of the incident will be provided to the relevant departments within 7 days of identifying the incident.

5.0 References

AECOM. (2018). *Bloomfield Colliery - Life of Mine Extension. Surface Water Assessment.*

Aquaterra. (2010). *Bloomfield Colliery Groundwater Management Plan.*

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Boughton, W. C. (1993). A Hydrograph-Based Model for Estimating the Water Yield of Ungauged Catchments. *Proceedings of the 1993 Hydrology and Water Resources Symposium, Institution of Engineers, Australia, National Conference Publication 93/14*, (pp. 317-324).

Business Environmet Pty Ltd. (2008). *Bloomfield Colliery Completion of Mining and Rehabilitation: Part 3A Environmental Assessment Project Application 07_0087.*

Evans and Peck. (2008). *Completion of Mining and Rehabilitation Project. Surface Water Assessment.*

Evans and Peck. (2010). *Completion of Mining and Rehabilitation Project. Water Management Plan - Site Water Balance,.*

HydroSimulations. (2017). *Bloomfield Colliery Extension Groundwater Modelling Assessment.*

The Bloomfield Group. (2012-2017). *Annual Environmental Management Review Reports.*

Appendix C

Erosion and sediment control plan

Appendix C Erosion and sediment control plan

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Bloomfield
5 August 2021
Doc No. Appendix C

Bloomfield Mining Operations Water Management Plan

Erosion and Sediment Control

Bloomfield Mining Operations Water Management Plan

Erosion and Sediment Control Plan

Client: Bloomfield

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Quality Information

Document Bloomfield Mining Operations Water Management Plan

Ref 60289290 – Appendix C

Date 10-Aug-2020

Previously Prepared by Kelly Mulhearn

Previously Reviewed by Amanda Kerr

Revision History

Rev	Revision Date	Details	Authorised	
			Name/Position	Signature
A	14-Mar-2019	Draft for Client Comments	Simon Murphy	
B	29-Mar-2019	DPE Review	Simon Murphy Project Manager	
C	05-Apr-2019	DPE Review	Simon Murphy Project Manager	
D	10-Aug-2020	Revised following DPIE Review	Gabriel Wardenburg Project Manager	
E	05 August 2021	Updated to include the "Bloomfield Site" under Abel Approval PA 05_0136	Chris Knight Group Environment Manager	

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Abbreviations

AEP	annual exceedance probability
CHPP	Coal Handling Preparation Plant
EPL	environment protection licence
ESCP	erosion sediment control plan
OCE	open cut examiner

1.0 Introduction

1.1 Background

Bloomfield Colliery is an open cut coal mining operation located approximately 20 km north west of Newcastle in NSW. The mine has been in operation for approximately (~180 years), utilising both open cut and underground extraction methods. This report has been prepared on behalf of Bloomfield Colliery for inclusion in the water management for the site. The purpose of this erosion and sediment control plan (ESCP) is to ensure the project area, as shown in **Error! Reference source not found.**, has adequate erosion and sediment control measures in place to comply with the requirements of the Project Approval (07_0087) and commitments made in the Environmental Assessment for the Part 3A application for continuing operations.

This ESCP also includes the area known as the "Bloomfield Site" as defined in the Abel Coal Project Approval MP 05_0136 which includes the Bloomfield Coal Handling and Preparation Plant, the Bloomfield Rail Loading Facility, Rail Loop and Rail Spur, and the Bloomfield Colliery open-cut pits which are used to emplace coal reject and tailings from the Abel Coal Project.

This plan is an updated version of the GSS Bloomfield Collieries Ltd ESCP (GSS Environmental, 2013).

The objective of the ESCP is to ensure that the discharge of all water from the site is managed and that it meets appropriate quality standards. The ESCP covers the area included in the Approval Area and "Bloomfield Site" as shown in **Error! Reference source not found.**.

1.1.1 Conditions of Approval

Condition 21 of Schedule 3 specifies the requirements for the preparation of the erosion and sediment control which are reproduced as follows:

The erosion and sediment control plan must:

a. be consistent with the requirements of Managing Urban Stormwater: Soils and Construction (Volume 2E – Mines and Quarries) manual (DECC 2008), or its latest version

b. identify activities that could cause soil erosion and generate sediment

c. describe measures to minimise soil erosion and the potential for transport of sediment downstream

d. describe the location, function and capacity of erosion and sediment control structures, and

e. describe what measures would be implemented to maintain the structures over time.

1.2 Erosion and sediment management principles

To minimise the potential for the generation of sediment the following key principles are applied to the site:

- coordination of mining to minimise exposure of disturbed soils
- separation/diversion of 'clean' water catchments from disturbed areas to minimise sediment-laden and mine water volumes for management
- collection and management of runoff sediment control devices
- appropriate storage and handling of topsoil materials
- revegetation of disturbed areas following site disturbance
- effective maintenance program for the site.

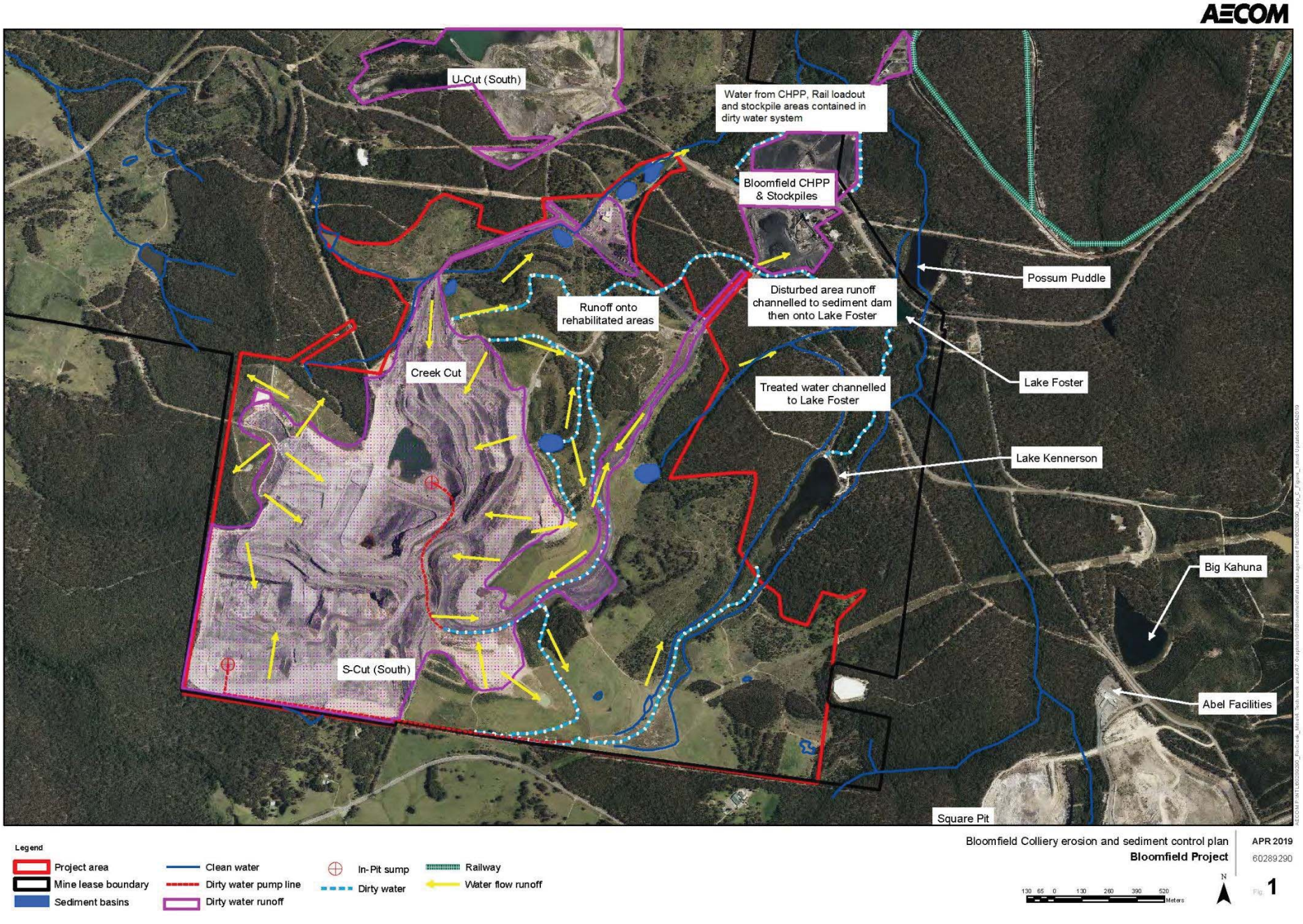
AECOM
U-Cut (South)
Water from CHPP, Rail loadout and stockpile areas contained in dirty water system
Bloomfield CHPP & Stockpiles
Possum Puddle
Disturbed area runoff channelled to sediment dam then onto Lake Foster
Runoff onto rehabilitated areas
Creek Cut
Lake Foster
Treated water channelled to Lake Foster
Lake Kennerson
Big Kahuna
S-Cut (South)
Abel Facilities
Square Pit
Legend
Project area
Mine lease boundary
Sediment basins
Clean water
Dirty water pump line
Dirty water runoff
In-Pit sump
Dirty water
Railway
Water flow runoff
Bloomfield Colliery erosion and sediment control plan
Bloomfield Project
APR 2019
60289290
130 65 0 130 260 390 520
Meters
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Fig. 1

1.3 Runoff water definitions

The following definitions have been adopted in this ESCP:

- Clean water – runoff water from undisturbed, long term regrowth (>5 years) or successfully established rehabilitation catchments.
- Dirty water. – runoff water from all exposed surfaces including hardstand areas, workshop, active pit and haul road areas. Note there is no distinction made between sediment laden water and mine water. All dirty water is combined and treated together for the project area in either Lake Kennerson or Lake Foster which are licensed discharged points. The exception to this definition is within the workshop area where potentially contaminated water is treated through the workshop underground sump, and sediment laden runoff water is treated in the sediment dam then flows into the adjacent creek.

1.4 Sources of erosion and sedimentation

The activities associated with the workshop area and active mining areas have been identified as having the greatest potential for erosion and sediment generation on the site.

The following activities are identified as having potential to cause soil erosion and generate sediment unless controlled:

- workshop area
- general mining operations, including blasting and haulage
- stripping of vegetation and topsoil
- cut and fill earthwork operations for road maintenance
- runoff from mine haul roads.

.

2.0 Erosion and sediment control

The regular inspection and maintenance of permanent and temporary structures ensures that the water management system and erosion controls remain effective. The following sections outline the erosion and sediment control structures and principles that are currently operating effectively and only require monitoring and maintenance, and structures that are recommended to be implemented ahead of mining to ensure adequate protection to downstream environments.

2.1 Minimising disturbance

Land disturbance will be minimised by clearing the smallest practical area of land ahead of mining, as well as ensuring the land is disturbed for the shortest possible and practical time. This will be achieved by:

- limiting the cleared width to that required to accommodate the proposed mining operations
- staging the clearing activities where ever possible so that only the areas which are actively being mined are cleared, therefore, limiting the time the areas are exposed
- conserve topsoil for later site rehabilitation or regeneration (in a stabilised stockpile)
- control water flow from the top of and through the project area by diverting up-slope 'clean' water away from disturbed areas and ensuring that concentrated flows are below erosive levels and sediment is retained from disturbed areas
- revegetating and stabilising reshaped overburden dumps as soon as practicable following mining.

General vegetation clearing and soil stripping will not be undertaken until earthwork operations are ready to commence. All proposed erosion and sediment control measures will be implemented in advance of, or in conjunction with, clearing activities. Prior to clearing commencing, the limits of clearing will be marked by pegs placed at intervals on each side of the disturbed area. All operations will be planned to ensure that there is no damage to any trees and pasture areas outside the limits to be cleared.

2.2 Clean water diversion

In order to minimise the volume of dirty water to be treated downstream in Lake Kennerson or Lake Foster, all runoff from clean water catchments shall be diverted into clean water drainage lines and off site into the natural creek system.

Suitably designed and constructed diversion drains will be implemented where practical in the project area in accordance with 'Managing Urban Stormwater Volume 1 (2004)' and 'Managing Urban Stormwater: Soils & Construction – Volume 2E Mines & Quarries (2008)' standards relating to channel design.

These clean water catchments are located on the western side of the active mining area and comprise of existing vegetation and regrowth.

The part of the workshop area which captures sediment laden water is treated via a series of sediment dams and then enters the natural creek system which flows into four mile creek.

2.3 Topsoil Stockpiles

Prior to any excavation or earthworks, the topsoil and associated vegetation will be placed immediately onto the reshaped overburden dumps for rehabilitation. Given the nature of mining operations, this is not always practical and in these cases once the topsoil is stripped it should be stockpiled (in a stabilised stockpile) for later use in rehabilitation.

The topsoil stockpiles will be placed away from roadways and other drainage lines and protected by constructing either sediment fencing around the perimeter or other suitable drainage structures. In the event of long term stockpiling (i.e. greater than 3 months), the stockpile will be sewn immediately with a cover crop of pasture/grasses, which will protect the soil from raindrop impact and rill erosion.

The following cover crop specification is recommended:

- September –March sowing - Japanese Millet @ 50 kg/ha
- April – August sowing - Oats/Ryecorn @ 50 kg/ha and Tetila Rye @ 5 kg/ha.

2.4 Long term erosion and sediment control structures

Lake Kennerson and Lake Foster are the two main dams to manage the dirty water (mine water and sediment laden water) from the active pits and haul road. Dirty water is transferred via pipes and drainage lines into these two dams. Lake Kennerson stores mine water for discharge subject to conditions under Environment Protection Licence (EPL No. 396). The stokpile dam is the main dam for the capture and control of dirty water from the CHPP, coal stockpiles and rail loadout areas. Water from this dam is pumped to Lake Foster where it can be reused in the CHPP or for dust suppression in the mining operations.

2.4.1 Sediment Dams

There are several existing sediment dams currently filtering sediment laden runoff water from disturbed areas of the mining operation as shown on the ESCP **Error! Reference source not found.**. The sediment dams are designed to capture storm event runoff water, holding the water to allow the sediments to drop out of suspension and then release the clean water via infiltration and evaporation. The ESCP reflects the requirements for current mining activities and will be revised and updated periodically to reflect the requirements during the next stages of mining and rehabilitation.

Sediment dams vary in desirable location, dam shape and size and will be designed and constructed with regard to the contributing catchment area, erosivity of the soil, storm intensities and average recurrence intervals. In sizing sediment basins on site, the recommended minimum design criteria for temporary erosion and sediment control measures outlined in Table 6.1 from Managing Urban Stormwater Soils and Construction Vol 2 Mines and Quarries will be followed. It is expected that the criteria will include >3 years standard receiving environment 5 day duration 90th percentile events. Sediment dams will be constructed, where practical, in accordance with the sediment dam standard drawings (SD6-4) of the ‘Blue Book’ which is contained in Appendix A.

Sediment dams require regular monitoring and maintenance to ensure adequate capacity and effective operation. Dams will be inspected quarterly for sediment build up and prior to the capacity being reduced to threshold levels, which render the dam ineffective, an excavator is required to de silt the dam. It is noted that some sediment dams on site are well vegetated and stable, however maintenance and de- silting is required to ensure adequate capacity is maintained, despite the potential disturbance of existing vegetation within the dam.

2.4.2 Haul road drainage

Haul roads across the site are regularly graded to ensure runoff water is safely transported to designated drainage lines without severe erosion or sediment build-up along mine traffic areas. The current practice on site is to channel roadside water along the length of road to a suitable entry into a dirty water drainage line. In-pit roads convey flows to in-pit sumps in the mine void, which are then pumped to dirty water drainage lines to be conveyed to the main sediment dams of Lake Kennerson and/or Lake Foster beyond the Project Area.

It was noted that on the coal handling preparation plant (CHPP) haul road the roadside drainage butted up against the toe of the rehabilitated batter. It is recommended to build up the toe of the rehabilitated batter to act as armouring against the erosive fast flowing runoff water during intense storm events. Shallow V drains along haul roads are adequate drainage for this site, providing suitable entry points into the designated drainage channels are constructed and maintained.

Inspections of the haul roads will be undertaken weekly or following heavy rainfall events to ensure the roads have not been subjected to severe rill or gully erosion, as well as to monitor the stability of the batter toe along the main CHPP haul road.

2.4.3 Workshop drainage

The majority of the disturbed area surrounding the workshop is designed to flow to a sump, which drains to underground workings. A small area to the north, including a bitumen sealed car park, drains to a series of sediment basins prior to entering a small drainage line then into Four Mile Creek.

2.5 Short term erosion and sediment control structures

2.5.1 Sediment fences

There may, on occasion, be a disturbance area which is either not protected by existing structures or requires additional temporary protection against erosion and sedimentation. In these cases it may be suitable to install sediment fencing.

Sediment fences filter run-off leaving the site, trapping sediment and allowing filtered water to pass. Sediment fences will be constructed around the base of any areas of exposed land that are not subject to concentrated overland flow and that are not adequately protected by existing structures. Sediment fencing will be installed around the extent of the disturbance area where sediment-laden water could potentially enter clean downstream receiving waters.

Sediment fences are normally placed on the contour or slightly convex to the contour. The contour on each end of the fence will be turned to create a stilling pond up slope of the fence. Where possible, a sediment fence system will consist of a series of overlapping fences. Each fence will be NO longer than about 40 metres. They will be designed to withstand the erosive forces from the design storm event, usually the 10 per cent annual exceedance probability (AEP), and will not intercept large concentrated or channelised flows. The sediment fences will be constructed in accordance with the sediment fence standard drawing (SD6-8) of the 'Blue Book' which is contained in Appendix A. Because these systems are prone to failure in relatively small events, subcatchments will be sufficiently small to constrain maximum flows to 50 litres per second in the design storm event.

Sediment fences require regular inspection and maintenance. Trapped sediments will be removed, pickets straightened, filter cloth re-secured and tightened.

2.5.2 Temporary check dams

Check dams are typically used in channels conveying concentrated flows to control flow velocity and minor gully erosion. They can be constructed form semipervious or impervious materials such as medium-size rock or sand and/or gravel filled bags.

Check dams will be installed within existing swale drains or drainage channels, which are not able to be regularly graded. The use of these devices will be limited to temporary erosion and sediment control in channels during construction or high disturbance phases mining

Check dams will be spaced so the toe of the upstream dam is level with the spillway of the next downstream dam. As with sediment fences, check dams will be installed prior to any works commencing on the site in existing channels and immediately after the construction of new channels. The check dams will be constructed in accordance with the rock check dam drawing (SD 5-4) of the "Blue Book' which is contained in Appendix A. Inspect the check dams after rain and remove the sediment as required. Damaged/shifted check dams will be repaired or replaced.

3.0 Revegetation

The following section outlines the general principles for revegetation of newly constructed erosion and sediment control structures and drainage lines as well as maintenance of existing structures.

3.1 General

The most effective way of controlling erosion is to establish and/or maintain a healthy vegetation cover. Vegetation provides effective surface protection against raindrop impact, binds the underlying soil to resist detachment by surface flows, and improves and maintains the soil's infiltration capacity thereby decreasing the velocity and volume of runoff. Vegetation can also improve the aesthetic appearance of an area, and the operational efficiency and longevity of structural sediment and erosion control measures employed.

3.2 Drainage line and slopes

3.2.1 Purpose on site

The technique proposed for vegetative stabilisation of all disturbed areas outside those to be sealed or lined with crushed rock is through the use of pastures and grasses. Some sections of reshaped overburden dumps also include the establishment of trees via direct tree seeding or tube stock planting.

3.2.2 Construction notes

- All rehabilitation slopes will be ripped and top dressed prior to the establishment of pasture seeds. Contour ripping generally provides the best surface for water capture and infiltration, therefore minimizing the volume of runoff water.
- In drainage channels, scarifying the top dressed surface provides a suitable environment for pasture seeds to germinate and establish.
- The larger high flow drainage lines may require rock scour protection in areas prone to high velocity flow rates and undercutting.

3.2.3 Maintenance

Rehabilitated slopes will be fertilized and sprayed for weeds in the first few years of establishment, in order to provide the best possible chance for thick pasture cover.

The spread of weeds will be minimised by ensuring that topsoil stockpiles are weed free prior to re-spreading topsoil on batter areas and monitoring & controlling weed populations should they occur. Weed control, if required, will be undertaken in a manner that will minimize soil disturbance. The use of herbicides will be carried out in accordance with the regulatory requirements. It is anticipated that regular monitoring of weeds, combined with low base weed populations, will enable a simplified weed control program to be effective. If herbicides are required, selective application will be used in preference to broad area application.

4.0 General maintenance and monitoring

The Mine Manager will ensure that all sediment and erosion control works are located as instructed in this ESCP or in any subsequent site instruction or updated ESCP. The Mine Manager will need to ensure that regular general inspections of the site are undertaken to ensure that all the environmental controls outlined in this report and shown in the ESCP figure are functioning effectively, and the responsibilities assigned in **Section 5.0** below are met. These inspections will coincide with regular environmental inspections and monitoring undertaken on site. Monthly checks will target temporary measures and controls with permanent features inspected more formally on a quarterly basis as part of the regular environmental monitoring undertaken onsite. The Mine Manager will also ensure that operations staff and contractors are operating within the designated area protected by the environmental controls, and to inform them of their responsibilities in minimising the potential for soil erosion and pollution to downstream receiving waters.

Site drainage and sediment control structures will be inspected regularly and after runoff events (>15 mm of rain) during the clearing phase to check for scouring of drains and accumulation of materials in sediment devices (e.g. dams, sediment filter fences & sand bags). Inspection areas will include the following:

- workshop area
- haul roads
- drainage lines
- pipe outlets
- rehabilitated areas.

Any signs of erosion along the length of the drains will be noted and remedial works undertaken as required. Where either high potential for erosion is probable (such as on steep slopes) or active erosion is observed, additional erosion controls will be constructed, such as but not limited to:

- establishment of vegetation cover
- armouring of the channel surface and construction of rock scour protection at the entry and discharge locations.

Regular visual checks will be made of any temporary sediment controls to ensure that they are functioning adequately and repaired where required.

5.0 ESCP responsibilities summary

The following section outlines details of the proposed erosion and sediment controls that have been discussed in this ESCP and the responsibilities associated with construction, monitoring and maintenance. The details of the surface water monitoring program are contained in the Surface Water Management Plan and are therefore not dealt with in the below table.

Table 1 ESCP responsibilities summary

Aspect	Management/Monitoring Strategy	Frequency	Responsibility
CHPP haul road drainage	Inspect status of erosion along the side of haul road to ensure the toe of the rehabilitated batter is stable and not undercutting. Grader maintenance of the haul road will be undertaken as required.	Weekly and following high intensity storm events.	Open Cut Examiner (OCE)
Sediment dams (as marked on ESCP Figure 1)	Inspect sediment build-up and integrity of structures. De-silt dams as required.	Quarterly	Environmental Officer
Constructed drainage lines (as marked on ESCP Figure 1)	Inspect drainage lines to ensure stable, not actively eroding and has adequate capacity. Clean out or repair as required.	Quarterly	Environmental Officer
Natural drainage lines in Southwest corner of the mine boundary	Inspect drainage lines for sedimentation from upstream catchment.	Quarterly	Environmental Officer
Pipe outflow from pit sumps	Inspect pipe outflow sites for erosion and scouring. Implement protection as required.	Monthly and following relocation	OCE
Rehabilitation areas and drainage lines on rehabilitated slopes	Inspect rehabilitation and drainage lines for adequate surface protection, ensuring sediment accumulation in drainage lines is not adversely affecting drain capacity.	Within 12 months of establishment and then every 2 years	Environmental Officer
Proposed clearing activities ahead of mining	Inspect sites to be cleared ahead of mining, ensuring adequate sediment controls are established prior to surface disturbance.	Prior to clearing activities	Environmental Officer
Temporary sediment controls (silt fence, sandbag weirs etc)	Inspect sediment control structures for sediment build up and clean out as required to maintain adequate capacity.	Monthly and following high intensity storm events	Environmental Officer
Review of this ESCP	Undertake review and update of this ESCP to ensure all aspects associated with the site are captured.	Following any modification of the conditions of the approval or significant changes to the mine plan	Environmental Officer
Reporting of ESCP findings and inspections	Results of ESCP inspections, maintenance activities and construction of erosion and sediment control structures are to be reported to mine management.	Monthly	Environmental Officer

6.0 References

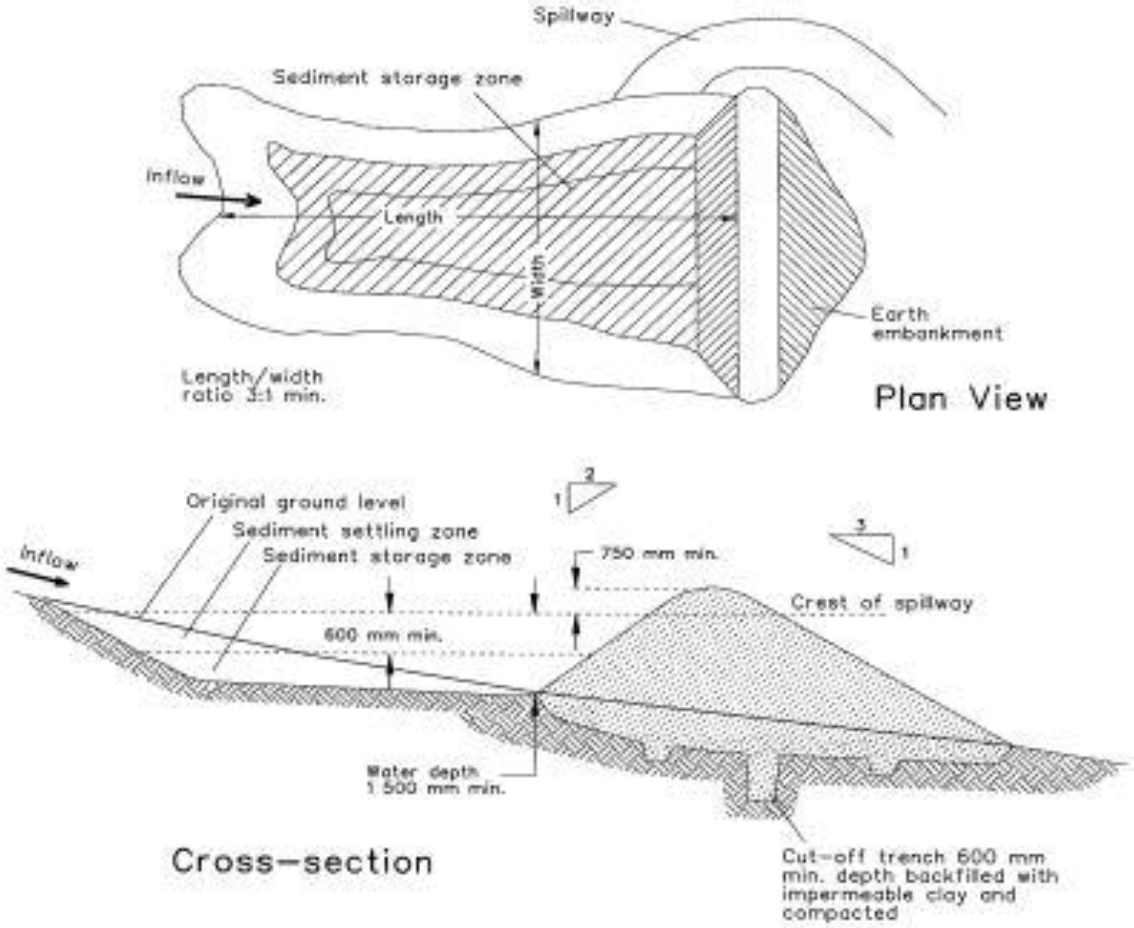
Department of Environment and Climate Change (2008), *Managing Urban Stormwater: Soils & Construction – Volume 2E Mines & Quarries*.
Landcom (2004), *Managing Urban Stormwater Soils and Construction Volume 1*, 4th Edition.

GSS Bloomfield Collieries Ltd ESCP (GSS Environmental, 2013).

Appendix A

Standard drawings

Appendix A Standard drawings

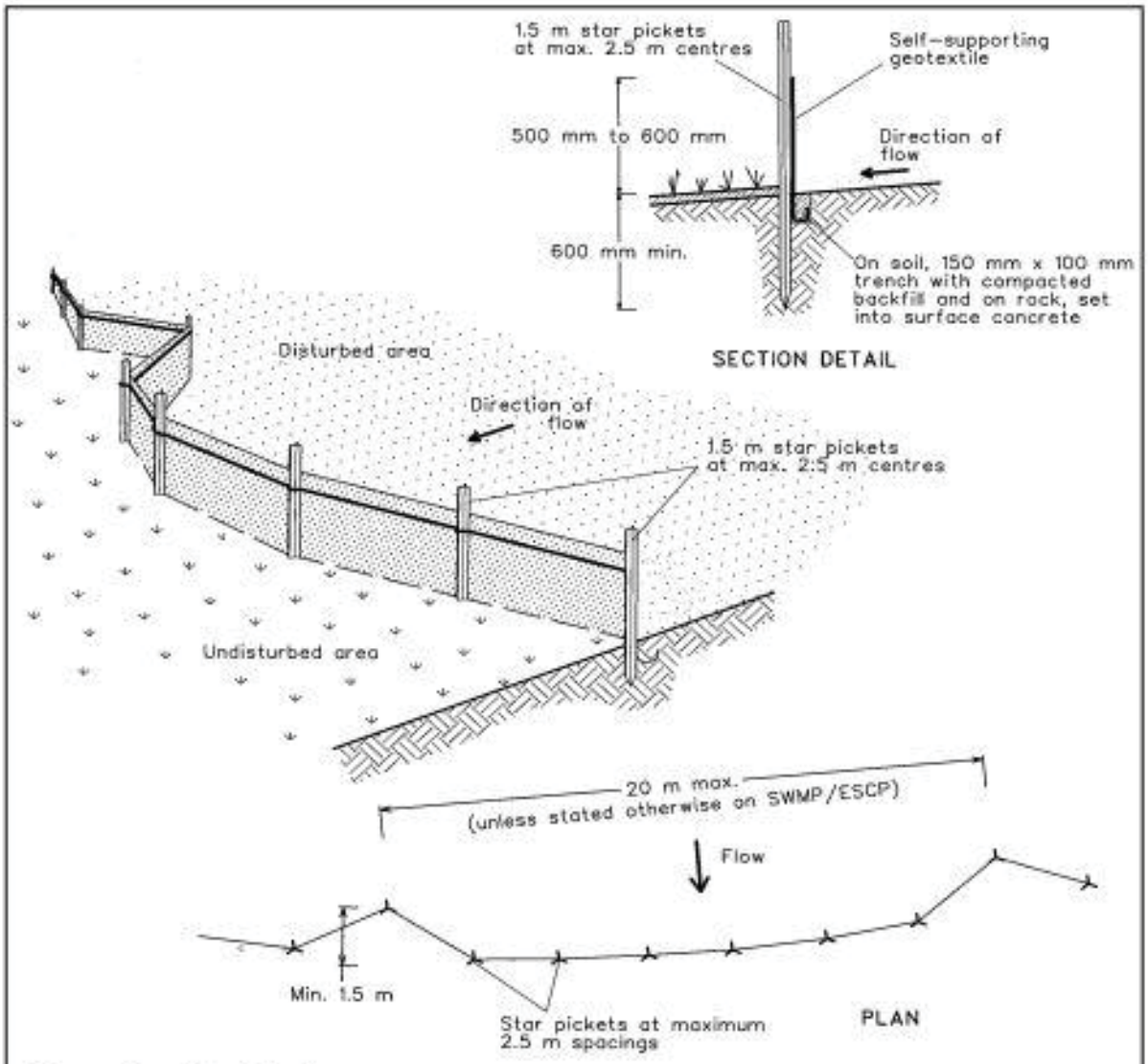


Construction Notes

1. Remove all vegetation and topsoil from under the dam wall and from within the storage area.
2. Construct a cut-off trench 500 mm deep and 1,200 mm wide along the centreline of the embankment extending to a point on the gully wall level with the riser crest.
3. Maintain the trench free of water and recompact the materials with equipment as specified in the SWMP to 95 per cent Standard Proctor Density.
4. Select fill following the SWMP that is free of roots, wood, rock, large stone or foreign material.
5. Prepare the site under the embankment by ripping to at least 100 mm to help bond compacted fill to the existing substrate.
6. Spread the fill in 100 mm to 150 mm layers and compact it at optimum moisture content following the SWMP.
7. Construct the emergency spillway.
8. Rehabilitate the structure following the SWMP.

EARTH BASIN - WET
(APPLIES TO 'TYPE D' AND 'TYPE F' SOILS ONLY)

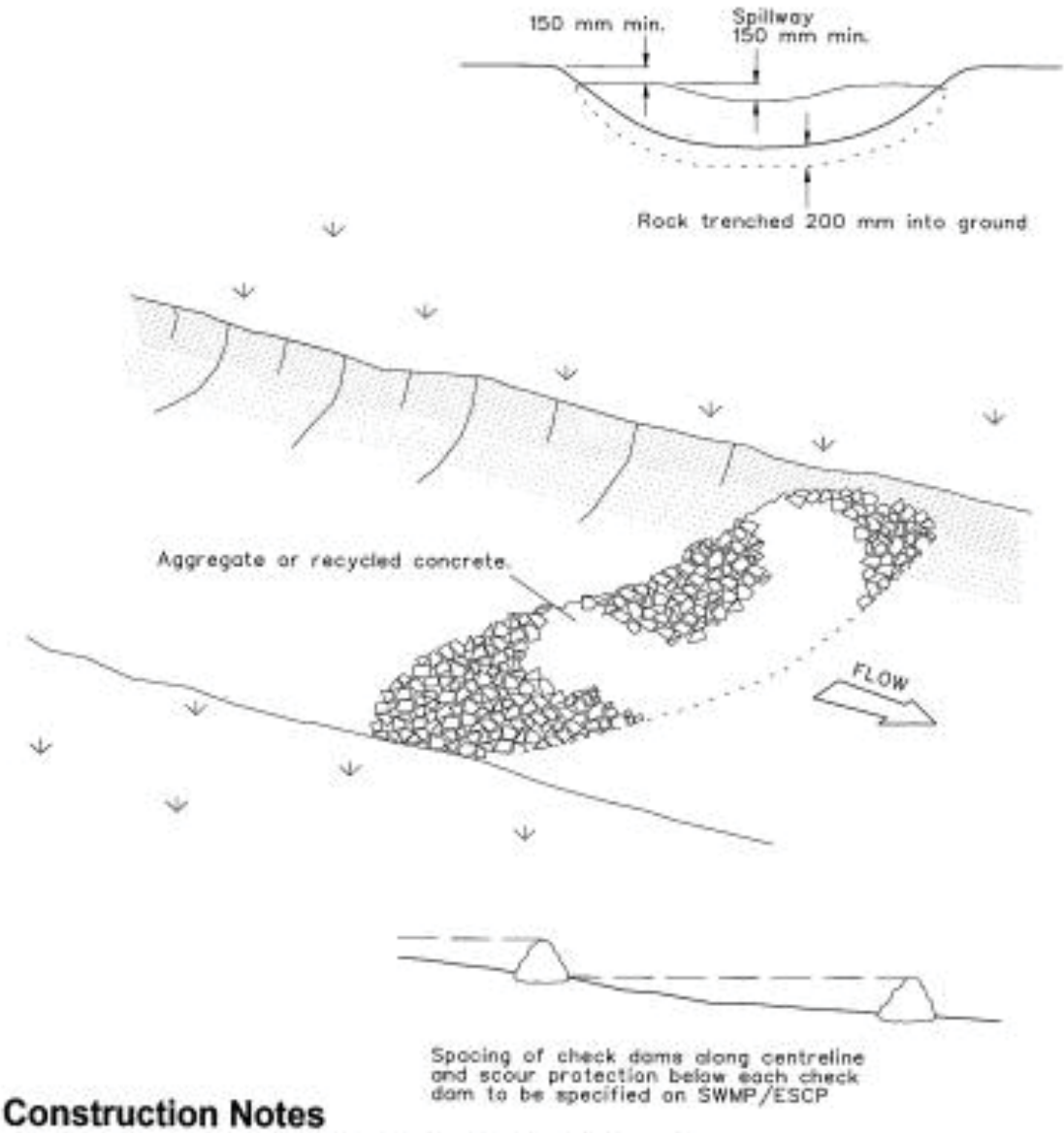
SD 6-4



Construction Notes

1. Construct sediment fences as close as possible to being parallel to the contours of the site, but with small returns as shown in the drawing to limit the catchment area of any one section. The catchment area should be small enough to limit water flow if concentrated at one point to 50 litres per second in the design storm event, usually the 10-year event.
2. Cut a 150-mm deep trench along the upslope line of the fence for the bottom of the fabric to be entrenched.
3. Drive 1.5 metre long star pickets into ground at 2.5 metre intervals (max) at the downslope edge of the trench. Ensure any star pickets are fitted with safety caps.
4. Fix self-supporting geotextile to the upslope side of the posts ensuring it goes to the base of the trench. Fix the geotextile with wire ties or as recommended by the manufacturer. Only use geotextile specifically produced for sediment fencing. The use of shade cloth for this purpose is not satisfactory.
5. Join sections of fabric at a support post with a 150-mm overlap.
6. Backfill the trench over the base of the fabric and compact it thoroughly over the geotextile.

SEDIMENT FENCE **SD 6-8**



Construction Notes

1. Check dams can be built with various materials, including rocks, logs, sandbags and straw bales. The maintenance program should ensure their integrity is retained, especially where constructed with straw bales. In the case of bales, this might require their replacement each two to four months.
2. Trench the check dam 200 mm into the ground across its whole width. Where rock is used, fill the trenches to at least 100 mm above the ground surface to reduce the risk of undercutting.
3. Normally, their maximum height should not exceed 600 mm above the gully floor. The centre should act as a spillway, being at least 150 mm lower than the outer edges.
4. Space the dams so the toe of the upstream dam is level with the spillway of the next downstream dam.

ROCK CHECK DAM

SD 5-4

Appendix D

Surface water report

Appendix D Surface water report

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The Bloomfield Group
05- August 2021
Doc No. Appendix D

Bloomfield Mining Operations Water Management Plan

Surface Water Monitoring Plan

Bloomfield Mining Operations Water Management Plan

Surface Water Monitoring Plan

Client: The Bloomfield Group

ABN: 76000106972

Prepared by

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05-Aug-2021

AECOM in Australia and New Zealand is certified to ISO9001, ISO14001 AS/NZS4801 and OHSAS18001.

Quality Information

Document	Bloomfield Mining Operations Water Management Plan
Ref	60289290 – Appendix D
Date	06-Aug-2020
Previously Prepared by	Kelly Mulhearn
Previoulsy Reviewed by	Amanda Kerr

Revision History

Rev	Revision Date	Details	Authorised	
			Name/Position	Signature
A	14-Mar-2019	Draft for Client Comment	Simon Murphy Project Manager	
B	29-Mar-2019	DPE Review	Simon Murphy Project Manager	
C	06-Aug-2020	Revised following DPIE Review	Gabriel Wardenburg Project Manager	
D	05 August 2021	Updated to include the "Bloomfield Site" under Abel Approval PA 05_0136	Chris Knight Group Environment Manager	

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Abbreviations

CHPP	Coal handling preparation plant
DO	dissolved oxygen
EC	electrical conductivity
TCM	total catchment management
TDS	total dissolved solids
TSS	total suspended solids
WM	water monitoring

1.0 Introduction

Bloomfield Colliery is an open cut coal mining operation located approximately 20 km north west of Newcastle in NSW. The mine has been in operation for approximately (~180 years) utilising both open cut and underground extraction methods. This report has been prepared on behalf of Bloomfield Colliery for inclusion in the Site Water Management for the site.

This Surface Water Monitoring Plan also includes the area known as the "Bloomfield Site" as defined in the Abel Coal Project Approval MP 05_0136 which includes the Bloomfield Coal Handling and Preparation Plant, the Bloomfield Rail Loading Facility, Rail Loop and Rail Spur, and the Bloomfield Colliery open-cut pits which are used to emplace coal reject and tailings from the Abel Coal Project.

This plan is an updated version of the Evans and Peck Surface Water Management (Monitoring and Response Plan (Evans and Peck 2010).

1.1 Objectives

This report addresses the monitoring and response requirements for surface waters within and adjacent to the area covered by the consent within the Bloomfield Mine lease area. This includes the following drainage systems:

- Buttai Creek
- Elwells Creek.

1.2 Conditions of consent

Condition of Consent No. 22 – specifies the requirements for the preparation of the surface water monitoring program which are reproduced as follows

The Surface Water Management and Monitoring Plan must include:

a. detailed baseline data on surface water flows and quality in creeks and other waterbodies that could be affected by the project

b. surface water and stream health impact assessment criteria

c. a program to monitor the impact of the project on surface water flows, quality and stream health

d. reporting procedures for the results of the monitoring program.

Condition of Consent 24 – Surface and Groundwater Response Plan

The Surface and Groundwater Response Plan must describe the measures and/or procedures that would be implemented to:

a. Investigate, notify and mitigate any exceedances of the surface water, stream health and ground water impact assessment criteria.

b. Compensate landowners of privately-owned land whose water supply is adversely affected by the project.

c. Mitigate and/or offset any adverse impacts on groundwater dependent ecosystems or riparian vegetation.

1.3 Surface water monitoring program

An integrated surface water monitoring program has been in operation for the Bloomfield, Abel and Donaldson Mines for several years. A number of monitoring sites associated with the integrated monitoring program are located in positions which provide historic water quality data for Elwells Creek and Buttai Creek. Error! Reference source not found. shows the locations of the relevant current water quality monitoring sites.

The monitoring locations, frequency and parameters to be tested as part of the monitoring program are outlined in **Table 1** and **Table 2**.

Table 1 Routine water quality monitoring sites and locations

Site	ID	Location
Four Mile Creek	WM10	John Renshaw Drive
	WM6	Upstream from Lake Foster
	WM7	Possums Puddle
	WM4	Possums Puddle Overflow
	WM3	Elwells Creek & Four Mile Creek Junction
	WM12	Shamrocks Creek & Four Mile Creek Junction
	WM11	New England Highway
Four Mile Creek tributary	WM2	Shamrock Creek
	WM5	Elwells Creek
Wallis Creek tributary	WM1	Adjacent old Rathluba Creek
	WM13	Buttai Creek
On-site water storage	WM8	Lake Foster
	WM9	Lake Kennerson

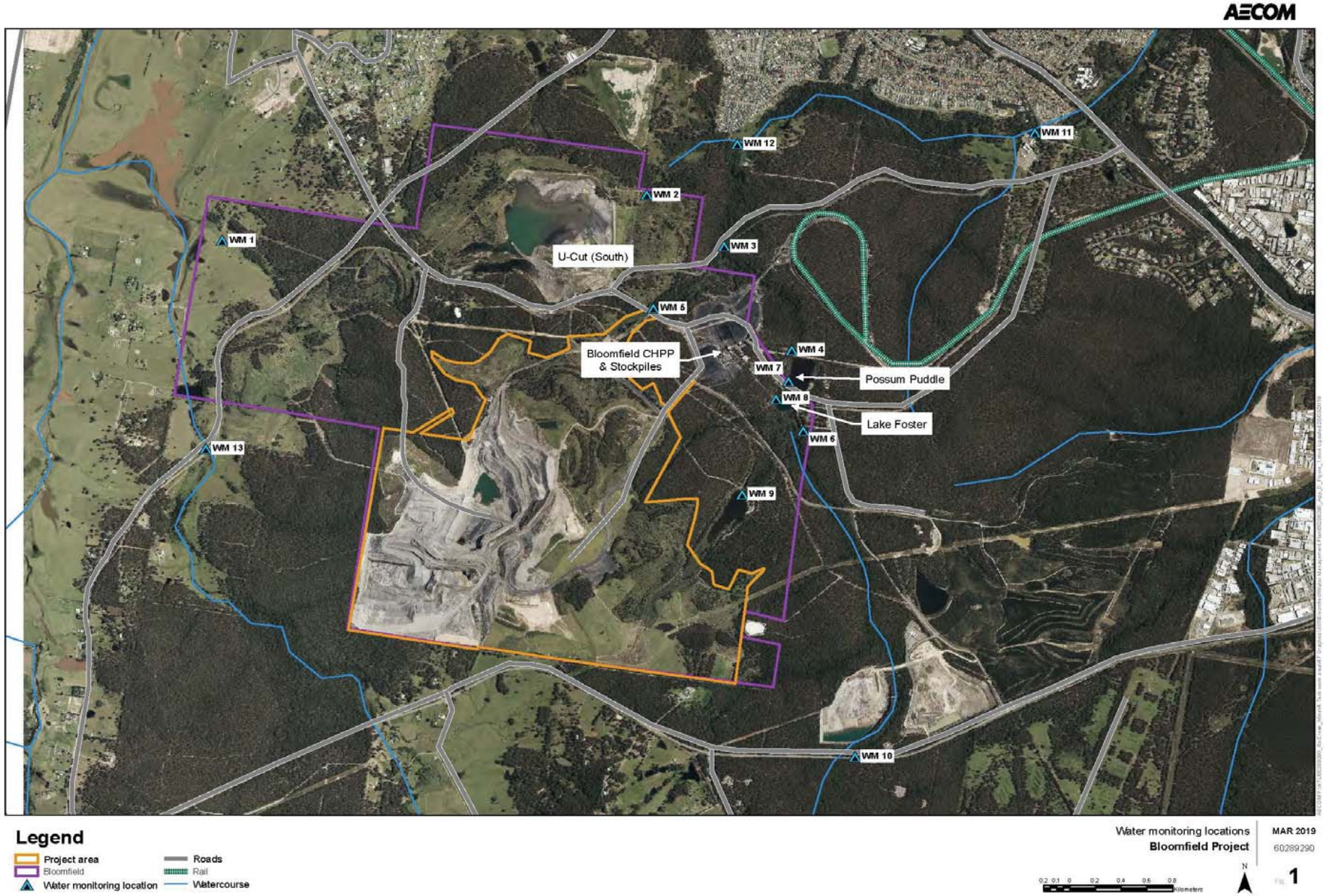
Water within the Project Area either drains to the mine pits (from where any excess is pumped to Lake Kennerson), or in the case of some sections of the haul road, to Lake Foster. Both these mine water storages form part of the integrated water management system for the mine and the Bloomfield coal handling and processing plant (CHPP). This integrated water management system was approved under the consent for the Abel Mine and expansion of the Bloomfield CHPP.

Table 2 Routine water quality monitoring frequency and parameters

Frequency	Parameters
Monthly field monitoring at all listed sites for the range of parameters listed	• Temperature • pH • Electrical conductivity (EC) • Turbidity • Oil and grease (visual observation) • Flow (visual observation)
Quarterly grab sample at all listed sites and laboratory analysis for the range of parameters listed	• Total suspended solids (TSS) • Total dissolved solids (TDS) • pH • EC • Dissolved oxygen
Six monthly grab sample at all listed sites and laboratory analysis for the range of parameters listed	• Chlorides • Sulfates • Alkalinity (Bicarb) Alkalinity (Carb) • Calcium • Magnesium • Sodium • Potassium

Aquatic ecology surveys of Four Mile Creek are undertaken every five years and aim to:

- assess the quality of aquatic ecology and riparian vegetation in sites up- and down-stream of the EPL discharge point;
- identify measurable differences in these attributes between up- and downs-stream pools and determine whether these differences are attributable to the EPL discharge point;
- assess whether the aquatic resources provide suitable and sustained aquatic habitat for fish and other aquatic biota and whether the streams continue to provide suitable fish passage; and
- identify protected or threatened aquatic species or communities residing within the study area.


AECOM
WM 12
WM 11
WM 2
WM 1
WM 3
U-Cut (South)
WM 5
Bloomfield CHPP
& Stockpiles
WM 4
WM 7
Possum Puddle
WM 8
Lake Foster
WM 6
WM 13
WM 9
WM 10
Legend
Project area
Bloomfield
Water monitoring location
Roads
Rail
Watercourse
Water monitoring locations
Bloomfield Project
MAR 2019
60289290
N
Fig 1

1.4 Baseline data

Water quality data collected by Bloomfield Colliery at Elwells Creek, adjacent to the Haul Road (WM5) between 1996 to 2020 and for Buttai Creek at Buchanan Road between 2010 and 2020 is summarised presented in the Table 3.

Table 3 Baseline data

Location													
Identification	WM10	WM6	WM7	WM4	WM3	WM12	WM11	WM2	WM5	WM1	WM13	WM8	WM9
pH													
Number of samples	340	393	389	405	392	294	477	170	261	159	113	486	410
Mean	7.0	7.0	7.3	7.6	7.3	7.4	7.3	6.2	6.5	4.4	7.4	8.0	8.2
Minimum	5.7	5.5	5.9	5.5	4.2	4.1	4.1	3.9	3.2	2.7	6.1	4.3	5.6
10th Percentile	6.5	6.5	6.6	6.9	6.8	6.8	6.8	4.7	4.8	2.8	6.7	7.6	7.9
90th Percentile	7.5	7.7	8.0	8.2	8.0	8.1	7.9	7.5	7.8	6.7	8.0	8.3	8.7
Maximum	8.7	9.1	9.3	9.3	8.9	8.7	8.7	8.4	8.5	8.0	8.5	8.9	10
EC													
Number of samples	340	393	390	405	394	294	454	170	261	161	113	486	410
Mean	399	230	415	1,179	1,661	2,274	2,279	1,147	1,892	2,948	668	5,137	4,836
Minimum	50	100	9	70	193	200	189	180	9	116	135	260	300
10th Percentile	180	136	180	199	390	556	690	330	450	850	353	3,495	2,692
90th Percentile	640	316	812	3,352	3,868	4,867	4,742	2,431	3,860	6,830	1,076	6,330	6,340
Maximum	4,900	2,780	4,960	7,360	6,080	8,260	8,070	5,900	8,010	14,400	1,600	9,700	9,000
TDS													
Number of samples	107	129	87	234	228	166	232	71	117	41	60	191	112
Mean	310	161	260	621	993	1,689	1,568	879	1096	1,447	467	3,777	3,083
Minimum	130	20	40	8	120	126	202	46	100	86	204	110	450
10th Percentile	180	80	115	107	213	325	321	247	230	280	331	2,230	1,585
90th Percentile	400	251	295	1,767	2,714	3,955	3,642	2,290	2,290	3,940	758	5,200	4,557
Maximum	3,390	1,760	3,580	5,660	5,210	7,015	6,555	5,620	6,110	5,825	1,020	8,140	5,500
TSS													
Number of samples	112	137	95	236	233	154	232	73	121	46	66	97	118
Mean	24	28	17	23	23	29	19	48	55	54	18	10	19
Minimum	2	1	1	1	1	1	1	4	1.0	1	2	1	1
10th Percentile	5	3	2	1	3	5	3	8	4.0	2	4	2	3
90th Percentile	50	69	42	45	50	65	40	106	118	74	38	21	35
Maximum	180	370	250	627	370	270	150	340	1001	1,272	74	68	294

1.5 Surface water and stream health impact assessment criteria

Water quality impacts for Buttai and Elwells Creek will be assessed in accordance with the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC/ARMCANZ, 2000) and the water quality aspects of the Hunter-Central Rivers Catchment Management Authority's *Wallis and Fisheries Creeks Total Catchment Management (TCM) Strategy (2001).* The Strategy references the *NSW Water Quality and River Flow Objectives: Hunter River*, which in turn reference the ANZECC guidelines as the default water quality trigger values for upper and lower threshold limits.

The ANZECC guidelines recognise that each stream has its own unique physico-chemistry and biology. The ANZECC guidelines recommend that site specific studies be undertaken to formulate relevant trigger values for a particular stream. If no site specific studies have been undertaken, the ANZECC guidelines provide default trigger values.

Proposed water quality trigger values for Buttai and Elwells Creek have been based on site-specific, historic water quality data. The trigger values are outlined in Section 1.6. Any subsequent exceedance of the trigger values will lead to further investigations to establish the cause of the exceedance and appropriate response action as set out in Section 2.0.

1.5.1 Water quality

The following key water quality parameters will provide initial lead indicators of stream health. They will be measured at the locations shown in Figure 1 by either field monitoring or laboratory analysis. An explanation of the parameters to be measured and some interpretation of the background monitoring information is outlined below.

1.5.2 Physical parameters

- **Temperature** influences many of the chemical reactions which occur in water as well as stimulating plant growth and animal activity. It also provides a measure of the degree of mixing within a water body. Temperatures of both creeks vary significantly between the seasons (Elwells Creek ranges from 8.7 to 23 degrees, and Buttai Creek from 10 to 27 degrees Celsius).
- **Turbidity** directly measures the impedance of light which may be due to suspended solids or finer, more colloidal particles. The presence of clay in streams of the study area means that increased flow often resuspends sediment leading to high TSS values.

1.5.2.1 Chemical parameters

- Dissolved oxygen (DO) will be measured in the field and provides an immediate indicator of water quality to support aquatic biota. In the study area, DO can be highly variable with flow, season and time of day. High flows lead to entrainment and higher DO levels.
- Electrical conductivity (EC) / Salinity is a measure of the concentration of dissolved salts in an aquatic system. The geology of the Hunter, particularly in coal bearing regions, has led to elevated salinity of surface waters (Marine Pollution Research, 1999). EC in the study area shows significant variability over time with observed EC over 8000 µS/cm in the tributaries and lower reaches of Four Mile Creek and Buttai Creek.
- Total dissolved solids (TDS), sulphates, chlorides, fluorides, calcium, magnesium, sodium, potassium and alkalinity will be analysed in the laboratory to provide further information on the chemistry that contribute to EC levels.
- pH is a critical water quality parameter. Slight changes can have significant impacts on a waterways health. Baseline pH data indicates Elwells Creek has a variable pH which is due to the natural geology of the area. On the limited historic data available for Buttai Creek it appears to be more stable.

1.5.3 Water level and flow monitoring

Surface water models predict the mining operation in the Upper Buttai Creek catchment will have small, short term impacts on stream base flows with rapid recovery post-mining. Furthermore, as Buttai Creek has highly variable and episodic flow, it would be difficult to ascertain the flow fluctuations attributable to the mining operation as opposed to natural variability. Therefore, flow will be noted as an observation.

The potential for impacts on groundwater on Buttai Creek are addressed in the groundwater monitoring program.

1.6 Water quality trigger values

The proposed water quality trigger values for Buttai Creek and Elwells Creek have been based on historic data collected over a number of years (Section 1.4). The upper and lower limit thresholds have been based on the 10th and 90th percentiles of collected baseline data as per ANZECC guidelines (rounded figures).

The trigger values provide an appropriate level of protection for the waterway and are reflective of the community values for the catchment areas. The trigger values will be reviewed annually and revised if necessary.

Under Environment Protection Licence (EPL) 396 Bloomfield is licensed to discharge waters to Four Mile Creek under wet conditions and to concentration limits for conductivity, filterable iron, pH and total suspended solids as per the EPL. Therefore no trigger values are provided for Four Mile Creek.

Table 4 Water quality trigger values

	WM5 - Elwells Creek	WM13 Buttai Creek
pH	5.0 – 7.8	6.7-8.0
EC (µS/cm)	430 – 3,860	402-1,100
TSS (mg/L)	4.0 - 230	4-38
DO	5-10.9	4.8-9.4

2.0 Response plan

2.1 Trigger Action Response Plan

A Trigger Action Response Plan (TARP) has been prepared (Table 5) and provides appropriate triggers and corresponding response actions for prevention or mitigation of adverse impacts to nearby water users or the natural environment as a result of mining.

The monitoring program outlined in Section 1.3 has been designed to detect changes to surface water quality and stream health or to indicate that an abnormal condition relating to mining has developed.

Trigger levels have been set for particular impacts at which a response is needed, and to help define an appropriate response in each case.

2.2 Response actions

In the event the monitoring results show an exceedance of the adopted water quality trigger values, an investigation into the potential sources and/or causes will be undertaken. The response actions listed below will be initiated. An action plan will be prepared to reflect these actions

- Once an exceedance is detected the circumstances of the event will be immediately investigated including a review of relevant monitoring data, meteorological conditions etc
- An assessment will be made to determine the reason for the exceedance, the potential magnitude of the impact and the level of future risk
- If assessed as being caused by the mining operation, and it is further assessed to be likely to cause an adverse impact on an existing beneficial or environmental use of surface water, then an appropriate preventative and/or remedial strategy will be prepared for discussion with relevant authorities including the Department of Planning, which may comprise:
  - additional monitoring including assessment of ecological aspects
  - modification of mine water management procedures
  - modification to mine water management facilities
  - (If appropriate) no change to operations
- A response/mitigation plan will be implemented to the satisfaction of the relevant
- If it is found that downstream water users have been adversely impacted, a compensation strategy would be developed in consultation with the landholder(s). This may include the provision of an alternative water supply, adequate compensation made available or some other appropriate agreement negotiated between the parties (for example, installation of an irrigation system, dam or stock water point). The timeframe for implementation of the compensation strategy would be agreed with the landholder(s). In the event that agreement cannot be reached regarding the compensation to be provided, the matter may be referred to the Department of Planning, Industry and Environment for resolution.

2.3 Reporting procedures

In the situation where an exceedance is detected and investigated, a report will be prepared and provided to Department of Planning, Industry and Environment and relevant agencies. The report will:

a. describe the date, time and nature of the exceedance / incident

b. identify the cause (or likely cause) of the exceedance / incident

c. describe what action has been taken to date

d. describe the proposed measures to address the exceedance / incident.

In relation to surface water management, the following information will be included in the Annual Review to the satisfaction of the Secretary and in accordance with Schedule 5, Condition 3 of the Project Approval:

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

2.4 Incident reporting

Incident reporting will be undertaken in accordance with Condition 6 of Schedule 5 for the Project.

The proponent will notify the Secretary and any other relevant agencies of any incident associated with the Project as soon as practical after the incident is identified. A detailed report of the incident will be provided to the Secretary and any relevant departments within 7 days of identifying the incident.

Table 5 Trigger action response plan

Aspect	Parameter	Frequency	Purpose	Trigger	Action	Responsibility	Timing	Purpose
Surface water monitoring	Surface water quality in grab sample	Monthly: - temperature, pH, EC, turbidity, oil and grease, flow Quarterly: -TSS, TDS, pH, EC, DO) 6-monthly: - chlorides, sulfates, alkalinity (bicarb) alkalinity (carb), calcium, magnesium, sodium, potassium)	To provide baseline water quality data and to identify any water quality impacts	WM5 – Elwells Creek pH: 5.0-7.8 EC: 430-3,860 TSS: 4.0-230 DO: 5-10.9 WM13 Buttai Creek pH: 6.7-8.0 EC: 402-1,100 TSS: 4.0-38 DO: 4.8-9.4	Repeat water quality sampling to confirm. Refer to an independent hydrologist for review.	Bloomfield Environmental Officer	Inform relevant agencies within 7 days. Investigation initiated within 1 week.	Inform agencies of baseline assessment and monitoring. Identify, investigate and report on impacts to surface water.
Stream Health	Aquatic ecology and riparian vegetation	5-yearly: - water quality parameters (flow, temperature, EC, pH, DO, turbidity) surface flows and conductivity - aquatic macroinvertebrate fauna (AusRivAS method) -aquatic habitat (River-Creek-Environment (RCE) score)	To provide baseline data on aquatic habitat site condition and to identify any impacts to aquatic ecology and riparian vegetation.	As per aquatic ecology surveys.	Refer to an independent ecologist for review.	Bloomfield Environmental Officer	Inform relevant agencies within 7 days. Investigation initiated within 1 week.	Inform agencies of baseline assessment and monitoring. Identify, investigate and report on impacts to aquatic and/or riparian environment.

Aspect	Parameter	Frequency	Purpose	Trigger	Action	Responsibility	Timing	Purpose
Licensed Discharge	Water quality and volume	As per EPL requirement for TSS, EC, pH, TDS and Fe	Ensure mining activities are not polluting Four Mile Creek	Limits stipulated by EPL Licence 369	Repeat water quality sampling to confirm. Investigation to be undertaken and reported in accordance with Licence requirements.	Bloomfield Environmental Officer	Inform relevant agencies within 7 days. Investigation initiated within 1 week.	Identify, investigate and report on impacts to Four Mile Creek

Appendix E

Groundwater report

Appendix E Groundwater report

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Bloomfield Collieries Pty Ltd
5 August 2021
Doc No. Appendix E

Bloomfield Mining Operations Water Management Plan

Ground Water Management Plan

Bloomfield Mining Operations Water Management Plan

Ground Water Management Plan

Client: Bloomfield Collieries Pty Ltd

ABN: 76000106972

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ABN 20 093 846 925

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D	07-Aug-2020	Revised following DPIE Review	Gabriel Wardenburg Project Manager	
E	5 August 2021	Updated to include the "Bloomfield Site" under Abel Approval PA 05_0136	Chris Knight Environmental Manager	

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Abbreviations

ARR	annual review report
Ca	Calcium
Cl	Chloride
CO_3	carbonate
DoI	Department of Industry – Lands and water
EC	electrical conductivity
EPL	Environment Protection Licence
Fe	Iron
HCO_3	bicarbonate
k	potassium
Mg	Magnesium
Na	sodium
SO_4	sulfate
TDS	total dissolved solids
TSS	Total suspended solids

1.0 Introduction

1.1 Background

Bloomfield Colliery is an open cut coal mining operation located approximately 20km north west of Newcastle in NSW. The mine has been in operation for approximately 180 years utilising both open cut and underground extraction methods. This report has been prepared on behalf of Bloomfield Colliery for inclusion in the Site Water Management for the site.

This plan is an updated version of the Aquaterra Bloomfield Colliery Groundwater Management Plan 25 March 2010 Aquaterra (2010)

Bloomfield operates under an Environment Protection Licence (EPL) 396, the licence authorises and regulates the scheduled activities on site.

1.2 Objectives

This groundwater management plan and groundwater response plan are intended for inclusion in an overall water management plan for Bloomfield Mine. The groundwater monitoring plan and groundwater response plan have been prepared in accordance with the specific environmental Conditions 23 and 24, stipulated in Schedule 3 of the Project Approval, under Section 75J of the Environmental Planning Assessment Act 1979.

This groundwater management plan also includes the area known as the “Bloomfield site” as defined in the Abel Coal Project Approval MP 05_0136 which includes the Bloomfield Coal Handling and Preparation Plant, the Bloomfield Rail Loading Facility, Rail Loop and Rail Spur, and the Bloomfield Colliery open-cut pits which are used to emplace coal reject and tailings from the Abel Coal Project.

1.3 Conditions of consent

The conditions below are addressed under **Sections 2** and **3** of this report and are as follows:

Condition of consent No. 23 specifies the requirements for the preparation of the groundwater monitoring program which are reproduced below:

The Groundwater Monitoring Program must include:

a. *further development of the regional and local groundwater model;*

b. *detailed baseline data to benchmark the natural variation in groundwater levels, yield and quality (including at any privately owned bores in the vicinity of the site);*

c. *groundwater impact assessment criteria;*

d. *a program to monitor the impact of the project on groundwater levels, yield, quality, groundwater dependent ecosystems and riparian vegetation;*

e. *procedures for the verification of the groundwater model; and*

f. *reporting procedures for the results of the monitoring program and model verification.*

24) The Surface and Groundwater Response Plan must describe the measures and/or procedures that would be implemented to:

a. *investigate, notify and mitigate any exceedances of the surface water, stream health and ground water impact assessment criteria;*

b. *compensate landowners of privately-owned land whose water supply is adversely affected by the project; and*

c. *mitigate and/or offset any adverse impacts on groundwater dependent ecosystems or riparian vegetation.*

1.4 Potential groundwater impacts

A groundwater assessment was undertaken 'Groundwater Impact Assessment Bloomfield Colliery – Life of Mine Extension' by AECOM in January 2018, supported by Hydro Simulations Bloomfield Colliery Extension Groundwater Modelling Assessment in October 2017 Hydro Simulations (2017) to assess key environmental issues for the completion and rehabilitation of open cut mining at Bloomfield.

Groundwater in the vicinity of the Project Area is saline and of negligible value for beneficial users. No adverse impacts on groundwater supply, quality or any groundwater dependent ecosystems are expected as a result of the Project.

The Groundwater Impact Assessment AECOM (2018) noted groundwater drawdown as a result of mining activities are expected to reach a maximum in 2025, at which time mining activities are scheduled to cease in the southern end of the approved extraction area and groundwater levels would start to recover. A drawdown of 10m is predicted in the surficial aquifer in the Bloomfield approved extraction area of the final mine void. Drawdown is generally less than 0.5 m outside the Bloomfield lease area apart from the south-west corner where the 2 m drawdown contour extends outside the lease approximately 600 m beneath Buttai Creek. The predicted drawdowns are not expected to negatively impact GDE's as historical mining in the area has lowered levels far below the ground surface. The final void will remain a sink and will have a wide spread effect of lowering water levels in the vicinity of the mine in the long term. A hypothetical monitoring point within the final void is predicted to only recover 15 m after 100 years Groundwater Impact.

1.4.1 Geology

The Colliery is located within the Permian Tomago Coal Measures of the Hunter Valley Coalfields within the Sydney Basin. The target coal seams are the Big Ben, Donaldson, Elwells Creek, Whites Creek and Upper and Lower Buttai seams (Aquaterra, 2008). Interburden between the coal seams consists of interbedded mudstone, siltstone and sandstone along with minor uneconomical coal seams. The overlying Newcastle coal measures do not outcrop at the site. The sediments dip to the south and south-west. Minor dykes and faults cross cut the strata.

To the west of the Colliery Quaternary alluvial deposits of gravel, sand, silt and clay are associated with Wallis Creek which in part forms a wetland system of disconnected ponds and swamps. To the east Quaternary sediments are associated with the Hunter River floodplain. Hexham Swamp has formed within the Quaternary sediments of the floodplain. Elsewhere across the site there are minor alluvial deposits associated with creeks such as Four Mile Creek and Buttai Creek.

1.4.2 Hydrogeology

Regional hydrogeology

There are two aquifer groups that dominate the Upper Hunter Valley, the alluvial deposits of the Quaternary and consolidated sedimentary rocks of the Permian. Groundwater can also occur in shallow unconsolidated material that form the regolith and is composed of localised alluvium, colluvium and decomposed rock away from the main creeks. This unconsolidated material located away from the creeks and swamps has negligible resource value, but is important in the groundwater recharge process. All unconsolidated materials are included in Layer 1 of the groundwater model.

Alluvial deposits consisting of gravel, sand and clays where saturated can deliver reliable yields and good quality water which are used for domestic and agricultural purposes. These deposits are typically orders of magnitude more permeable than the Permian age coal seams.

Within the Permian age sedimentary rocks groundwater is typically of poor quality and of low yield. The coals seams represent the main water baring units of the Permian strata and can function as a semi-confined aquifer with vertical leakage from above and below interburden. Weathered zones near or at the surface can act as recharge zones and can form vertically and horizontally disconnected perched aquifers. Permeability's within the coal seams range from 0.001 to 12 m/day and decrease exponentially with depth (AGE, 1984).

The sedimentary rock interburden has permeability in the range of 0.0013 m/ day to 0.4 m/day (AGC 1984).

Regionally the piezometric surface is a subdued reflection of the topography. At higher elevation features the water table is typically deeper while at low lying features (e.g. valleys) it is typically closer to the ground surface. The potentiometric surface is more controlled by regional recharge and discharge features. Recharge occurs at or near outcrop to the north with groundwater discharging to the south. There is one low-lying location beside Pambalong Nature Reserve where the potentiometric surface for the Donaldson Seam pre-mining was 20+m above the ground surface (C081A), whereas the water table was below surface (C081B). Mining impact has since taken C081A water level well below surface, whereas the water level in C081B is still just below surface and has not been affected by mining. There is believed to be very limited hydraulic connectivity between the alluvium and Permian Coal Measures (Aquaterra, 2008).

Local hydrogeology

The hard rock Permian coal measures are the main aquifer unit for the site, with the coal seams themselves representing the most permeable material within the formation. Groundwater typically is restricted to the cleat and fractures within the coal.

Groundwater is also present in the Quaternary alluvium, swamp, floodplain and estuarine sediments. The alluvial groundwater is shallow with groundwater levels being topographically controlled.

The Bloomfield groundwater monitoring network consists of five standpipe piezometers and five multi-level Vibrating Wire Piezometers. The potentiometric heads measured within the coal show a progressive decline with depth. There are stronger vertical gradients on the southern boundary and minimal gradients at the western sites (HydroSimulations, 2017).

Groundwater in the region shows climatic trends where groundwater elevation drops in response to periods of decreased rainfall (Aquaterra, 2008). Long-term mining effects on the local groundwater system can be seen in the hydrographs prepared by HydroSimulations showing a decrease in groundwater elevation in piezometers monitoring the deeper coal seam aquifers, which isn't seen in the upper alluvial aquifer, with the exception around the Donaldson Open Cut. This infers the alluvium/ weathered overburden and the deeper coal measures are not hydraulically connected. The alluvium and weathered Permian Coal Measures can become hydraulically connected within the deeper coal measures close to the open cuts within fractured strata in the subsidence zones above underground mines, such as above the Donaldson Open Cut.

The highest groundwater levels are in the northern part of the site where the coal measures outcrop. Pre mining the lateral hydraulic gradient would have been to the south and south east, however as a result of open cut mining, large sinks now exist and the natural gradient has been reversed in some locations (Aquaterra, 2008; HydroSimulations, 2017).

2.0 Groundwater monitoring

2.1 Further development of the groundwater model

The Bloomfield Coal groundwater model by HydroSimulations (2017) was developed to assess an extension to the life of mine modification (mod 4).To assess the groundwater impacts, associated with completion of mining and rehabilitation.

The current regional model that includes Bloomfield, Donaldson, Abel and Tasman Mines was modified and partially recalibrated by HydroSimulations in 2016, with emphasis on the Abel Mine.

Several modifications were subsequently made to the current model in 2017 to improve its suitability for assessing the effects of mining at Bloomfield. The following changes were made by HydroSimulations:

- re-build of the model geometry in the Bloomfield area only
- inclusion of old Big Ben underground works (not in current Abel Model)
- inclusion of a dyke in the Bloomfield Area (not in the current Abel model)
- Contraction of the southern extent of the model from northing 6350000 to 6357420. This reduced the very large number of model cells which exceed the industry benchmark of 1 million cells. This contraction does not affect the results of interest
- extension of model calibration from December 2015 to April 2017.

No changes were considered necessary for the following features:

- position of the northern boundary at northing 6374000
- cell sizes (maximum 100m x 100m at Bloomfield
- inclusion of Donaldson, Abel, Tasman mines for cumulative impact assessment

Circumstances which may trigger further development or refinement of the groundwater model include:

- a significant change to the mine plan
- acquisition of new hydrogeological information, such as groundwater levels and aquifer properties (i.e. hydraulic conductivity) which are different to calibrated values used in the model
- groundwater drawdown and inflows which significantly exceed model predictions for that stage of mining.

2.2 Baseline data

Due to the long history of mining on the site and areas surrounding the site, pre mining baseline groundwater level and quality information is not available.

The available groundwater baseline data include monitoring records from Bloomfield as well as the neighbouring Abel and Donaldson mines. Groundwater monitoring at Abel and Donaldson have been collected routinely since January 2006 to April 2017.

The Bloomfield groundwater monitoring network includes a combination of 24 standpipes and vibrating wire piezometers across 8 sites (Table 1**,** Figure 1). Seven of the sites have multi-level piezometers installed which monitor pressures of various coal seams. Seven piezometers are standpipes which target alluvium or coal measures and allow monitoring for both water level and water quality. In addition there are eight pre-existing bores or old mine shafts (known as BL1 to BL8), however there is little information available about their construction details or what aquifers they target.

Bloomfield baseline groundwater monitoring commenced during the groundwater impact assessment program in 2007. Since this time groundwater elevations have been recorded regularly and samples taken to analyse water quality.

Table 1 Monitoring piezometers

Site	Piezometer	Easting	Northing	Surface RL (mAHD)	Depth	Screen Interval / Piezometer Level (m below surface)	Formation
Site 1	VW1-35	363632	6370167	17.4	171	35	Donaldson Seam (33.0 – 35.4 m)
	VW1-46	363632	6370167			46	Big Ben Seam (44.3 – 47.2 m)
	VW1-171	363632	6370167			171	Rathluba Seam (170 – 171 m)
Site 2	SP2-1	365112	6371264	65.2	65	50 – 53, 62 – 65	Donaldson Seam (55.2 – 61.4 m)
	SP2-2	365112	6371264	65.2	85	82 – 85	Big Ben Seam (79 – 94 m)
	VW2-189	365112	6371264	65.2	189	189	Rathluba Seam (187.8 – 191.3 m)
Site 3	SP3-1	366732	6371893	38.8	14	11 – 14	Alluvium/weathered Permian
	VW3-131	366732	6371893	38.8	131	131	Rathluba Seam (129.7 – 131.5 m)
Site 4	SP4-1	367612	6370989	27.8	78.4	75.4 – 78.4	Rathluba Seam (75.4 – 77.4 m)
	SP4-2	367612	6370989	27.8	9.4	6.4 – 9.4	Alluvium/weathered Permian
Site 5	VW5-62	366700	6368083	55.7	90	62	White Ck Seam (62.3 – 63.1 m)
	VW5-71	366700	6368083			71	Donaldson Seam (70.5 – 71.9 m)
	VW5-90	366700	6368083			90	Big Ben Seam (89.3 – 89.7 m)
Site 6	VW6-96	365337	6368293	52.5	130	96	White Ck Seam (95.1 – 96.7 m)
	VW6-114	365337	6368293			114	Donaldson Seam (113.2 – 114.7 m)
	VW6-128	365337	6368293			128	Big Ben Seam (128.0 – 129.3 m)
Site 7	SP7-1	364619	6368701	24.9	11.2	9.2 – 12.2	Alluvium/weathered Permian
	VW7-70	364619	6368701	24.9	110	70	White Ck Seam (67.9 – 69.8 m)
	VW7-95	364619	6368701			95	Donaldson Seam (90.0 – 91.8 m)
	VW7-107	364619	6368701			107	Big Ben Seam (104.7 – 107.7 m)

Site	Piezometer	Easting	Northing	Surface RL (mAHD)	Depth	Screen Interval / Piezometer Level (m below surface)	Formation
Site 8	SP8-1	363072	6369002	22.5	9.9	6.9 – 9.9	Alluvium/weathered Permian
	VW8-83	363072	6369002	22.5	238	83	Donaldson Seam (80.4 – 84.0 m)
	VW8-97	363072	6369002			97	Big Ben Seam (91.5 – 98.5 m)
	VW8-238	363072	6369002			238	Rathluba Seam (237.2 – 240.2 m)
BL01	Old fan shaft	363789	6371466	16.1		?	?
BL02	BL02	365994	6372249	26.7		?	?
BL03	BL03A	366422	6368077	63.6	72	?	?
	BL03B	366422	6368077		53	?	?
BL04	BL04	366519	6368076	61.5	52	?	?
BL05	BL05	367385	6367957	75.4	46	?	?
BL07	BL07	367211	6368485	57.6	26	?	?
BL08	BL08	367029	6368431	52.3	49	?	?
Abel Project	CO78A	367140	6367054	77	101	99-96, 90-87	Whites Creek Seam (Abel's Donaldson Seam)
	CO78B				24	24-18	Alluvium/weathered Permian
	C087	367187	6367079	74	18.3	18.3-12.3	Alluvium/weathered Permian
Donaldson Project	REGDPZ1	371142	6371207		33	27-33	No information
	FMC1						No information
	FMC2						No information
	DPZ3	368774	6368609	49.1	30	6.8-18.8	Undifferentiated coal measures below Whites Creek Seam *(Abel's Lower Donaldson Seam)*
	DPZ6			57.7	43	26.7-42.5	Whites Creek Seam (Abel's U and L Donaldson Seams)

Site	Piezometer	Easting	Northing	Surface RL (mAHD)	Depth	Screen Interval / Piezometer Level (m below surface)	Formation
	DPZ7A	368848	6367641	55.4	18	12.9-16.9	Overburden above Whites Creek Seam *(Abel's Upper Donaldson)*
	DPZ7B			55.4	41	22.9-34.9	Whites Creek Seam (Abel's L Donaldson Seam)
	DPZ8	369375	6368074	51.8	33	22.2-32.2	Whites Ck and Donaldson Seams (Abel's L Donaldson and Big Ben)

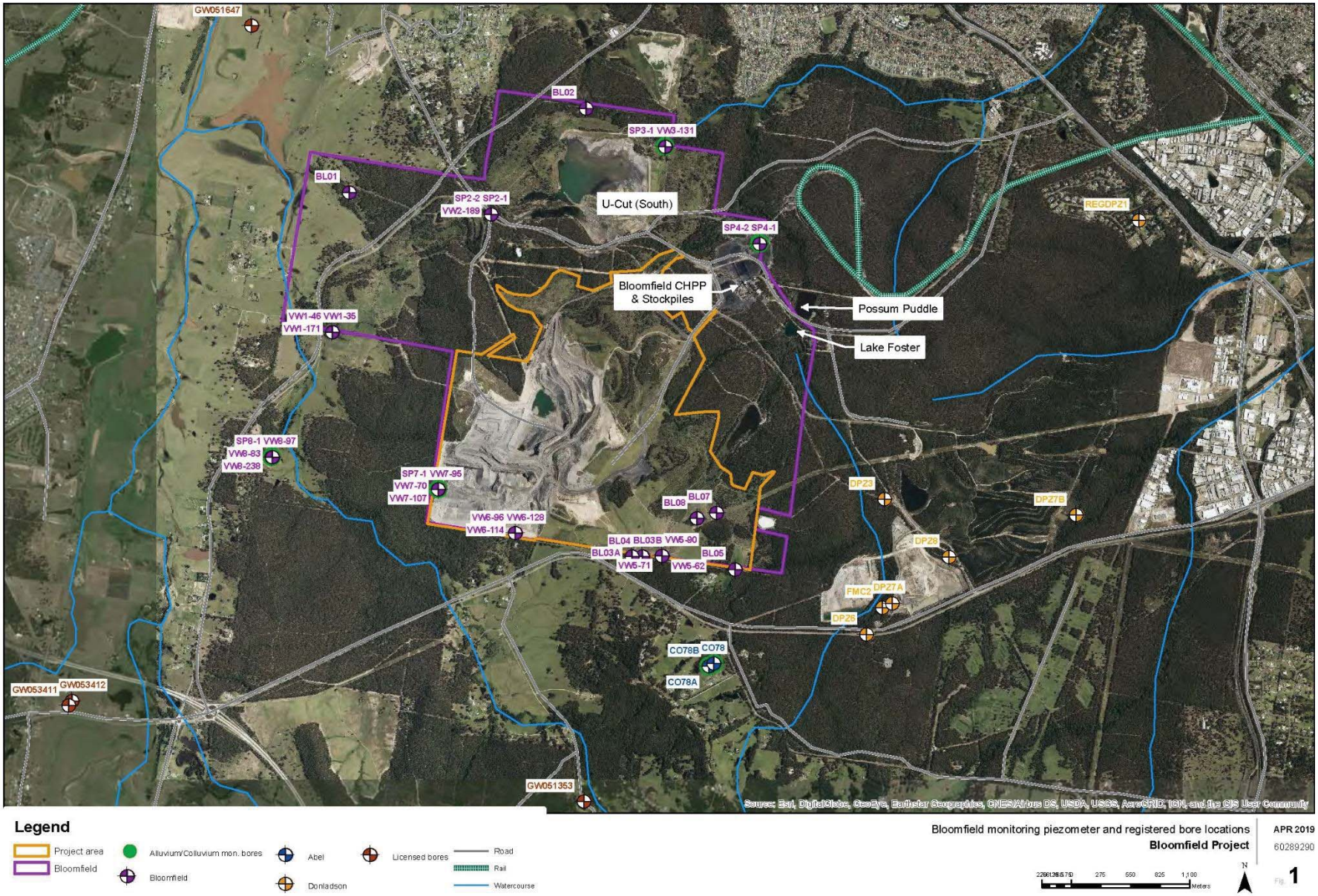


Figure 1 Bloomfield monitoring piezometer and registered bore location plan

2.2.1 Groundwater levels

Groundwater levels in the Project Area show the accumulated effects of long-term mining. Due to the long period of time mining has occurred on the site (~180 years), there is no evidence to suggest what pre-mining groundwater levels might have been. However, the influence of mining on water levels is apparent by the marked differences in groundwater levels between shallow and deeper coal measures.

The 2017 Annual Review Report for Bloomfield Collieries ARR (2017) provides the groundwater monitoring results for 2017 and previous years. The results are fairly consistent and do not show any real trends. The S cut high wall was moved west and is now within a few meters of Bore PD7.1. Bore PD7.1 was 11 metre deep in alluvium/weathered Permian and is now dry. Refer Appendix A. for the Bloomfield piezometer hydrographs.

2.2.2 Groundwater quality

Groundwater in the vicinity of the mine is generally:

- Saline and of negligible beneficial use. Total Dissolved Solids (TDS) concentrations ranged from 100mg/L to 13,000 mg/L (Aquaterra, 2008)
- pH is generally close to neutral (Aquaterra, 2008, Business Environment, 2008).

The shallow alluvial aquifer, which is associated with Wallis Creek and the Hunter River floodplain, is inferred to be in direct hydraulic connection with the lower reaches of the major tributary streams in the area. This is based on a close correlation between the surface water and groundwater levels (Aquaterra, 2008) and groundwater baseflow in the ephemeral water courses, which is likely to reverse direction during periods of heavy surface water flow.

Groundwater in the localised surficial weathered bedrock is inferred to be in hydraulic connection with the high-level streams. These limited occurrences of surficial groundwater do not represent a significant or regionally extensive aquifer system, and are not considered to be part of the surface water flow system.

There is no evidence of connectivity between surface waters and the deeper aquifers of the coal measures (Aquaterra, 2008).

Modelling of the groundwater and surface water interactions for surface water systems surrounding Bloomfield found that all watercourses were inferred to be gaining systems with the exception of Buttai Creek and Hexham Swamp. The Surface Water Assessment conducted by AECOM (2017) found the final proposed landform will result in a reduction in the catchment area draining towards the final void to approximately 52 Ha, a decrease from the 103 Ha under the currently approved final landscape design. This increases the catchment to Buttai Creek by 41 hectares.

Groundwater samples taken from a number of Bloomfield bores are presented in Appendix B. The main water quality characteristics of groundwater within the Bloomfield Lease area are summarised below:

Salinity

Salinity is variable, ranging from 1,700 to 15,000mg/l for groundwater bores.

Total Dissolved Solids (TDS)

Ranges from 1,000 – 10,000 (mg/L).

pH

pH from 2010 to 2018 ranges from 3.5 to 8 for boreholes PD2.1,PD2.2, PD3, PD4.2, PD7.1 and PD8.1.

Dissolved metals

Dissolved metal concentration triggers are based on Table 3.4.1 Australian and New Zealand Guidelines for Fresh and Marine Water Quality Volume 1, ANZECC 2000.

Nutrients

Limited sampling for nutrients revealed concentrations of all parameters to be generally within the ANZECC guidelines.

2.3 Impact assessment criteria

Impact assessment criteria are recommended for:

- mine inflow rate
- mine inflow water quality
- near surface groundwater levels, in particular groundwater levels near Buttai and Wallis Creeks
- impacts on surficial groundwater levels and/or creek base flows
- impacts on existing licensed users

2.3.1 Mine inflow rates

Predicted groundwater extractions via mine inflows are presented in the AECOM 2018 Groundwater Impact Assessment. Inflows in 2006 are predicted to be 0.9 ML/d at the start of open cut mining and will peak around 1.6 ML/d (year 2013) in the calibration period and a peak of 1.5 ML/d in the prediction period. These rates do not incorporate evaporation losses that will occur when the groundwater is exposed to the atmosphere. In 2025 at the cessation of mining inflows are predicted to be approximately 1.0 ML/d.

The groundwater model is conservative and applies higher rainfall recharge to the model at various locations across the model domain, resulting in higher predicted mine flows. Two areas of increased modelled recharge are as follows:

1. Mine spoil area; and
2. Catchments of surface water run-off diversions[1]

The mine spoil area (43.3 ha) and the hardstand workshop area (7.5 ha) west of the mine spoil area will receive no rainfall recharge as runoff is captured from these areas and discharged off-site. A recharge rate of 5% of annual rainfall was applied to these areas to keep the model stable. Removal of this water from the model will reduce the mine inflows by 22.61 ML/year.

Clean water catchments across the site divert clean surface water runoff to storage dams which are part of the natural surface water system limiting rainfall recharge. There are four clean water sub-catchments with a total surface area of 623 ha as follows:

1. Buttai Creek – 269 ha;
2. Four Mile Creek – 141 ha;
3. Possum Puddle west 135 ha; and
4. Possum Puddle east 78ha.

A reduction in groundwater recharge from 5% (modelled) to 4% across these catchments is considered realistic to account for the enhanced rainfall runoff. Removal of this water from the model will reduce the mine inflows by 55.4 ML/year.

Thus in total the mine inflow refinements which include a reduction in rainfall recharge from the mine spoil area and clean water sub-catchments would reduce mine inflows by a total of 78.0 ML/year.

The estimated annual water requirements for licensing is summarised in **Table 2** based on the revised mine inflows for the water year. The water year is assumed to be from July through to June.

Table 2 Modelled Mine and refined inflows for the water year

Water Year	Licence Requirement (ML/year)	
	Modelled	Refined inflow
2016/17	447.5	369.5
2017/18	487.5	409.5
2018/19	520	442
2019/20	540.5	462.5
2020/21	560	482
2021/22	491	413
2022/23	338	260
2023/24	310	232
2024/25	367	289
2025/26	183.5	105.5
2026/27	0	0

The predicted licence requirements from the refined inflows vary from 369.5 ML/year in 2016/17, reaching a maximum of 482 ML/year in 2020/21 and declining to zero in 2026/27. These predicted mine inflows are within the existing mine licence discharge licence of 500ML/year.

2.3.2 Mine inflow water quality

Water is pumped from the pit sump into Lake Kennerson. Surface water runoff from disturbed areas is also directed towards the lake. Water is then fed into Lake Foster (which also receives water from various sources) and ultimately discharged into Four Mile Creek. The water quality of the discharged water is monitored as part of the discharge monitoring requirements.

As the lake water is a mixture of both surface water runoff and mine inflows (groundwater, surface water and tailings water), the actual water chemistry of groundwater inflow alone is difficult to determine.

Since 2007 the water quality (EC, TDS, pH, and TSS) of mine water discharged into Four Mile Creek has been variable, with TDS in the range of 1,350 mg/L to 5,088 mg/L. Apart from an isolated number of exceedances, all water quality parameters have been within the EPL discharge thresholds.

The salinity and pH of mine water discharged to Four Mile Creek will be monitored throughout the mine life. An observed increase or decrease in salinity by more than 25 percent outside the expected range (1,300 mg/L to 6000 mg/L) sustained over a consecutive 6 month period would require a response action as detailed in Section 3.3 of this report.

Mine inflow water quality significantly different from the above range would not itself be cause for concern, as groundwater within the coal measures is highly variable, with measured TDS ranging from 1,700 mg/L to 14,800 mg/L.

A rapid change to a significantly lower or higher salinity at any time might indicate that a source of surface water or near surface groundwater may have been induced to inflow into the mine. Likewise a sudden change to the average pH of the mine inflow water may indicate the interception of a new source of inflows.

2.3.3 Baseflow impacts

The model was set up to accept baseflow if groundwater levels exceeded riverbed elevations, but not to allow leakage as most streams in the area are ephemeral. The model was able to predict reduction to baseflow but was unable to predict increases in leakage from losing streams. Baseflow simulations were run for both mining and null simulations.

The predictions are:

- Four Mile Creek is predicted to be converted to a losing stream around 2011, therefore its average baseflow of 0.24kL/ day would be lost;
- The difference between mining and null runs for all other water courses was negligible, indicating that Bloomfield mining (as distinct from cumulative impacts) is having an insignificant effect on baseflow capture; and
- Leakages for Hexham Swamp differed by no more than 1 kL/ day between both mining and null. This would be within numerical error bounds.

2.3.4 Impacts to licensed users

Predicted groundwater heads have been modelled to show groundwater level and drawdown at the completion of mining in 2025.

Drawdown as a result of mining activities at the Colliery are expected to reach a maximum in the Mine Year 20 or 2025, at which time mining activities are scheduled to cease in the southern end of the approved extraction area and the groundwater levels would start to recover (HydroSimulations, 2017).

Drawdown of approximately 5 m is predicted in the surficial aquifer layer 1 in the Bloomfield extraction area and final mine void (alluvial and regolith) although it is limited in extent. Significant drawdown is also evident within the lease area to the north-west of approved extraction area corresponding with historical open cut and underground mining. Drawdown from the open cut is propagating into the high permeability underground voids, although there is some spatial confinement with the north-westerly trending dyke.

Drawdown is generally less than 0.5 m outside the Bloomfield lease area apart from the south-west corner where the 2 m drawdown contour extends outside the lease approximately 600 m beneath Buttai Creek (HydroSimulations, 2017).

The predicted drawdowns are not expected to negatively impact GDE's as historical mining in the area has previously lowered water levels far below the ground surface.

The Donaldson open cut and final void are predicted to experience significant drawdown, however there is no overlap of the water table drawdowns produced by the various mines (HydroSimulations, 2017).

Predicted drawdown at the end of mining in nearby registered bores (within 5 km) are shown in Table 3. All predicted drawdown values are cumulative. As outlined in Table 3 the purpose of the majority of registered bores within 5 km of the mine are for monitoring. Only four bores are constructed for non-monitoring purposes and the predicted drawdown in each of these bores is less than one metre.

Most of the drawdown are predicted to be less than one metre, however drawdowns between 1-2 m are predicted for three bores (GW078047, GW078128 and GW078044), which is within the Aquifer Interference Policy threshold of 2 m.

Parts of the regolith (Model Layer 1) are predicted to be dewatered due to the watertable drawdown associated with the Donaldson open cut and final void.

Table 3 Predicted drawdown in registered bores at end of mining 2025

Bore number	Easting (MGA)	Northing (MGA)	Lithology	Bore depth (m)	Purpose	Drilled year	Predicted drawdown (m)
GW200415	369986	6373738	sandstone	20.1	monitoring	2004	<1
GW078120	371176	6368590	mudstone/shale	24	monitoring	1997	<1
GW080034	365222	6370959	#	NA	monitoring	NA	<1
GW078125	370970	6368464	siltstone/sandstone	30	monitoring	1997	<1
GW058760	371142	6371207	sandstone/siltstone	33	farming	1983	<1
GW061307	371299	6371148	shale/sandstone	30	domestic	1984	<1
GW200414	369960	6373761	sandstone	10	monitoring	2004	<1
GW078123	369309	6386165	sandstone/siltstone	33	monitoring	1997	17
GW051647	362896	6373006	sandstone	12	stock	1980	<1
GW078047	370784	6368800	siltstone	54.3	monitoring	1997	1.5
GW078122	368666	6367663	sandstone	35.4	monitoring	1997	<1
GW078124	369883	6368018	mudstone	40	monitoring	1997	20
GW078045	371836	6369892	siltstone	30.5	monitoring	1997	<1
GW078128	370912	6369893	siltstone/mudstone	30	monitoring	1997	2
GW051353	365986	6365810	shale	49.7	domestic	1997	<1
GW079892	366598	6372257	regolith	6.69	monitoring	1980	<1
GW078046	368651	6368741	siltstone/sandstone	30.4	monitoring	NA	<1
GW079948	370081	6372613	#	NA	monitoring	1997	<1
GW078044	370428	6370151	siltstone	30.1	monitoring	NA	1.4
GW078127	369073	6366406	siltstone/mudstone	30	monitoring	1997	<1
GW078126	371890	6367736	Siltstone/mudstone	30	monitoring	1997	<1
GW078121	368619	6367262	siltstone	43	monitoring	1997	<1

Notes: # unknown

2.4 Monitoring program

The groundwater monitoring program that has been operating on the Bloomfield mine since 2007 will be continued and expanded to include the neighbouring Donaldson, Abel and Tasman areas, as an integrated monitoring system covering all four sites. It will also be integrated with the surface water monitoring program. The groundwater monitoring program will include:

- Quarterly measurement of water levels in the existing network of piezometers to be monitored through the life of the project.
- Six monthly sampling of all standpipe piezometers, for laboratory analysis of electrical conductivity (EC), total dissolved solids (TDS) and pH.
- Annual collection of water samples from all standpipe piezometers for laboratory analysis of a broader suite of parameters:
  - physical properties (EC, TDS and pH)
  - major cations and anions (Calcium (Ca), Magnesium (Mg), Sodium (Na), Potassium (K), Chlorine (Cl), Sulfate (SO_4), Bicarbonate (HCO_3) and Carbonate (CO_3))
  - nutrients
  - dissolved metals
- Record pump time from the pit to estimate the volume of mine water pumped from the open cut mine.

The following table outlines the groundwater monitoring program undertaken at Bloomfield Colliery

Table 4 Groundwater monitoring plan

Analyte	Quarterly	6 monthly	Annual
Water levels	x	x	x
pH		x	x
Electrical Conductivity		x	x
Total dissolved solids		x	x
Filterable Iron			x
Chloride			x
Sulphate			x
Alkalinity			x
Calcium			x
Magnesium			x
Sodium			x
Potassium			x

Aquatic ecology surveys of Four Mile Creek are undertaken every five years and aim to:

- assess the quality of aquatic ecology and riparian vegetation in sites up- and down-stream of the EPL discharge point
- identify measurable differences in these attributes between up- and downs-stream pools and determine whether these differences are attributable to the EPL discharge point
- assess whether the aquatic resources provide suitable and sustained aquatic habitat for fish and other aquatic biota and whether the streams continue to provide suitable fish passage
- identify protected or threatened aquatic species or communities residing within the study area.

2.5 Reporting procedures

The following information will be included in the Annual Review Report (ARR) in accordance with Condition 3 Schedule 5 of the Project Approval:

- a summary of the monitoring results for the project during the past year
- an analysis of these monitoring results against the relevant:
  - impact assessment criteria/limits
  - monitoring results from previous years
  - predictions in the EA
- Identification of any trends in the monitoring results over the life of the project.

Incident reporting will be undertaken in accordance Condition 3 Schedule 5 of the Project Approval.

3.0 Response plan

3.1 Contingency measures

In the event of any adverse impacts or water quality degradation beyond predictions in the 2018 Groundwater Impact Assessment, Bloomfield will commission an assessment of the causes, will develop a staged response program satisfactory to the Department of Planning, Industry and Environment to mitigate the adverse impacts, and will attempt to establish and implement measures to limit further adverse impact.

The identification process and response protocols to potential adverse outcomes are provided in the trigger action response plan (TARP) provided in Table 5. The responses proposed incorporate a staged assessment and development of management measures deemed appropriate for each individual event should it occur.

Specific trigger levels have been designed to alert Bloomfield to observed parameter responses which are outside of normal variation and/or predicted responses, or where observed parameter values do not follow anticipated trends.

3.2 Trigger Action Response Plan (TARP)

The Trigger Action Response Plan (TARP) provides appropriate triggers and corresponding response actions for prevention or mitigation of adverse impacts to nearby water users or the natural environment as a result of mining.

The monitoring program outlined in Section 2.0 has been designed to detect changes to groundwater levels, groundwater quality or inflow rates, or to indicate that an abnormal condition relating to mining has developed.

Trigger levels have been set for particular impacts at which a response is needed, and to help define an appropriate response in each case (Table 5).

Aspects assessed to be at risk are summarised in **Section 2.3** of this report and fully explored in the Groundwater Impact Assessment Report (AECOM, 2018). These include both predicted and unpredicted impacts, and include:

- groundwater level
- groundwater quality
- hydraulic connection to Wallis Creek and Buttai Creek
- groundwater users (Private Bores)
- cumulative impacts.

3.3 Response action

In the event of any exceedance, the following response action would be initiated:

- initiate immediate review of circumstances including results of monitoring
- assessment undertaken to determine the likely reason(s) for the exceedance
- If assessed as being caused by the mining operation, and it is further assessed to be likely to cause an adverse impact on an existing beneficial or environmental use of surface water or groundwater, then an appropriate preventative and/or remedial strategy would be recommended, which may comprise:
    - additional monitoring
    - provision of alternative water supply or other negotiated agreement with landholders if found to be adversely impacted or
    - (If appropriate) no change to operations.
- The above response program will be carried out in consultation with the Department of Planning, Industry and Environment.

Table 5 Trigger action response plan

Aspect	Parameter	Frequency	Purpose	Trigger	Action	Responsibility	Timing	Purpose
Groundwater Monitoring	Groundwater level in piezometers	Quarterly	To provide baseline water level data and to identify any water level impacts	Alluvium/Colluvium Piezometers: An additional drawdown of 1m relative to the predicted drawdown in the near surface groundwater levels	Repeat water level monitoring to confirm. Refer to an independent hydrogeologist for review	Bloomfield Environmental Officer	Inform relevant agencies within 7 days. Investigation initiated within 1 week.	Inform agencies of baseline assessment and monitoring. Identify, investigate and report on impacts to groundwater levels.
	Groundwater quality in piezometers	6 monthly: pH, EC, TDS Yearly: Cations, Anions, Nutrients & Dissolved metals	To provide baseline water quality data and to identify any water quality impacts	An observed increase or decrease in salinity by more than 25 percent outside the min or max baseline range, sustained over a consecutive 6 month period	Repeat groundwater sampling to confirm. Refer to an independent hydrogeologist for review	Bloomfield Environmental Officer	Inform relevant agencies within 7 days. Investigation initiated within 1 week.	Inform agencies of baseline assessment and monitoring. Identify, investigate and report on impacts to groundwater quality.
Hydraulic connection with near surface groundwaters and baseflow impacts	Groundwater level in piezometers	Quarterly	To identify any baseflow impacts to the creeks	Alluvium/Colluvium Piezometers: An additional drawdown of 1m relative to the predicted drawdown in the near surface groundwater levels Coal Measures: Nil	Repeat water level monitoring to confirm. Refer to an independent hydrogeologist for review	Bloomfield Environmental Officer	Inform relevant agencies within 7 days. Investigation initiated within 1 week.	Ensure adequate baseflows are maintained to Wallis and Buttai Creeks.
	Groundwater quality in piezometers	6 monthly: pH, EC, TDS Yearly: Cations,	Identify any water quality impacts to near surface	An observed increase or decrease in salinity by more than 25 percent outside the	Repeat groundwater sampling to confirm. Refer to an	Bloomfield Environmental Officer	Inform relevant agencies within 7 days. Investigation	Identify, investigate and report on water quality impacts to near surface ground waters

Aspect	Parameter	Frequency	Purpose	Trigger	Action	Responsibility	Timing	Purpose
		Anions, Nutrients & Dissolved metals	ground waters	min or max baseline range, sustained over a consecutive 6 month period	independent hydrogeologist for review		initiated within 1 week.	associated with Wallis and Buttai Creeks.
Mine inflows	Flow rate	Daily (record of pump times kept when pumping)	Identify unexpected high mine inflows and determine whether this will impact on near-surface groundwater	An observed inflow rate 100% in excess of the predicted inflow rate at any stage during the mine life sustained for 3 consecutive months	Refer to an hydrogeologist for review	Bloomfield Environmental Officer	Inform relevant agencies within 7 days. Investigation initiated within 1 week.	Identify, investigate and report on drawdown impacts to existing users and creeks
Licenced Discharge	Water quality and volume	As per EPL requirement for TSS, EC, pH, TDS and Fe	Ensure mining activities are not polluting Four Mile Creek	Limits stipulated by EPL Licence 369	Repeat water quality sampling to confirm. Investigation to be undertaken and reported in accordance with Licence requirements.	Bloomfield Environmental Officer	Inform relevant agencies within 7 days. Investigation initiated within 1 week.	Identify, investigate and report on impacts to Four Mile Creek

4.0 References

ANZECC, 2000. Australian and New Zealand Guidelines for Fresh and Marine Water Quality.

Aquaterra Consulting Pty Ltd, 2008a. Bloomfield Completion of Mining and Rehabilitation Groundwater Modelling. Report to Peter Dundon and Associates Pty Ltd. May 2008.

Aquaterra Consulting Pty Ltd, 2008b. Bloomfield Completion of Mining and Rehabilitation Groundwater Impact Assessment. Report to Peter Dundon and Associates Pty Ltd. September 2008.

Aquaterra Consulting, 2010. Bloomfield Colliery Groundwater Management Plan, March 2010.

HydroSimulations, 2017. Bloomfield Colliery Extension Groundwater Modelling and Assessment, October 2017

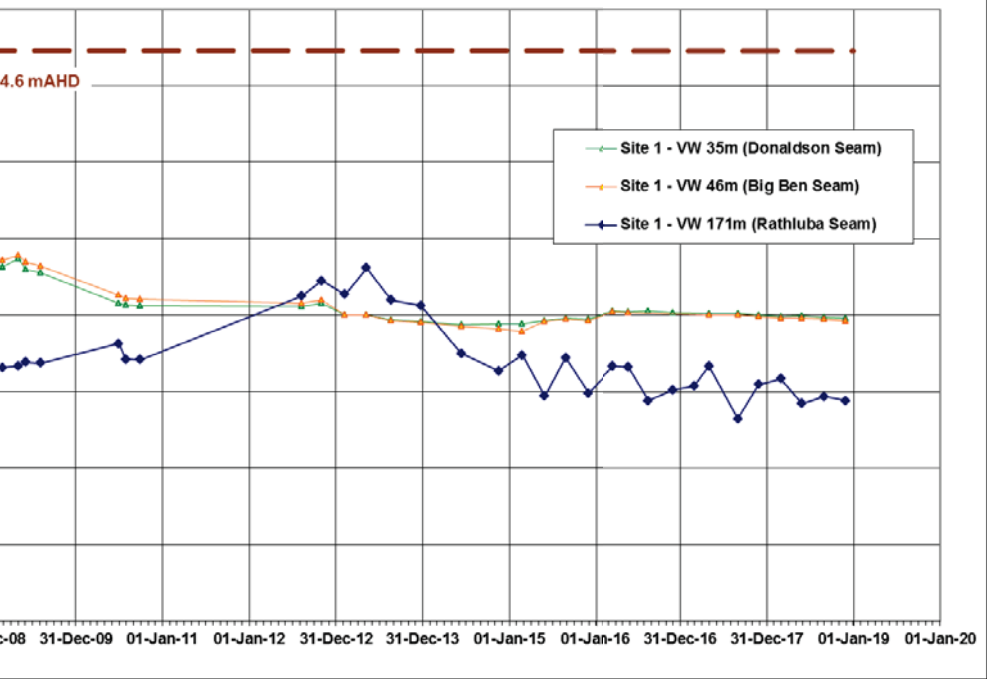
AECOM, 2018, Groundwater Impact Assessment Bloomfield Colliery Pty Ltd, January 2018

Appendix A

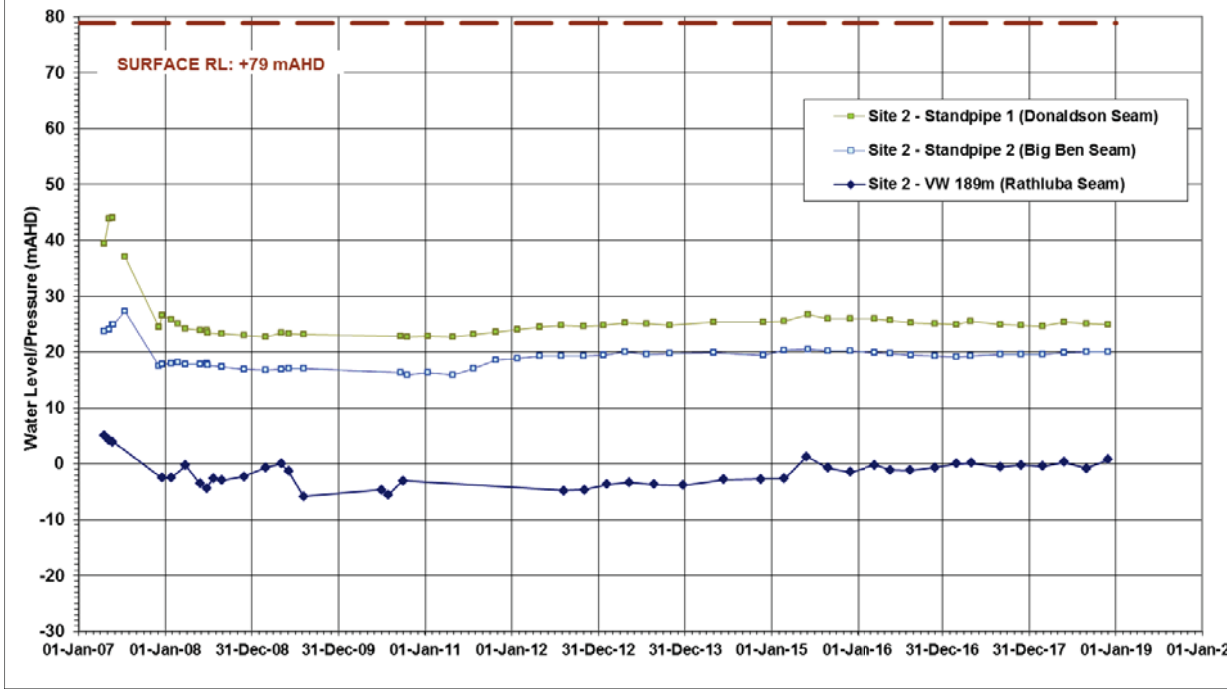
Hydrographs

Appendix A Hydrographs

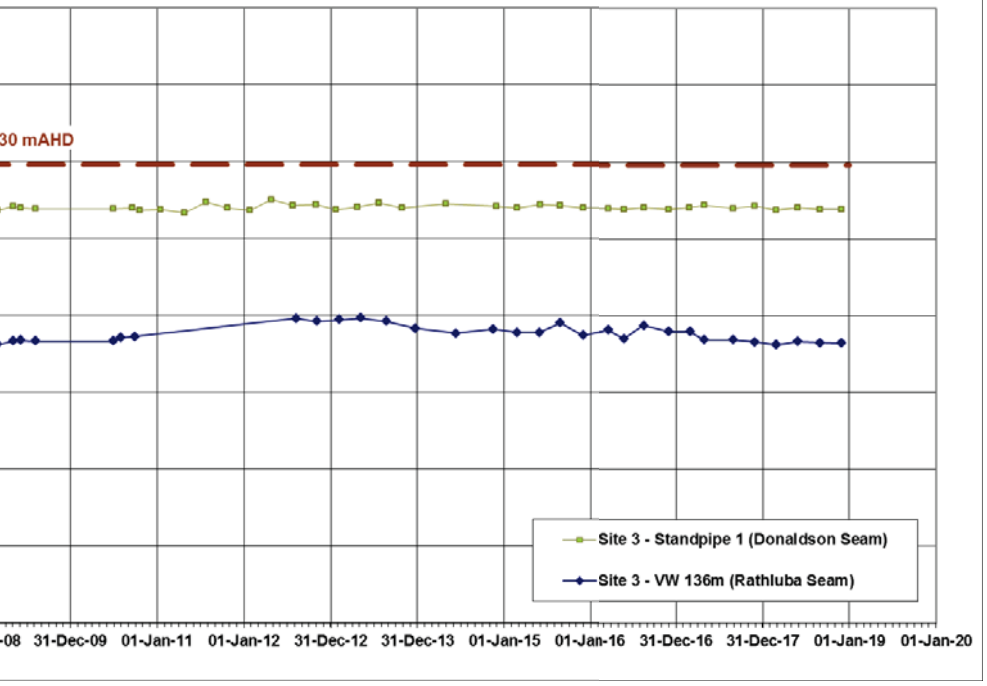
GROUNDWATER LEVEL HYDROGRAPH - BLOOMFIELD Site 1



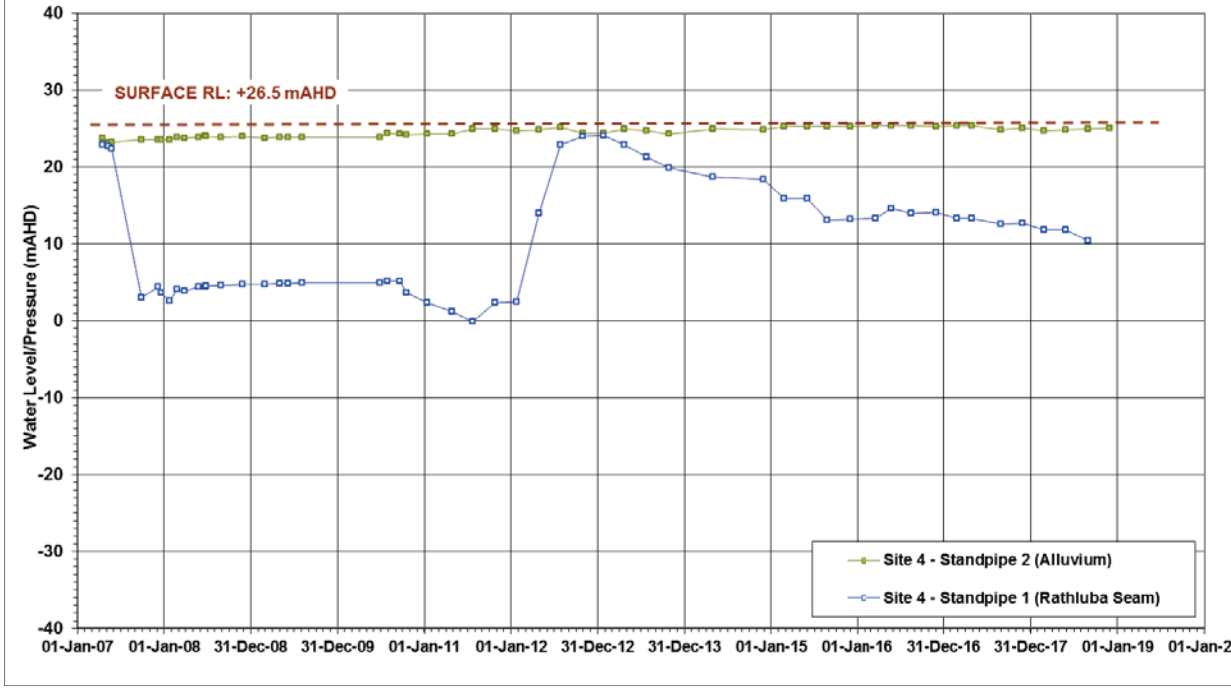
GROUNDWATER LEVEL HYDROGRAPH - BLOOMFIELD Site 2



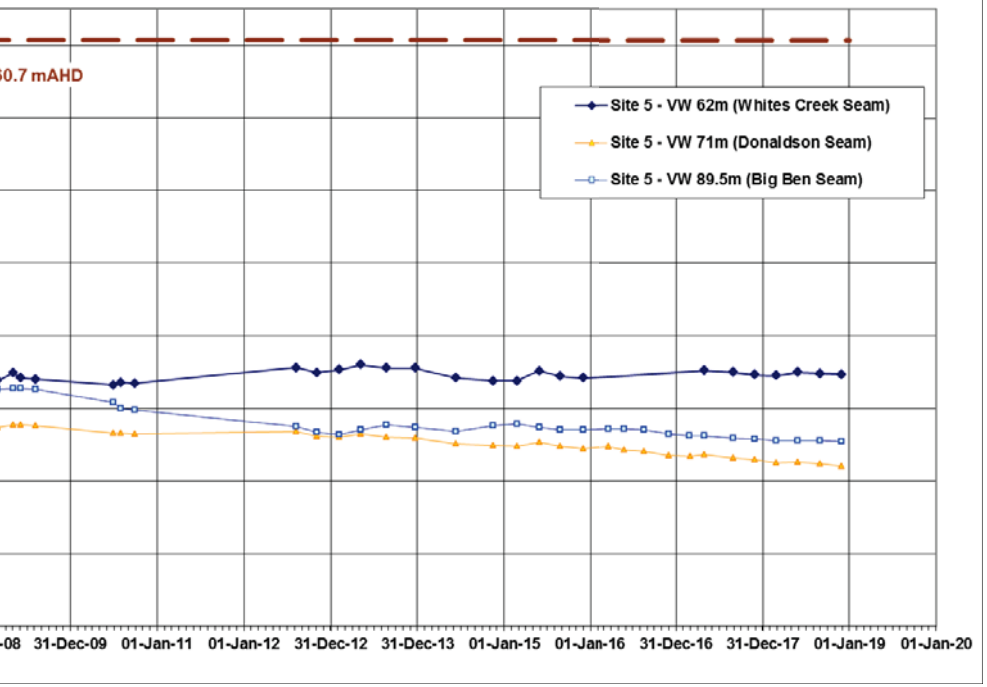
GROUNDWATER LEVEL HYDROGRAPH - BLOOMFIELD Site 3



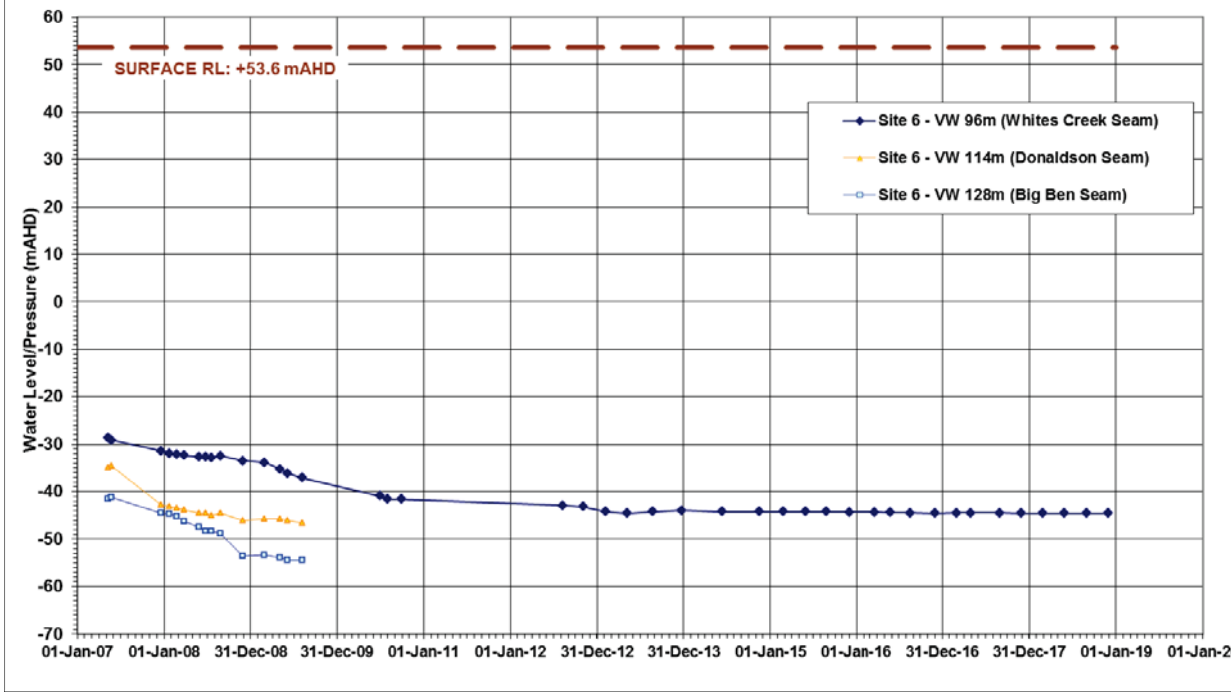
GROUNDWATER LEVEL HYDROGRAPH - BLOOMFIELD Site 4



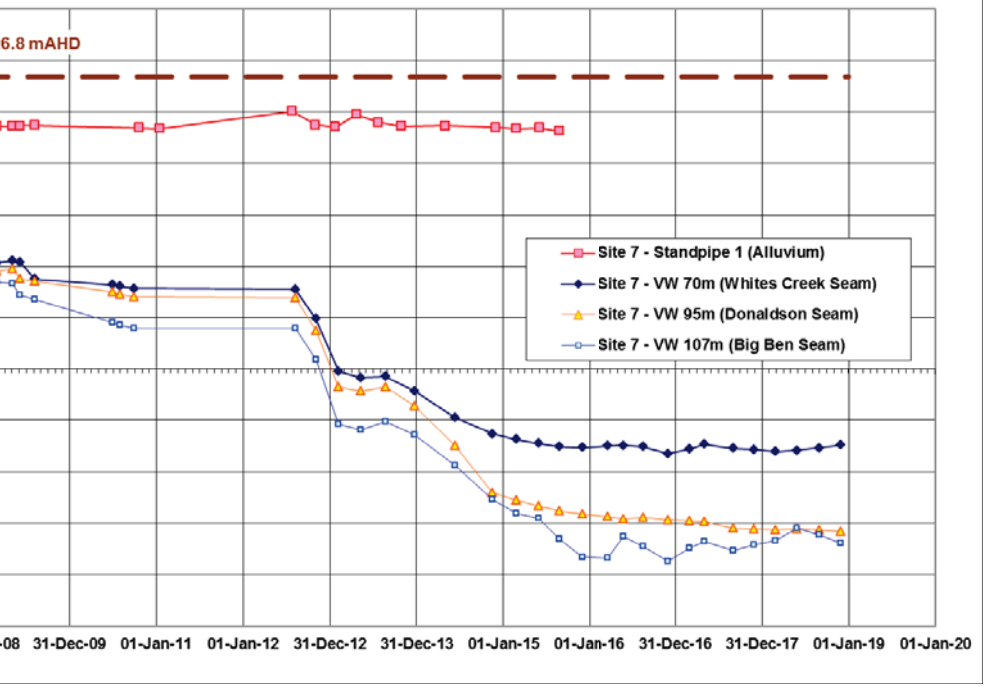
GROUNDWATER LEVEL HYDROGRAPH - BLOOMFIELD Site 5



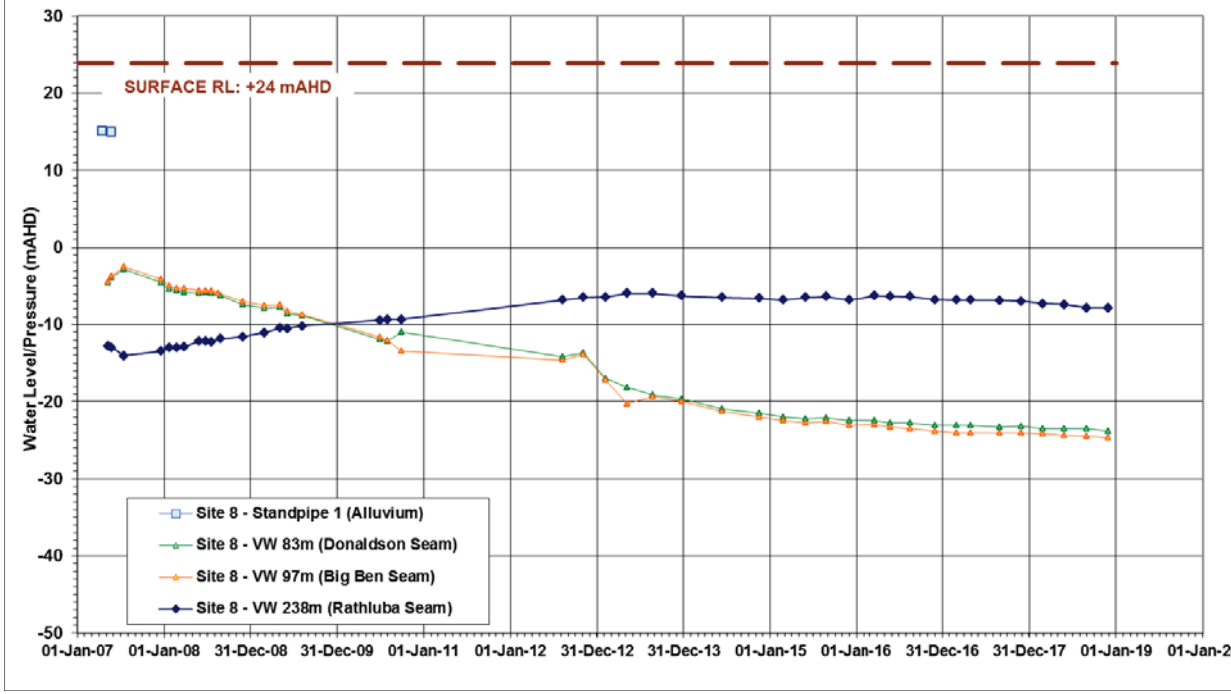
GROUNDWATER LEVEL HYDROGRAPH - BLOOMFIELD Site 6



GROUNDWATER LEVEL HYDROGRAPH - BLOOMFIELD Site 7



GROUNDWATER LEVEL HYDROGRAPH - BLOOMFIELD Site 8



Appendix B

Groundwater chemistry

Appendix B Groundwater chemistry

Bore **PD2.1** **Buttai Reservoir**

Date	RL	Depth (m)	pH	EC (uS/cm)	TDS (mg/L)	Alkalinity (mg/L)	Sulphate (mg/L)	Chloride (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Potassium (mg/L)	Iron (mg/L)	Comments
20-Sep-10	22.87	56.33	6.67	5350	3780	569	730	1330	32	74	1150	24	0.29	
19-Oct-10	22.63	56.57	6.72	6000	3100	553	802	1210	34	78	1330	27	2.45	
14-Jan-11	22.84	56.36	6.6	6420	3750	598	718	1260	30	73	1310	28	1.47	
27-Apr-11	22.61	56.59	6.6	6560	3610	483	953	1120	32	90	1200	26	2.14	
25-Jul-11	23.13	56.07	6.64	6320	3810	541	621	1230	30	72	1280	28	1.28	
26-Oct-11	23.64	55.56	7.09	6170	3660	503	506	1290	27	67	1270	29	1.61	
25-Jan-12	24.02	55.18	7.06	5720	3330	430	607	1300	34	56	1180	29	1.39	
27-Apr-12	24.44	54.76	6.64	5270	3490	409	418	1270	36	47	1130	29	1	
27-Jul-12	24.71	54.49	7.32	6120	3830	355	608	1650	134	74	1320	35	0.05	
31-Oct-12	24.64	54.56	6.74	5950	3990	592	874	1240	48	79	1370	33	11.4	
24-Jan-13	24.80	54.40	7.3	6360	4130	590	816	1190	67	78	1320	31	0.85	
22-Apr-13	25.23	53.97	6.81	6080	4170	549	654	1210	54	79	1220	30	0.79	
24-Jul-13	25.00	54.20	7.21	6820	3830	212	450	1700	159	34	1290	37	1.99	
28-Oct-13	24.82	54.38	6.87	6380	3990	622	726	1200	38	80	1310	31	2.06	
02-May-14	25.34	53.86	6.84	6460	3800									
29-Nov-14	25.40	53.80	7.3	6460	3740	560	503	1600	96	53	1220	27	0.05	
24-Feb-15	25.42	53.78												
03-Jun-15	26.72	52.48	6.7	6350	3170									
26-Aug-15	25.87	53.33												
30-Nov-15	25.92	53.28	6.9	5520	3420	350	310	1300	87	33	1300	33	0.05	
21-Mar-16	25.92	53.28												
25-May-16	25.70	53.50	7	5000	2600									
19-Aug-16	25.17	54.03												
30-Nov-16	25.12	54.08	7.3	4700	3010	330	220	1200	120	16	1100	29	0.01	
27-Feb-17	24.89	54.31												
01-May-17	25.54	53.66	8	3920	2513									
31-Aug-17	24.86	54.34												
29-Nov-17	24.74	54.46	7	4650	3020	280	400	1200	72	25	1100	24	0.02	

Source: ARR (2017)

Bore **PD2.2** **Buttai Reservoir**

Date	RL	Depth (m)	pH	EC (uS/cm)	TDS (mg/L)	Alkalinity (mg/L)	Sulphate (mg/L)	Chloride (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Potassium (mg/L)	Iron (mg/L)	Comments
20-Sep-10	16.29	63.37	6.69	5140	4500	319	1890	695	183	180	943	20	4.22	
19-Oct-10	15.88	63.78	6.79	5780	4300	333	2010	706	185	180	1040	22	8.83	
14-Jan-11	16.38	63.28	6.65	6170	4220	342	2300	728	191	189	1070	24	9.19	
27-Apr-11	15.87	63.79	6.42	6270	4500	288	1890	701	171	206	952	23	7.52	
25-Jul-11	17.12	62.54	6.29	6090	4250	239	1800	806	167	209	972	27	31.1	
26-Oct-11	18.58	61.08	7.03	5960	4320	206	1740	791	157	204	1000	29	6.23	
25-Jan-12	18.81	60.85	7.07	6460	4840	483	1480	1130	100	177	1170	33	0.05	
27-Apr-12	19.23	60.43	6.44	5720	4230	282	1360	1110	106	194	1090	33	23.6	
27-Jul-12	19.21	60.45	6.52	5720	4390	272	1710	1070	97	182	1110	32	30.5	
31-Oct-12	19.23	60.43	6.35	5650	4040	205	1840	892	100	178	1190	33	32.9	
24-Jan-13	19.36	60.30	6.73	5810	4110	241	1820	838	115	203	1140	31	29.1	
22-Apr-13	19.95	59.71	6.4	5480	3990	217	1480	852	76	160	1070	30	32.4	
24-Jul-13	19.53	60.13	6.81	6120	4100	246	1520	899	84	168	1140	32	12.2	
28-Oct-13	19.65	60.01	6.54	6450	4140	271	1490	901	79	154	1160	30	26.4	
02-May-14	19.94	59.72	6.46	6260										
29-Nov-14	19.36	60.30	6.7	5880	3610	302	1440	1010	70	127	1040	24	0.05	
24-Feb-15	20.35	59.31												
03-Jun-15	20.44	59.22	6.7	6110	3050									
26-Aug-15	20.22	59.44												
30-Nov-15	20.16	59.50	6.6	5670	4180	310	1300	890	66	150	1200	34	10	
21-Mar-16	19.90	59.76												
25-May-16	19.79	59.87	6.8	5800										
19-Aug-16	19.36	60.30												
30-Nov-16	19.24	60.42	6.7	5730	5510	400	2100	690	280	230	1200	25	1.9	
27-Feb-17	19.18	60.48												
01-May-17	19.32	60.34	7.3	5370	3447									
31-Aug-17	19.60	60.06												
29-Nov-17	19.63	60.03	6.8	5670	4030	360	1300	1100	55	120	1400	28	0.01	

Source: ARR (2017)

Bore PD3 **Shamrock Lane**

Date	RL	Depth (m)	pH	EC (uS/cm)	TDS (mg/L)	Alkalinity (mg/L)	Sulphate (mg/L)	Chloride (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Potassium (mg/L)	Iron (mg/L)	Comments
20-Sep-10	23.88	7.12	4.1	2660	2090	1	958	220	34	112	374	21	0.09	
19-Oct-10	23.62	7.38	6.37	5890	5120	217	2710	510	262	311	884	27	22.6	
14-Jan-11	23.78	7.22	6.59	6040	4940	168	2890	507	247	300	878	29	0.05	
27-Apr-11	23.27	7.73	6.7	6680	5390	134	2790	545	256	333	863	28	0.05	
25-Jul-11	24.75	6.25	6.24	6520	5280	134	2440	614	247	309	874	30	7.05	
26-Oct-11	23.97	7.03	6.52	6420	5170	120	2780	615	267	328	1010	34	0.05	
25-Jan-12	23.62	7.38	7.03	6580	6640	130	3160	595	273	347	980	33	0.06	
27-Apr-12	24.97	6.03	6.26	6190	5280	185	2670	604	286	331	957	33	0.38	
27-Jul-12	24.29	6.71	6.35	6350	5860	158	3530	622	308	345	985	33	0.61	
25-Oct-12	24.38	6.62	6.54	6820	5880	98	3280	599	362	380	1020	35	0.05	
24-Jan-13	23.70	7.30	6.07	6520	5430	2	3880	484	354	365	977	33	0.11	
22-Apr-13	24.01	6.99	5.74	5800	5340	46	3070	433	210	354	896	34	113	
24-Jul-13	24.61	6.39	5.76	6520	5720	85	3240	448	281	377	915	35	34.2	
22-Oct-13	23.92	7.08	4.63	6660	5480	1	3030	444	241	351	874	35	62.1	
02-May-14	24.48	6.52	6.2	6970										
29-Nov-14	24.17	6.83	3.5	6840	6390	5	3690	547	317	332	870	28	2.97	
24-Feb-15	23.98	7.02												
03-Jun-15	24.36	6.64	5.9	3820	1900									
26-Aug-15	24.27	6.73												
30-Nov-15	23.98	7.02	6.2	5550	5720	110	2700	400	290	330	960	37	71	
21-Mar-16	23.93	7.07												
25-May-16	23.84	7.16	6	3500	1800									
19-Aug-16	24.02	6.98												
30-Nov-16	23.89	7.11	5.2	3480	3190	15	1500	220	130	170	640	24	0.01	
27-Feb-17	24.03	6.97												
01-May-17	24.33	6.67	6.3	3740	2399									
31-Aug-17	23.97	7.03												
29-Nov-17	24.24	6.76	5.9	4670	4660	28	2600	390	240	270	990	29	17	

Source: ARR (2017)

Date	RL	Depth (m)	pH	EC (uS/cm)	TDS (mg/L)	Alkalinity (mg/L)	Sulphate (mg/L)	Chloride (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Potassium (mg/L)	Iron (mg/L)	Comments
20-Sep-10	5.23	21.35	7.17	12600	8200	520	306	3950	190	298	1980	32	0.05	
19-Oct-10	3.61	22.97	7.48	12800	7760	534	309	4390	188	291	2230	35	0.05	
14-Jan-11	2.42	24.16	7.16	13600	8290	548	359	4110	173	276	2180	38	0.05	
27-Apr-11	1.21	25.37	7.18	14800	7750	561	354	4130	178	301	2100	37	0.05	
25-Jul-11	-0.06	26.64	7.15	13700	7840	522	271	4230	176	295	2210	39	0.05	
26-Oct-11	2.36	24.22	7.53	13300	7760	461	387	4210	175	309	2350	43	0.05	
25-Jan-12	2.46	24.12	7.61	13100	8340	502	640	4320	164	331	2240	42	0.21	
27-Apr-12	14.00	12.58	6.24	2420	1890	28	1150	98	127	96	328	12	0.13	Case fail
27-Jul-12	22.97	3.61	6.34	6340	1950	27	1240	56	116	97	295	14	0.2	
25-Oct-12	23.98	2.60	6.54	10470	7350	244	2680	2040	198	402	1870	35	14.8	
24-Jan-13	24.13	2.45	6.64	10440	7040	324	2180	2600	189	352	1880	32	9.07	
22-Apr-13	22.89	3.69	6.59	10670	7700	284	1900	2600	191	384	2010	32	6.54	
24-Jul-13	21.35	5.23	6.78	11170	7400	303	1810	2560	209	386	1930	35	5.32	
28-Oct-13	19.88	6.70	7.09	11650	7460	353	1830	2640	192	360	1870	34	0.15	
02-May-14	18.69	7.89	7.06	11300										
29-Nov-14	18.41	8.17	7.2	10800	7610	400	1800	2810	193	321	1760	25	0.05	
24-Feb-15	15.93	10.65												
03-Jun-15	15.96	10.62	6.8	10760	5380									
26-Aug-15	13.18	13.40												
30-Nov-15	13.21	13.37	7.1	9200	7650	390	2000	2800	190	370	2300	39	0.04	
21-Mar-16	13.31	13.27												
25-May-16	14.62	11.96	5.9	2020	1010									
19-Aug-16	14.00	12.58												
30-Nov-16	14.08	12.50	6.7	4030	3200	130	980	720	150	160	780	20	0.14	
27-Feb-17	13.32	13.26												
01-May-17	13.37	13.21	7.1	2580	1638									
31-Aug-17	12.64	13.94												
29-Nov-17	12.70	13.88	6.7	4650	3660	150	1200	1000	160	180	930	21	0.07	

Source: ARR (2017)

Bore PD4.2 **Product Stockpile Pad**

Date	RL	Depth (m)	pH	EC (uS/cm)	TDS (mg/L)	Alkalinity (mg/L)	Sulphate (mg/L)	Chloride (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Potassium (mg/L)	Iron (mg/L)	Comments
20-Sep-10	24.30	2.69	5.63	8390	7870	69	3900	1150	123	424	1500	30	19.5	
19-Oct-10	24.24	2.75	5.59	9060	8630	73	4870	438	163	527	1700	34	45	
14-Jan-11	24.31	2.68	5.4	9970	8880	55	5740	462	134	492	1790	37	36.8	
27-Apr-11	24.33	2.66	5.36	10800	8770	45	5470	398	147	531	1690	37	33	
25-Jul-11	24.99	2	4.32	9440	5990	1	4670	364	179	510	1540	37	0.87	
26-Oct-11	24.96	2.03	5.72	8220	4600	24	4550	358	261	520	1330	34	57.1	
25-Jan-12	24.80	2.19	5.63	7610	8550	7	4370	277	195	482	1180	31	50.6	
27-Apr-12	24.89	2.10	5.35	5890	5710	1	3210	230	168	366	930	26	63.3	
27-Jul-12	25.19	1.80	5.44	5440	6400	12	4260	238	182	415	1030	29	44.1	
25-Oct-12	24.46	2.53	3.82	7210	6780	1	4580	245	286	489	1110	31	65.4	
24-Jan-13	24.48	2.51	5.67	6760	5960	26	4940	176	298	465	1060	27	71	
22-Apr-13	24.98	2.01	5.16	6180	6430	22	4500	156	272	465	1030	26	89.2	
24-Jul-13	24.80	2.19	5.41	7160	6940	26	4410	184	351	475	1010	26	79.4	
28-Oct-13	24.34	2.65	5.7	7650	7390	1	4370	229	326	474	1050	26	77.5	
02-May-14	24.99	2.00	5.75	7100										
29-Nov-14	24.91	2.08	4.2	7300	7260	5	4600	338	410	403	958	21	16.5	
24-Feb-15	25.24	1.75												
03-Jun-15	25.28	1.71	5.5	7780	3870									
26-Aug-15	25.26	1.73												
30-Nov-15	25.29	1.70	5.9	5930	7310	49	4400	270	360	400	1100	31	50	
21-Mar-16	25.41	1.58												
25-May-16	25.39	1.60	5.5	6200	3400									
19-Aug-16	25.38	1.61												
30-Nov-16	25.26	1.73	5.5	5730	6640	25	3900	230	360	360	1000	25	0.06	
27-Feb-17	25.40	1.59												
01-May-17	25.41	1.58	6.6	5740	3681									
31-Aug-17	24.88	2.11												
29-Nov-17	25.02	1.97	6.2	5910	7420	49	4500	220	440	390	1200	26	36	

Source: ARR (2017)

Bore PD7.1 **South Cut Boundary**

Date	RL	Depth (m)	pH	EC (uS/cm)	TDS (mg/L)	Alkalinity (mg/L)	Sulphate (mg/L)	Chloride (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Potassium (mg/L)	Iron (mg/L)	Comments
20-Sep-10	17.13	10.37	6.71	4620										
19-Oct-10	16.94	10.56	6.57	4760	2640	418	477	1020	160	124	731	14	8.66	
14-Jan-11	16.78	10.72												No sample
27-Apr-11														No access
25-Jul-11														No access
26-Oct-11														No access
25-Jan-12	17.65	9.85	6.67	3020	1720	508	99	693	73	69	455	14	0.74	
27-Apr-12	19.08	8.42	5.71	2670	1850	30	434	571	75	77	408	11	13.9	
27-Jul-12	20.14	7.36	4.84	4840	1540	2	290	741	40	58	415	10	22.7	
31-Oct-12	17.48	10.02	6.44	3560	2340	211	507	848	132	110	587	14	32	
24-Jan-13	17.11	10.39	6.86	3620	2340	234	559	756	125	104	557	14	13.4	
22-Apr-13	19.52	7.98	5.15	1754	1210	7	243	446	25	36	340	7	0.27	
24-Jul-13	17.96	9.54	6.18	2220	1240	74	289	475	45	46	376	9	1.91	
28-Oct-13	17.31	10.19	6.32	7120	4680	95	444	1810	208	217	904	21	28.1	
02-May-14	17.36	10.14	5.87	12000										
29-Nov-14	17.05	10.45	6.5	8650	6420	187	562	2870	237	270	1130	19	31.3	
24-Feb-15	16.80	10.70												
03-Jun-15	16.95	10.55	6.1	6990	3480									
26-Aug-15	16.33	11.17												
30-Nov-15														Dry
21-Mar-16														Dry
25-May-16														Dry
19-Aug-16														Dry
30-Nov-16														Dry
27-Feb-17														Dry
01-May-17														Dry
31-Aug-17														Dry
29-Nov-17														Dry

Source: ARR (2017)

Appendix F

Regulatory Correspondence

Appendix F Regulatory Correspondence

NSW GOVERNMENT | Planning & Environment

Planning Services
Resource Assessments
Contact: Jack Murphy
Phone: 8217 2016
Email: jack.murphy@planning.nsw.gov.au

Mr Greg Lamb
Environmental Officer
Bloomfield Colliery Pty Ltd
PO Box 4
East Maitland NSW 2323

Dear Mr Lamb,

Bloomfield Coal Project (PA 07_0087)
Appointment of Suitably Qualified and Experience Person

I refer to your email dated 19 September 2018 requesting the Secretary's endorsement of suitably qualified and experienced experts to prepare the Water Management Plan for the Bloomfield Coal Project (PA 07_0087).

The Department has reviewed the credentials of Ms Kelly Mulhearn and Ms Amanda Kerr of AECOM and agrees that they are suitably qualified experts. In accordance with condition 19 of Schedule 3 of PA 07_0087, the Secretary endorses Ms Kelly Mulhearn and Ms Amanda Kerr to prepare the above document.

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

Yours sincerely

19/9/18

Megan Dawson
A/Director Resource Assessments
as the Secretary's nominee

DOC19/323870-1

AECOM
PO Box 73
HUNTER REGION MAIL CENTRE NSW 2310

Email: Kelly.Mulhearn@aecom.com

Attention: Kelly Mulhearn

Dear Ms Mulhearn

REQUEST FOR CONSULTATION – BLOOMFIELD WATER MANAGEMENT PLAN

Reference is made to your email dated 11 April 2019 to the Environment Protection Authority ("EPA") requesting consultation in relation to the *Bloomfield Water Management Plan*.

The EPA encourages the development of such plans to ensure that proponents have met their statutory obligations and designated environmental objectives. However, the EPA does not undertake consultation of these documents as our role is to set environmental objectives for environmental/conservation management, not to be directly involved in the development of strategies to achieve those objectives.

The EPA has not undertaken consultation of this report and accordingly offers no comment in relation to it.

If you wish to discuss the matter further, please contact me on 02 4908 6869.

Yours sincerely

JENNY LANGE
Regional Operations Officer - Hunter
Environment Protection Authority
17 April 2019

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Phone 02 4908 6800
Fax 02 4908 6810
TTY 133 677
ABN 43 692 285 758
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Contact: Ellie Randall
Phone: 02 4275 9308
Email: ellie.randall@nrar.nsw.gov.au

Our ref: OUT19/8762

Kelly Mulhearn
Principal Environmental Engineer
AECOM
PO Box 73
Hunter Region MC NSW 2304

email: Kelly.mulhearn@arcom.com

2 July 2019

Dear Kelly

Project Approval 07-0087 - Bloomfield Water Management Plan

Thank you for giving the Department of Industry – Lands and Water (DoI Water) the opportunity to comment on the Bloomfield Water Management Plan. DoI Water has reviewed the plan and provides the following comments:

Prior to approval

1 **Groundwater Monitoring**: Requirement *(a)* – '*further development of the regional and local groundwater model'*. The groundwater model is to be revised with guidance on timeframes and specific 'development' objectives.

2 **Groundwater Monitoring**: Requirement (b) – 'detailed baseline data to benchmark the natural variation in groundwater levels, yield and quality (including at any privately owned bores in the vicinity of the site) *in the absence of 2 years of baseline pre-mining data, the proponent must use the earliest available data of known date and source/origin would suffice, with acknowledgement of its limitations.*.

3 **Groundwater Monitoring**: Requirement *(c)* - '*groundwater impact assessment criteria'* is to be expanded on with detail on assessment techniques (e.g. charting groundwater level against cumulative deviation rainfall data, comparing observations with numerical model predictions etc.).

4 **Groundwater Monitoring**: Requirement (d) – 'a program to monitor the impact of the project on groundwater levels, yield, quality, groundwater dependent ecosystems and riparian vegetation'. A program is proposed but needs to be more prescriptive in terms of the bores to be monitored (i.e. locations, depths and strata targeted) and how they will cater for recognising impacts to GDE's and riparian vegetation.

5 **Groundwater Monitoring**: Procedures to be included for *(e)* '*verification of the groundwater model* and *(f)* reporting on '*the results of the monitoring program and model verification'.*

6 **Surface and Groundwater Response Plan**: Include, within the Surface and Groundwater Response Plan (Part F of the Water Management Plan), measures and/or procedures for investigation of, compensation for, and mitigation of impacts to groundwater (quantity and quality).

7 **Water Management Plan**: Establish a consistent relationship between the text, specifically ’Parts’ and ‘Appendices’, and explain this at the start of the main text. The plan can be unclear in distinguishing the purpose of ‘Parts’ vs ‘Appendices’.

Should you have any further queries in relation to this submission please do not hesitate to contact Ellie Randall on (02) 4275 9308. Additionally, a hydrogeologist can be made available if further clarification is required. Please note the generic email address for correspondence is nrar.servicedesk@industry.nsw.gov.au.

Yours sincerely

Alison Collaros
Licensing and Approvals Manager (East)
Natural Resources Access Regulator
Department of Planning, Industry and Environment

Review of each element against requirements

An assessment has been undertaken with direct reference to the conditions of the Project Approval (dated 3 September, 2009) and identification of groundwater-related requirements, which occur within sections on:

1. Water Management Plan
2. Site Water Balance
3. Groundwater Monitoring
4. Surface and Groundwater Response Plan

Conditions of approval that have not been adequately represented in the Water Management Plan, and subsequently are at risk of not being adequately addressed are summarised below, with comments by DoI Water:

Water Management Plan

'The Proponent must prepare a Water Management Plan for the project to the satisfaction of the Secretary……..'
The Plan consists of six 'Parts', four of which (Parts B, C, D and E) have corresponding Appendices (Appendices B, C, D and E) at the back of the Plan.
It is unclear upfront within the Plan whether the Appendices are full / expanded versions of the Parts, or are additional detail or data to support selected aspects of the Parts, or whether the relationship varies between the different Parts and Appendices. This needs to be made clear at the front of the Plan, and possibly at the front of each Part.
Note: Parts B and C make reference, as they should, to their corresponding Appendices, but Parts D and E make no such reference.

Groundwater Monitoring

'The Groundwater Monitoring Program must include:

(a) further development of the regional and local groundwater model;

Requirement (a) is unclear, as it provides no guidance on timeframes or specific 'development' objectives. The proponent has subsequently responded with a list (in the Plan) of modifications made to the model, without any indication of when these were made.

(b) detailed baseline data to benchmark the natural variation in groundwater levels, yield and quality (including at any privately owned bores in the vicinity of the site);

The proponent has advised that there is no pre-mining data to use as a benchmark, and no alternative data is proposed. A benchmark could still be established with the earliest data available.

(c) groundwater impact assessment criteria;

Proposed impact assessment criteria are satisfactory, but could be expanded on with detail on assessment techniques (e.g. charting groundwater level against cumulative deviation rainfall data, comparing observations with numerical model predictions).

(d) a program to monitor the impact of the project on groundwater levels, yield, quality, groundwater dependent ecosystems and riparian vegetation;

A groundwater monitoring program is described in section. 5.5, but it does not appear to include nearby licenced production bores. It is uncertain whether the monitoring program includes both shallow and deep bores (in relation to mine depth - as no information has been provided on the depth of either the current open cut mine, or the previous underground operations). Further it is

not clear how the monitoring program will cater for recognising impacts to GDE's and riparian vegetation.

(e) procedures for the verification of the groundwater model;

No procedures provided

(f) reporting procedures for the results of the monitoring program and model verification'

No procedures provided.

Surface and Groundwater Response Plan

'The Surface and Groundwater Response Plan must describe the measures and/or procedures that would be implemented to:

*(a) investigate, notify and mitigate any exceedances of the surface water, stream health and **ground water impact** assessment criteria;*
*(b) compensate landowners of privately-owned land whose **water supply is adversely** affected by the project; and*
*(c) mitigate and/or offset any adverse impacts on **groundwater dependent ecosystems** or riparian vegetation.'*

Part F of the Plan comprises a '*Surface and Groundwater Response Plan'.* Investigation of, compensation for, and mitigation of impacts to groundwater (quantity and quality) have not been considered in Part F.

Mr Greg Lamb
Environmental Advisor
Bloomfield Colliery
Four Mile Creek Road
Ashtonfield, NSW, 2323

02/09/2020

Dear Mr Lamb

Bloomfield Coal Project (MP_07_0087)
Bloomfield Mining Operations Water Management Plan

I refer to the *Bloomfield Mining Operations Water Management Plan* which was submitted in accordance with Conditions 19 to 24 of Schedule 3 of the approval for the Bloomfield Coal Project (MP_07_0087).

The Department has carefully reviewed the document and is satisfied that it addresses the consent conditions and the Department's review comments of 17 July 2020.

Accordingly, the Planning Secretary has approved the *Bloomfield Mining Operations Water Management Plan* (Revision Rev1, dated August 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 02 8289 6873.

Yours sincerely

Matthew Sprott
Director
Resource Assessments (Coal & Quarries)

as nominee of the Planning Secretary

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