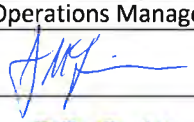
Ashton Coal
2018 Annual Review

Photos on title page:
Underground operations,
Grey Crowned Babbler recorded during targeted species searches (Umwelt)

Table 1 Title Block

Name of Operation	Ashton Coal
Name of Operator	Ashton Coal Operations Limited
Development consent number	DA No. 309-11-2001-i
Name of holder of development consent	Ashton Coal Operations Pty Limited
Mining Lease number	ML 1529 ML 1533 ML 1623
Name of holder of mining lease	ML 1529 -Ashton Coal Mines Limited, ML 1533 - White Mining Limited (ACN 009713893), White Mining (NSW) Limited (ABN 19 089 414 595), ICRA Ashton Pty Ltd ACN 097 499 780, ML 1623 - White Mining (NSW) Limited (ACN 089 414 595) Austral-Asia Coal Holdings Pty Ltd (ACN 110 038 663) and ICRA Ashton Pty Ltd (ACN 097 499 780) *
Water Licence Number	See Section 7
Name of holder of water licence	Ashton Coal Mines Limited
MOP / RMP start date (1)	28 March 2013
MOP / RMP end date (1)	30 June 2018
MOP start date (2)	1 July 2018
MOP end date (2)	26 February 2024
Annual Review Start date	1 January 2018
Annual review end date	31 December 2018
I, Aaron McGuigan, certify that this Annual Review is a true and accurate record of the compliance status of Ashton Coal for the period 1 January 2018 to 31 December 2018 and that I am authorised to make this statement on behalf of Ashton Coal Operations Limited. Note: a) The Annual Review is an 'environmental audit' for the purposes of section 122B (2) of the Environmental Planning and Assessment Act 1979. Section 122E provides that a person must not include false or misleading information (or provide information for inclusion in) an audit report produced to the Minister in connection with an environmental audit if the person knows that the information is false or misleading in a material respect. The maximum penalty is, in the case of a corporation, $1 million and for an individual, $250,000. b) The Crimes Act 1900 contains other offences relating to false and misleading information: section 192G (Intention to defraud by false or misleading statement—maximum penalty 5 years imprisonment); sections 307A, 307B and 307C (False or misleading applications/information/documents—maximum penalty 2 years imprisonment or $22,000, or both).	
Name of Authorised reporting officer	Aaron McGuigan
Title of authorised reporting officer	Operations Manager
Signature of authorised reporting officer	
Date	27-3-19.

*As of 31 December 2018, the Leaseholder names are correct. During 2014 Ashton Coal underwent some ownership changes. Applications were submitted to DRE for title changes but have not yet been processed.

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1 Statement of Compliance

The Annual Review guidelines require a statement of compliance which includes a summary table that highlights the compliance status of the operation with its relevant approval conditions, as at the end of the reporting period. This is shown in Table 2.

Table 2 Statement of Compliance as at 31 December 2018

Were all conditions of the relevant approvals complied with?	
Development Consent 309-11-2001-I (Mod 5)	yes
ML 1529	yes
ML 1533	yes
ML 1623	yes
EL 5860	yes
EL 4918	yes
EPL 11879	no
RML5061098	yes
Section 126 approval (8/4/2004)	yes
Section 126 approval (17/01/2007)	yes
Section 100 approval (2/01/2007)	yes
Section 100 approval (1/03/2012)	yes
AHIP 1131017	yes
AHIP 1130976	yes
WAL 984	yes
WAL 997	yes
WAL 1120	yes
WAL 1121	yes
WAL 1358	yes
WAL 6346	yes
WAL 8404	yes
WAL 15583	yes
WAL 19510	yes
WAL 29566	yes
WAL 23912	yes
WAL 36702	yes

Were all conditions of the relevant approvals complied with?	
WAL 36703	yes
Groundwater Licence 20BL169508	yes
Groundwater Licence 20BL173716	yes
Groundwater Licence 20BL173735	yes

Table 3 Non Compliances

Relevant Approval	Condition Number	Condition Summary	Compliance Status	Comment	Where addressed in Annual Review
EPL 11879	M2.2	Real time PM10 monitoring	Non-compliant	0.3 per cent of PM10 data was not captured within the reporting period.	Table 16
EPL 11897	M2.3	Groundwater Monitoring	Non-compliant	Data could not be collected from decommissioned bores.	Section 7.4.1

Table 4 Compliance Status for Table 3

Risk Level	Colour Code	Description
High	Non-compliant	Non-compliance with potential for significant environmental consequences, regardless of the likelihood of occurrence
Medium	Non-compliant	Non-compliance with: • Potential for serious environmental consequences, but is unlikely to occur, or • Potential for moderate environmental consequences, but is likely to occur
Low	Non-compliant	Non-compliance with: • Potential for moderate environmental consequences, but is unlikely to occur, or • Potential for low environmental consequences, but is likely to occur
Administrative non-compliance	Non-compliant	Only to be applied where the non-compliance does not result in any risk of environmental harm (eg. Submitting a report to government later than required under approval conditions).

2 Introduction

The Ashton Coal Project (ACP) is located approximately 14 kilometres north-west of Singleton in the Upper Hunter Valley, New South Wales (NSW). The ACP is adjacent to the Open-Cut mines of Glendell (Glencore), Rixs Creek and Rixs Creek North (Bloomfield Group), Hunter Valley Operations (Yancoal and Glencore) and Ravensworth Operations (Glencore). Adjacent Underground mines include Glennies Creek and Ravensworth Underground Mine (Glencore).

The ACP is operated by Ashton Coal Operations Limited (ACOL), and includes a decommissioned open cut coal mine, an underground coal mine, a Coal Handling and Preparation Plant (CHPP) and a rail siding. The Ashton Underground Coal Mine is approved to produce 5.45 Million tonnes per annum (Mtpa) of coal. In 2018, 1.9 million tonnes of run of mine coal was produced. This coal was processed and

exported through the Port of Newcastle, New South Wales.

Current operations are approved under DA 309-11-2001-i (Mod 5). This approval has been modified ten times, with the most current approval being Modification 5, granted on 20 June 2016. ACOL holds the South East Open Cut Project (SEOC) approved under MP 08_0182 (Mod 1). The SEOC Approval has not been taken up and is not within the scope of this AR.

This AR details the ACP's environmental and community performance for the reporting period 1 January 2018 to 31 December 2018. The operational area is shown in Figure 1.

This AR is a statutory approval requirement and has been prepared in accordance with the Ashton Coal Mine Project Approval (DA No. 309-11-2001-I (Mod 5); Schedule 5, Condition 10), annual reporting requirements of Mining Leases 1529, 1533, 1623 and 1696 and the commitments outlined in the Mining Operations Plan (MOP). The AR is written in accordance with the NSW Government Annual Review Guideline as published in October 2015.

The AR is distributed to a range of stakeholders and is available on the Ashton Coal website at http://www.ashtoncoal.com.au.

2.1 Mine Contacts

Relevant mine contacts are listed in Table 5.

Table 5 Mine contact details

Name	Role	Phone contact details
Aaron McGuigan	Operations Manager	(02) 6570 9104
Phillip Brown	Environment and Community Relations Superintendent	(02) 6570 9219 Mobile: 0439 909 952
Environment and Community Response Line	n/a	1800 657 639 Email: Ashton.environment&community@yancoal.com.au

Figure 1 Overview of operations

3 Approvals

Details of ACP's existing statutory approvals as at 31 December 2018 are provided below in Table 6. Water licences held by the ACP are discussed in Section 7.

Table 6 ACOL's primary statutory approvals as at 31 December 2018

Approval	Description	Issue date	Expiry date
Development consents or project approvals issued by the DPE			
DA 309-11-2001-i	Development Consent for the ACP (current development consent is Modification 5)	11/10/2002 Last modified 20/6/16	26/2/2024 or 12 years from recommencement of open cut operations, whichever is later.
Mining leases and exploration licences issued by the DPE-RR			
ML 1533	Mining Lease	26/02/2003	26/02/2024
ML 1529	Mining Lease	10/09/2003	11/11/2021
ML 1623	Mining Lease	30/10/2008	30/10/2029
EL 5860	Exploration Licence (EL)	23/10/2017	21/05/2020
EL 4918*	Exploration Licence	17/12/2010	17/12/2015
EPL issued by the EPA			
EPL 11879	Environment Protection Licence (EPL)	01/01 (anniversary date)	Not specified

* Renewal for exploration licence 4918 was lodged with DPE-RR on 17 December 2015.

Table 7 ACOL's other statutory approvals as at 31 December 2018

Approval	Description	Expiry date
Radiation Management Licence		
RML5061098	Radiation Management Licence	06/04/19
Aboriginal heritage		
Section 90 Consent Permits AHIP 1131017 AHIMS Permit ID 3436	Longwalls 1-4: Salvage excavations. Community collection. Harm to certain Aboriginal objects through proposed works. Certain Aboriginal objects must not be harmed	23/12/21
Section 90 Consent Permits AHIP 1130976	Longwalls 5-8: Movement only of certain Aboriginal objects. Test excavations. Salvage excavations. Community collection. Harm to certain Aboriginal objects through proposed works. Certain Aboriginal objects must not be harmed	26/08/31
Voluntary Conservation Agreement		
Conservation Agreement	Conservation agreement over the southern conservation area. Agreement between The Minister administering the NPW Act 1974 and Ashton Coal Mines Limited for Ashton Coal Mine.	Perpetuity
Tailings Emplacement approval		
S126 Approval	Emplacement of carbonaceous materials Ashton North East Open Cut (NEOC) Issued 08/04/04	Perpetuity
S126 Approvals	Emplacement of carbonaceous materials Ravensworth Void 4 Issued 17/01/07	Perpetuity
S100 Approval	Emplacement of coarse rejects materials in the NEOC void Issued 01/03/12	Perpetuity
S100 Approval	Emplacement of fine rejects in the Ravensworth Void No 4 Issued 2/01/2007	Perpetuity

During the reporting period, Ashton Coal received a letter from EPA entitled 'invitation to show cause – For possessing regulated material (sealed source devices) without a current radiation licence'. Following discussions with EPA, the Radiation Management Licence was renewed and no further action was taken.

3.1 Changes to approval documents

During the reporting period there were no changes to the development consent. In July 2017 a modification to EPL 11879 was lodged to streamline groundwater monitoring requirements, remove outdated conditions relating to open cut operations (e.g. Hours of operation and blasting activities) and align the EPL boundary with the development consent. The EPL variation is still in process.

3.1.1 South East Open Cut

ACOL hold the South East Open Cut Project (SEOC), to the south east of current approved surface operations. The SEOC approval (MP 08_0182) has not been taken up and is not within the scope of this AR. An administrative modification for the South East Open Cut SEOC Project was lodged in 2017 which sought to amend conditions which impose obligations or require compliance at a time prior to the physical commencement of the project. This was approved by the Independent Planning Commission in August 2018.

3.2 Mining Operations Plan

During 2018 the Mining Operations Plan (MOP) and the Rehabilitation Cost Estimate (RCE) was revised and approved. The approved MOP covers the period from 27 September 2018 to 30 September 2021 and was approved by DRG on 27 September 2018. The MOP satisfies the requirements of ESG3 Mining Operations Plan (MOP) Guidelines as published September 2013.

During the next reporting period, the MOP will be reviewed to ensure that the rehabilitation monitoring program is operating as effectively as possible. Recommendations may lead to changes to performance criteria, monitoring and measurement.

3.3 Extraction Plans

ACOL operates under a number of approved Extraction Plans, which give detailed information on how the impacts of subsidence will be managed as a result of the operation. Approved extraction plans can be found on the Ashton Coal website. During the reporting period, ACOL operated under the Upper Lower Liddell Seam Longwalls 201-204 Extraction Plan.

3.4 Environmental Management Plans

ACOL has developed a range of environmental management plans to meet the requirements of DA 309-11-2001-I (Mod 5). Management plans are reviewed and maintained in accordance with Schedule 5 Condition 6. A summary of the status of the management plans is provided in Table 8. Management plans required by the consent are published on http://www.ashtoncoal.com.au.

Table 8 Status of management plans as at 31 December 2018

Environmental management plan	Condition	Approval date	Reviewed
Environmental Management Strategy	Schedule 5 condition 1	04/10/2017	22/3/2018
Noise	Schedule 3 Condition 9	04/10/2017	14/12/2017
Air Quality	Schedule 3 Condition 17	04/10/2017	4/12/2017
Heritage	Schedule 3 condition 34	04/10/2017	20/02/2018
Biodiversity	Schedule 3 condition 28	04/10/2017	27/03/2018
Water	Schedule 3 Condition 26	01/03/2018	27/03/2018

Schedule 5 condition 3 allows management plans to be updated under the conditions of the consent that applied prior to the approval of Modification 5, or otherwise with the approval of the Secretary. Schedule 5, Condition 6 of the Project Approval requires review of all management plans within three months of the submission of the Annual Review.

4 Operations summary

During the reporting period there were no material changes to operations at the ACP. Open cut mining ceased in September 2011, with remaining open cut rehabilitation works completed between 2011 and 2012 (with the exception of the Open Cut Void which is used as coarse reject emplacement. There has been no topsoil works or overburden movement since this time. A summary of 2018 underground operations is provided below in Section 4.4. Mine Progression is shown in Figure 2.

4.1 Exploration

During the reporting period there was no surface exploration undertaken on the ACP and consequently no rehabilitation was undertaken on any boreholes.

4.2 Construction

During the reporting period the construction of the back road fan was finalised. The shaft was constructed during 2017 using the raise bore method from the Upper Lower Liddell (ULLD) seam to the surface. The back road fan surface infrastructure was moved from the ULD shaft to the ULLD shaft and the ULD fan site was decommissioned during the reporting period.

There was no rehabilitation of drilling sites or completed boreholes during the reporting period. Boreholes that are yet to be grouted or that require additional testing have been secured with borehole caps. During the reporting period there were no material variations from the MOP related to construction activities.

4.3 Hours of operation

Under Schedule 2, condition 8 of the Development consent DA 309-11-2001-i, underground mining may be undertaken 24 hours a day 7 days a week. Surface construction works on the site are limited to day periods only in the case of construction of gas wells, and day and evening periods only in the case of all other construction activities. There were no variations to approved operating hours during the reporting period.

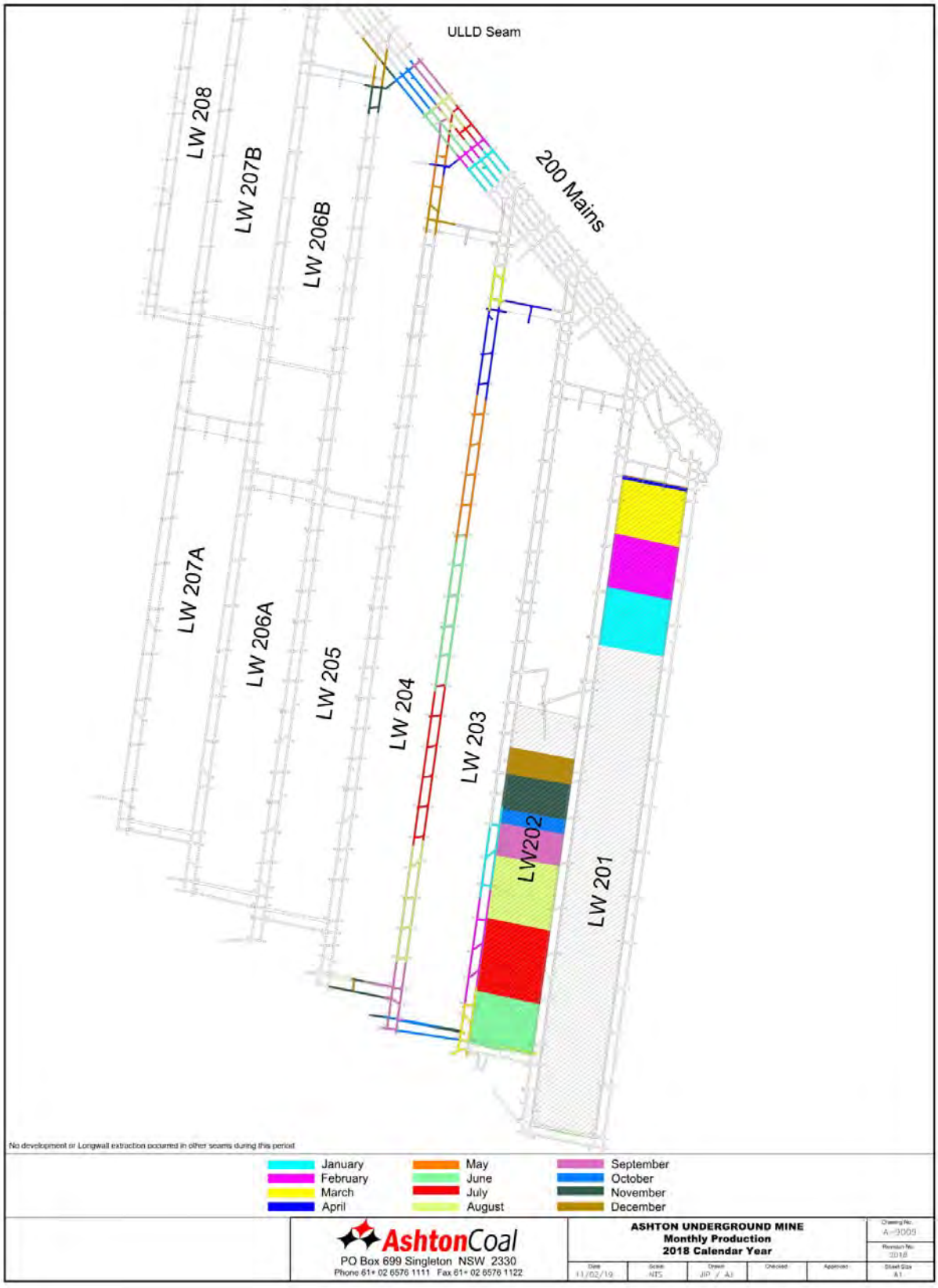

Figure 2 Mining Production, 2018

4.4 Mining

The underground mine is approved to extract coal from the Pikes Gully (PG), Upper Liddell (ULD), ULLD and Lower Barrett (LB) coal seams. The underground mine utilises the longwall method of coal extraction, following continuous miner development of main headings and twin heading gate-roads. The coal seam thickness varies from about 1.8m to 2.8m high. All underground roadways are driven at approximately 2.6 m mined height. The longwall has been designed to allow extraction of the full seam thickness. The expected underground mine life is until approximately 2027.

During the reporting period, coal was mined from the Upper Lower Liddell Seam (ULLD) (LW201 and LW 202). As detailed in the MOP, approximately 1.9 million tonnes of ROM coal was mined from the underground operations, resulting in approximately 825,000 t of product coal, which was transported by rail to the Port of Newcastle. Table 9 provides a summary of the mine's performance figures for the reporting period.

Table 9 Mine Performance Data, 2018

Material	Approved Limit (DA309-11-2001i)	2017 (previous reporting period)	2018 (current reporting period)	2019 (MOP Forecast)
Topsoil stripped	-	0	0	0
Topsoil Spread	-	0	0	0
Overburden	-	0	0	0
ROM Coal (t)	5,450,000	2,790,532	1,960,953	3,492,941
Coarse Reject (t)	-	1,342,842	897,707	1,308,355
Tailings (t)	-	291,740	252,503	327,089
Product Coal (t)	-	1,536,598	825,049	1,857,497

4.4.1 Gas management

During the reporting period, there were no new gas drainage boreholes constructed. There was minimal flaring of gas due to engineering issues with the gas drainage plant, which were resolved by the Original Equipment Manufacturer (OEM) towards the end of December. Gas management reverted to free venting, which had been utilised prior to the installation of flares, in order to maintain the health and safety of underground mine workers while issues with the gas drainage plant were addressed. Free venting resulted in higher greenhouse gas emissions during 2018 when compared to the previous year.

4.5 Next Reporting Period

In accordance with the approved Extraction Plan for Longwalls (LW) 201-204 in the ULLD, mining operations will continue during 2019 to mine in LW 202 before moving to LW 203 and potentially LW 204 towards the end of the year.

5 Actions required from previous review

Ashton committed to a number of actions in the 2017 AR and further actions were identified in the review of the AR by DPE and DRG. These are outlined in Table 10.

Table 10 Actions required from previous review

Action required from previous annual review	Source of Action	Action undertaken	Where discussed in annual review
Mine Operations Plan - Develop a new MOP according to the new Mine Operation Plan guideline and lodge for approval by the end of June 2018.	2017 Annual Review	A new MOP was lodged and approved during the reporting period.	3.2
NEOC runoff - Finalise best option for surface water runoff from the NEOC. Budget for future earthworks that may be required. Lodge a variation to the EPL if required. Update water management plan as required.	2017 Annual Review	Options for surface water runoff were finalised during the reporting period. Budgets and EPL variations will be completed in the future when the project is aligned with current mine plans.	Section 9.5
Baseline fauna survey, NEOC - Conduct a baseline fauna survey on the NEOC to further understand colonisation of NEOC rehabilitation. This information will be fed into future baseline data and completion criteria for parts of the NEOC rehabilitation.	2017 Annual Review	A baseline Fauna survey was undertaken in the NEOC Trees over Grass rehabilitation area during the reporting period. Further information is provided in Section 6.4.4	Section 6.4.4
Administrative – please include the Report's figures and tables in the table of contents and number the pages throughout the document. Include Table 3 – Compliance Status Key in accordance with the Department's AR guidelines.	DPE Annual review 2017 Letter, 3/9/18	Figures and tables are included in the contents section and pages are numbered.	Throughout
Approvals - please include all approvals in the Statement of Compliance in accordance with Schedule 2, Condition 9.2 a) of the approval. Consider including separate sub-headings to address the requirements of Schedule 2, Condition 9.3 e) of the Approval.	DPE Annual review 2017 Letter, 3/9/18	All approvals are listed in the Statement of Compliance. Schedule 2, condition 9.3e) was removed from the Project Approval in 2016.	Table 2
Figures - for completeness please include the proposed South East Open Cut project in Figure 1 and include an appropriate legend.	DPE Annual review 2017 Letter, 3/9/18	Noted. Figure 1 has been amended	Figure 1
Incidents and complaints - please include more information with the resolution of incidents or complaints e.g. what were the dust (or noise) results	DPE Annual review 2017 Letter, 3/9/18	Further information is included regarding each complaint. The trend graph contains at least five years of results. All complaints are included on the complaints register on the website.	Section 10.3 Figure 20

Action required from previous annual review	Source of Action	Action undertaken	Where discussed in annual review
and meteorological conditions during the incidents/complaints. Extend the complaint trend graph to include the life of the project (or last 5 years at least). Please ensure all complaints are included in the complaints register on the website.			http://www.ashtoncoal.com.aucommunity-complaints-register/
Greenhouse gas — please provide the emission data for the reporting year, and previous years, to establish the trend.	DPE Annual review 2017 Letter, 3/9/18	Noted. See data provided in Section 0	Section 0
Waste Management — please provide the breakup and total waste data for the reporting year, and previous years, to establish the trend.	DPE Annual review 2017 Letter, 3/9/18	Additional information on waste management has been included as requested.	Section 6.7
Water Management — please provide a table showing the actual water balance for the reporting year and the trend so far. Please provide correspondence that demonstrates that DPI Water (previously NoW) have endorsed the Independent Expert that prepares the Groundwater Management Report (as required by Condition 9.2d).	DPE Annual review 2017 Letter, 3/9/18	A water balance table has been included in Section 7.1. The current consent does not require an Annual Groundwater Management Report, or the endorsement of DPI Water. This is not applicable to this annual review.	Table 19
Biodiversity- please provide specific progress data for each designated area especially the North East Open Cut rehabilitation and compare with the proposed trajectory (now 5 years since completion)Clearly identify what management actions were undertaken in each biodiversity area.	DPE Annual review 2017 Letter, 3/9/18	See Section 6.4.4 and 9.5 for details on the North East Open Cut rehabilitation. The MOP comparison tables compare the trajectory proposed in the MOP to the actual biodiversity monitoring for each rehabilitation and biodiversity area. These can be found in Appendix 1	Section 6.4.4 Section 9.5 Appendix 1.
Aboriginal Heritage – please include a discussion on the need to increase (or otherwise) the area of the heritage conservation area as required by Schedule 2 condition 9.2g) of the approval.	DPE Annual review 2017 Letter, 3/9/18	Not applicable. Modification 5 does not contain this condition. A plan of management (appendicised to the FFMP) was developed in consultation with the RAPs and is one tool used to manage the conservation area.	N/A
Community Consultation – please include specific details of community consultation undertaken during the reporting period. Caution should be exercised when describing community activity in general terms and	DPE Annual review 2017 Letter, 3/9/18	Specific details have been included in Section 10. Community engagement activities are undertaken in a systematic manner and due to minimal changes over the past few years, there has been very little variance in the way Ashton Coal engages with its communities. Please note that community engagement	Section 10

Action required from previous annual review	Source of Action	Action undertaken	Where discussed in annual review
when the report continues to use the same text year on year.		required by the South East Open Cut Project is out of scope for this annual review.	
The AEMR is accepted subject to the following items:	DPE Resources Regulator (DPE-RR) Letter, 19 December 2018		
The approximate volume of topsoil / subsoil stripped and spread is to be reported in future AEMRs	DPE-RR Letter, 19 December 2018	Minimal topsoil has been disturbed during the reporting period. Any topsoil stripped was conducted under a Ground Disturbance Permit. Further information is found in section 9.2.	section 9.2
A map is to be included in future AEMRs that demonstrates the location of mine related disturbance and rehabilitation areas during the reporting period as per Plans 3A – 3D within the currently approved Mining Operations Plan.	DPE Resources Regulator Letter, 19 December 2018	A map is included as Figure 18	Figure 18
Corrective Action 1: White Mining (NSW) Pty Ltd is to undertake a review of topsoil and cleared vegetation management commitments in the currently approved MOP to determine whether they are appropriate for operations at the Ashton Coal Operations. Following the completion of the review, White Mining (NSW) Pty Ltd is to develop a topsoil and cleared vegetation management strategy that details requirements prior to, during and after stripping and clearing and consider the scale of associated disturbance areas. The strategy is to describe methods adopted to ensure commitments are implemented including identifying roles and responsibilities, processes implemented for quality assurance purposes (such as record keeping) and monitoring requirements to verify against thresholds described in the Trigger Action Response Plan (TARP). The topsoil and cleared vegetation management strategy is to be submitted to the Resources Regulator	DPE Resources Regulator Inspection Outcome letter, 6 June 2018.	Noted. This was submitted to the Resources Regulator during the reporting period.	-

Action required from previous annual review	Source of Action	Action undertaken	Where discussed in annual review
by no later than 31 October 2018, and incorporated into the MOP when next submitted.			
Corrective Action 2: White Mining (NSW) Pty Ltd is to review the most recent Rehabilitation Cost Estimate submitted to the Department and delineate liabilities included in the Rehabilitation Estimate Associated with: a) Infrastructure that is currently not utilised by Ashton Coal Operations but is being retained pending future mine works. Infrastructure includes (but is not limited to) dewatering bore holes and associated ventilation infrastructure; b) The laydown area associated with the South East Open Cut. The Rehabilitation Cost Estimate is to be submitted to the Resources Regulator no later than 6 July 2018.	DPE Resources Regulator Inspection Outcome letter, 6 June 2018.	RCE was completed and lodged with the Department during the reporting period.	Section 3.2
Corrective Action 3: White Mining (NSW) Pty Ltd is to develop a weed control strategy for the Bowman's Creek Diversion area. A weed control and revegetation strategy is also to be developed for areas recently rehabilitated that lack adequate vegetative cover and are dominated by weeds (including the recently constructed ventilation fan batters). Both strategies and works completed in accordance with the strategies are to be reported in the 2018 Annual Review submitted for Ashton Coal Operations.	DPE Resources Regulator Inspection Outcome letter, 6 June 2018.	See Section 6.6.1. A weed control plan is prepared annually and acted upon during the year. At the end of the year a summary report of weed control works is prepared and the next weed action plan is prepared. Weed control at Ashton Coal is well planned and budgeted each year, particularly around the creeks and rivers to ensure the weed load is minimised downstream of our operations.	See Section 6.6.1

6 Environmental Performance

Table 11 outlines the key performance or management issues and how they have been addressed, as well as the implementation of any management measures from the reporting period and proposed improvements for following years. The environmental aspects covered have conditions in the current development consent, and may or may not require management plans.

Where practical, environmental management of the main environmental aspects managed at the ACP have been discussed in Table 11. Where tabulating the information is not practical, further detail is included in the following sections of the report.

The ongoing drought conditions at Ashton Coal have influenced many of the monitoring and survey results during the year, including air quality, biodiversity and rehabilitation, with further information found in each relevant section.

Table 11 Environmental Performance Summary

Aspect	Approval criteria/ EIS prediction	Performance during the reporting period	Trend / key management implications	Implemented / proposed management actions.
Noise (Section 6.2)	See Table 13	Compliant with EPL and Development Consent conditions. For more detail, see Table 13. During the reporting period there were three noise complaints, investigation indicated that they were not due to Ashton Coal's operations. Noise results this reporting period were below the predictions made in the EIS.	Noise monitoring results during the reporting period follow the trends of past years: Ashton Coal's operations are largely inaudible in the surrounding community and minimal noise complaints have occurred.	The Noise Management Plan will be reviewed and updated if necessary to ensure best practice noise management techniques appropriate to the current operational status of the ACP and current policies and guidelines.
Air Quality (Section 0)	See section 6.3.2 for detail on approval criteria and background levels.	Compliant with Development consent.	There was 100 per cent data capture for the depositional dust gauge and 99 per cent data capture for TEOMs. There were no events where Ashton Coal's operations were assessed to have contributed over 50ug/m^3 daily average. There were no air quality complaints or reportable incidents related to air quality in the reporting period.	Air Quality will continue to be managed in accordance with the Air Quality Management Plan.

Aspect	Approval criteria/ EIS prediction	Performance during the reporting period	Trend / key management implications	Implemented / proposed management actions.
Visual Amenity and Lighting	Implement reasonable and feasible measures to mitigate visual and offsite impacts of lighting, Ensure no unshielded light shines above the horizontal, and All external lighting must comply with Australian Standard AS4282 (INT) 1997.	Visual amenity and lighting management at ACOL are managed in accordance with good management practices. Fixed lighting is utilised to illuminate the areas around the underground surface facilities, CHPP and open cut workshop. Earthen bunds are constructed and trees planted as a visual screen for infrastructure where possible. During the reporting period, earthen bunds and tree screens were inspected and maintained as required. Dead trees removed from screen along New England Highway, livestock exclusion fences installed. 600 tubestock trees were planted in tree screens along the New England Highway to further shield current and future operations from the highway.	There have been no lighting or visual amenity related incidents or complaints during the reporting period. ACOL will continue to effectively manage lighting and visual amenity according to the Lighting Management Plan and the Mining Operations Plan.	Lighting will continue to be managed to minimize impacts on the local community and highway traffic while maintaining lighting levels necessary for operational and safety needs.
Waste management (section 6.7)	The applicant must: Minimise and monitor the waste generated by the development, Ensure appropriate storage, handling and disposal of waste, Manage onsite sewage treatment and disposal, Report on waste management and minimisation in the AR.	Waste management will continue to be managed in accordance with Ashton Coal's waste management plan and the conditions of consent. Waste Management followed similar trends to previous years, with no significant changes to waste volumes or management throughout the year.	Ashton Coal's waste management contractor continues to do weekly inspections of operational areas and these are provided in monthly reports. Any issues are rectified immediately or area supervisors notified if necessary. There were no reportable incidents or community complaints relating to waste, chemical or hydrocarbon management.	Waste management will continue to be managed in accordance with the waste management contract and the conditions of consent.
Spontaneous Combustion	16 (a) Ashton Coal must implement reasonable and feasible measures to minimise offsite odour, fume and dust emissions including those	During the reporting period there was no spontaneous combustion in the rehabilitation or the CHPP stockpile areas. Spontaneous combustion surrounding the Void 4 tailings storage facility was monitored and managed where required. These areas	The nature of the loosely compacted overburden containing high levels of carbonaceous material requires ongoing management and maintenance of spontaneous combustion at the Void 4 tailings facility. New outbreaks are not	Ashton Coal will continue to monitor and manage spontaneous combustion.

Aspect	Approval criteria/ EIS prediction	Performance during the reporting period	Trend / key management implications	Implemented / proposed management actions.
	generated from spontaneous combustion.	will continue to be monitored to measure effectiveness, and ongoing management of spontaneous combustion will be undertaken.	common, and some areas may extinguish without any management works undertaken.	
Aboriginal Cultural Heritage	There are stringent requirements for the management of Aboriginal Cultural Heritage at Ashton Coal. Requirements of the development consent and AHIP 1131017 (Longwalls 1-4) and AHIP 1130976 (Longwalls 5-8) are detailed in the Aboriginal Cultural Heritage Management Plan (ACHMP)	During the reporting period, salvage works were completed in the LW 203 subsidence crack zone.	Over 20,000 artefacts have now been salvaged and analysed. Ongoing works are minor in nature and will cover areas of potential subsidence cracking associated with Longwalls in the ULLD seam.	During the next reporting period, Ashton Coal will continue to hold ACCF meetings and conduct minor monitoring and salvage works as required.
Bushfire	Bushfire at ACOL is managed in accordance with the Bushfire Management Plan which documents fire prevention and control measures to reduce the risk of and protect the operations and surrounding neighbours from bushfire.	During the reporting period, firebreaks were slashed around fence lines, pipelines and other infrastructure. There was one bushfire recorded on ACOL owned land adjacent to the Main Northern Railway line and ACP rail loadout.	Firebreaks are maintained at Ashton Coal on a schedule to mitigate impacts of bushfire. An investigation was undertaken and it is probable that the fire started as a result of works at an adjacent operation.	The prevention of bushfire on ACOL owned lands will continue to be actively managed in accordance with the Bushfire Management Plan.
Biodiversity (Flora and Fauna)(Section 6.4)	See Section 6.4	All required biodiversity monitoring was undertaken during the reporting period. Further information is included in Section 6.4	Bowmans Creek experienced low and no flow conditions for most of the reporting period due to sustained drought conditions in the region. This impacted aquatic ecology results but was not attributable to mining impacts. Consistent with previous years, the key management issue relating to biodiversity onsite is weed management.	During the next reporting period Biodiversity will continue to be managed through the Flora and Fauna Management Plan.

Aspect	Approval criteria/ EIS prediction	Performance during the reporting period	Trend / key management implications	Implemented / proposed management actions.
Bowmans Creek Diversion (Section 6.4.5 to 9.4)	See Section 9	Bowmans Creek Diversion is a major environmental aspect for ACOL. Performance during the reporting period is discussed in sections: • 6.4.2 Aquatic ecology – Bowmans and Glennies Creek, • 6.6 Pest Management, • 9.4Bowmans Creek Diversion Management, • 9.3 Bowmans Creek Diversion Rehabilitation Monitoring Program, and • 9.1 Rehabilitation status.	See the following sections: • 6.4.2 Aquatic ecology – Bowmans and Glennies Creek, • 6.6 Pest Management, • 9.4Bowmans Creek Diversion Management, • 9.3 Bowmans Creek Diversion Rehabilitation Monitoring Program, and • 9.1 Rehabilitation status.	A focus on weed control will continue to facilitate the ongoing success of the diversion rehabilitation.
Water – Surface water (Section 0)	See Section 7	Surface water quality trends indicate no adverse mining impacts on the water quality of the local waterways. Flows and water quality during the year have been impacted by the ongoing drought conditions in the Upper Hunter Valley.	There have been no reportable incidents or community complaints in relation to water quality during the reporting period. No TARPs under the Water Management Plan were triggered.	ACOL will continue to manage water in accordance with the Water Management Plan and appropriate water licences.
Water – Groundwater (Section 7.4)	See Section 7	During the reporting period, no unpredicted impacts to groundwater systems were identified. An annual Groundwater Management Report is included as Appendix 2.	There have been no reportable incidents or community complaints in relation to groundwater during the reporting period.	Groundwater will continue to be managed in accordance with the Water Management Plan.

6.1 Meteorological Data

Meteorological data is used at Ashton to interpret environmental impacts and to understand air quality and noise management outcomes. Ashton has two meteorological monitoring stations: Monitoring Site 1 (predominantly used to monitor for noise and air quality impacts in adverse weather conditions) and the Repeater Station (the main monitoring site).

During the reporting period, the Repeater station was relocated from offsite to the NEOC rehabilitated area. This enables easier access and maintains representative site conditions.

A summary of meteorological data recorded at the Repeater monitoring station during the reporting period is provided in Table 12. Rainfall is included Figure 3 and seasonal wind roses as Figure 4.

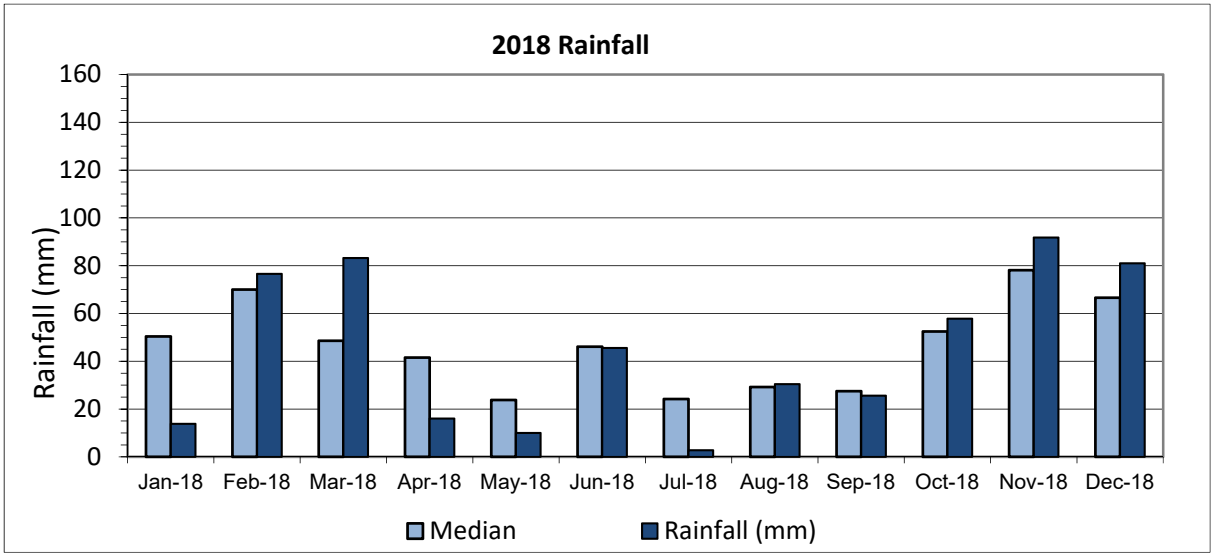

Figure 3 Annual Rainfall

Table 12 2018 Summary of meteorological results from the Repeater Monitoring Station

Parameter	Units	2018	2017	2016	2015
Total rainfall	mm	534	518	754	902
Maximum monthly rainfall	mm	92 (recorded in November)	147 (recorded in March)	138 (recorded in February)	270 (recorded in April)
Minimum monthly rainfall	mm	3 (recorded in July)	1.6 (recorded in July)	23 (recorded in August)	15 (recorded in September)
Maximum temperature	°C	42.6 (recorded in January)	46 (recorded in February)	40.9 (recorded in December)	39.3 (recorded in November)
Minimum temperature	°C	2.3	1.0 (recorded in July)	2.2 (recorded in July)	2.7 (recorded in July)

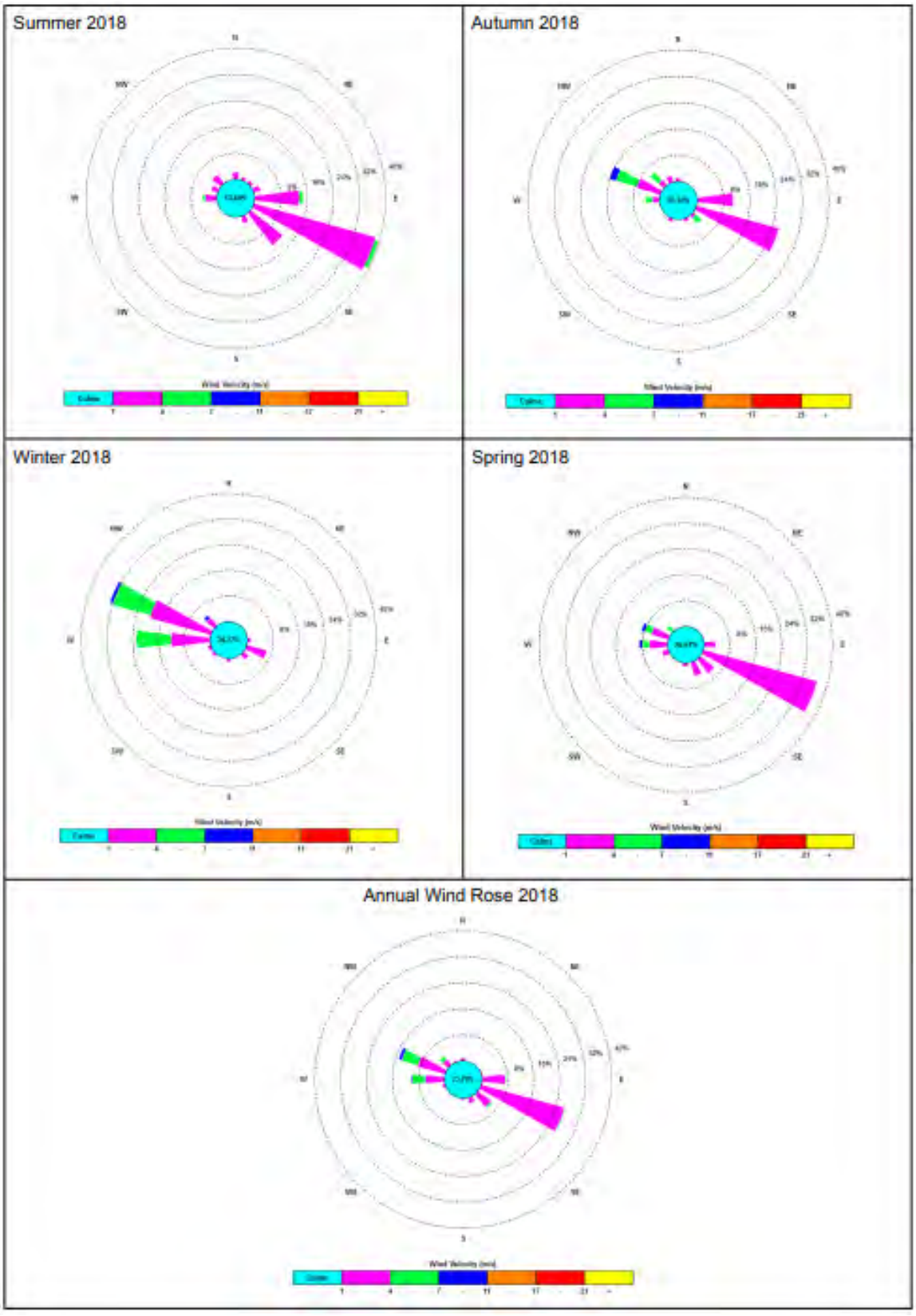

Figure 4 Seasonal and Annual Wind Roses, 2018

6.2 Noise

6.2.1 Environmental Management

The Ashton Coal Noise Management Plan details the relevant noise impact assessment criteria, compliance procedures and controls relating to mining activities.

Attended noise monitoring is used to determine compliance. Received levels from various noise sources are noted and particular attention is paid to the extent of potential mine contribution. Consistent with previous years, during 2018 potential noise generating activities from the ACP included underground mine related activities, construction of a new back road fan for the ULLD seam, maintenance of equipment, operation of the CHPP, train loading and land management activities. Noise mitigation measures include properly maintaining mobile plant, CHPP and ventilation fans, limiting hours of mobile noise generation (such as drilling activities), permanent noise mitigating engineering controls at the CHPP, and pit top facilities located below natural surface level.

6.2.2 Environmental Performance

Noise generated by the ACP must not exceed limits as specified in Appendix 6 of DA 309-11-2001-i (Mod 5) and condition L2.1 of EPL 11879.

At each of the three monitoring locations, the mine's average noise energy over a 15 minute period ($LAeq_{(15min)}$), and the highest noise level generated for 0.6 seconds during one minute ($LA1_{(1min)}$) (in the absence of any other noise), is measured on a monthly basis. When the mine is measurable and where meteorological conditions result in criteria applying (in accordance with the project approval), a low frequency noise assessment was conducted in accordance with the *Noise Policy for Industry*.

An analysis of periodic attended noise monitoring results indicate operations were generally not audible at any of the three monitoring locations. There were measurable results recorded in July (Site N4, 35 $LAeq_{(15min)}$ and 41 $LA1_{(1minute)}$, August (Site N2, 31 $LAeq_{(15min)}$ and 34 $LA1_{(1minute)}$, and October Site N3 <30 $LAeq_{(15min)}$ and <30 $LA1_{(1minute)}$. Monitored results were in compliance with relevant criteria. No secondary monitoring was required during the reporting period.

Noise did not exceed the relevant $L\ Aeq_{(15\ min)\ or}$ $L\ Aeq_{(1min)}$ criterion at any location at any time, indicating nuisance and sleep disturbance noise generation was within specified noise limits.

There were three community noise complaints received during the reporting period, in July, September and October. In all instance's investigations into noise levels and operations being undertaken at the time concluded that the noise was not likely to have been generated by Ashton Coal's operations.

A summary of results from the ACP's attended noise monitoring is provided in Table 13 and Table 14.

Details of the noise complaints registered during the reporting period are found in Section 10.3.

Table 13 Attended Noise Monitoring Results LAeq (15 min)

LAeq (15min)	N2	N3	N4
Noise impact criteria (Intrusive criteria) (LAeq (15min)) Night	36	36	36
Noise Impact criteria (LAeq (1min)) Night	46	46	46
Predicted noise level for 2014 for each monitoring location (2002 EIS)*	37	N/A	N/A
January	NM	IA	IA
February	IA	IA	IA
March	IA	IA	IA
April	IA	IA	IA
May	IA	IA	IA
June	IA	IA	IA
July	NM	NM	35
August	31	NM	IA
September	IA	IA	IA
October	IA	<30	IA
November	IA	IA	IA
December	IA	IA	IA

* 2014 is the year that best represents current mining operations as modelled in the 2002 EIS.
IA – no site noise was audible at the monitoring site.
NM – some site noise was audible but could not be quantified

6.2.3 Trends and management measures

Noise monitoring results during the reporting period follow the trends of the past few years, where Ashton Coal's operations are largely inaudible in the surrounding community. Noise generated by ACOL operations during the next reporting period are expected to remain consistent with the past three years.

Table 14 Attended Noise Monitoring Results LA1 (1 min)

LA1 (1min)	N2	N3	N4
Noise Impact criteria (LAeq (1min)) Night	45	45	45
Predicted noise level for 2014 for each monitoring location (2002 EIS)*			
January	NM	IA	IA
February	IA	IA	IA
March	IA	IA	IA
April	IA	IA	IA
May	IA	IA	IA
June	IA	IA	IA
July	NM	NM	41
August	34	NM	IA
September	IA	IA	IA
October	IA	<30	IA
November	IA	IA	IA
December	IA	IA	IA

* 2014 is the year that best represents current mining operations as modelled in the 2002 EIS.
IA – no site noise was audible at the monitoring site.
NM – some site noise was audible but could not be quantified

Figure 5 Meteorological and Noise Monitoring Locations

6.3 Air Quality

6.3.1 Environmental Management

Ashton Coal's air quality monitoring network consists of a network of real-time fine particulate monitors that operate continuously, a high volume air sampler operated in accordance with a schedule set by the NSW EPA and a depositional dust gauge in Camberwell village.

Depositional dust monitoring is carried out in accordance with *Australian Standard 3580.10.1:2003 Determination of particulates – Deposited matter – Gravimetric method* and analysed for insoluble solids and ash residue. Depositional dust samples are collected on a 30 day (plus or minus two days) basis from one approved depositional dust gauge monitoring site in accordance with the approved Air Quality and Greenhouse Gas Management Plan (AQGGMP).

Three statutory real-time tapered element oscillating microbalance sampler (TEOM) are used to record fine dust particles (i.e. particulate matter 10 microns and less (PM_{10})) on a continuous basis. These monitors are based upstream (Site 9) and downstream (Site 10 and Site 2) of Ashton Coal's operations and are used to calculate Ashton Coal's contribution to air quality, particularly close to Camberwell village. There is also one TEOM used for operational management purposes (Site 7), which is not reflective of impacts on sensitive receptors. Site 2 is due to be removed from the AQGGMP and the EPL, pending acceptance of the EPL variation lodged in 2016. The locations of air quality monitoring sites at Ashton Coal are shown in Figure 6.

Controls have been put in place in accordance with the approved management plan to reduce the potential for the generation and movement of dust from Ashton Coal's operation area. These controls are considered to have been adequate for the reporting period, and will continue to be applied during the next reporting period. The controls include:

- Large earth berms and tree screens between the operations and the village have been constructed and trees established;
- Roads are clearly delineated and maintained and water carts utilised around the site to keep trafficked areas in a damp condition;
- All stockpiles are kept damp by the use of fixed or mobile water sprays under dry and windy conditions;
- All diesel equipment used on site is maintained properly and fitted with appropriate pollution control devices; and
- Predictive modelling is utilised on a daily basis to plan for high risk dust days and modify planned operations if required.

In addition to existing controls, Ashton environmental staff monitor for new leading industry air quality management practices (through review of air quality periodicals and regulatory informational correspondence, attendance at industry air quality working groups and community forums, and discussions with other operations). Where such practices are deemed potentially useful within the ACP context, the application will be reviewed with relevant operational staff and an implementation strategy prepared, where determined suitable.

Figure 6 Location of air quality monitoring sites

6.3.2 Environmental Performance

6.3.2.1 Depositional Dust Gauges

One depositional dust gauge is required in the Ashton Coal Air Quality Monitoring Program. Depositional dust gauge data capture rates for the reporting period were 100 per cent.

In accordance with DA 309-11-2001-I (Mod 5), the criterion for the maximum total deposited dust level is 4 grams per square metre per month (g/m^2/month) over an annual averaging period. The criterion for the maximum increase in deposited dust levels due to ACP's operations over an annual averaging period at any one dust gauge is 2 g/m^2/month.

Table 15 shows the annual average insoluble solids over the 2015 to 2018 reporting periods and the background levels from the 2002 EIS. There was no exceedance of the 4g/m^2/month at Site D6 during the reporting period.

Table 15 Comparison of annual average deposited dust results, 2015 - 2018

Site reference	Location	2018 annual average g/m^2/month	2017 annual average g/m^2/month	2016 annual average g/m^2/month	2015 annual average g/m^2/month	Annual Average EIA Background Values g/m^2/month
D6	St Clements Church	2.98	3.45	3.0	3	1.5

Contamination by bird droppings, insects and vegetation is a common issue for depositional dust monitoring systems. During this reporting period there were two contaminated results, recorded in April and July, both contaminated by bird droppings. These results are not included in the annual average calculations. A depositional dust gauge is deemed contaminated by an independent monitoring contractor or a National Association of Testing Authority (NATA) accredited laboratory. Results found to be contaminated are excluded from the annual average calculation.

6.3.2.2 Tapered Element Oscillating Microbalance Samplers (TEOM)

Under the approved AQMP there are two statutory PM_{10} TEOM monitoring stations in operation, as well as one operational management TEOM and the local Upper Hunter Air Quality Monitoring Network (UHAQMN) TEOM based in Camberwell village (Table 16). There is an additional TEOM currently required under the EPL (Site 2), however upon finalisation of the EPL review this will be removed.

A summary of the results from the real-time PM_{10} TEOM monitoring sites for the reporting period is provided in Table 17. Figure 7 shows the trend in PM_{10} results over the last five years. During the reporting period the short term 24-hour impact assessment criteria of 50 $\mu g/m^3$ was exceeded on 74 days, including air emissions from all sources. An investigation into each event was undertaken, including a review of wind direction data and upstream/ downstream monitoring points, as well as assessing regional air quality trends and localised influences or events at the time. There were no days when Ashton Coal's calculated contribution exceeded 50$\mu g/m^3$ and required DPE notification. These exceedances and the contributions that may be attributable to Ashton Coal operations are shown in Table 18.

Table 16 Purpose, location and performance of TEOM sites.

Monitoring Station No	Particulates measured	Monitor Purpose	Location	Data capture (%)
7	PM_{10}	Management tool for assessment of upstream air quality	West of Ashton Coal	99
9	PM_{10}	Upstream monitoring point. May be used as a downstream monitoring point depending on prevailing wind direction.	Centre rail	99
10	PM_{10}	Downstream monitoring point. May be used as an upstream monitoring point depending on prevailing wind direction. Also used to calculate TSP compliance.	St Clements Church	99.7
UHAQMN	PM_{10} and $PM_{2.5}$	Reference site only (not compliance related data).	Camberwell Village	99.5 and 98.6, respectively
2	PM_{10}	EPL Monitoring site - will be removed upon the completion of the EPL review as per condition E1.1.	Camberwell Village, south of the New England Highway.	100

Table 17 Summary of TEOM PM_{10} results 2018

Monitoring station number	Minimum 24- hour result µg/m^3	Maximum 24-hour result µg/m^3	Short term criteria (µg/m^3)	Reporting period annual average µg/m^3	Long term Criteria annual average µg/m^3
Site 7	4.5	146.8	50	26.5	30
Site 9^	5.7	235.9		36.1	
Site10	5.5	199.9		27.4	
Site 2	4.5	169.9		24.9	
UHAQMN PM_{10}	6.0	243.9		31.1	
UHAQMN $PM_{2.5}$	2.1	22.6	25	8.4	8*

^ Site 9 is a boundary site that is not located near any privately owned residence and does not create a non-compliance with consent conditions. * Advisory reporting only

Table 18 TEOM Exceedance Investigations 2018

Date	Site 2 PM_{10} results	Site 9 PM_{10} results	Site 10 PM_{10} results	Potential calculated ACOL Contribution	Notes
01-Jan-18	19.1	31	61.1	34	
08-Jan-18	28.2	50.6	34.5	2.6	
13-Jan-18	24	53.4	31.3	22.1	
09-Feb-18	37.9	61.5	52.1	20.2	
11-Feb-18	29	59.7	46.7	11.6	
12-Feb-18	25.7	52.2	37.3	14.9	
14-Feb-18	24.2	62.9	42.4	20.5	
15-Feb-18	48.4	80.2	64.2	28.5	high regional PM_{10} day (fires)
16-Feb-18	33.1	83.9	46.6	42.2	high regional PM_{10} day (fires)
15-Mar-18	28.2	54.7	50.7	22.6	high regional PM_{10} day (fires)
17-Mar-18	27.9	51.4	41.5	9.9	
18-Mar-18	33.5	66.8	53.8	21.3	
19-Mar-18	48.2	81.3	64.2	6.95	
09-Apr-18	31.5	58.8	44.3	14.5	
12-Apr-18	29.8	69.4	45.6	17.74	
13-Apr-18	36.2	70.7	61.9	22.28	
15-Apr-18	49.2	121	81.7	15.2	
16-Apr-18	21.6	63.7	32.7	24.23	
04-May-18	37.4	110.1	68.8	17.3	
08-May-18	31	56	36.4	13.7	
09-May-18	31.4	52.8	37.5	15.3	
10-May-18	32.5	105.1	59.2	10	
11-May-18	24.2	130.8	53.1	19.6	

Date	Site 2 PM_{10} results	Site 9 PM_{10} results	Site 10 PM_{10} results	Potential calculated ACOL Contribution	Notes
12-May-18	15.7	70.3	27.2	30.3	
18-May-18	31.6	68.6	37.3	6.25	
20-May-18	24	59.9	37.1	22.8	
21-May-18	24.8	117.7	53	20.5	
15-Jun-18	36.2	58.2	43.2	15.3	
16-Jun-18	25.4	63.5	29.8	6.89	
06-Jul-18	43.1	60.6	54.1	17	
12-Jul-18	36.6	51.6	38.9	14.8	
13-Jul-18	32.1	53.6	35	16.2	
15-Jul-18	42.2	50.6	47.1	29.6	
16-Jul-18	48.2	82.7	52.9	20.1	
17-Jul-18	53.6	67.6	62.9	30.8	
18-Jul-18	70.9	94.6	72.1	22.5	
19-Jul-18	65.2	69.4	62	16	
20-Jul-18	60.6	92.8	68.2	24.6	
23-Jul-18	48.7	50.1	47.7	20.1	
24-Jul-18	73.6	107.3	80.8	26.5	
25-Jul-18	61.1	81.9	67.8	14.1	
26-Jul-18	48.8	60.6	46.6	14	
28-Jul-18	51.1	56.4	48.5	8.1	
29-Jul-18	44	53.8	46	7.8	
30-Jul-18	39.2	69.4	43.3	26.1	
31-Jul-18	44	85	47.7	8.1	
01-Aug-18	46.3	64.1	46.4	17.7	
03-Aug-18	42.7	55.9	38.4	17.5	
04-Aug-18	67.8	74.8	66.8	19.2	

Date	Site 2 PM_{10} results	Site 9 PM_{10} results	Site 10 PM_{10} results	Potential calculated ACOL Contribution	Notes
07-Aug-18	41.6	72.6	45.3	10.45	
08-Aug-18	28.1	60.5	33.8	26.7	
11-Aug-18	44.7	64.9	49.2	16.7	
15-Aug-18	46	90.8	54.8	17.5	
16-Aug-18	36.4	86.9	44	24.8	
17-Aug-18	42.9	51.9	40.9	14.6	
18-Aug-18	48.6	75	49.8	25.2	
19-Aug-18	36.4	53.1	39.7	13.4	
21-Aug-18	33.7	55.6	41.2	14.4	
15-Sep-18	66.2	81.7	74.9	20.1	
19-Sep-18	59.2	75.1	67	13	
22-Sep-18	52.2	55.9	44.5	3.7	
20-Oct-18	27.9	54.5	48.3	8.7	
31-Oct-18	39.2	52.4	28.6	23.7	
02-Nov-18	54.5	68.8	59.1	20.4	
03-Nov-18	39.5	56.1	35.5	20.6	
06-Nov-18	67.9	103.6	45.5	22.7	
07-Nov-18	40.5	50.2	41.9	8.3	
21-Nov-18	61.3	58.8	67.4	25.1	
22-Nov-18	169.9	235.9	199.9	12.9	
23-Nov-18	135.1	213.2	153.7	17.6	
24-Nov-18	37.5	85.5	41.1	44	
25-Nov-18	35.4	74.1	40.7	5.17	
26-Nov-18	56	30.8	25.8	10.6	
02-Dec-18	51.1	75.1	70.7	12.9	
04-Dec-18	47.6	57.3	43.9	13.4	

6.3.3 Trends and key management implications

During the reporting period, PM_{10} levels rose to the highest levels in the last five years (See Figure 7). This can be attributed to the extended period of hot, dry weather being experienced through the Hunter Valley over this time.

As a response to the higher than usual particulate matter results, predictive weather tools, such as the EPA's Upper Hunter incremental-dust-risk forecast model and the Weatherzone Ashton Coal Daily Dust Alert have been utilised on a daily basis and communicated to operational personnel as required throughout the reporting period, and operations altered as necessary on high risk dust days.

Monitoring results indicate that the ACP continues to meet air quality requirements in accordance with DA 309-11-2001-i (Mod 5), indicating that current air quality management practices are effective.

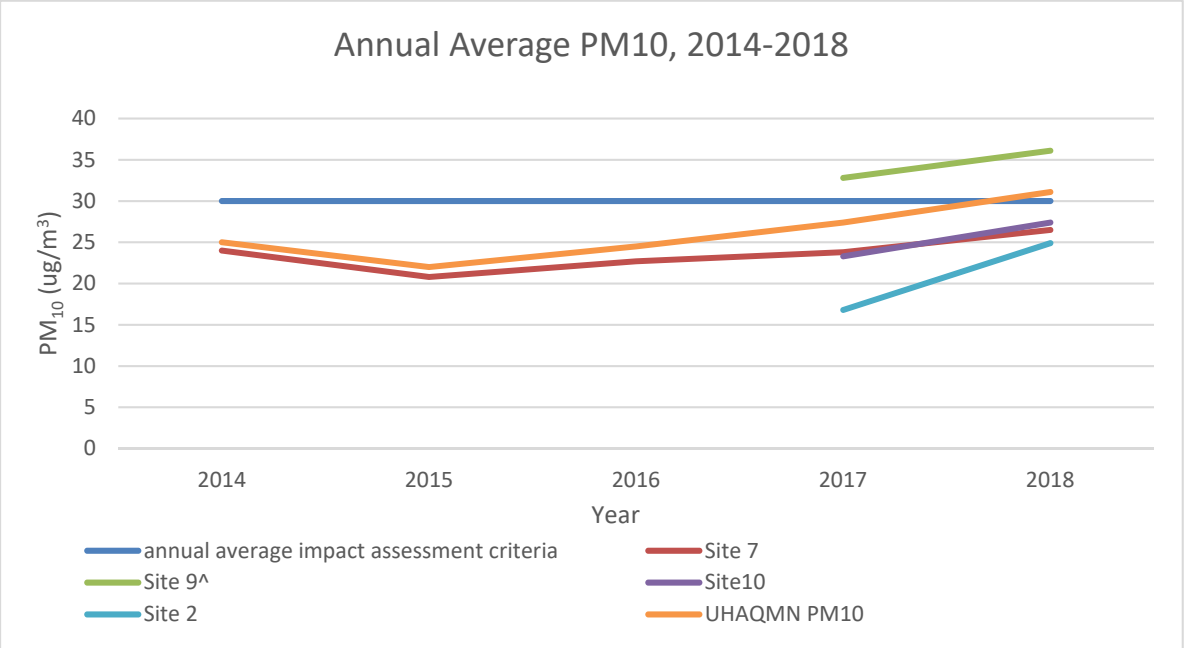

Figure 7 Particulate matter trends, 2014 - 2018

There were no reportable incidents or community complaints relating to air quality during the reporting period.

6.3.3.1 Greenhouse gas reporting

Yancoal Australia Ltd reported greenhouse gas emissions results under the National Greenhouse and Energy Reporting Scheme (NGER) for the 2017-2018 reporting period. ACOL Scope 1 emissions totalled 259,148 $tCo2_{-e}$ (tonnes CO_2 equivalent) compared to 339,443 tCo_{2-e} for the previous reporting period of 2016-2017. ACOL Scope 2[1] emissions for 2017-2018 were 35,506 $tCo2_{-e}$ compared to 36,805 for the 2016-2017 reporting period.

[1] **Scope 1** emissions are the results of direct greenhouse has production from a sites operations and include fugitive emissions from active underground mines comprised of ventilation, gas drainage, flaring and post-mining gas where applicable. **Scope 2** are indirect greenhouse gas emissions and arise principally from the greenhouse gases generated in the production of electricity which has been purchased from an energy provider.

It is difficult to analyse any trend in greenhouse gas emissions over the past five years at Ashton. There are large variables in emissions when compared to production and operations at the time. These variables can be attributed to changes in gas management (installation of the gas drainage and flaring facility, development of gas drainage pipelines, and technical issues related to gas drainage and flaring), as well as significant differences in gas levels depending on the seams and longwalls being mined. There is a high level of variation in gas levels from seam to seam in Ashton Coal's approved operations.

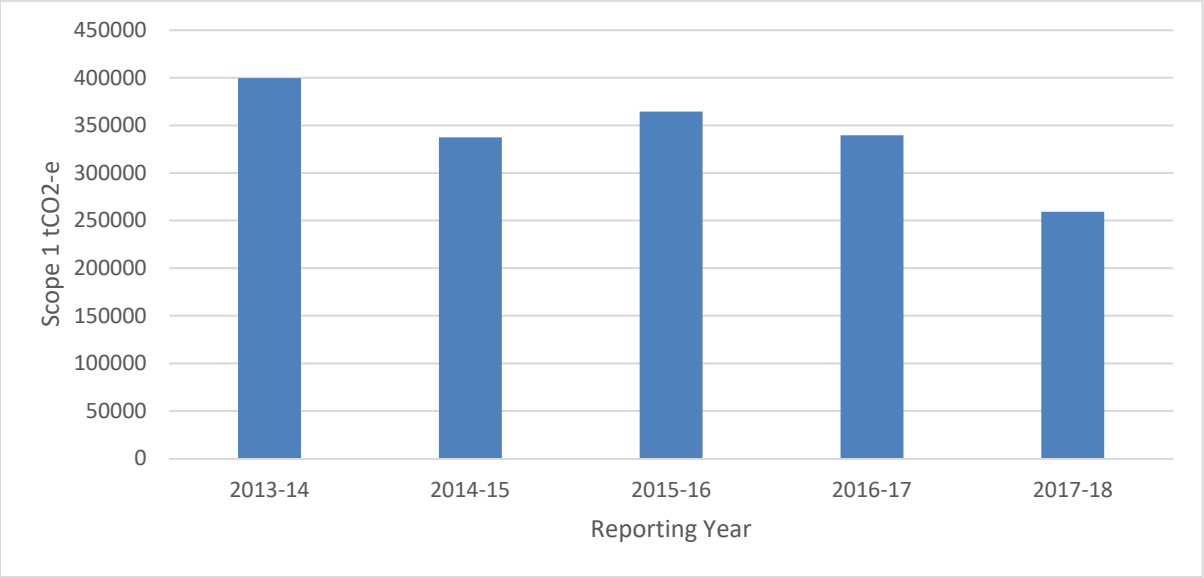

Figure 8 Greenhouse gas emissions, 2013 - 2018

6.4 Biodiversity (Flora and Fauna)

Biodiversity is managed under the Ashton Coal Flora and Fauna (Biodiversity) Management Plan (FFMP) and the Southern Woodland Voluntary Conservation Agreement (VCA). Each year the ACP undertakes extensive terrestrial and aquatic flora and fauna monitoring to track progress against management plan and closure objectives.

The monitoring program is aimed at tracking the condition of habitat areas over time and ensuring that the management plan's established performance indicators and project approval requirements are being met. It includes terrestrial and aquatic monitoring, weed and vertebrate pest monitoring and associated management measures where required.

The monitoring program covers important biodiversity areas onsite such as the VCA, Bowmans Creek diversion, the groundwater-dependent River Red Gum communities, vegetation corridors and creeks and rivers. It complements the rehabilitation monitoring of Bowmans Creek, North East Open Cut and the farmland over the underground mine which is discussed in Section 9. A monitoring form as requested by the NSW Office of Environment and Heritage (OEH) in the VCA is included as Appendix 4.

6.4.1 Fauna Monitoring

Fauna Monitoring was undertaken in accordance with the Flora and Fauna Management Plan in June

and November 2018. Eight pre-existing survey sites were sampled in 2018 - four sites that have been undermined in the past (impact) and four in remnant vegetation that have had no mining activities (control). Among these control and impact sites, two consisted of riparian habitat, and the remaining six sites were woodland. Each site was systematically sampled using a variety of fauna survey methodologies including small and medium mammal trapping, mammal hair sampling, funnel trapping for reptiles, echolocation recording for microchiropteran bat species, remote camera detection, call playback surveys for nocturnal birds/mammals and active searches (diurnal and nocturnal) for amphibians, reptiles, mammals and birds.

Two additional survey sites were established within the Bowmans Creek Diversion rehabilitation area and in the North East Open Cut (NEOC) rehabilitation area. Monitoring undertaken in these sites included mammal hair sampling, remote camera detection and active searches for amphibians, reptiles, mammals and birds.

Nine threatened species were recorded within the site: the grey-crowned babbler (eastern subspecies) (*Pomatostomus temporalis temporalis*), speckled warbler (*Pyrrholaemus sagittatus*), spotted harrier (*Circus assimilis*), brush-tailed phascogale (*Phascogale tapoatafa*), grey-headed flying-fox (*Pteropus poliocephalus*), little bentwing-bat (*Miniopterus australis*), southern myotis (*Myotis macropus*), eastern bentwing bat (*Miniopterus orianae oceanensis*) and greater broad-nosed bat (*Scoteanax rueppellii*). Each of these species has been recorded in previous surveys within the ACP except for the little bentwing-bat. Each of the species is listed as vulnerable under the *Biodiversity Conservation Act NSW 2016* (BC Act) and the grey-headed flying-fox is listed as vulnerable under the *Environment Protection Biodiversity Conservation Act Cth 1999* (EPBC).

Consistent with the findings from 2017, the grey crowned babbler is utilising each of the woodland remnants in the ACP site with 18 observations of this species and 16 nests attributed to this species recorded during the 2018 survey period.

In 2018, the brush-tailed phascogale was recorded on 13 occasions from trapping and remote camera methods. This species was caught five times and recorded on remote camera at six times, including within the NEOC rehabilitation area where it has not been previously recorded. Although not certain on the size of the population within the ACP, mark-recapture data identified five different individuals were captured, with one individual that was recaptured during the survey period. Since 2015, 46 records have been made from the bi-annual fauna monitoring surveys.

During the 2018 surveys, a total of 143 fauna species were recorded in the ACP site. Analysis of pooled species data demonstrated similar species diversity between the control (110) and impact (111) areas.

Based on this similarity, there is little indication from fauna results that mining is having an adverse impact. Similarly, comparison among faunal groups indicates that species diversity was consistent with the exception of amphibians, which had significantly lower species diversity at the impact sites compared with the control sites. This difference is most likely explained by the current drought conditions and not due to mining activities.

When compared to previous years, the species diversity among faunal groups remained generally consistent with the exception of amphibians (see section 6.4.2). The results of the fauna monitoring surveys within the ACP site indicate that threatened fauna species and their habitats have not been adversely impacted by mining. The threatened species diversity recorded in 2018 is slightly higher than

the 2017 monitoring results however such variation is expected when monitoring a dynamic biological system. A focus of future monitoring will be to check for amphibian recovery when the drought breaks.

6.4.2 Aquatic ecology – Bowmans and Glennies Creek

The 2018 stream health monitoring program was characterised by persistent no-flow and drought conditions in Bowmans Creek, and variable yet constant flow conditions in Glennies Creek sustained by dam releases. The prolonged below average rainfall in Bowmans Creek catchment resulted in very low (<0.5 ML/day) flow rates throughout January to April 2018 which resulted in the study creek section being reduced to a series of isolated refuge pools separated by dry creek sections. These pools became smaller and shallower between April and the spring 2018 survey in November when there was a complete lack of flows, as registered at the Bowmans Creek flow gauge.

Most of the Bowmans Creek study area, including both creek diversion channels, were dry for both surveys, with sections of creek bed colonised by terrestrial plants. Several long-term monitoring sites were unable to be sampled in 2018, with two new (temporary) sites incorporated into the monitoring program as a result. The remaining long-term site refuge pools had reduced significantly in size and for both 2018 surveys, resulting in limited availability and diversity of aquatic habitats when compared to former surveys.

Aquatic ecology monitoring was undertaken during spring and autumn of 2018 in accordance with the monitoring program outlined in the Flora and Fauna Monitoring (Biodiversity) Management Plan (FFMP). Results of stream health monitoring were lower than in previous years due to the natural environmental responses to prevailing climatic conditions.

In the absence of high flow scouring flood events, there were no variations to site aquatic habitat condition (RCE) channel attributes, and for most sites the RCE scores were consistent with former survey scores (signifying channel stability associated with no-flow episodes). There were subtle variations relating to aquatic vegetation between surveys in both Bowmans and Glennies Creeks which resulted in *Low* trigger values in autumn and spring. Investigation of the low results found this is more a consequence of individual site RCE score stability over the seasonal long-term monitoring period prior to 2018 which resulted in very low Standard Deviations (SD) for those sites and consequent Mean - SD trigger values very close to the mean. Variations at sites BCUp and BC6 were due to fluctuating ratios of filamentous green algae cover compared to macrophyte cover within site pools, itself, one of the consequences of drought conditions, as contracting of pool water bodies provide favourable conditions for algal proliferation and for die-back of exposed macrophytes in surrounding dry channel areas. In contrast to Bowmans Creek, variations in RCE scores between autumn and spring 2018 at both Glennies Creek sites were due to favourable consistent flow conditions that resulted in proliferation of macrophytes between surveys.

The Bowmans Creek study area generally provides much greater habitat complexity during periods of continuous flow, including undercut banks, detrital accumulations and a variety of submerged and emergent macrophytes (e.g. water primrose, water milfoil, curly, sago and clasped pondweeds, cumbungi and river clubrush). As pool areas contracted during the prolonged periods of low rainfall and flow, the integrity of aquatic ecosystems declined due to both direct habitat loss and deteriorating water quality. Shallow isolated pools are subjected to greater temperature and dissolved oxygen fluctuations, and turbidity plus nutrient levels generally increase in part due to the limited water area

that contains larger fish such as carp which disturb bottom sediments.

As stream/pool aquatic ecosystem integrity deteriorates from consistent flow conditions to isolated pool dry out, the macroinvertebrate community structure changes to one with both lower diversity of taxa and increases in the dominance of those taxa tolerant to adverse conditions, as exemplified by the number of Bowmans Creek sites that recorded SIGNAL values below the Long term Monitoring Standard Deviation (LTM – SD) range over both surveys.

The contraction of pool areas further serves to concentrate remaining fish species and numbers, this resulted in an overall higher number of fish taxa recorded from the study area sites in 2018, including six native species and two introduced species. Numerous dead carp were observed during the spring 2018 surveys in dry channel area, and it can be assumed that numerous other species would have perished during the prolonged refuge pool drying out process that has occurred throughout the study area over the previous 2 years.

It is concluded that the below LTM-SD trigger values recorded during the combined Bowmans Creek and Glennies Creek stream health sampling results from autumn and spring 2018 are all attributable to natural environmental responses to the prevailing climatic conditions and consequently the 2018 stream health results can be used to generate new long-term rolling means for 2019 LTM trigger calculations, as per the TARP conditions. No further action is required under the Flora and Fauna (Biodiversity) Management Plan TARP.

6.4.3 Southern Voluntary Conservation Area

A Voluntary Conservation Agreement was made between ACOL and the Minister for the Environment under the NP&W Act on the 16 September 2010. The Southern Woodland Conservation Area (VCA) contains remnant Hunter Valley vegetation, threatened fauna species and archaeological sites of high significance, including the Glennies Creek Site containing a number of Grinding Grooves. The Agreement covers 65.66 hectares of land above the existing ACOL underground mine (Figure 1). Section G – I of the VCA agreement acknowledges that Development Consent DA309-11-2001-i issued by the Department of Planning on the 11 October 2002, permits the mining of coal by longwall methods in four seams beneath the VCA and any impacts to the surface conservation area as a direct result of mining operations.

Monitoring of the VCA was undertaken in spring 2018 and includes monitoring three quadrats using the BioBanking Assessment Methodology 2014 and a walkover survey of the VCA to identify biodiversity features, including threats, management issues and habitat features for native fauna.

The OEH mandated quadrat monitoring determined that the condition of all three monitoring sites is rated as ‘healthy’. The two woodland sites are dominated by native species and the grassland site has relatively low native species diversity and high cover of exotic species.

Subsidence and weed issues were identified during the walkover inspection. Subsidence cracks occur through the VCA. See section 8.1for more information on subsidence and repair works undertaken in this area over the reporting period.

The main weeds of concern in the southern VCA, all of which are priority weeds in the Hunter, are African boxthorn (*Lycium ferocissimum*) and African olive (*Olea europaea subsp. cuspidata*) on the slopes and balloon vine (*Cardiospermum grandiflorum*) near the Hunter River and Glennies Creek.

Replacement nest boxes have been installed since the last monitoring period, providing additional habitat for hollow-dependent fauna species in the VCA. Nest boxes in the VCA target arboreal mammals and micro-bats, and were inspected during biannual fauna monitoring surveys. The contents of the nest boxes were inspected using a nest-view video system pole camera with a view screen at ground level. Access to nest boxes was gained through the hinged lids of the nest boxes (if still intact) by lifting the lids with the camera pole. Nest boxes were checked for the presence of an animal or its evidence such as scats and nests (e.g. glider leaf-ball nest, bird eggs, etc.). Nest boxes were inspected on the same day to avoid recording the same individual animal in a different nest box during a single survey period. Instances of non-target fauna species were recorded including the presence of invertebrates and their nests, as these can discourage the use of nest boxes by target species.

Nest boxes were inspected for resident fauna occupying the boxes, pest species, and damage. Common brushtail possums (*Trichosurus vulpecula*) were the only species found using nest boxes, with five possums occupying four boxes on four occasions. All nest boxes monitored were located within the VCA area (Figure 3.2). The contents and condition of all nest boxes monitored during winter and spring 2018 surveys within the study area are included in Table 3.5. Refer to Appendix 2 for the GPS location of each nest box.

Management measures undertaken in the VCA during the reporting period include weed management (see Section 6.6.1 and Figure 9) and Subsidence cracking Repair (See Section 8.1 and Figure 17), nest box replacement and pig trapping.

6.4.4 NEOC baseline fauna survey

Open cut mining operations in the NEOC ceased in 2011 and planting of rehabilitation was completed in 2013. Flora monitoring has been undertaken over the life of the mine and as the area matures, fauna monitoring has been added to the rehabilitation monitoring program. 2018 marked the first year of fauna monitoring on the NEOC rehabilitated area. Fauna surveys were conducted at a new transect that was established in the 2018 survey period within the 'Trees over Grass – NEOC' domain.

The Trees over Grass - NEOC domain consists of planted narrow-leaved ironbark (*Eucalyptus crebra*), grey box (*E. moluccana*) and spotted gum (*Corymbia maculata*), which had evidence of flowering during the reporting period. When in flower, these trees are likely to be used by nectarivorous birds such as the white-plumed honeyeater (*Lichenostomus penicillatus*) as well as a shrub layer for sheltering superb fairywrens (*Malurus cyaneus*) and other small birds that were identified on the NEOC during the targeted surveys. A total of 28 bird species were recorded within the NEOC in 2018.

Salvaged hollow-bearing trees have been incorporated into the NEOC area as habitat. These would likely be used by hollow-bearing mammals such as common brushtail possums (*Trichosurus vulpecula*). Of the 20 hair funnels that were installed along the NEOC rehabilitated area and the Bowmans Creek revegetated area, only one hair funnel returned an identifiable hair sample. This sample was from the NEOC and consisted of common brushtail possum (*Trichosurus vulpecula*) hair.

Similarly, salvaged timber and dead trees have been constructed into log piles, which would be used by reptiles and small mammals. Three species of reptile were recorded within the NEOC rehabilitation area and were observed utilising the augmented habitat of timber piles within the Trees over Grass domain.

The spotted harrier (*Circus assimilis*) was also recorded on three occasions during the surveys within the northern woodland, Bowmans Creek diversion and NEOC areas. This species is listed as Vulnerable under the BC Act, and has been recorded previously on the ACP.

One species of amphibian was recorded at the NEOC, being the common froglet (*Crinia signifera*). This species commonly occurs in a wide range of habitats and is typically one of the first frog species to colonise new areas. It is expected that amphibian species diversity will increase as these rehabilitated/ revegetated areas become more established.

The fauna species diversity in the NEOC are lower compared to both control and impact areas surveyed, however this is to be expected as these areas are relatively young with limited habitat. The total number of species recorded in the NEOC rehabilitation area was 38.

6.4.5 Bowmans Creek Riparian Zone

Monitoring of eight 400 m^2 quadrats and eight transects along Bowmans Creek were conducted in winter and spring 2018. Individual river red gum (*Eucalyptus camaldulensis*) trees which form part of an endangered population were also surveyed for condition and evidence of reproduction and threats.

A total of 93 species were recorded at the monitoring quadrats, including 31 (33 per cent) native and 62 (67 per cent) exotic. The abundance of weed species is the main threat to biodiversity in this domain.

Evidence of reproduction of river oak (*Casuarina cunninghamiana* subsp*. cunninghamiana*) was observed at most transects, however significant dieback was also observed which cannot be attributed to ACP mining operations and may be the result of recent drought conditions experienced in the Hunter Valley. The majority of river red gum trees were observed as healthy, with no significant dieback recorded, however insect attack and weed infestation is posing a threat to some individuals.

Significant weed control works were undertaken in the riparian zone during the reporting period (see Figure 9).

6.5 Farmland rehabilitation (pastures above underground mining)

Monitoring of the Underground Mining Area (Pasture and Trees over Grass (ToG) domains) was undertaken in winter 2018 and included 52 rapid data points (RDPs) along two transects to assess ground cover and disturbances, LFA at three sites and a walkover inspection of the ToG domain which form habitat corridors through the underground mining area.

The majority of RDPs are dominated by native grasses and the density of groundcover vegetation is inversely correlated with the density of the canopy stratum, with grassland recording the highest average per cent cover in the ground layer.

The walkover inspection identified the presence of a number of exotic species, some of which are priority weeds in the Hunter, as well as erosion, subsidence cracking and evidence of pest animals.

The main threat to biodiversity within the Pasture and ToG domains in the Underground Mining Area is the presence and proliferation of exotic species. The removal of stock from the habitat corridors is recommended to allow for natural regeneration of canopy and shrub species.

Specific land management measures undertaken in this area during the reporting period include the

management of key weed infestations (see Figure 9) and the remediation of a legacy farm garbage dump area, which involved clean up and disposal of old rubbish and regrading land to appropriate contours.

6.6 Pest Management

Weed and pest management are undertaken at ACP in accordance with the MOP, FFMP and good land management principles.

6.6.1 Weed Management

Weed control programs are focussed on species locally declared under the Weed Control Order 2014 (NSW *Biosecurity Act 2015*), or raised as weeds of concern by local landholders, Hunter Local Land Services, or Singleton Council. As well as opportunistically targeted general environmental and agricultural weeds, species specifically prioritised during the reporting period included:

- African boxthorn;
- Mother-of-millions;
- St John's wort;
- Green cestrum;
- Galenia;
- Castor oil plant;
- Balloon and madeira vine;
- Prickly pear and tiger pear;
- Cobblers pegs; and
- Wild olive (various species).

Weed control focusses on larger or newly identified populations of weeds, highly invasive species, and species of concern highlighted by local stakeholders. Priority areas for treatment included the mine site boundary, Bowmans and Glennies Creeks / riparian corridors, rehabilitation areas and conservation offset areas. Treatment methods included chemical spraying, cut and paste, and mechanical slashing. Areas of weed control activities and the species treated during 2018 are shown in Figure 9.

As a result of a Resources Regulator inspection during the reporting period, the following corrective action was issued:

> *White Mining (NSW) Pty Ltd is to develop a weed control strategy for the Bowman's Creek Diversion area. A weed control and revegetation strategy is also to be developed for areas recently rehabilitated that lack adequate vegetative cover and are dominated by weeds (including the recently constructed ventilation fan batters). Both strategies and works completed in accordance with the strategies are to be reported in the 2018 Annual Review submitted for Ashton Coal Operations.*

In response to this, a 'Topsoil and Cleared Vegetation Management Strategy' was developed. Works completed under the Topsoil and Cleared Vegetation Management Strategy include weed management (included in this section), continued implementation of the Ground Disturbance permit during the reporting period, (including topsoil management actions and rehabilitation of disturbed sites where applicable) (see Section 9.2) and monitoring of sensitive landscape areas (Section 6.4).

Weed control is an ongoing practice at Ashton Coal, and each year a Weed Action Plan is developed, including a timeline for weed control that focusses on the best seasonal conditions for control of various weeds onsite. This plan is then implemented during the year.

6.6.2 Vertebrate pest management

During the reporting period, Ashton Coal continued an integrated control program to combat the presence of feral and overabundant native animals on ACP properties. The program consisted of the following activities:

- Pest monitoring - reported pest sightings (staff, contractors, public), motion-trigger trail cameras and site inspections;
- Autumn / winter pig trapping – multi-site, intermittent program, consisting of free feeding, cage trapping, and dispatch of trapped pigs by firearm;
- Winter / spring dog and fox baiting (two three-week programs) – laying of sodium fluoroacetate (1080) baits (buried and ejector) in accordance with the Pesticide Control (1080 Bait Products) Order 2017 and the NSW Pesticide Control (1080 Ejector Capsules) Order 2015.
- Winter kangaroo cull – in accordance with Landholder's Licence to Harm Protected Animals issued by NSW National Parks and Wildlife Service.

Program timings were coordinated with other land managers in the Singleton/ Muswellbrook region to increase the overall effectiveness of the campaigned pest control programs. During 2018 the integrated pest control program at ACP, 100 kangaroos were shot and tagged, 21 pigs were trapped and shot, with 18 wild dogs and 73 foxes taking 1080 baits.

In 2019 a more comprehensive program has been coordinated by the Local Land Service and most major landholders in the area. The program will target wild dogs and pigs in April 2019.

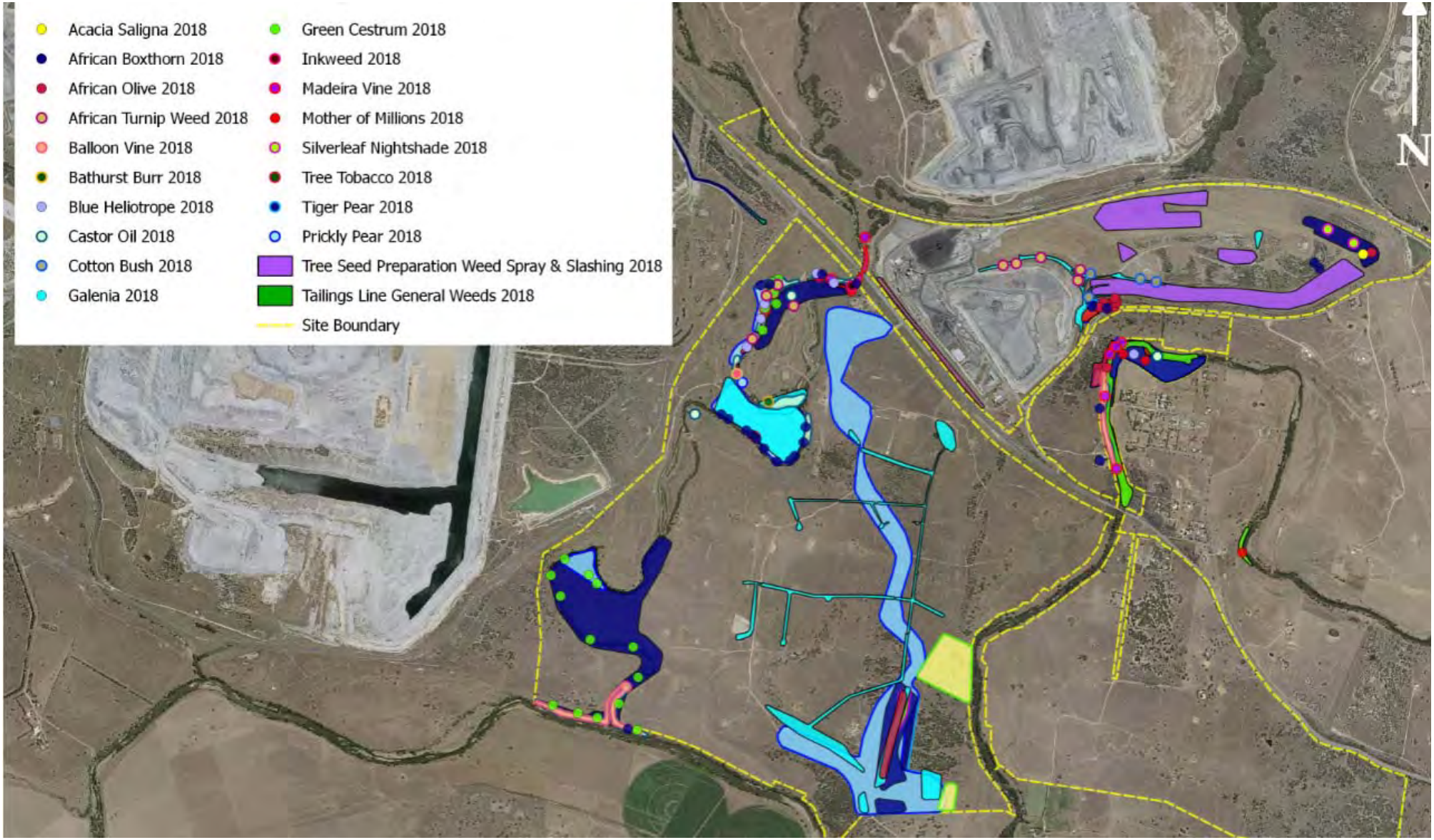

Figure 9 Weed control works, 2018

6.7 Waste Management

Waste management will continue to be managed in accordance with the Waste Management Plan and conditions of consent. There were no significant changes to waste volumes or management throughout the year. ACP's waste management contractor does weekly inspections of operational areas to identify any improvements or issues that need to be addressed. These inspections are recorded in monthly reports. Annual waste totals are presented in Figure 10. The break up and total waste data as requested in the DPE feedback from last year's AR is shown in Appendix 3. Any issues are rectified immediately or area supervisors notified if necessary. There were no reportable incidents or community complaints relating to waste, chemical or hydrocarbon management.

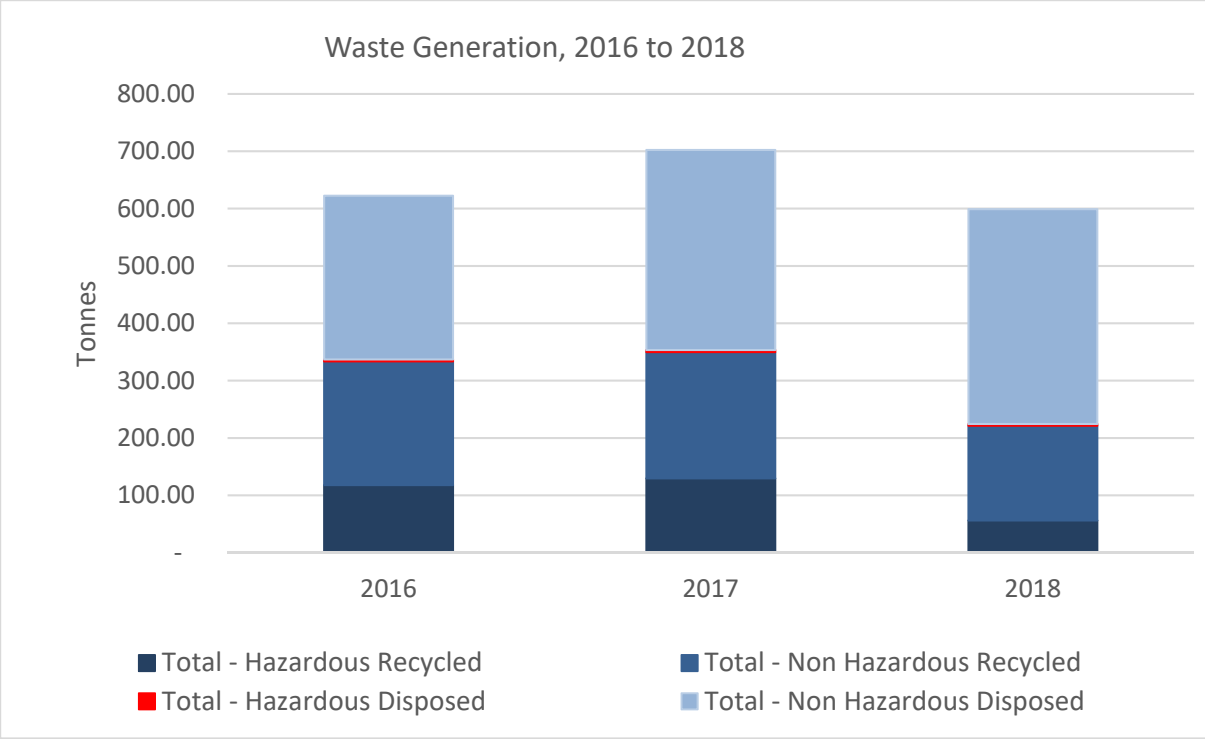

Figure 10 Waste Management 2016-2018

6.8 Heritage

There are stringent requirements for the management of Aboriginal Cultural Heritage at Ashton Coal.

Requirements under DA 309-11-2001-i, AHIP 1131017 (LW 1-4) and AHIP 1130976 (LW 5-8) are detailed in the Heritage Management Plan (HMP). Condition 34 (c) calls for regular consultation with the Aboriginal community in the conservation and management of Aboriginal cultural heritage.

During the reporting period, archaeological salvage works for Longwall 203 were undertaken, involving a walking survey of the longwall subsidence cracking zones, test pits and salvage works. An old farm rubbish dump site was also monitored as part of a remediation project in the Oxbow site.

There were three Aboriginal Community Consultation Forum (ACCF) meetings held during the reporting period. ACCF meetings discuss current mine operations, upcoming cultural heritage fieldwork, management of cultural heritage, and provide the Aboriginal community an opportunity to

contribute to cultural heritage matters. There was an additional meeting held during the reporting period to assist in finalising the Artefact Reburial Protocol developed by the RAPs. The artefact reburial protocol was first discussed in 2012, and after a number of specific workshops has been presented and approved by the ACCF.

7 Water Management

ACP manages water through its approved Site Water Management Plan (SWMP) and associated surface and groundwater monitoring programs, last approved in March 2018. ACP operations are situated between Bettys Creek in the north, the Hunter River in the south, Glennies Creek in the east and Bowmans Creek and its associated floodplain in the west. Bowmans Creek and Glennies Creek are tributaries of the Hunter River, while Bettys Creek is a tributary of Bowmans Creek. The Hunter River and Glennies Creek are regulated systems, whereas Bowmans and Bettys Creeks are ephemeral. Monitoring of surface and ground water is conducted in accordance with the approved monitoring programs.

Ashton Coal is a zero discharge site. No water was discharged offsite during the reporting period. No compensatory water has been required or provided to private landholders in the reporting period.

7.1 Water Balance

Ashton Coal maintains a water balance for the site. The water balance assists in forecasting and modelling different climatic and site scenarios. A series of flow meters and surveyed volumes are utilised to monitor the use and transfer of water between key water storages on-site. Water storages are surveyed on a regular basis to ensure the accuracy of water volume data. A schematic overview of the site's water management system can be found in Figure 11.

The water balance is reported annually in accordance with the Mineral Council of Australia's Water Accounting Framework for the Minerals Industry (2012) (MCA WAF) on a calendar year basis:

http://www.minerals.org.au/file_upload/files/resources/water_accounting/WAF_UserGuide_v1.2.pdf.

The MCA WAF allows sites to account for, report on and compare site water management practices in a rigorous, consistent and unambiguous manner that can easily be understood by non-experts. The MCA WAF focusses on the flows between the environment and the boundary of the operation i.e. the inputs, outputs and diversions. Table 19 shows Ashton Coal's annual water balance for the reporting period.

7.1.1 Water Demands

The ACP has three main water demands; Coal Handling and Preparation Plant (CHPP) supply, underground supply and above ground dust suppression. A total of 1.95 million tonnes (Mt) of coal was processed over the 2018 calendar year resulting in a CHPP demand of approximately 618 ML or 317 litres per feed tonne. Metered underground supply was 204 ML while dust suppression use over the 2018 calendar year was measured to be 34 ML.

Table 19 Ashton Coal Water Balance Summary, 2018

Inputs	Volume (ML)
Precipitation and Runoff	405
Rivers and Creeks	294
Aquifer Interception	274
water entrained in mined coal	104
Total Inputs	**1078**
Outputs	Volume (ML)
Discharge	0
Seepage from tailings storage	289
Evaporation	244
water entrained in product coal, coarse rejects and tailings	519
Loss from Ventilation rise	268
Total Outputs	**1320**
Calculated Change in storage	**-242**
Actual Change in storage	**-260**
Imbalance in actual water storage	0.8%

Note to Table: Unless all flows and stored water volumes have a Flow Type of 'measured' with a Confidence Level of 'high', a water imbalance is to be expected. When expressed as a percentage of total inputs plus total outputs, the imbalance at the ACM over the 2018 calendar year is 0.8%.

7.1.2 Inputs and Outputs

Rainfall/runoff and aquifer interception are the principal water resources for the ACM with approximately 253 hectares (ha) captured by the surface water management infrastructure on site. Over the 2018 calendar year, modelling indicates rainfall/runoff accounted for 37.5% of the total water inputs to the water management system while groundwater interception and extraction accounted for approximately 25.5%. Water sourced from the Hunter River and Glennies Creek accounted for 27.3% while water entrained in the feed coal accounted for 9.7% of the total water inputs. Major outflows from the ACM over the 2018 calendar year included evaporation (18.5%), entrainment in product coal and rejects (39.3%), loss from the underground (20.3%) and seepage (21.9%).

7.2 Water take and licencing

Water NSW requires water take to be reported over a financial year period (i.e. 1 July 2017 to 30 June 2018). Consequently, this water take section is reported in a manner consistent with this requirement.

ACP measures its water take in accordance with the approved SWMP. Measured water take is partitioned in accordance with the protocol detailed within the SWMP which incorporates a combination of site observations, measurements and predictions of the site Groundwater Model.

Water take occurs via two separate methods: incidental (or passive) take, and pumped surface

water take. Incidental take occurs through mining induced fracturing of aquifers which report to the underground workings. This water is removed from the mine by a network of dewatering pumps. Pumped surface water take involves active pumping from Glennies Creek and the Hunter River to provide higher quality water for a variety of uses including potable water, use in equipment and as fire-fighting water at the mine.

Table 20 Water Management Act 2000 Licences and associated water take for FY18.

Water Licence Number	Water NSW Reference	Water sharing Plan, source and management zone	Entitlement (ML)	Passive take / inflows (ML)	Active pumping (ML)	Total (ML)
984	20AL201282	Hunter Regulated Water Sharing Plan, surface water, zone 3A (Glennies Creek)	9	0	0	0
997	20AL201311	Hunter Regulated Water Sharing Plan, surface water, zone 3A (Glennies Creek)	11	0	0	0
1120	20AL201624	Whole Water Source (Hunter Regulated River Water Source)	3	0	0	0
1121	20AL201625	Hunter Regulated Water Sharing Plan, surface water, zone 1B (Hunter River from Goulburn River Junction to Glennies Ck Junction)	335	3.21	4.54	7.75
1358	20AL203056	Hunter Regulated Water Sharing Plan, surface water, zone 3A (Glennies Creek)	4	0	0	0
6346	20AL203106	Hunter Regulated Water Sharing Plan, surface water, zone 1B (Hunter River from Goulburn River Junction to Glennies Creek Junction)	15.5	0.87	0	0.87
8404	20AL200491	Hunter Regulated Water Sharing Plan, surface water, zone 3A (Glennies Creek)	80	20.57	0	20.57
15583	20AL204249	Hunter Regulated Water Sharing Plan, surface water, zone 3A (Glennies Creek)	354	8.22	257.79	266.01
19510	20AL211015	Hunter Regulated Water Sharing Plan, surface water, zone 1B (Hunter River from Goulburn River Junction to Glennies Creek Junction)	130	0	0	0
23912	20AL211423	Hunter Unregulated and Alluvial Water Sources 2009, surface water, Whole Water Source (Jerry's Water Source) (Bowmans Creek)	14	0	0	0
29566	20AL212287	Hunter Unregulated and Alluvial Water Sources 2009, Aquifer, Jerry's Management Zone (Jerry's Water Source)	358	10.57	0	10.57

Water Licence Number	Water NSW Reference	Water sharing Plan, source and management zone	Entitlement (ML)	Passive take / inflows (ML)	Active pumping (ML)	Total (ML)
36702	20AL212975	Hunter Unregulated and Alluvial Water Sources 2009, Surface water, Jerry's Management Zone (Jerry's Water Source) (Bowmans Creek)	116	0	0	0
36703	20AL212976	Hunter Unregulated and Alluvial Water Sources 2009, Surface water, Jerry's Management Zone (Jerry's Water Source) (Bowmans Creek)	150	9.57	0	9.57
TOTAL, 2017-18			1579.5	**53.01**	**262.33**	**315.34**
TOTAL, 2016-17				74.3	244.28	318.58
TOTAL 2015-16				95	235	330

7.3 Surface Water

7.3.1 Environmental Management

Surface water at the ACP is managed in accordance with the approved SWMP. Appropriate controls have been put in place to mitigate potential causes of water pollution. These controls are considered to have been adequate for the reporting period. Water quality for the creeks and rivers surrounding ACP operations is monitored by an independent consultant at 14 approved monitoring sites. The location of the surface water monitoring sites is shown in Figure 14 and described in Table 21 Analysis of all water samples collected is undertaken by a NATA accredited laboratory. Monthly water samples were collected and analysed during the reporting period for pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS) and Total Suspended Solids (TSS).

The SWMP aims to minimise any adverse impacts on receiving waters downstream of operations; including Glennies Creek, Bettys Creek and Bowmans Creek, all of which drain into the Hunter River. The SWMP also outlines measures for managing water on site. The approved surface water monitoring program has established impact assessment criteria, described as trigger values which, if activated, would lead to a response in terms of more intensive monitoring, investigation and if required, remedial action.

During the reporting period, the SWMP was revised and approved. As a result of this review, a number of water monitoring sites were relocated to minimise access issues on privately owned land, and ensure wet weather did not impede access to monitoring sites. Site SM11 was replaced with SM11a and SM13 was replaced with SM13a in February 2018. SM11a and SM13a both have a full year of data and have been included in this report from January 2018.

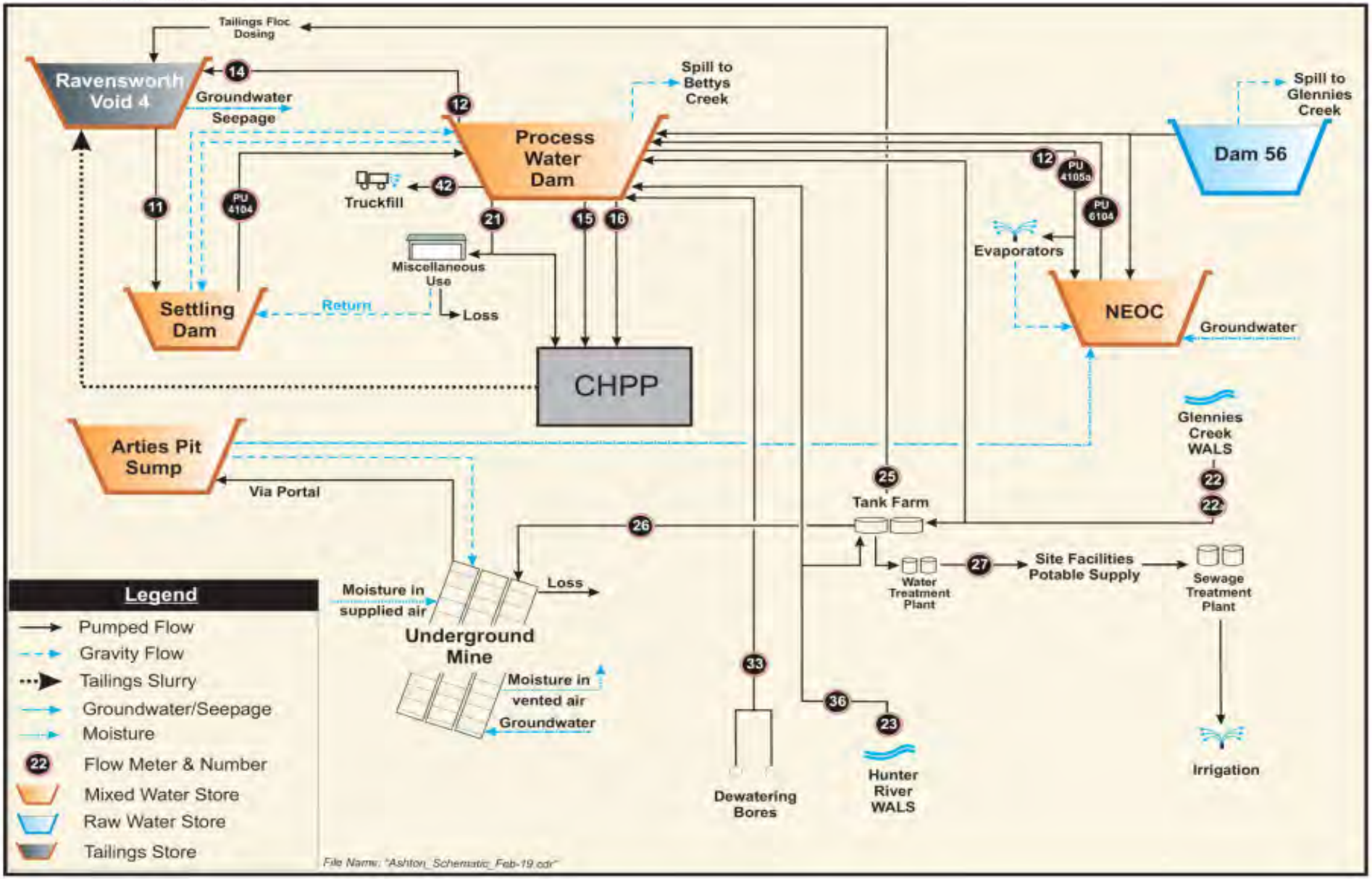

Figure 11 Ashton Coal Water Management Schematic

***** All dams must have spillways constructed to ensure dam wall stability. Dams at the ACP are managed to prevent spills occurring.

7.3.2 Environmental Performance

The location of surface water monitoring sites and data capture rates are provided in Table 21. A summary of the surface water quality data for statutory sites during the reporting period is provided in Table 22 and graphically in Figure 12 and Figure 13.

Table 21 Surface water monitoring locations and data capture rates

Site	Stream	Location	Data capture rate %
SM 1	Bettys Creek	Glendell land upstream of Ashton	0*
SM 2	Bettys Creek	Just upstream of confluence with Bowmans Creek	0*
SM 3	Bowmans Creek	Water pool at north west corner of mine lease	100
SM 4	Bowmans Creek	Water pool immediately downstream of New England Highway	100
SM 4a	Bowmans Creek	Former channel	42*
SM 5	Bowmans Creek	Halfway down Ashton property	0*
SM 6	Bowmans Creek	Just upstream of confluence with Hunter River	100
SM 7	Glennies Creek	Upstream of Ashton Mine	100
SM 8	Glennies Creek	Halfway down Ashton property	100
SM 9	Hunter River	Upstream of confluence with Bowmans Creek	100
SM10	Hunter River	Downstream of confluence with Bowmans Creek	100
SM 11a	Glennies Creek	Upstream of confluence with Hunter River	100
SM 12	Hunter River	Downstream of confluence with Glennies Creek	100
SM 13a	Hunter River	Upstream of confluence with Glennies Creek between Bowmans Creek and Glennies Creek	100

*SM1, SM2 and SM5 were too dry to sample for the whole reporting period, SM4a for 7 months.

Table 22 Water Quality Summary, 2018

Creek System		pH	EC	TDS	TSS
			µS/cm	mg/L	mg/L
Bettys Creek (SM1 and SM2)	Minimum	-	-	-	-
	Maximum	-	-	-	-
	Average	-	-	-	-
Bowmans Creek (SM 3, 4, 4A, 5,6)	Minimum	7	506	716	2
	Maximum	8.4	5250	3550	304
	Average	7.8	1974	1561	37
Glennies Creek (SM7, 8 and 11a)	Minimum	6.9	208	131	1
	Maximum	7.9	418	254	39
	Average	7.7	304	193	9
Hunter River (SM9, 10, 12, 13A)	Minimum	7.5	228	138	1
	Maximum	8.2	888	535	37
	Average	8	557	329	15

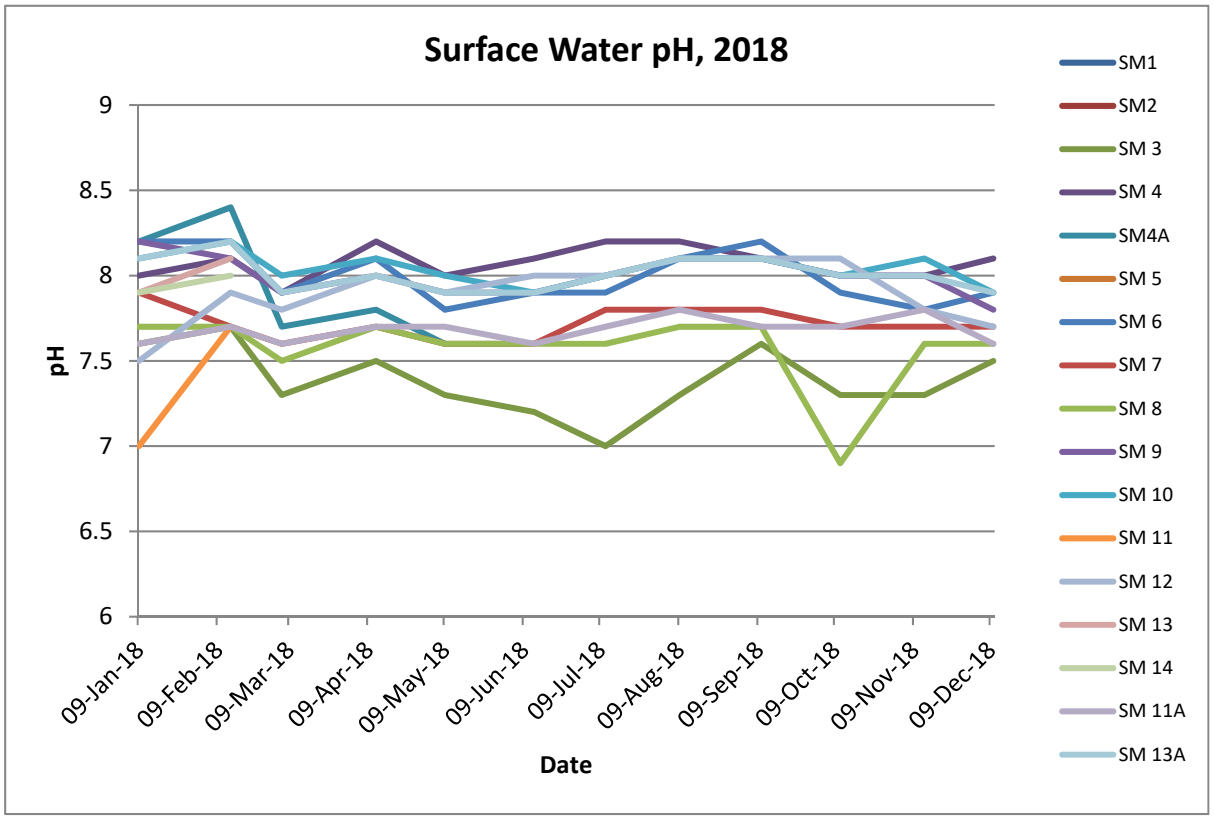

Figure 12 Surface Water pH, 2018

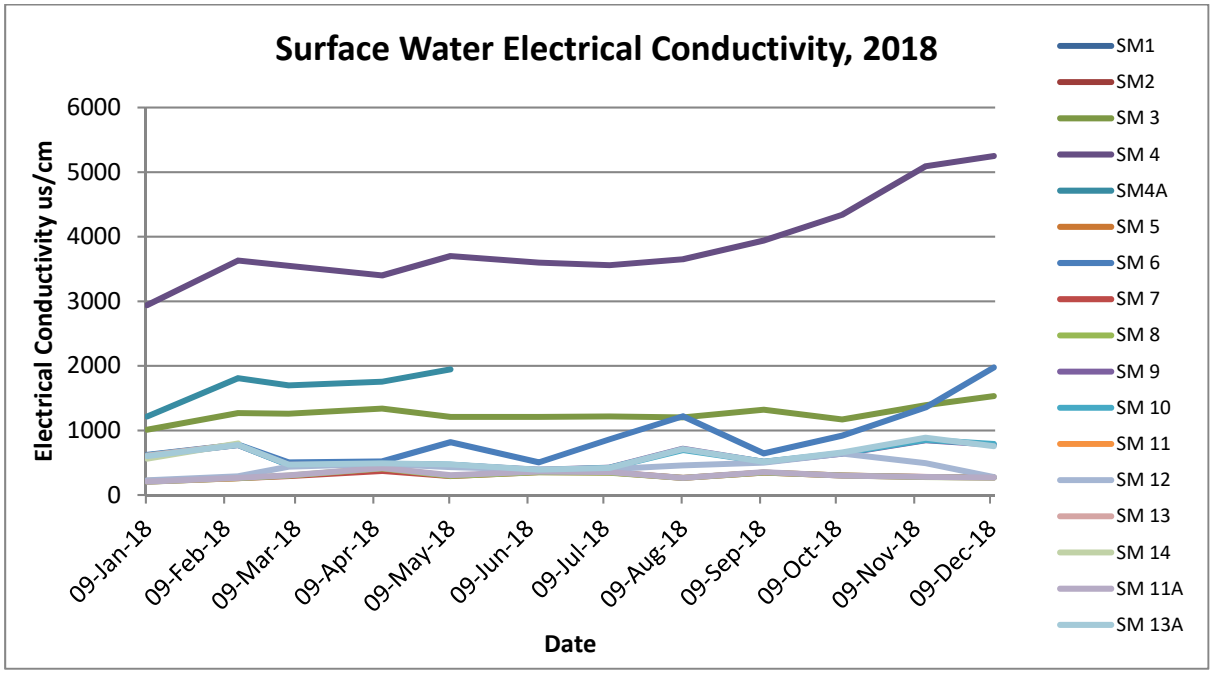

Figure 13 Surface Water Electrical Conductivity, 2018

Results during this reporting period follow similar trends to previous years in the Hunter River and Glennies Creek, which is to be expected since they are regulated water flows and generally maintain consistent minimum flow. Bowmans Creek water quality was indicative of the continued dry conditions throughout most of the reporting period, leading to higher conductivity, suspended and dissolved solids. The high conductivity results at Site SM4 on Bowmans Creek are expected in dry conditions, as a coal outcrop in the river pool influences water quality at this site when there is low or no flow.

There were no variations from baseline during the reporting period that triggered a response investigation. The monitoring data collected during the reporting period continued to indicate no adverse impacts from ACP mining on surface water quality around the mine site.

7.4 Groundwater

7.4.1 Environmental Management

The groundwater monitoring network at Ashton Coal is complex. Monitoring coverage is focussed in areas within and adjacent to the mining associated subsidence footprint, notably:

- Saturated quaternary sediments (alluvium) including Bowmans Creek Alluvium (BCA), Glennies Creek Alluvium (GCA) and Hunter River Alluvium (HRA).
- Shallow Permian sandstone and minor coal seams referred to in this report as coal measures overburden (CMOB).
- Permian coal measures of varying thickness targeted by mining.

Groundwater is managed in accordance with the ACP SWMP. The SWMP was updated and approved in March 2018 to reflect Modification 5 to the development consent and satisfy the requirement to review management plans within three months of the submission of an annual review or completion of an Independent Environmental Audit.

A groundwater model is utilised to predict impacts and changes to the hydrogeological regime of the site. During 2016 the groundwater model was updated and recalibrated using up to date monitoring data and mine plans. The model has been effective during this reporting period, with no reportable exceedances of impacts from those modelled and approved.

ACOL's approved groundwater monitoring program has established impact assessment criteria. Impact assessment criteria can be described as trigger values that, if exceeded, would lead to a response in terms of more intensive monitoring, investigation and ultimately if required remedial action.

Monitoring of water levels and water quality parameters is undertaken on a monthly basis at selected monitoring bores. Physical parameters – pH, EC and temperature are monitored quarterly and chemical speciation is undertaken on relevant bores annually.

The annual groundwater summary is included as Appendix 2.

In accordance with the conditions of approval of the LW201-204 Extraction Plan, during the reporting period a technical review of historical groundwater impacts was completed and accepted by DPE.

Figure 14 Ashton Coal surface water monitoring locations

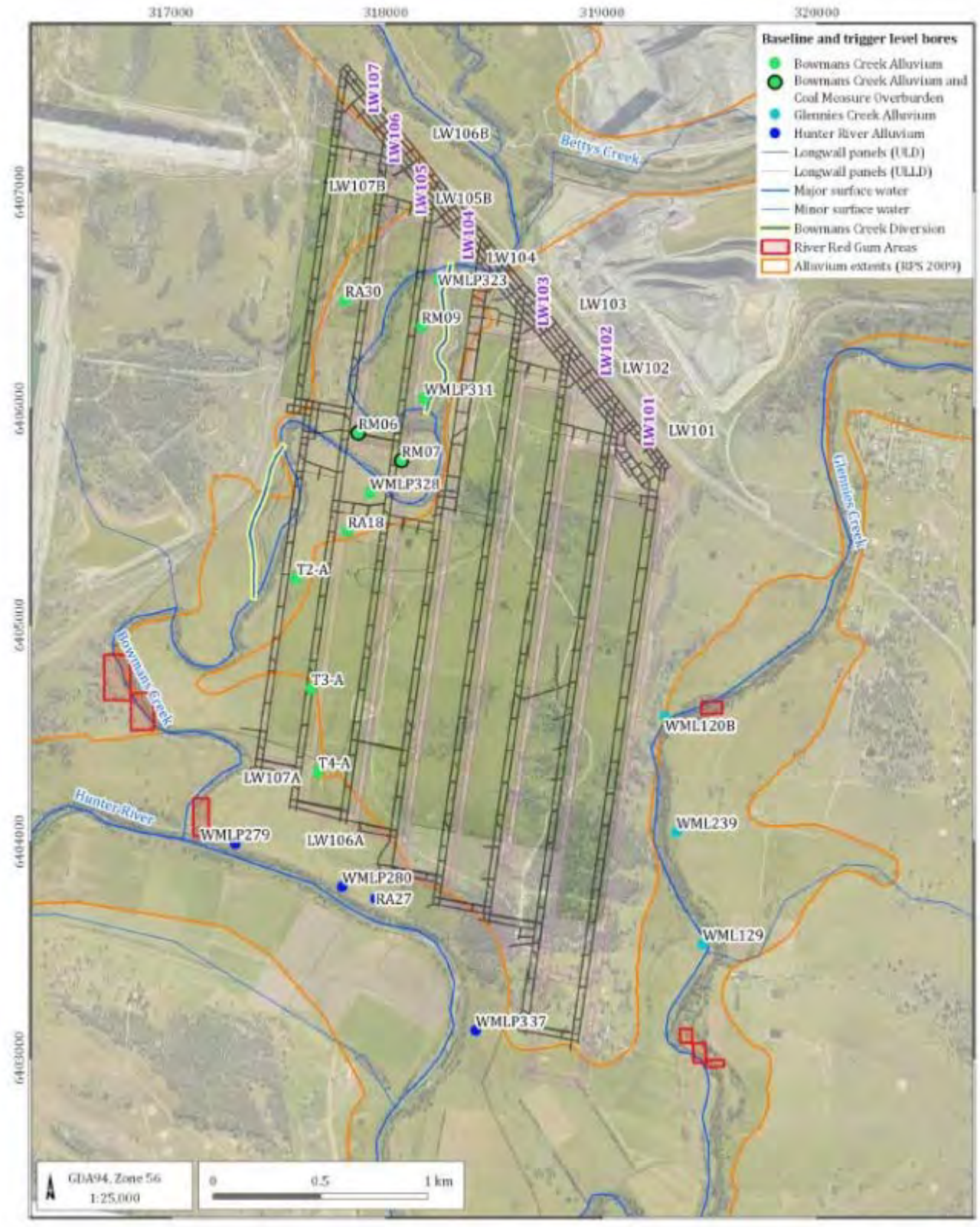

Figure 15 ACOL's groundwater level baseline and trigger level monitoring bores

7.4.2 Environmental Performance Summary

7.4.2.1 Groundwater Quality

Groundwater quality was predominantly within impact assessment criteria, with the exception of pH exceeding trigger values on 2 occasions – WML 337 (Hunter River Alluvial) and WMLP 358 (Glennies Creek Alluvial). These were minor isolated variations from trigger values in the first quarter of the reporting period, after which all results were within relevant water quality criteria.

Three Bowmans Creek Alluvial bores had EC readings slightly above their trigger levels during the reporting period (WMLP 328, WMLP 311 and WMLP 323). The trends of these bores, including the slight exceedances, are shown in Figure 16 EC trends, Bowmans Creek Alluvial Bores, 2018Figure 16.

Investigations were undertaken into the exceedance of trigger levels. The investigations concluded that the northern area of the Bowmans Creek Alluvial received low levels of recharge from Bowmans Creek, which had been dry since April 2018. The below average rainfall over the rest of the year was not enough to generate flow in Bowmans Creek or recharge the groundwater system. The resulting lack of recharge was a gradual decline in groundwater elevation and a rise in EC which was contributed to climatic conditions.

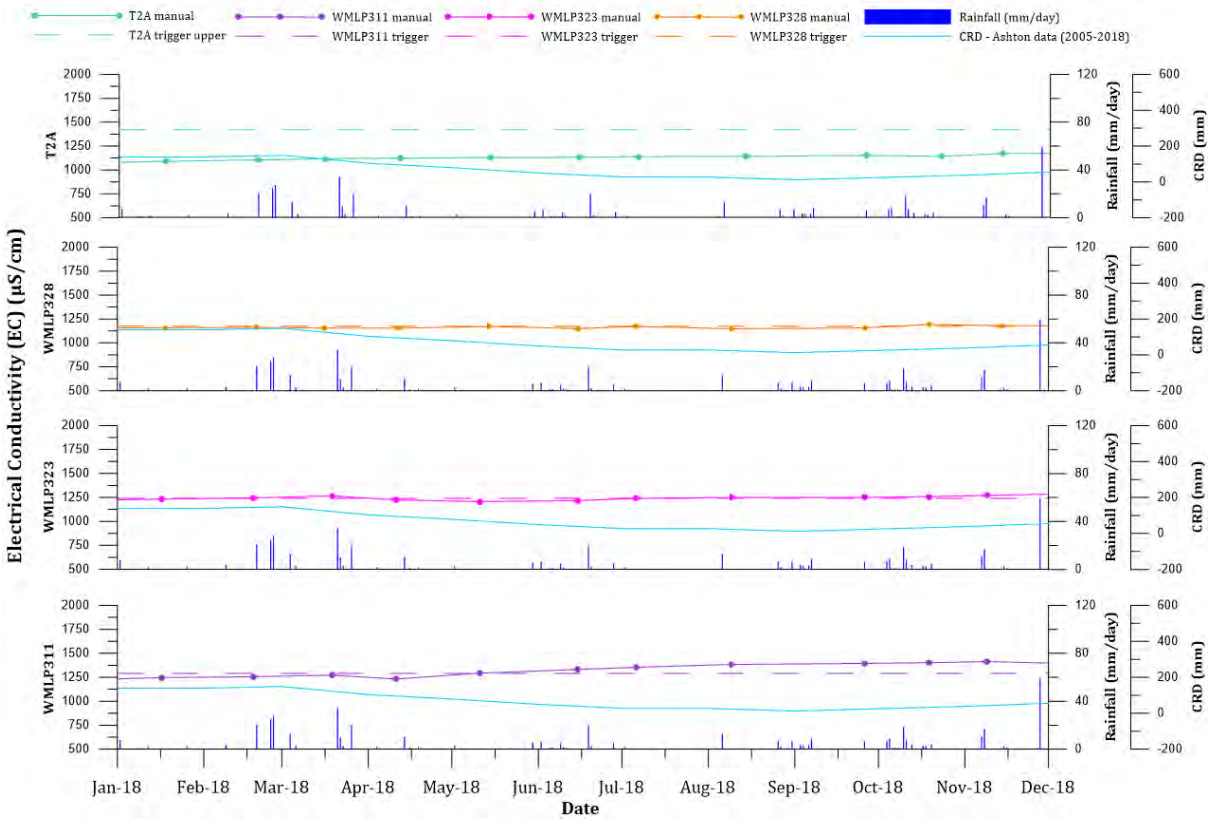

Figure 16 EC trends, Bowmans Creek Alluvial Bores, 2018

7.4.2.2 Groundwater level

Groundwater levels in Bowmans Creek Alluvial bores reflected the sustained dry conditions, with WMLP 328 under the trigger value level since July 2018. The investigation identified that the area has received a relatively low level of recharge from Bowmans Creek and rainfall due to the recent dry conditions and are not related to mining impacts. This bore will continue to be monitored and reaction to future rain will be examined. Other alluvial bores remained stable, mostly as a result of Glennies Creek and the Hunter River regulated flows.

Coal Measures overburden bores in the vicinity of Longwall 202 all remained relatively constant throughout the year. Those bores not influenced by proximity to the Hunter River and Glennies Creek have demonstrated a gradual slow decline in groundwater level during the reporting period which can be attributed to declining Cumulative Rainfall Departure (CRD) and sustained low rainfall.

Further information on groundwater performance during 2018 is included in Appendix 2.

8 Mine Subsidence

Underground longwall mining operations commenced in February 2007. Mining of the PG seam (LWs 1-8) and ULD seams LW 101 to LW 106A are completed. As at the end of the reporting period, operations are mining in LW 202 (in the ULLD Seam).

During the reporting period, mining operations occurred in LW 201 and LW 202 in the ULLD seam. Extraction of LW201 was completed in April 2018 and commenced in LW202 in June 2018. Subsidence monitoring was undertaken in accordance with the relevant extraction plan- *Ashton Coal Mine Longwalls 201-204 Extraction Plan November 2016*. Monitoring included both regular survey monitoring and visual inspection of environmental, land and infrastructure features.

There were no unexpected impacts to the environment or infrastructure during this reporting period.

The progress of ULLD LW extraction is shown in Figure 2.

8.1 Subsidence Monitoring and Remediation

Monitoring of subsidence is conducted on the surface during the extraction of all Longwalls using longitudinal subsidence lines. Subsidence monitoring sections are located over the start and finish of each panel, a main cross line extending over all seven southern panels and a dedicated cross line extending over LW 6B, 7B and 8. All panels have monitoring data from each start and end line, and various cross lines relevant to panel, surface or strata features.

Table 23 and Table 24 outline the maximum subsidence parameters predicted and recorded (incrementally and cumulatively) during regular survey of subsidence lines as the longwalls pass each location.

Table 23 Incremental Subsidence Monitoring of LW201 and LW202, 2018

	Incremental Subsidence (m)	Incremental Strain (mm/m) (General Background / Stacked Edge)	Incremental Tilt (mm/m) (General Background / Stacked Edge)
Longwall 201			
Predicted EP	2.5	43 / 76	76 / 150
LW1CL2 *	2.46	8 / NA	37 / NA
LW101CL2 *^	2.23	10 / NA	33 / NA
XL8 *	2.11	7 / NA	35 / NA
Longwall 202			
Predicted EP	2.7	40 / 70	70 / 140
LW2CL1 *	2.9	13 / NA	50 / NA
LW102CL1 *^	2.42	25 / NA	46 / NA

* No stacked edge on this survey line, N/A stacked edges are not applicable to this line

Table 24 Cumulative Subsidence Monitoring of LW201 and LW202, 2018

	Cumulative Subsidence (m)	Cumulative Strain (mm/m) (General Background / Stacked Edge)	Cumulative Tilt (mm/m) (General Background / Stacked Edge)
Longwall 201			
Predicted EP	5.7	74 / 170	120 / 350
LW1CL2 *	5.35	44 / NA	117 / NA
LW101CL2 *^	4.05	16 / NA	51 / NA
XL8 *	4.97	33 / NA	137 / NA
Longwall 202			
Predicted EP	5.7	63 / 150	110 / 300
LW2CL1 *	5.36	25 / NA	54 / NA
LW102CL1 *^	4.49	34 / NA	68 / NA

* No stacked edge on this survey line. N/A stacked edges are not applicable to this line

^ line installed post Pikes Gully seam extraction therefore cumulative figures exclude PG subsidence

Incremental subsidence in Longwall 202 exceeded extraction plan predictions by 0.2metres, however it remains well under cumulative subsidence predictions. Cumulative tilt measurements for Longwall 201 also exceeded the predictions in the extraction plan during the reporting period. Both of these exceedances triggered a Level 1 TARP response, which involved additional monitoring and internal reporting requirements. There has been no unpredicted impact to natural or built features as a result of the exceedance of predicted subsidence impacts outside extraction plan predictions.

Areas mined during the reporting period were all on ACOL owned land. Built features in the operational area include ACOL owned gas drainage infrastructure, a private Right of Way (ROW) access to Property 130 and a 132kv transmission line. During the reporting period there was no reported damage to these features as a result of subsidence with the exception of predicted minor subsidence cracking to the ROW. The ROW was closed and an alternate access provided while cracking was repaired. The ROW was reopened following the completion of repair works.

Rehabilitation of the surface cracks has been occurring as extraction continues with a small excavator backfilling and smoothing cracks. Affected surface roads have been repaired to smooth compression humps and minor cracks. Areas of subsidence associated with the mining of LW201 within the

Voluntary Conservation area have been rehabilitated during the reporting period. See Figure 17 for areas of subsidence repair during the reporting period.

Ponding has become evident in some subsided areas after rainfall events, typically in those areas which were flat pre-mining. Remediation is planned in consideration of the currently approved multi seam mining which will see the same area undermined for up to four times. Presently, the ponding does not present a significant risk and serves as a water source for stock which graze over the lease. There is no indication of any significant lateral movement of the steep slope adjacent to Glennies Creek or of the New England Highway road cutting (to date).

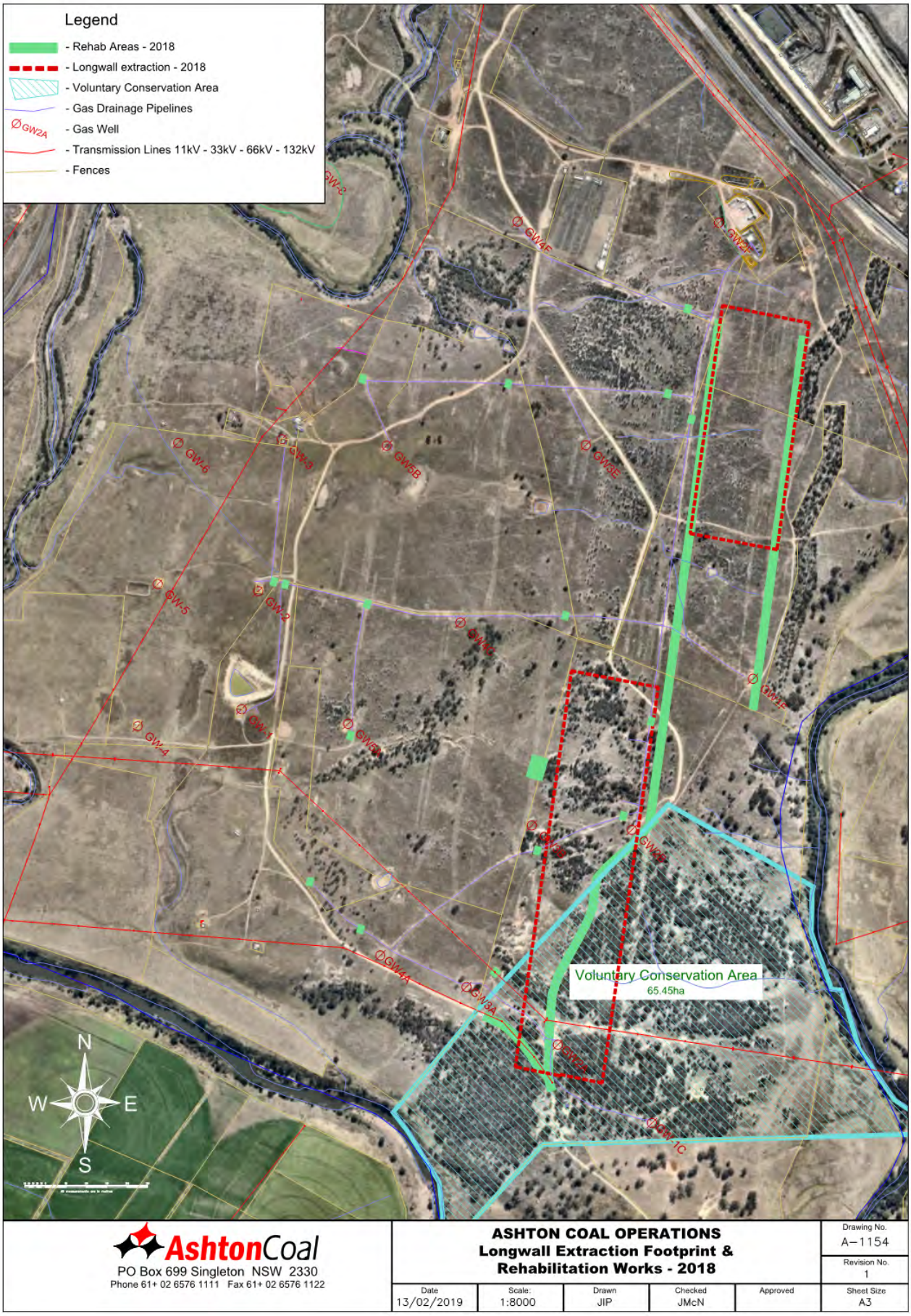

Figure 17 Subsidence cracking rehabilitation, 2018

9 Rehabilitation and Land Management

Rehabilitation and land management activities undertaken are outlined in the MOP 2018-2024 approved in September 2018. Rehabilitation monitoring was primarily conducted in accordance with the superseded MOP – 2013-2017 during this reporting period. Monitoring will be undertaken in accordance with the approved MOP in 2019. There were no notable variations in activities when compared with the MOP.

Any areas required by the operation to be disturbed go through a Ground Disturbance Permit process. This ensures the appropriate checks are performed prior to disturbance, and that the appropriate amount of area is cleared.

Consistent with the MOP, there were no areas of rehabilitation relinquished or signed off by DPE-RR during the reporting period.

During the next reporting period, rehabilitation will be monitored and maintenance conducted as required. Rehabilitation monitoring is being reviewed and, during 2019, rehabilitation monitoring will reflect a revised monitoring regime.

The main primary domains (or land management units) under active rehabilitation or monitoring and maintenance during the reporting period are listed below:

- Bowmans Creek Riparian Zone – which includes the excised sections of Bowmans Creek and the River Red Gum population south of the diversions.
- Bowmans Creek Diversion – rehabilitation monitoring of the diverted creek sections is continuing in accordance with the commitments made in the Bowmans Creek Diversion Environmental Assessment, water management plan and MOP.
- Pasture – Underground Mining Area Farmland above the underground mine – effective land management to ensure the land remains viable farmland is the focus over this area, which is managed in accordance with the MOP and the FFMP.
- Trees over Grass – Underground
- North East Open Cut – rehabilitation has been completed in this area. Monitoring and maintenance activities are ongoing in accordance with the MOP and the FFMP.

The MOP defines rehabilitation phases for each domain, and the completion criteria for each phase. For each domain, specific performance indicators have been established to allow the progress of rehabilitation to be measured. Consistent with MOP requirements, the performance indicators and current condition (measured during the 2018 rehabilitation monitoring) are described in Appendix 1...

9.1 Rehabilitation status

Open cut rehabilitation was completed in 2013, with the exception of the NEOC void, which is used as coarse reject emplacement. Rehabilitation maintenance is carried out on the NEOC rehabilitation on an as needs basis to enhance species diversity. Maintenance activities generally include weed management, slashing to promote species diversity as well as maintenance of some contour banks through re-topsoiling and seeding where required. Rehabilitation improvement has been undertaken on the NEOC in the form of slashing and weed control works in preparation for the continuation of a tree seeding trial in 2019. Following the preparation works, three hectares of tree seeding was completed in 2018, and a further two hectares of tree seeding was postponed until more favourable conditions prevail.

During the reporting period land maintenance activities were carried out above the underground operations, including weed management, repair of subsidence cracking, rehabilitation of the ULD ventilation fan site and gas drainage lines.

Rehabilitation activities have been undertaken in accordance with the MOP (see Figure 18), with the exception of mining not proceeding as far as predicted (see Figure 2). Rehabilitation of subsidence cracking is up to date (see Figure 17), with initial repairs of the northern part of LW201 and the southern part of LW202 being undertaken during the reporting period, along with remedial treatment of re-opened cracks in the southern sections of LW201.

Table 25 Rehabilitation Status

Mine area type	Previous Reporting Period (Actual) (ha)	This reporting period (Actual) (ha)	Next reporting period (Forecast) (ha)
	2017	2018	2019
Total mine footprint[1]	909.6	909.6	909.6
Total Active disturbance area[2]	177.3	177.3	177.3
Land being prepared for rehabilitation[3]	0	0	0
Land under active rehabilitation[4]	732.2	732.2	732.2
Completed rehabilitation[5]	0	0	0

[1] Total Mine Footprint: includes all areas within a mining lease that either have at some point in time or continue to pose a rehabilitation liability due to mining and associated activities. As such it is the sum of total active disturbance, decommissioning, landform establishment, growth medium development, ecosystem establishment, ecosystem development and relinquished lands (as defined in the DRE MOP/RMP guidelines). Subsidence remediation areas are excluded.

[2] Total Active Disturbance includes all areas ultimately requiring rehabilitation such as: on-lease exploration areas, stripped areas ahead of mining, infrastructure areas, water management infrastructure, sewage treatment facilities, topsoil stockpile areas, access tracks and haul roads, active mining areas, waste emplacements (active/unshaped/ in or out of pit), and tailings dams (active/unshaped/uncapped).

[3] Land being prepared for rehabilitation – includes the sum of mine disturbed land that is under the following rehabilitation phases – decommissioning, landform establishment and growth medium development (as defined in the DRE MOP/ RMP guidelines)

[4] Land under active rehabilitation – includes areas under rehabilitation and being managed to achieve relinquishment – includes the following rehabilitation phases as described in the DRE MOP/RMP guidelines – 'ecosystem and land use establishment' (area seeded or surface developed in accordance with final use) and 'ecosystem and land use sustainability' (revegetation assessed as showing signs of trending towards relinquishment or infrastructure development).

[5] Completed rehabilitation – requires formal sign-off by DRE that the area has successfully met the rehabilitation land use objectives and completion criteria.

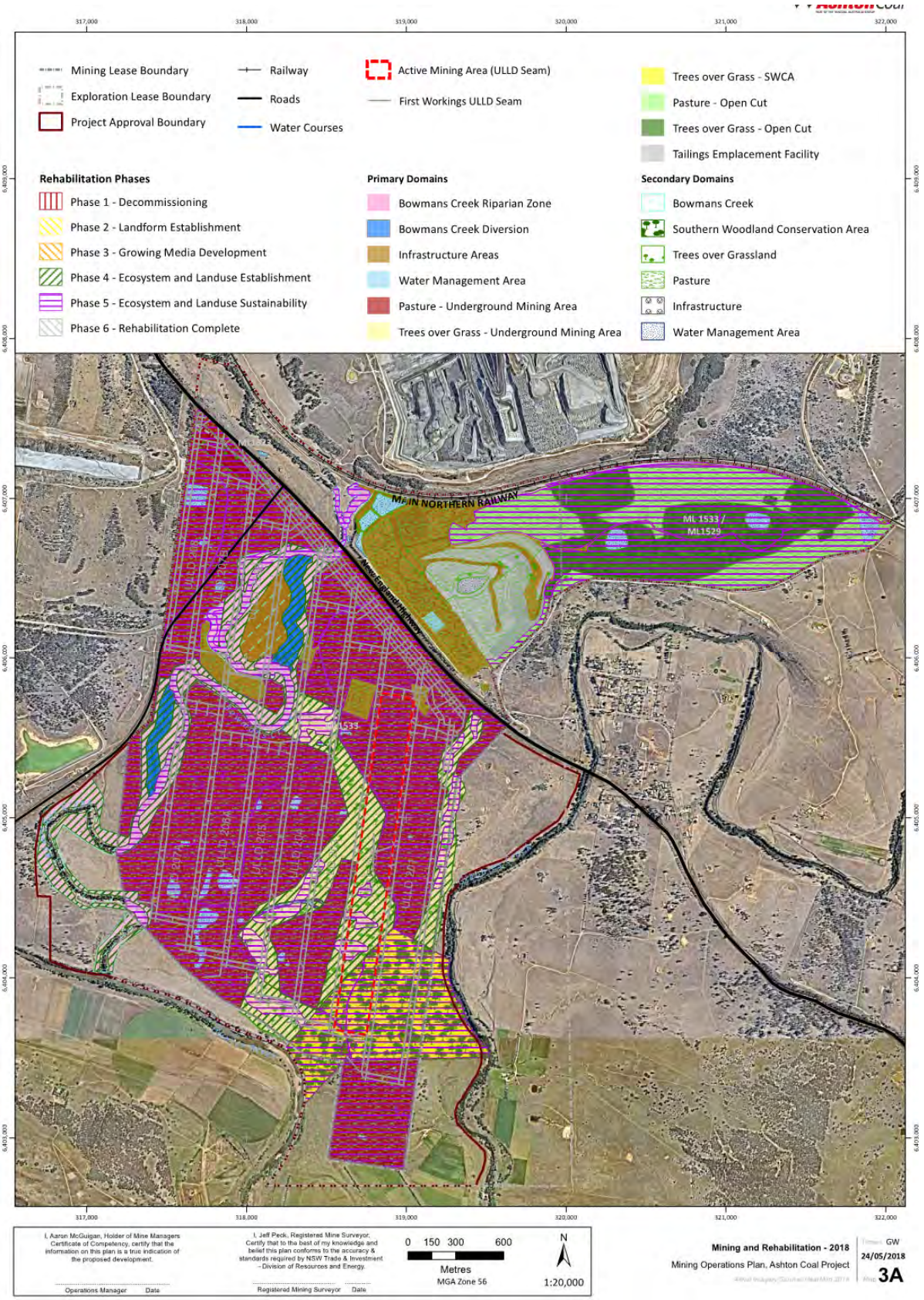

Figure 18 mining and rehabilitation in 2018

9.2 Ground Disturbance

Ground Disturbance at Ashton Coal is managed using the Ground Disturbance Permit (GDP). During the reporting period, there were a number of minor ground disturbances approved at Ashton Coal, as shown in Figure 19.

Ground disturbance during the reporting period included:

- small areas of steel fencing erected around gas drainage infrastructure (such as junction boxes and tube bundle sites) to minimise damage by grazing cattle,
- Scraping vegetation (not topsoil) from the North East Open Cut rehabilitation prior to tree planting
- Relocate the repeater weather station to the NEOC rehabilitation area
- Minor subsidence cracking repair along Longwall 201
- Grader scrapes associated with monitoring for aboriginal cultural heritage prior to subsiding the area
- Cleaning up old farm dumps identified over the underground mining area.

These activities did not require topsoil stripping or stockpiling as the areas disturbed were minor. Subsidence cracking repair works strip the soil, repair cracks, and respread topsoil, generally in the same day.

9.2.1 Topsoil Management

Topsoil is managed in accordance with the measures outlined in Section 3.5 of the 2018 MOP. Assessment and management of topsoil disturbance is undertaken as part of the GDP process, with topsoil management requirements depending on the scale of proposed disturbance. However, where appropriate, conditions will generally include:

- Topsoil suitability, including stripping depths and areas;
- Materials not to be stripped, or requiring special management, due to constraints or deficiencies; and
- Management requirements relating to topsoil stripping, handling, stockpiling and re-use.

ACP has two existing residual topsoil stockpiles (NEOC and Bowmans Creek Diversion). Where these stockpiles were borrowed from during the reporting period, excavated faces were re-shaped and seeded with a protective cover crop. There were no areas requiring topsoil stripping or stockpiling during the reporting period as the areas disturbed were minor. Subsidence cracking repair works strip the soil, repair cracks, and respread topsoil, generally in the same day. No broadscale topsoil disturbance was undertaken during the reporting period, and the limited topsoil disturbed during small scale projects (where recoverable) was replaced at the same location and depth as recovery.

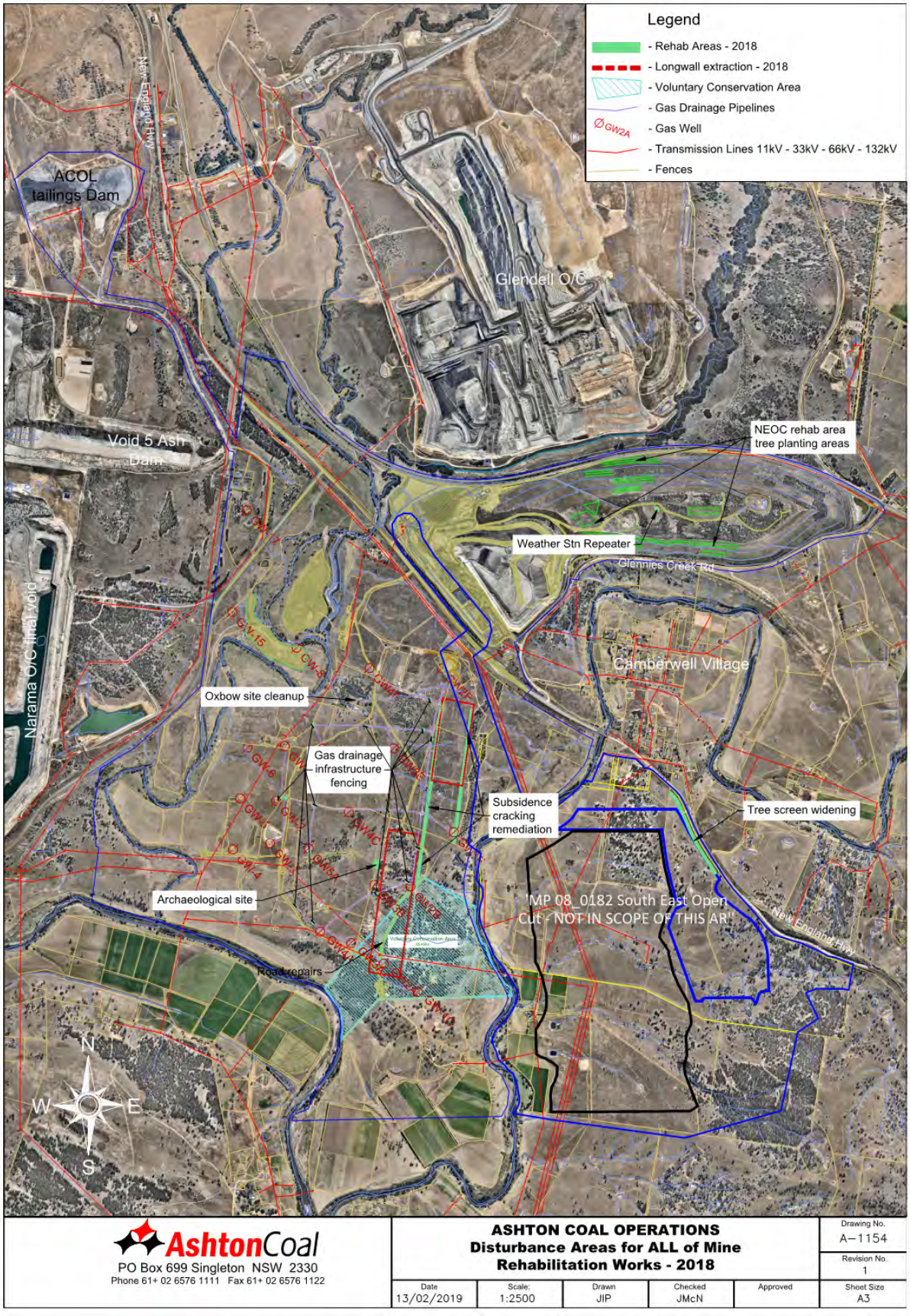

Figure 19 Ground Disturbance during reporting period

9.3 Bowmans Creek Diversion Rehabilitation

Eleven existing 200 m^2 quadrats were surveyed in spring 2018 to monitor the condition of vegetation and survivability of rehabilitation plantings of river oak and eucalypts, predominantly river red gum (Eucalyptus spp.) trees along two diversions to Bowmans Creek.

Five river oak analogue sites were also established and surveyed for the first time in 2018. A total of 91 species were recorded at sites situated on the Bowmans Creek Diversion (BCD), 37 (41 per cent) of which are native and 54 (59 per cent) exotic.

Diversion rehabilitation sites have a higher proportion of native species than analogue sites with a total of 70 species recorded, 16 (23 per cent) of which are native and 54 (77 per cent) of which are exotic. Total species numbers are comparable to last year's monitoring program, where there were 67 species recorded (Table 26).

Monitoring data indicates that trees planted along the BCD are surviving and increasing in height. The land function analysis (LFA) indices at Diversion sites are also comparable to those recorded at Analogue sites, suggesting that the planted areas are retaining resources on site at levels similar to equivalent mature remnant vegetation.

Table 26 Number of species recorded in the BCD, 2015 to 2018

	2015	2016	2017	2018
Total species recorded	50	43	67	70
Native	16	14	29	16
Exotic	34	29	38	54

9.4 Bowmans Creek Diversion Management

The two reaches of the BCD (Eastern and Western), have been constructed in the underground mining area as shown in Figure 14. Construction commenced on the Eastern diversion in March 2011 and on the Western diversion in February 2012. Both were commissioned with flow through each diversion in November 2012. Temporary low level block banks have been constructed across the original channel of Bowmans Creek, directing low flows into the diversion reaches. High (flood) flows are designed to overtop the temporary block banks in order that such flows not pass through the diversion until full vegetation establishment. The construction program has been completed (engineering sign off obtained) with the exception of permanent block banks which will be constructed one year prior to mining LW 106B (in the ULD Seam).

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

- flow channels that mimic the hydraulic and geomorphic characteristics and provide similar resilience;
- fish passage and a diversity of aquatic habitat;

- enlarged areas of ecologically diverse, naturally vegetated, riparian corridor; and
- a free draining floodplain that is vegetated to a standard consistent with the final intended land use.

In addition to general land management and environmental monitoring, there are a number of rehabilitation and monitoring commitments specific to the BCD that are reported in this AR, as shown in Table 27.

Table 27 Bowmans Creek Diversion Commitments

Commitment	Status	Further detail
Survey of bed and banks including bed samples at six months, one year, two years and at five yearly intervals, or after a flood with a peak flow of greater than 150m3/s. (Development consent, Appendix 3, Mod 6, commitments 7.1 and 7.2)	Surveys were undertaken in 2013, 2014 and 2017.	This section
Fish passage and aquatic ecology in stream diversions are monitored and remain within acceptable levels, or appropriate remedial measures considered.	Fish results detailed in section 6.4.2 demonstrate that the diversion channels were predominantly dry during the year	See section 6.4.2
Community structure in the diversion channels are monitored bi-annually to record growth rates, species abundance as well as percentage cover to determine a final structural complexity index.	Annual monitoring was undertaken in 2017.	See section 6.4.2 and 9.3

The scheduled surveys of the morphology of the BCD have been completed, along with surveys of the control reaches, which are natural reaches of Bowmans Creek unaffected by the diversions. This work comprehensively surveyed the diversions at established cross-sections and along the bed. The objective is to compare the morphology with previous surveys to determine how much change has occurred over time. As some degree of change in the morphology of the channel bed and banks is normal and expected for any river, the change in the diversions is also compared against the change monitored at the control reaches. To date, the morphological change in the diversions have been largely within the expected limits, and similar to that observed in the control reaches. Also, the rock bars, installed as part of the design to maintain the bed profile, have resisted repeated flood events.

9.5 North East Open Cut rehabilitation

North-east open cut (NEOC) rehabilitation includes two domains being Pasture and Trees over Grass (ToG). Six 400 m^2 quadrat sites were monitored in the NEOC during spring 2018, including four Pasture sites and two ToG sites. Six analogue sites located within native woodland and native grassland were also surveyed which provide quantitative benchmark data for comparison. Monitoring included the collection of floristic data and LFA data at all sites, as well as soil analysis at rehabilitation sites. A walkover inspection of ToG rehabilitation was undertaken for the first time in 2018. The total number of species recorded in the Pasture rehabilitation sites collectively is comparable to the total number of species recorded in the analogue Pasture sites, with 51 and 55 species recorded, respectively.

Around twice the number of native species were recorded at analogue sites, when compared to rehabilitation sites. A total of 45 species were recorded in ToG rehabilitation sites collectively, compared with 70 in analogue sites. ToG Analogue sites contain a higher diversity of native species than rehabilitation sites, being 44 and 21 species, respectively. Soil analysis and LFA data indicate that rehabilitated sites are generally trending toward analogue sites over time with regard to soil characteristics and retention of resources. The walkover inspection of the ToG rehabilitation identified a relatively low incidence of management issues, including exotic species and minor erosion issues.

Weed spraying and slashing works on the NEOC rehabilitation has been a focus over the past five years, and has continued during this reporting period. Around 5 hectares of the NEOC was slashed, sprayed for weeds and scarified during the reporting period to prepare for additional tree planting to boost tree numbers in some parts of the ToG domain in 2019.

Over the past few years, surface water runoff from the NEOC have been the subject of a number of studies. As the rehabilitation is progressing, ACOL is considering options to allow surface water from the NEOC to flow offsite. Options for surface water runoff were finalised during the reporting period. In the present drought conditions, it is not feasible to divert water offsite. Options require earthworks and modifications to existing approvals and or applications for new approvals, which may be developed in the future when the project is aligned with current mine plans.

9.6 Research

No research was undertaken during the reporting period at Ashton Coal.

10 Community

Ashton Coal has developed procedures and plans to minimise its impact on local communities, and contributes to community projects that benefit local people.

10.1 Community Support Program

Ashton Coal provides support to a range of local community groups, initiatives and sponsorships within the area. The Community Support Program aims to make a genuine positive difference in the communities in which Yancoal operates offering cash grants and in-kind support. The program sources and selects initiatives to meet the needs of four specific categories: health, social and community, Environment and Education and training.

More information on the Community Support Program can be found at http://www.ashtoncoal.com.au/page/sustainability/community/community-support-program/

During the reporting period, over $25,000 was presented to community groups for the following projects:

- Singleton Public School P&C who are fund raising for new playground equipment for their school.
- Singleton PCYC who are providing air conditioning for their premises
- Mt Olive Community Hall for an awning and storage area. Their hall gets used a lot by the local

community

- Singleton Neighbourhood centre for a training program for their volunteers. They open their centre for locals, aged and veterans to come and do washing, cook meals and other support as required.
- Team McInerney who are fundraising for the cancer council. The McInerney's are the Singleton Relay for Life Ambassadors.

10.2 Community Engagement

Two of the key engagement processes at Ashton Coal are the Community Consultative Committee (CCC) and the Aboriginal Community Consultation Forum (ACCF).

The CCC meets every four months as agreed by the committee. Community Consultative Committee meeting minutes and presentations can be found on the Ashton Coal website: http://www.ashtoncoal.com.au/page/sustainability/community/community-consultative-committee/

The ACCF is a community engagement process in place to ensure ongoing dialogue between the Aboriginal Community and Ashton Coal. ACCF meetings regularly discuss planned mining operations, potential impacts to Country, upcoming projects and salvage works. There were three meetings held during 2017 and regular meetings will continue during the next reporting period (see Section 6.8 for further information).

Neighbours are able to make contact with CCC members or call the community response line (1800 657 639), to keep up to date, voice concerns or make complaints. Ashton Coal staff will meet with community members and keep them informed as requested. During the reporting period there was little change or variation in operations, and no formal consultation program was undertaken.

The Ashton Coal website, www.ashtoncoal.com.au includes project approval documents, CCC meeting minutes, community complaint records, environmental monitoring information, environmental audits, environmental management plans, annual environmental management reports and community support program applications.

A free-call 24-hour Community Response Line (1800 657 639) allows the community to contact the operation directly to ask questions or raise concerns about mining activities. The operation of the community response line is required by Ashton Coal's development consent and environmental protection licence.

10.3 Complaints

Figure 20 shows complaints by type over the past six years. Figure 21 shows the complaint numbers over the life of mine, and illustrates a decreasing trend over time, with the greatest reduction in complaints around the time of open cut mine completion.

There were four complaints received during 2018, three in relation to noise and one in relation to the 2017 annual review document. Details of each complaint is found in the 2018 complaints register, reproduced in Table 28.

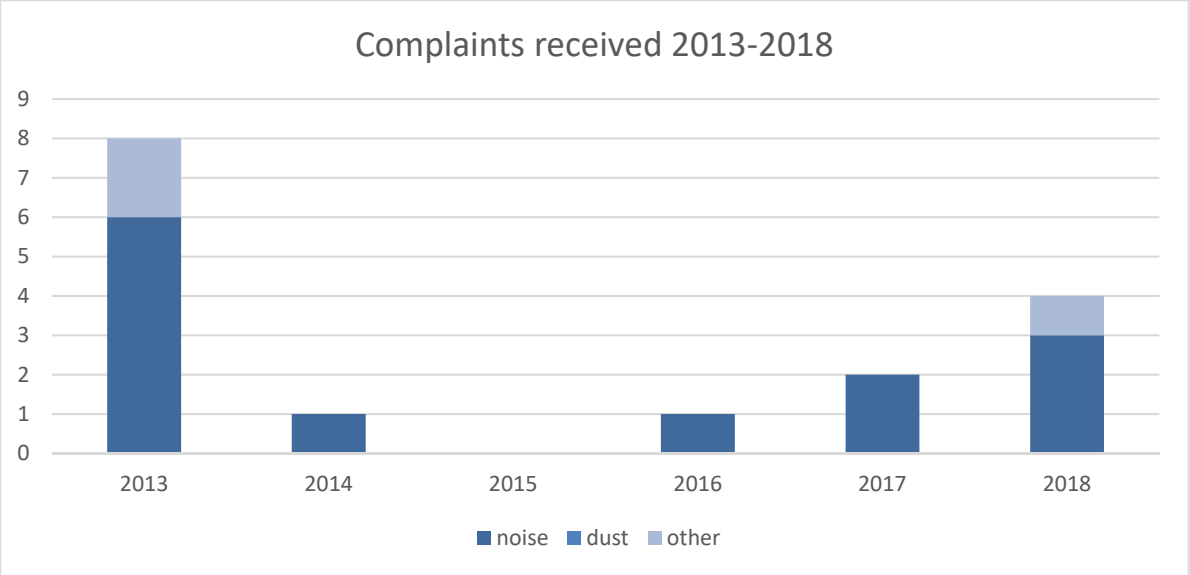

Figure 20 Complaints, 2013 -2018

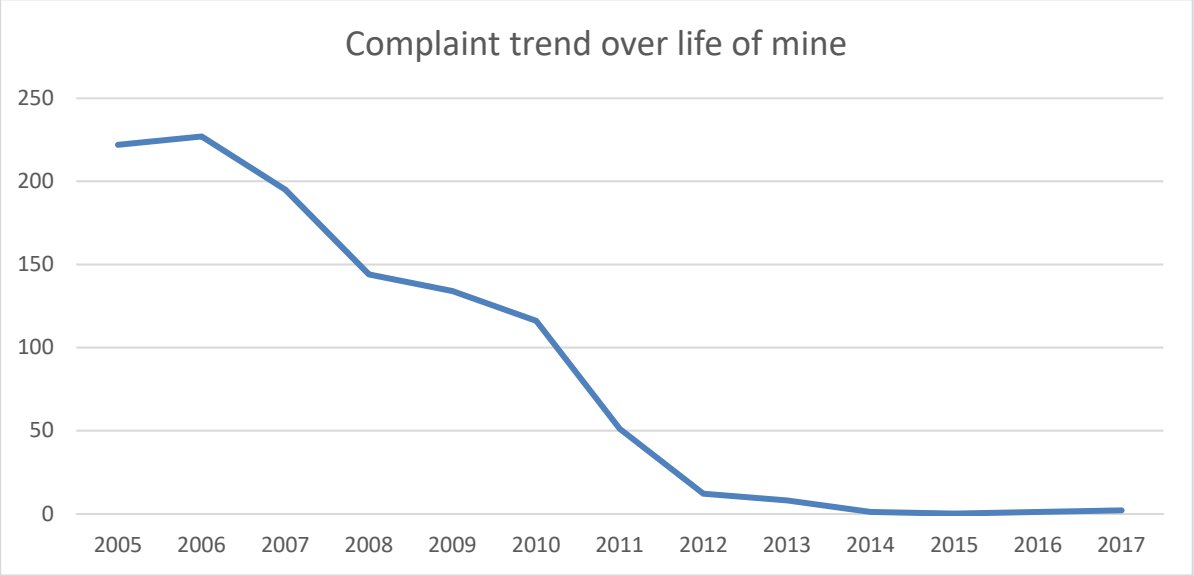

Figure 21 Complaints over life of mine

Table 28 Ashton Coal 2018 Complaints Register

Ashton Coal Operations Pty Limited Complaints Register - 2018		
Date & Time	Nature of Complaint	Details and Response
18/07/2018 0823	Noise	Complaint received from resident of Camberwell via Ashton community Contact Line. Message read: *(Complainant name)….."Called to complain regarding noise which is coming from the mines. Noise started yesterday (17/07/2018) at 8pm and it was still going on at 8am today (18/07/2018)."* Noise monitoring results were reviewed for the 12 hours referred to in the complaint. Monitoring results showed no elevated noise levels attributable to Ashton. The CHPP superintendent was interviewed regarding the complaint. He investigated CHPP operations for the previous 24 hours and found nothing out of the ordinary to support excessive noise coming from site. CHPP had been on maintenance shut down for two hours by 8AM on 18/7/18. Attempted to return call to complainant, with no success.
15/07/2018 0935	Annual Review	DPE Singleton received a complaint from a nearby resident regarding the 2017 Annual Review inaccurately reporting community consultation. Ashton reviewed the 2017 Annual Review content and consultation undertaken during reporting period. A response letter was sent to DPE on 17/8/18, with evidence included for at least one example of each type of consultation reported in Annual Review.
09/09/2018 0727	Noise	Complaint received from resident of Camberwell via Ashton community Contact Line. Message read: *machinery noise coming from the mine - going on for a couple of hours* Noise monitoring results for 3 hours covering the time of the complaint were reviewed. Met conditions (SSW-SW @ 1.1 – 1.8 m/s) would not have enhanced noise from Ashton and no inversion was in place. Monitoring results showed no elevated noise levels attributable to Ashton, and audio recordings indicated highway traffic noise and mine truck noise (no mine trucks were operating at Ashton). The CHPP superintendent stated that no excessive noise was audible from CHPP operations, and no out of the ordinary activities would be generating excessive noise. Call to complainant returned at 13:20 on 10/9/18 to inform that ACOL was not the source of the noise on Sunday morning. Complainant acknowledged.
26/10/2018	Noise	Complaint received from resident of Camberwell via Ashton community Contact Line. Message read: *caller has provided address of **x** Dawson street but no other details other than his first name noise coming from over hill - requests mine be shut down - requests that the mining company go back from where they came from and that we don't need to dig holes anymore* Noise monitoring results for midnight to 7am were reviewed. Met conditions from 02:30 to 07:00 (WNW @ 1.5 – 2.0 m/s) may have enhanced noise from the direction of Ashton at times. No inversion was in place. Monitoring results showed no elevated noise levels attributable to Ashton, and audio recordings indicated highway traffic noise (0500-0700), some dozer noise and mine truck noise (no dozer or mine trucks were operating at Ashton). The CHPP superintendent stated washing operations didn't start until 0615, and no dozers were operating at any time after 9pm. Light trade maintenance tasks at the time would not have been generating excessive noise. Email to complainant at 13:03 on 26/10/18 to inform that ACOL was not the source of the noise on Sunday morning.

11 Independent audit

During 2016 an Independent Audit of operations was undertaken against the conditions of modification 10, DA 309-11-2001-i. A total of 1,550 conditions and commitments were assessed resulting in 27 non-compliances, 16 of which were administrative. No High risks were identified in the audit.

All actions have been completed except for one relating to stormwater runoff on the NEOC. An options analysis was completed during 2017 and was peer reviewed in 2018. The peer review has highlighted that diverting stormwater runoff offsite may be detrimental in terms of water capture storage and use onsite, which has led to alternative options being considered to ensure the water from the rehabilitation stays on site. This will continue during 2019.

The Audit can be found on Ashton Coal's website at:
http://www.ashtoncoal.com.au/page/publications/environmental/environmental-audits/.

12 Incidents and non-compliances during the reporting period

There were no reportable incidents at Ashton Coal during 2018.

ACP will continue to work towards compliance to all conditions during 2019.

13 Activities to be completed in the next reporting period

Activities to be addressed and completed during the next reporting period are detailed below in Table 29.

Table 29 Actions to be completed next reporting period

Action	Due for completion by	Action summary
Independent Environmental Audit	31 December 2019	Commission and complete an Independent environmental Audit in accordance with Schedule 5 condition
North East Open Cut and Underground Surface Trees over Grass rehabilitation enhancement	31 December 2019	Enhancement of areas of Trees over Grass rehabilitation to encourage more tree growth on NEOC and the underground surface biodiversity corridors through weed management, appropriate soil management and additional seed and seedling plantings. Conduct a review of current fauna monitoring program and identify specific KPIs for rehabilitation.
New England Highway Tree Screen		Further maintenance and enhancement of the tree screen extension along the New England Highway.

14 References

Global Acoustics (2018) *Noise Monitoring results, Jan – Dec 2018*.

Umwelt (2019) *2018 Fauna Monitoring Program, Ashton Coal*.

Marine Pollution Research (2019) *Ashton Coal AEMR 2018Aquatic Ecology monitoring, Bowmans and Glennies Creeks*.

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Enright land management (2019) *Ashton Coal Operations Weed Action Plan.*

J R Richards (2018) *Ashton Coal Mine Waste Statistics December 2018.*

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Horn, Peter (2016) *Independent Environmental Audit, Ashton Coal Operations*

Ashton Coal Operations Limited (November 2016) *Ashton Coal Project, Longwalls 201- 204 Extraction Plan.*

Ashton Coal Operations Limited, Environmental Management Strategy and Management plans, http://www.ashtoncoal.com.au/page/publications/environmental/environmental-management- plans/

Department of Planning and Environment (2016) Development consent for the Ashton Coal Project (DA 309-11-2001-I, modification 5)

15 Appendix 1 – Rehabilitation and Biodiversity – Progress against MOP

Table A1.1 Assessment of monitoring results against domain objectives and performances measures identified in Table 32 of Ashton Coal Mining Operations Plan (MOP) (ACOL 2017) – Ecosystem and Landuse Establishment (Phase 4)

Domain Objective	Performance Indicator	Performance Measure	Completion Criteria	Justification/Source	Current Status
Bowmans Creek Riparian Zone (Bowman's Creek Original Channel and River Red Gum Population)					
Limit soil compaction and the spread of weeds by minimising site access by vehicles and stock	Fencing	Adequate fencing is installed and maintained.	Vehicle access is restricted to nominated site access roads as far as practical. Stock is excluded.	ACOL Weed Management Plan *Noxious Weeds Act* 1993 Australian and NSW Weed Strategies TSC Act – Key Threatening Processes	**Achieved** Fencing is satisfactory and stock access is restricted
Invasive species, weeds and feral animals are effectively controlled or eliminated from site.	Distribution and density of weeds.	Annual Weed Inspection and findings reported in AEMR/Annual Review.	Weeds and pest animal species, and abundance are comparable to analogue sites.		**Not yet achieved** Further weed control is required
	Distribution and number of feral animals. Damage caused by feral animals.	Annual vertebrate pest survey and findings reported in AEMR/Annual Review.		*Rural Lands Protection Act* 1998 FFMP	
The rehabilitated landscape is enhanced using best available practices and materials.	Provision of nest boxes.	Installation of nest boxes reported in AEMR/Annual Review.	Nest boxes established at a ratio of 1:3 in	FFMP	**Not yet achieved** No nest boxes observed
		Nest boxes monitored annually and results reported in AEMR/Annual Review.	Nest boxes established are monitored and maintained.		

Domain Objective	Performance Indicator	Performance Measure	Completion Criteria	Justification/Source	Current Status
Establish vegetation profile consistent with the planned final landuse.	Revegetation species mix applied in accordance with Table 21 of this MOP.	Reporting and monitoring protocol as per the Bowmans Creek Diversion Rehabilitation Strategy (ACOL, e) employing a modified vegetation complexity assessment method (Newsome & Catling 1979).	Species mix used aligns to the intended final land use.	Florabank Guidelines (1999)	**Achieved** Planted river red gum trees are surviving
	Structural complexity scores.		Groundcover includes tussock grass clumps, areas of open ground and fallen timber.	Bowmans Creek Diversion Rehabilitation Strategy (ACOL, e)	
			Mid-stratum is very open to sparse, > 2 metres in height.		
			Over-storey structure ranges from forest (i.e. riparian corridor) to woodland (i.e. floodplain areas), with a diverse yet clumped species composition that is consistent with reference sites.		
Bowman's Creek Diversion					
Limit soil			Vehicle access is restricted to nominated site access	ACOL Weed Management	**Achieved** Fencing is satisfactory and stock access is restricted

Domain Objective	Performance Indicator	Performance Measure	Completion Criteria	Justification/Source	Current Status
compaction and the spread of weeds by minimising site access by vehicles and stock.	Fencing	Adequate fencing is installed and maintained.	roads as far as practical.	Plan *Noxious Weeds Act 1993* Australian and NSW Weed Strategies TSC Act - Key Threatening Processes	
			Stock is excluded.		**Achieved** Stock have been successfully excluded.
Invasive species, weeds and feral animals are effectively controlled or eliminated from site.	Distribution and density of weeds	Annual Weed Inspection and findings reported in AEMR/Annual Review.	Weeds and pest animal species, and abundance are comparable to analogue sites.		**Not yet achieved** Ongoing weed control efforts are required
	Distribution and number of feral animals	Annual vertebrate pest survey and findings reported in AEMR/Annual Review.		*Rural Lands Protection Act 1998* FFMP	**Not the focus of this monitoring report**
	Damage caused by feral animals				**Achieved** No evidence of feral animal damage was observed in this domain
Establish vegetation profile consistent with the planned	Revegetation species mix applied in accordance with Table 24	Rehabilitation/planting activities reported in AEMR/Annual Review including date of seeding and species mix used.	Species mix used aligns to the intended final land use.	Florabank Guidelines (1999)	**Achieved** Species that have been planted to date are in accordance with Table 22 of the MOP.
		Reporting and monitoring protocol as	Groundcover includes tussock grass clumps, areas of open ground and fallen timber.		**Not Achieved** Groundcover still predominantly composed of exotic grasses and herbs
					Partially Achieved

Domain Objective	Performance Indicator	Performance Measure	Completion Criteria	Justification/Source	Current Status
final land use.	Structural complexity scores	per the Bowmans Creek Diversion Rehabilitation Strategy (ACOL, e) employing a modified vegetation complexity assessment method (Newsome & Catling 1979).	Mid-stratum is very open to sparse, > 2 metres in height.	Bowmans Creek Diversion Rehabilitation Strategy (ACOL, e)	Established mid-storey species are very sparse and many are >2 m tall and are mature, however species diversity is low.
			Over-storey structure ranges from forest (i.e. riparian corridor) to woodland (i.e. floodplain areas), with a diverse yet clumped species composition that is consistent with reference sites.		**Partially Achieved** Overstorey establishment has been largely successful in River Oak Forest and Red Gum Woodland, however the density is trending toward a forest structure rather than woodland. This may naturally resolve itself over time as the trees matures and natural dieback occurs.
			Structural complexity scores are broadly comparable to reference sites.		**Not yet achieved** The vegetation structure is too young to be compared to mature reference sites.
Trees over Grass - Underground Mining Area					
Invasive species, weeds and feral animals are effectively controlled	Distribution and density of weeds	Annual Weed inspection and findings reported in AEMR/Annual Review.	Weeds and pest animal species and	ACOL *Weed Management Plan* *Noxious Weeds Act 1993* Australian and NSW Weed Strategies	**Not yet achieved** Ongoing weed control efforts are required
	Distribution and number of feral	Annual vertebrate pest			

Domain Objective	Performance Indicator	Performance Measure	Completion Criteria	Justification/Source	Current Status
or eliminated form site	animals Damage caused by feral animals	survey and findings reported in AEMR/Annual Review.	abundance are comparable to analogue sites	TSC Act – Key Threatening Processes *Rural Lands Protection Act 1998* FFMP	**Not the focus of this monitoring report** However evidence of feral animals was not significant or widespread
Safety risks are eliminated as far as reasonably practicable	Bushfire hazard reduction works	Bushfire hazard reduction activities reported in AEMR/Annual Review.	Bushfire management activities undertaken in accordance with the consent agreement	*Rural Fires Act 1997*	**Not the focus of this monitoring report**
Establish a vegetation profile consistent with the planned final land use	Revegetation species mix applied in accordance with Table 24 (MOP)	Rehabilitation/planting activities reported in AEMR/Annual Review including date of seeding and species mix used.	Species mix used aligns to the intended final land use.	DA Schedule 3, Condition 41	**Not yet achieved** The species mix of planted areas is consistent with Table 24 of the MOP. A native shrub layer is largely absent from this domain and a large proportion of the habitat corridor does not contain trees.
Trees over Grass - Southern Voluntary Conservation Area					
Manage the southern woodland conservation area in accordance with the Conservation Agreement.	Conservation Agreement.	Baseline information and data included in Annexure B of the conservation agreement.	Southern woodland conservation area managed in accordance with the Conservation Agreement.	FFMP, MOP, Conservation	**Partially Achieved** Ongoing management required
		Access roads are appropriately designated.	Vehicle access is restricted to nominated site access		

Domain Objective	Performance Indicator	Performance Measure	Completion Criteria	Justification/Source	Current Status
Limit soil compaction impacts and the spread of weeds by minimising site access by vehicles.	Site accessibility.		roads.	Agreement	**Achieved** Stock is excluded and vehicle access is restricted. Disused access tracks are regenerating.
		Stock movements are controlled and fencing is maintained. Activities reported in AEMR/Annual Review.	Stock is excluded from areas undergoing revegetation in accordance with the FFMP and conservation agreement.		
		Reported in AEMR/Annual Review.	Any access tracks no longer required are closed to allow natural regeneration.		
Invasive species, weeds and feral animals are effectively controlled or eliminated from site.	Distribution and density of weeds.	Annual Weed Inspection and findings reported in AEMR/Annual Review.	Weeds and pest animal species, and abundance are comparable to analogue sites.	FFMP, Conservation Agreement	**Not yet achieved** Weeds require ongoing management
	Distribution and number of feral animals.	Annual vertebrate pest survey and findings reported in AEMR/Annual Review.		Rural Lands Protection Act 1998 Flora and Fauna (Biodiversity) Management Plan (FFMP) (ACOL, g)	**Not the focus of this monitoring report** However evidence of feral animals was not significant or widespread
	Damage caused by feral animals.		All activities undertaken in accordance with FFMP and conservation agreement.	FFMP, Conservation Agreement	
	Appropriate management activities.	Management activities reported in AEMR/Annual Review.			
		Installation of nest	Nest boxes established at a ratio of 1:3 in accordance with the		

Domain Objective	Performance Indicator	Performance Measure	Completion Criteria	Justification/Source	Current Status
The rehabilitated landscape is enhanced using best available practices and materials.	Provision of nest boxes.	boxes reported in AEMR/Annual Review.	conservation agreement, FFMP and vegetation clearance protocol.	FFMP, Conservation Agreement	**Partially achieved** Majority of damaged or poor condition nest boxes have not been replaced
		Nest boxes monitored annually and results reported in AEMR/Annual Review.	Nest boxes established are monitored and maintained.		
	Tree hollows.	Tree hollows relocated during clearing activities where practical and reported in AEMR/Annual Review.	Tree hollows relocated to southern woodland conservation area during vegetation clearing in accordance with FFMP.		**Not applicable**
	Bushfire hazard reduction works.	Bushfire hazard reduction activities reported in AEMR/Annual Review.	Bushfire management activities undertaken in accordance with the conservation agreement.	*Rural Fires Act* 1997	**Not the focus of this monitoring report**
Disturbed land is rehabilitated as soon as is practicable to a level equal to or better than the original landscape.	Revegetation species mix applied in accordance with Table 24 of the MOP.	Rehabilitation/planting activities reported in AEMR/Annual Review including date of seeding and species mix used.	Species mix used aligns to the intended final land use.	DA Schedule 3, Condition 42	**Not applicable**

Table A1.2 Assessment of monitoring results against domain objectives and performances measures identified in Table 33 of Ashton Coal Mining Operations Plan (MOP) (ACOL 2017) – Ecosystem and Landuse Sustainability (Phase 5)

Domain Objective	Performance Indicator	Performance Measure	Completion Criteria	Justification/Source	Current Status
Pasture – NEOC					
Restored and maintained to the same or higher land capability and agricultural suitability than prior to mining.	LFA Organisation Index	Annual Rehabilitation Monitoring Report	Performance indicator is broadly comparable to that of analogue sites.	DA Schedule 3, Condition 41 CSIRO Methodology for Ecosystem Function Analysis (Tongway, 2004)	**Achieved**
	LFA Stability Index				**Achieved**
	LFA Infiltration Index				**Achieved**
	Land Capability Class		Field data results are used to define land capability and include: Climate Soil texture Position Slope Erosion pH Drainage Rock		**Partially Achieved.** pH is assumed to still be high. Establishment of grazing trials would determine if successful
Final Landform is sustainable and	Weed species abundance and				**Not yet achieved** Rehabilitation sites contain a higher diversity of exotic

Domain Objective	Performance Indicator	Performance Measure	Completion Criteria	Justification/Source	Current Status
resilient to environmental pressures	diversity		Performance indicator is broadly comparable to that of analogue sites.		species compared to analogue sites
	Groundcover				**Achieved** Groundcover is comparable to analogue sites
Trees over Grass – NEOC					
Ecological diversity will be maintained or enhanced	Foliage Cover	Annual Rehabilitation Monitoring Report	Vegetation structure and complexity is broadly comparable to that of analogue sites.	DA Schedule 3, Condition 41 CSIRO Methodology for Ecosystem Function Analysis (Tongway, 2004)	**Achieved**
	Tree Diversity		Diversity of maturing tree and shrub species is broadly comparable to that of analogue sites.		**Achieved**
	Tree Density		Density of maturing tree and shrub species is broadly comparable to that of analogue sites.		**Not measured** Current monitoring methodology does not measure tree densities at rehabilitation or analogue sites
	Tree health/condition		Vegetation condition is broadly comparable to that of analogue sites.		**Achieved**
	Flowers, fruit, new growth				**Achieved**
	LFA Organisation		Index is broadly		**Achieved**

Domain Objective	Performance Indicator	Performance Measure	Completion Criteria	Justification/Source	Current Status
Ecosystem function is restored	Index		comparable to that of local remnant vegetation.		
	LFA Stability Index				**Achieved**
	LFA Infiltration Index				**Achieved**
Pasture – Underground Mining Area					
Restored and maintained to the same or higher land capability and agricultural suitability than prior to mining	LFA Organisation Index	Annual Rehabilitation Monitoring Report	Performance indicator is broadly comparable to that of analogue sites.	DA Schedule 3, Condition 29 CSIRO Methodology for Ecosystem Function Analysis (Tongway, 2004)	**Achieved**
	LFA Stability Index				**Achieved**
	LFA Infiltration Index				**Achieved**
	Land Capability Class		Field data results are used to define land capability and include: Climate Soil texture Position Slope Erosion pH Drainage Rock		**Achieved**
					Achieved

Domain Objective	Performance Indicator	Performance Measure	Completion Criteria	Justification/Source	Current Status
Final Landform is sustainable and resilient to environmental pressures	Weed species abundance and diversity		Performance indicator is broadly comparable to that of analogue sites		Weed species are common, however diversity and abundance is comparable to analogue sites
	Groundcover				**Achieved**
Trees over Grass - Underground Mining Area					
Ecological Diversity will be maintained or enhanced	Foliage Cover	Annual Farm Land Report	Vegetation structure & complexity is broadly comparable to that of analogue sites	DA Schedule 3, Condition 41 CSIRO Methodology for Ecosystem Function Analysis (Tongway, 2004)	**Achieved** (Eastern corridor) **Partially achieved (**West and Central corridors)
	Tree Diversity		Diversity of maturing tree and shrub species is broadly comparable to that of analogue sites		**Achieved** (Eastern corridor) **Partially achieved (**West and Central corridors) – bulloak is dominating the canopy in some areas and the shrub layer is largely absent, due to grazing
	Tree Density		Density of maturing tree and shrub species is broadly comparable to that of analogue sites		**Partially achieved** Eastern corridor – more dense than analogue due to young age West & Central corridors – large areas of grassland without trees
					Achieved (Eastern corridor)

Domain Objective	Performance Indicator	Performance Measure	Completion Criteria	Justification/Source	Current Status
	Tree Health/condition		Vegetation condition is broadly comparable to that of analogue sites		**Partially achieved (**West and Central corridors) – condition is impacted by grazing and compaction
	Flowers, fruit, new growth				
Ecosystem function is restored	LFA Organisation Index		Index is broadly comparable to that of analogue sites		**Not measured**
	LFA Stability Index				
	LFA Infiltration Index				

16 Appendix 2 – Annual Groundwater Report

Australasian Groundwater and
Environmental Consultants Pty Ltd

Report on

Yancoal - Ashton Coal
Annual Groundwater Monitoring Review 2018

Prepared for
Yancoal Australia Limited

Project No. G1922C March 2019
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Report on

Yancoal – Ashton Coal
Annual Groundwater Monitoring Review 2018

1 Introduction

The Ashton Coal Project (ACP) is located 14 km west of Singleton in the Hunter Valley region of New South Wales (NSW) (Figure 1.1). The ACP consists of decommissioned open cut and active underground mining to access a series of coal seams within the Permian Foybrook Formation. Ashton Coal Operations Ltd (ACOL) is wholly owned and operated by Yancoal Australia Limited (Yancoal).

Between 2003 and 2011, coal was recovered from eleven seams of varying thickness, down to and including the Lower Barrett Seam (LB), from an open cut mine known as the North-East Open Cut (NEOC). Between 2007 and 2016, underground longwall mining extracted coal from the Pike's Gully (PG) Seam, the Upper Liddell (ULD) and the Upper Lower Liddell Seams (ULLD). Mining in longwall panel LW202, within the ULLD began in June 2018.

The underground mine is located south of the New England Highway and includes a diversion of Bowmans Creek via two excavated and lined channels. The channels have re-routed Bowmans Creek to areas located above abandoned longwall panels.

1.1 Objective

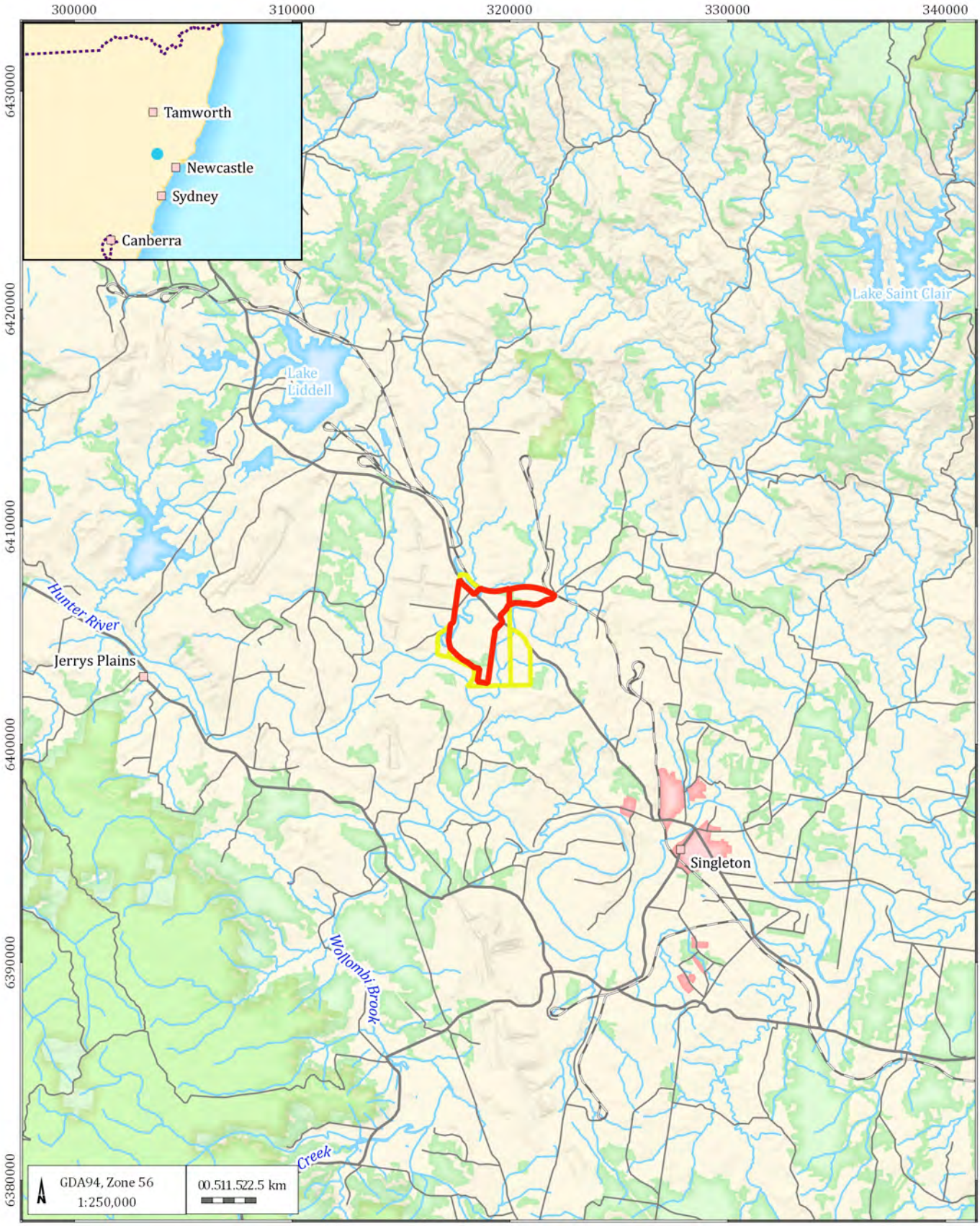
The ACOL development consent (DA 309-11-2001-i – 11 February 2002) last modified June 2016, requires that groundwater be monitored for potential impacts from mining. In 2018, the Department of Planning and Environment (DPE) approved the current water management plan (WMP; Ashton document HSEC Management System Plan Doc. No. 3.4.1.8 version 10, dated 01 March 2018). The WMP outlines the groundwater monitoring program and trigger values for groundwater levels and quality in the various groundwater systems located within the ACP site.

This report summarises the data collected by Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) from January 2018 to December 2018. This report reviews all groundwater monitoring data for the past year.

1.2 Scope

The scope undertaken to achieve the objectives includes:

- review and assess rainfall, groundwater levels, pH and electrical conductivity (EC) and water chemistry results from groundwater monitoring;
- comparison of groundwater monitoring results against WMP triggers;
- notify ACOL of exceedances which require the enactment of the WMP groundwater response plan; and
- make recommendations regarding the groundwater monitoring network and program, where necessary, to ensure ongoing quality control/assurance of the groundwater monitoring.



LEGEND

- Ashton mining lease
- Ashton exploration lease
- Study area location
- Populated place
- Built up area
- Major road
- Minor road
- Rail
- Watercourse
- Water area
- Reserve
- Vegetation
- Land

Yancoal Ashton - AEMR 2018 (G1922C)

Study area location

DATE 13/02/2019

FIGURE No: **1.1**

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2 Physical setting

The Ashton underground mine is located south of the New England Highway, bounded by the Hunter River to the south and two Hunter River tributaries – Glennies Creek and Bowmans Creek to the east and west, respectively (Figure 1.1). Underground operations intend extracting four coal seams, PG, ULD, ULLD and LB, via a longwall arrangement.

The underground workings (LW1 to LW8) extracted coal from the PG seam and underlying ULD seam (LW101 to LW108). Noteworthy, LW notation increases from east westward 1 to 8. Currently longwall mining is taking place within LW202 of the ULLD seam (LW201 to LW208). LW202 is located in the east of the mining lease (ML) close to Glennies Creek and the Glennies Creek alluvium. The final LW panels within ULLD seams are located down dip of LW202, in the western portion of the ML.

2.1 Climate and rainfall

Climate monitoring data collected by Ashton Weather Station and the Bureau of Meteorology (BOM) was obtained from Singleton STP (BOM station 61397), located about 13 km southeast of Ashton. The Ashton Weather station has 13 years of rainfall data for the period 1 July 2005 to present, while the Singleton STP station has 16 years of rainfall data dating from 2002 to present. A summary of average monthly rainfall from Singleton STP (BOM station 61397), and the Ashton Weather station for 2018 is presented in Table 2.1. Precipitation is predominant in November to March; whereas, the winter months are generally drier. The data presented in Table 2.1 shows that rainfall at Ashton in 2018 was above average for five months of 2018 (February, March, June, October, November, and December); whereas rainfall at Singleton was only above average for one month (October).

Table 2.1 Average Monthly Rainfall 2018 (mm)

Month	Ashton average monthly rainfall (mm)	% of long term average	Singleton STP average monthly rainfall (mm)	% of long term average
Jan	13.8	24%	3.3	5%
Feb	76.6	100%	61.9	72%
Mar	83.2	112%	53.8	85%
Apr	16	26%	26	44%
May	10	29%	10.2	37%
Jun	45.6	61%	39.4	60%
Jul	2.8	11%	7	29%
Aug	30.4	98%	10.4	35%
Sep	25.6	64%	20.8	55%
Oct	57.8	128%	66.9	145%
Nov	91.8	117%	53.8	70%
Dec	81	127%	65.7	91%

An evapotranspiration (EVT) rate of 765 mm/year was sourced from the Bureau of Meteorology (BOM) database for the Ashton area.

Long-term rainfall trends can be characterised using the Cumulative Rainfall Departure (CRD) method (Bredenkamp et al., 1995). CRD shows trends in rainfall relative to the long-term monthly average and provides a historical record of wetter and drier periods. A rising trend in slope in the CRD plot indicates periods of above average rainfall, while a declining slope indicates periods of below average rainfall. CRD has been used in this study to give context to variations in groundwater levels and chemistry.

The CRD for Ashton weather station and Singleton STP station (#61397) are shown on Figure 2.1. CRD trends for both stations showed below average rainfall for 2018 represented by a declining CRD slope. Ashton site data indicates a recovery in the CRD towards the end of 2018 (rising trend), which matches the above average monthly rainfall recorded during those months (October to December 2018).

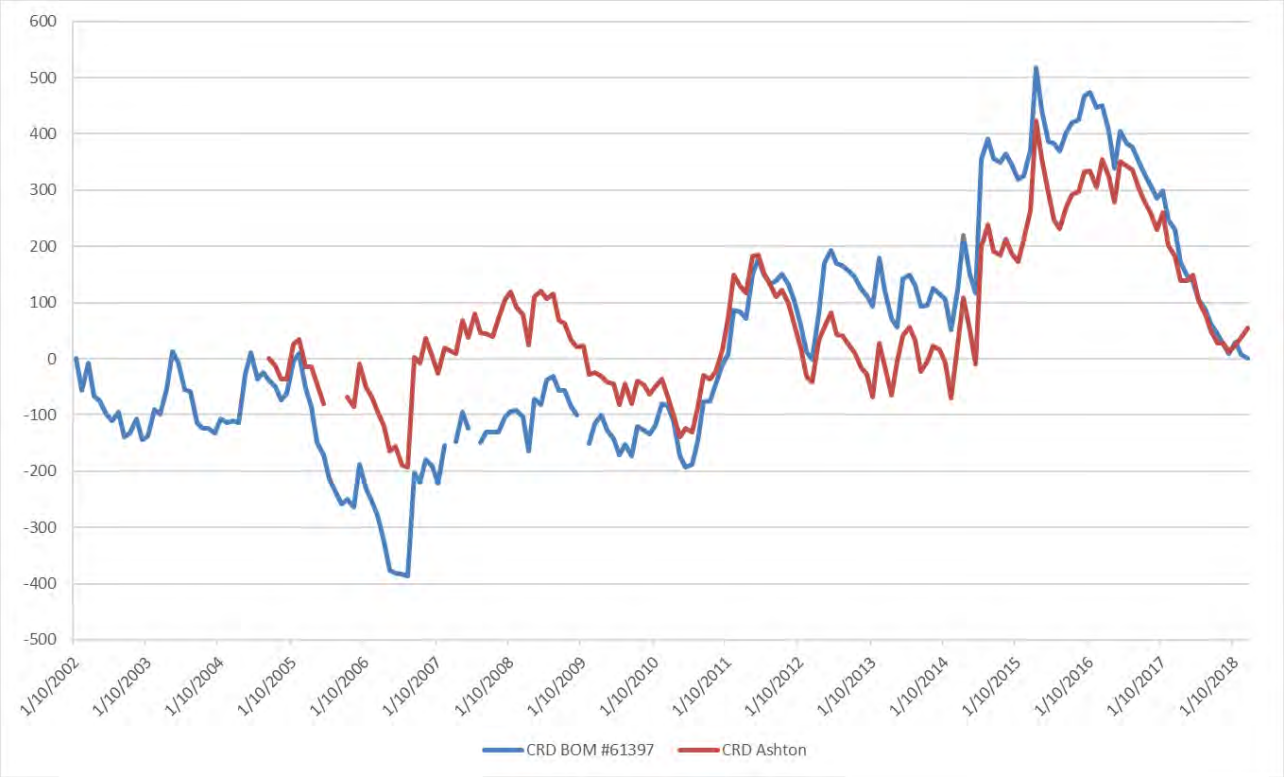

Figure 2.1 Cumulative Rainfall Departure

2.2 Surface water

The Ashton mine lease is bounded by Bowmans Creek on the west, Bettys Creek (tributary of Bowmans creek) on the north, Glennies Creek on the east side and Hunter River on the south. Both Bowmans and Glennies Creeks are an affluent of the Hunter River. The three main water courses are described below:

- Hunter River is the main surface water body with a catchment area at Bowmans Creek of 13,590 km^2. The flow is regulated by Glenbawn dam and by other licensed extractions and releases.
- Glennies Creek and its associated alluvium are located to the east of the underground workings and the Pike's Gully sub-crop area. The catchment area is approximately 600 km^2 and up to half of the Glennies Creek catchment feeds into Lake St. Clair, located within the far north eastern section of the catchment. Water from Lake St. Clair discharges into Glennies Creek under controlled release.

- Bowmans Creek natural channel is above the longwall panel LW6B/LW106B and its associated alluvium are over LW5 to LW8. It is the main water course over the underground workings area. Bowmans creek was diverted in two locations to minimise the impact of mining on both the creek and the potential inflows to the underground workings. The construction of the eastern diversion commenced in March 2011 and the western diversion commenced in February 2012. Both diversions were commissioned in November 2012 and are located within the Bowmans Creek Alluvium (BCA). The diversions were designed to replicate the natural creek setting in terms of channel cross sectional variability in bed level and ecological features (i.e. resting pools). The diversions were lined with a geosynthetic clay liner to minimise leakage from the creek.
- Bowmans Creek flow is not regulated and is monitored according to the WMP. The stream flow gauging station no. 210130, from the NSW Office of Water, was installed in October 1993 and is used as a flow baseline for Bowmans creek with a catchment area of 240 km^2. This station is located in the middle section of the creek on the mining lease, upstream to the western diversion.

2.3 Mining

The longwall panels accessing the ULLD (LW202) are generally offset 24 m to the east and 10 m south from the overlying ULD longwall panels. This offset is designed to reduce the resulting subsidence and associated impacts to the surrounding environment. That said, the northern extent of PG, ULD, ULLD longwalls, and the main gate road, are aligned resulting in a "stacked edge" where subsidence impacts are slightly more noticeable at the surface than elsewhere.

Timing of longwall panel coal extraction are summarised in Table 2.2.

Table 2.2 Longwall panel schedule

Longwall panel	Target seam	Start date	End date
LW1	PG	12/03/2007	15/10/2007
LW2	PG	10/11/2007	21/07/2008
LW3	PG	20/08/2008	3/03/2009
LW4	PG	2/04/2009	15/10/2009
LW5	PG	4/01/2010	7/06/2010
LW6A	PG	9/07/2010	22/11/2010
LW7A	PG	22/03/2011	8/08/2011
LW7B	PG	3/10/2011	17/01/2012
LW8	PG	27/02/2012	5/06/2012
LW101	ULD	31/07/2012	16/06/2013
LW6B	PG	14/07/2013	10/10/2013
LW102	ULD	10/11/2013	24/07/2014

Longwall panel	Target seam	Start date	End date
LW103	ULD	21/08/2014	21/06/2015
LW104A	ULD	23/07/2015	16/01/2016
LW104B	ULD	3/02/2016	11/04/2016
LW105	ULD	17/05/2016	26/09/2016
LW106A	ULD	18/10/2016	31/05/2017
LW201	ULLD	7/07/2017	04/05/2018
LW202	ULLD	07/06/2018	Present

2.4 Conceptual hydrogeology

2.4.1 Hydrostratigraphy

Ashton is located in the central Hunter Valley of NSW where the lower sequences of the Whittingham Coal Measures (Singleton Supergroup) subcrop (Figure 2.2). Within the Ashton mining lease, the Hebden seam to the Bayswater seam (inclusive) subcrop. The underground operation targets the PG, ULD, ULLD and the LB seams.

The Whittingham Coal Measures dip west south-west in the Ashton area, an orientation locally controlled by the Camberwell Anticline to the east of the mine and the Bayswater Syncline to the west. The top target coal seam at Ashton, the PG seam, subcrops under the Glennies Creek alluvium (GCA) approximately 150 m east of the mine, while the lowest target coal seam, the LB seam, subcrops under regolith approximately 2 km to the east of the mine. In the western portion of the mining area, the overburden above the PG seam ranges in thickness between 100 m (north end of LW7) and 190 m (south end of LW7).

The stratigraphic sequence in the region comprises two distinct units: Quaternary alluvium and Permian strata. The Permian strata comprise coal seams (typically 2 m to 2.5 m thick) with overburden and interburden (typically 30 m thick between successive seams) consisting of sandstone, siltstone, tuffaceous mudstone, and conglomerate. The Quaternary alluvium consists of unconsolidated silt, sand and gravel in the alluvial floodplains of the Hunter River (HR), Bowmans Creek (BC) and Glennies Creek (GC). The alluvium unconformably overlies the Permian within the floodplains of the HR, BC and GC. Elsewhere, the Permian is overlain by a regolith comprising colluvium, eluvium and completely weathered rock, which interfaces with the floodplain alluvium at the flanks of the valleys.

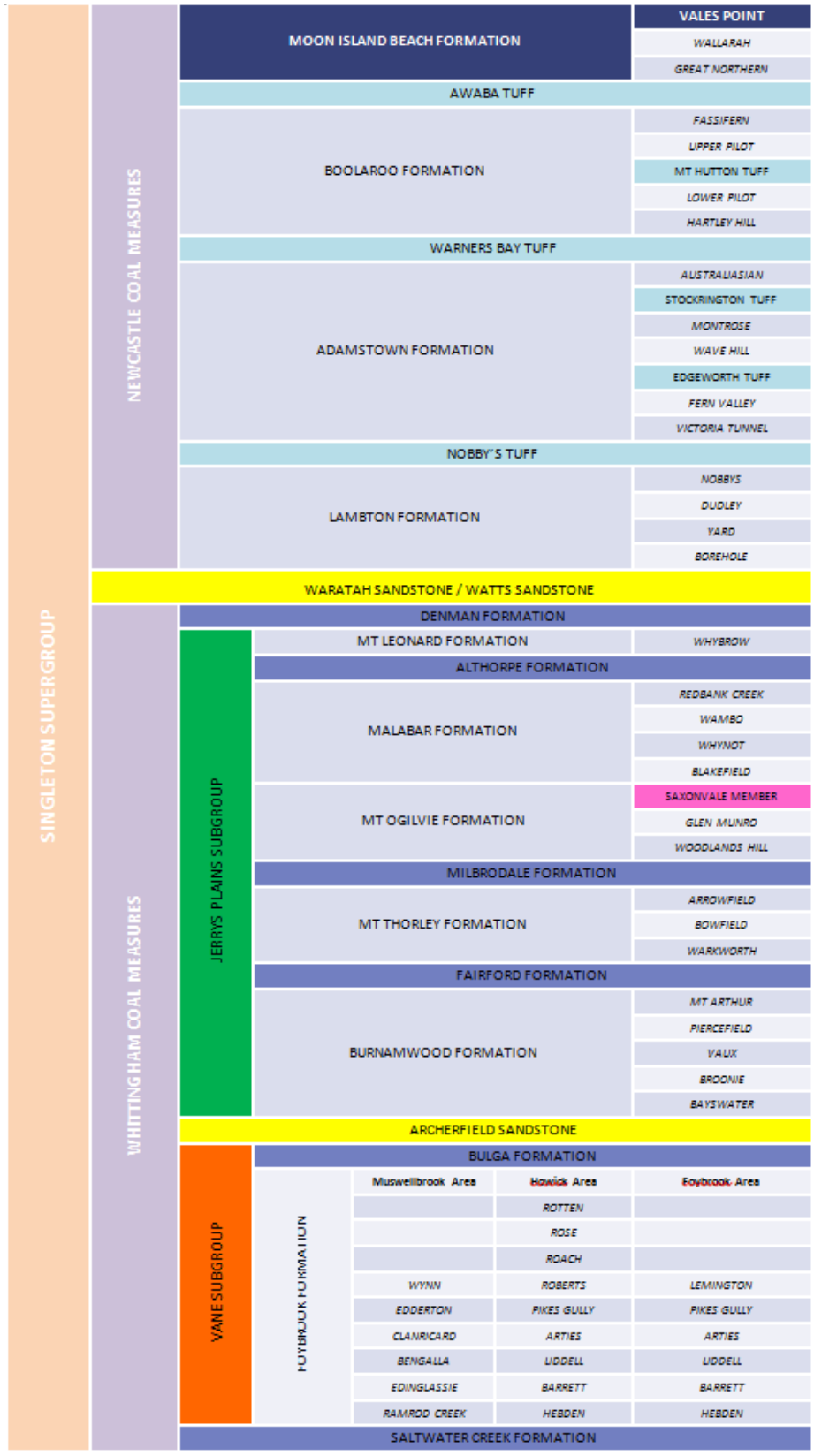

Figure 2.2 Singleton Super Group sequence stratigraphy (AGE, 2016)

2.4.1.1 Quaternary alluvium/Regolith

Ashton is overlain by Quaternary alluvium associated with the HR, BC, and GC. The Bowmans Creek alluvium (BCA) and GCA are in direct connection to the Hunter River alluvium (HRA). The Quaternary/recent aged alluvium/colluvium along the HR, GC and BC flood plains comprises two distinct depositional units, a surficial fine-grained sediment and coarser basal material. The surficial alluvium comprises shallow sequences of clay, silty sand, and sands. Along the minor drainage lines, the surficial alluvium is typically constrained within 500 m of the creeks and is between 7 m to 15 m thick.

Away from the floodplain areas, the Permian coal measures sequence is overlain by a layer of regolith, comprising colluvium/eluvium, and completely weathered rock that collectively have soil rather than rock properties and interface with the alluvium at the flanks of the floodplain areas. The regolith layer varies in thickness, but is typically 15 m to 20 m thick above rock.

2.4.1.2 Permian strata

The Whittingham Coal Measures comprise Permian aged coal seams interbedded with siltstone, sandstone, shales and conglomerates. The Whittingham Coal Measures are up to 400 m thick at Ashton, but regionally they range from approximately 250 m to 600 m thickness. At Ashton, the lower portion of the Whittingham Coal Measures is present on site. The profile extends from above the Bayswater seam to the Hebden seam (Figure 2.2).

Locally, the Whittingham Coal Measures are further divided to (AGE, 2016):

- four main target coal seams – PG, ULD, ULLD and the LB;
- a large number of coal seams and plies of varying thickness, including the Bayswater seam, up to 20 Lemington seam plies, the Arties seam, and a number of Liddell seam and Barrett seam plies that are not proposed to be mined in the Ashton underground mine; and
- interburden sediments comprising siltstone, sandstone, conglomerate and claystone.

Over 20 plies of the Lemington seam profile and the overlying Bayswater seam are present within the PG seam overburden. The largest Lemington seam plies are of similar thickness as the four target seams, and may have similar hydraulic properties.

2.4.2 Recharge

Recharge is interpreted to occur from direct rainfall to the ground surface, infiltrating into the formations through the thin soil cover and regolith. The coal measures also occur at subcrop in localised zones beneath the HRA, GCA, and the BCA. In these areas, the Permian coal measures are interpreted to be recharged by downward seepage and then downdip flow along the most permeable strata in the sequence, primarily the coal seams (Aquaterra, 2009 and AGE 2016).

The combined surface water catchment area potentially providing recharge to the Ashton area is significantly greater in size than the mine area itself. Ashton is located immediately adjacent the confluences of the Hunter River with Bowmans and Glennies Creeks. The Ashton surface and underground infrastructure is located entirely within the Bowman's and Glennies Creek catchments, which extend approximately 30 km and 45 km to the north of Ashton, respectively.

Bowmans and Glennies Creek have up to fourth order tributaries up-stream of the site and rainfall falling within the respective catchments flow through the Ashton area. The Bowmans and Glennies Creeks catchments span approximately 300 km^2 and 600 km^2, respectively.

2.4.3 Groundwater flow

The Quaternary alluvium and regolith combined is interpreted (AGE, 2016) to be an unconfined groundwater system that is recharged by rainfall infiltration, streamflow and upward leakage from the underlying stratigraphy, particularly along GC and BC.

The water table in the alluvium/regolith is a subdued reflection of topography. Groundwater within the HRA flows generally in an easterly direction, while groundwater within GCA and the BCA flows generally in a southerly direction towards the HR, with local flow towards the respective river/creeks.

The direction of groundwater flow for the coal seams is influenced by the local geomorphology and structural geology as well as the long history of mining within the region. Groundwater flow within the Permian coal measures is understood to be to the south-west consistent with the dip direction of the coal seams.

The mining of the PG seam and ULD seam has impacted the groundwater regime at Ashton. Mining has induced subsidence cracking that extends to the ground surface above parts of Ashton, and to a lesser height above the goaf in other areas where the cover depth above the PG seam is greater (ie near the western side of the mine area). It is likely that in areas of shallower cover depth, this cracking has penetrated both the overburden of the PG, along with the BCA. Surface cracking is also visible along and across the longwall panels areas immediately following subsidence. This surface cracking is expected to extend for only a limited depth below surface and may or may not intersect with the subsidence cracking emanating up from the goaf, depending on cover depth and subsidence magnitude.

There is also potential for recharge from the GCA through connectivity with the PG seam (AGE, 2016), which hydraulic testing showed was significantly more permeable close to outcrop than at depth (Peter Dundon and Associates, 2006). Inflows into the workings during mining of LW1 were not significantly greater than during mining of LW1 tailgate (TG1A). This would indicate that mining of LW1 did not increase the connectivity or flow from the PG seam in subcrop beneath the GCA. Although inflows were higher during mining of TG1A than subsequent inflows from subsided strata during extraction of LW1, the total inflows to the end of LW1 were below predicted inflows, and the observed impacts on GCA were less than predicted, confirming that the proximity to Glennies Creek has not resulted in an unexpected level of connectivity and inflows from the Glennies Creek floodplain.

The presence of subsidence cracking over parts of the underground mine increases the potential connectivity of the mine with the water within the creeks and associated alluvium. Planned LW panels within the underlying ULD, ULLD and LB seams may allow for reactivation of subsidence and subsidence related fracturing within these areas (AGE, 2016). Figure 2.3 shows the conceptual hydrogeology after AGE (2016).

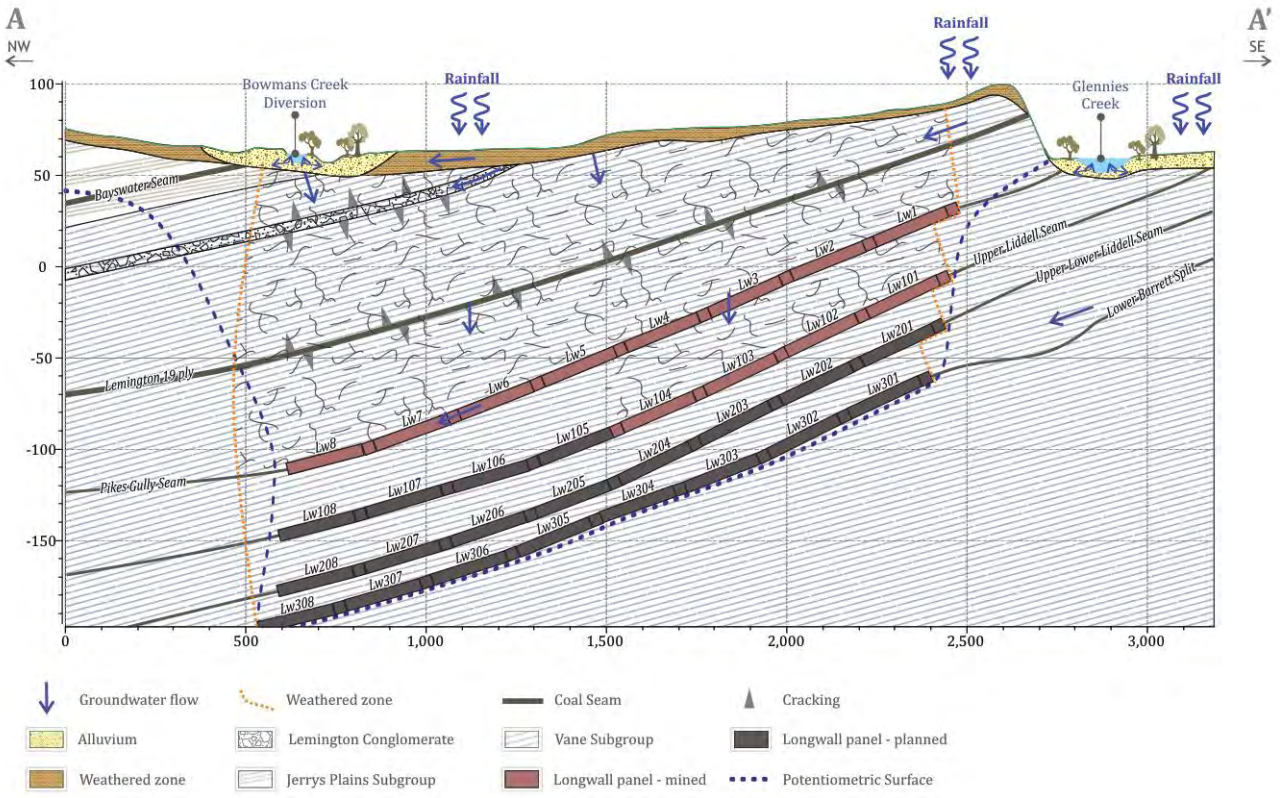

Figure 2.3 Conceptual hydrogeology – north-west to south-east – not to scale (AGE, 2016)

3 Groundwater management plan

The WMP (2016) was updated and submitted for DPI Water for approval in June 2017. The updated WMP (2018) includes a slightly modified monitoring regime that includes alluvium and coal measure bores east of Glennies Creek. The updated WMP (2018) also has a broader array of monitoring bores in the network, and targeted water quality triggers. Details of these monitoring locations are summarised in Appendix D; and the groundwater monitoring plan, including monitoring parameters and frequency, is summarised in Appendix B. The updated WMP (2018) received approval in March 2018, therefore monitoring rounds for January through March were performed according to the WMP version 8 (2016) guidelines, and all monitoring rounds from March onwards are enacted under the updated WMP version 10 (2018).

3.1 Groundwater monitoring network

The ACOL groundwater monitoring network consists of more than 100 monitoring bores, of which up to 54 are monitored as part of the WMP, in either monthly, quarterly, or annual campaigns (Appendix A). The WMP (2018) outlines the monitoring plan and key monitoring locations in areas potentially sensitive to mining impacts.

Monitoring of groundwater levels, VWP pressure heads, and water quality parameters at these bores sufficiently captures the lateral groundwater system behaviour of the alluvial aquifers, the interburden, and the coal seam aquifers at the site. The current groundwater monitoring network is considered suitable to detect changes to groundwater across the site.

The WMP monitoring locations and respective monitoring targets are presented in Figure 3.1.

The groundwater monitoring program includes the monitoring of:

- groundwater levels;
- groundwater (piezometric) pressures;
- field water quality parameters – pH and EC;
- groundwater sampling for comprehensive chemical analysis (including ph, electrical conductivity (EC), field temperature, total dissolved solids (TDS), turbidity, cations/anions/alkalinity, nitrate, nitrite, total nitrogen, total phosphorous, copper, lead, zinc, nickel, iron, manganese, arsenic, selenium, cadmium, chromium); and
- monitoring of groundwater level and EC as required by Environmental Protection License (EPL) 11879.

Monitoring frequency is as follows (Appendix B):

- monthly monitoring of groundwater level and field water quality at selected alluvial piezometers;
- monthly monitoring of groundwater level and piezometric pressure in longwall-specific piezometers during active extraction at relevant longwalls;
- quarterly monitoring of groundwater level, piezometric pressure and field water quality at selected piezometers;
- biannual monitoring for monitoring bores specified by EPL 11879; and
- annual sampling at selected piezometers for comprehensive chemical analysis.

LEGEND

- Longwall panels (ULLD)
- Bowmans Creek Alluvium
- Bowmans Creek Alluvium and Coal Measure Overburden
- Bowmans Creek Colluvium
- Coal measure
- Coal measure overburden
- EPL bores
- Glennies Creek Alluvium
- Hunter River Alluvium
- VWPs

Yancoal Ashton - AGMR 2018 (G1922C)

WMP groundwater monitoring network

DATE 25/02/2019

FIGURE No: **3.1**

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3.2 Trigger values

The WMP outlines trigger values for groundwater level and quality for monitoring bores in the Bowmans Creek Alluvium (BCA), Glennies Creek Alluvium (GCA) and the Hunter River Alluvium (HRA).

A recorded water level below the defined trigger level at a monitoring bore at any time between March 2018 and the end of mining of LW204 in the ULLD, sustained for three consecutive months, would trigger a response under the WMP. Groundwater elevation trigger levels are summarised in Table 3.1. Groundwater quality trigger levels are summarised in Table 3.2. Similar to groundwater elevation, three consecutive measurements outside of these values trigger a response under the WMP. In addition, if a recorded value at a monitoring bore differs extremely from the preceding three readings at that location and there are no unusual events that could have caused the difference, a response would be triggered. The WMP groundwater response plan, for cases where trigger values are exceeded, is summarised in Appendix C.

Table 3.1 Groundwater elevation trigger levels for alluvial monitoring bores

Aquifer	Monitoring bore	Base of alluvium elevation (mAHD)	Assigned trigger value end of mining in LW204 (Upper Lower Liddell Seam) (mAHD)
BCA*	WMLP311	55.64	57.5
	WMLP323	59.47	59.2
	WMLP328	49.42	55.15
	T2A	49.69	54.17
GCA	WML120B	51.12	51.45
	WML129	45.44	49.8
	WML239	50.82	49.78
	WMLP343	50	51.33
	WMLP346	49.18	51.35
	WMLP349	48.84	50.82
	WMLP358	50.16	50.79$
HRA	WMLP279	45.1	48.82
	WMLP280	44.92	48.63
	WMLP337	48.05	47.73
	WMLP336	47.87	48.15

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

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

Table 3.2 Groundwater quality trigger levels for alluvial monitoring bores

Aquifer	Monitoring bore	Groundwater pH trigger - Lower (5th percentile)	Groundwater pH trigger - Upper (95th percentile)	Groundwater EC trigger (µS/cm) (95th percentile)
BCA	WMLC113C	6.6	7.4	1445
	WMLP311	6.5	8	1289
	WMLP323	6.5	8.1	1241
	WMLP326	6.6	7.5	2078
	WMLP328	6.6	8.2	1175
	T2A	6.7	7.7	1422
GCA	WML120B	6.4	7.7	1387
	WML129	6.7	8	740
	WML239	6.3	7.4	984
	WMLP343	6.2#	8#	1059&
	WMLP346			1005&
	WMLP349			2900&
	WMLP358			600&
HRA	WMLP279	6.3	7.5	1276
	WMLP280	6.6	7.9	2034
	WMLP337	6.8	7.8	3254
	WMLP336	6.2	8.2	1708

Notes: *Data reviewed for trigger derivation includes historical data to June 2017.*

 # Temporary triggers – the new bore additions to the Glennies Creek alluvium monitoring network have minimal historical pH monitoring data. In these cases, rather than establishing a statistically based trigger, the previous Glennies Creek alluvium quality triggers have been maintained. These triggers will be adjusted in future based on data collected under this WMP.

& Temporary triggers – the new bore additions to the Glennies Creek alluvium monitoring network have minimal historical monitoring data. In these cases, rather than establishing a statistically based trigger based on the 95th percentile, a temporary trigger has been established as 200 µS/cm above the highest measured EC value. These triggers will be adjusted in future based on data collected under this WMP.

4 Groundwater monitoring results

Up to March 2018 groundwater monitoring and sampling was completed at the frequency specified in the WMP version 8 (Section 3), and as of March 2018, the revised WMP, version 10 (Section 7.3). Groundwater levels and quality trends for trigger bores are presented in Figure 4.1 through Figure 4.20.

4.1 Alluvium monitoring

4.1.1 WMP compliance groundwater levels

The groundwater level trends and trigger levels for the BCA, GCA and HRA compliance monitoring bores are presented in Figure 4.1, Figure 4.2, Figure 4.3 and Figure 4.4, respectively. Daily rainfall measurements and CRD have also been plotted and used to compare water level trends. The river and creek water levels (sourced from NSW Office of Water on-line database[1]) are presented graphically in Figure 4.5.

The following observations are noted:

- BCA groundwater levels (Figure 4.1) have been declining throughout the year, which corresponds to the declining CRD. There was one groundwater level exceedance requiring action under the WMP (2018). Groundwater levels in WMLP328 have remained below the WMP (2018) specified trigger level since July. Per WMP (2018) protocol (Appendix C) an investigation was undertaken to determine the cause of the decline in SWL. The investigation found that the area has received a relatively low level of recharge from Bowmans Creek and rainfall due to the recent dry conditions. Thus, determining that the decline in groundwater level, and trigger level exceedances in WMLP328 are not mining related, but due to recent climatic conditions (AGE, 2018). When further exceedances were identified in this bore over the following months (e.g. October to January), they were considered to be due to the same sustained dry conditions that triggered the initial notification. As such, no further action was considered necessary.
- The water level in WMLP 311 is declining at a rate faster than the other BCA monitoring bores, and will be monitored in the future. The water level decline is within approved limits for the BCA.
- GCA groundwater levels (Figure 4.2 and Figure 4.3) were stable throughout the year, varying by less than one metre. This is likely due to the Glennies Creek being a regulated stream.
- HRA groundwater levels (Figure 4.4) were stable throughout the year, varying by less than one metre.

Groundwater elevations are higher in the north (BCA and GCA) and generally flow southward towards the HRA. Groundwater levels in the BCA declined steadily through the year, which corresponds to a declining CRD and recent drought conditions. GCA and HRA groundwater was relatively stable throughout the year with minimal response to rainfall recharge.

No mining related impacts to alluvium groundwater levels were measured. As such, the measured levels were within the approved ranges.

[1] http://realtimedata.water.nsw.gov.au/water

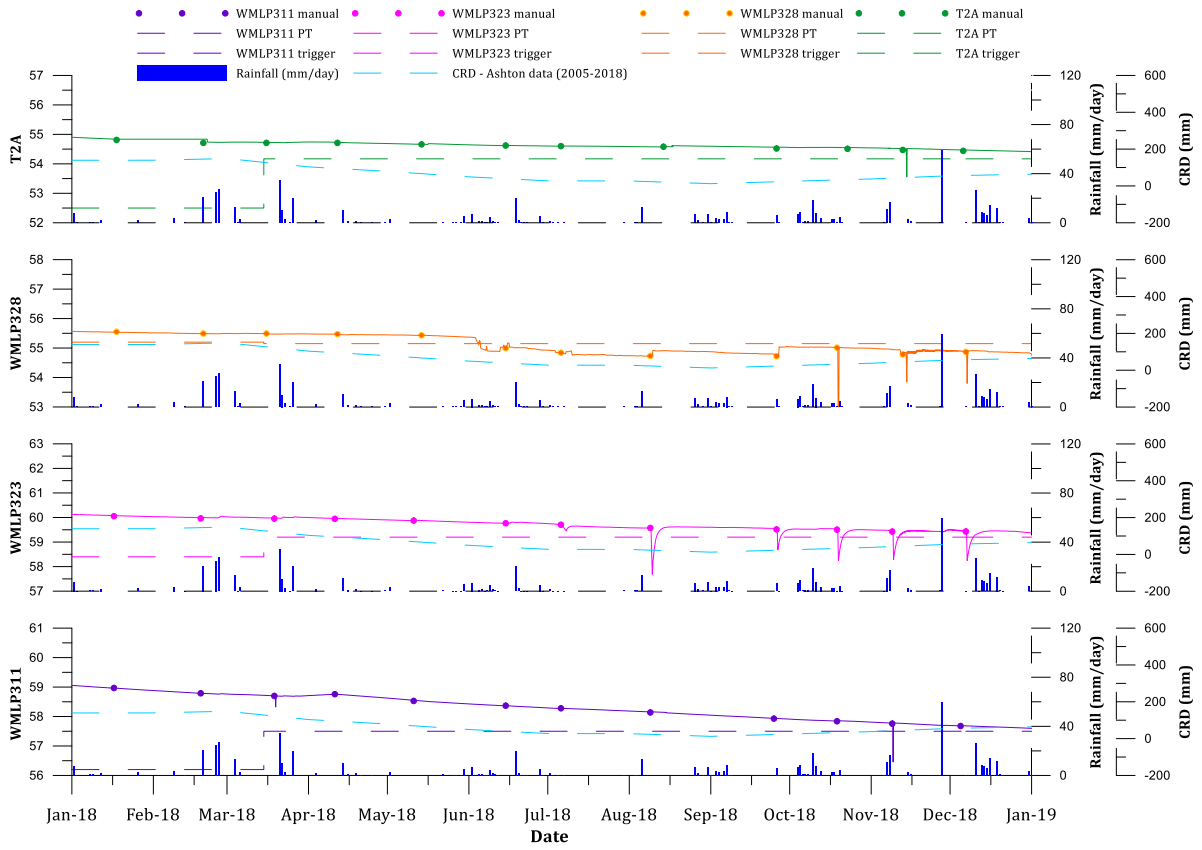

Figure 4.1 Bowmans Creek alluvium trigger bores hydrograph

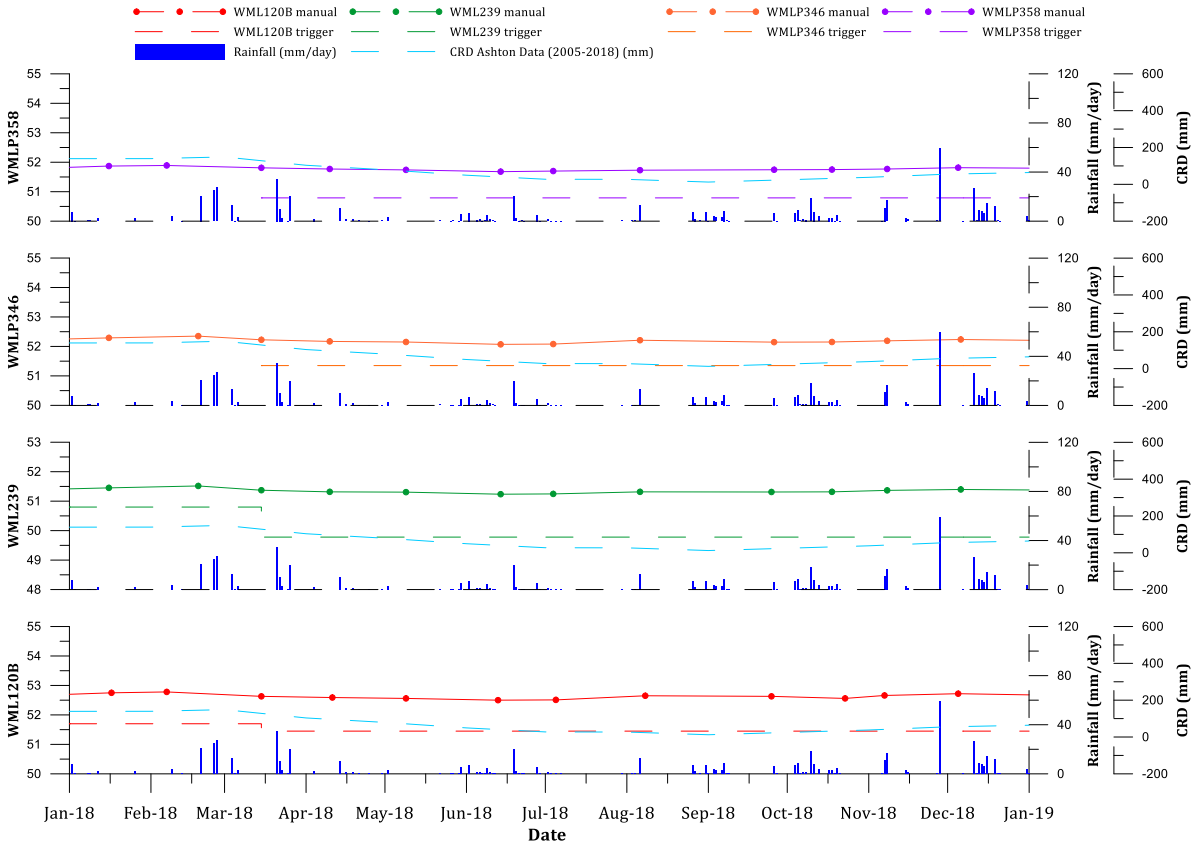

Figure 4.2 Glennies Creek alluvium trigger bores hydrograph (1)

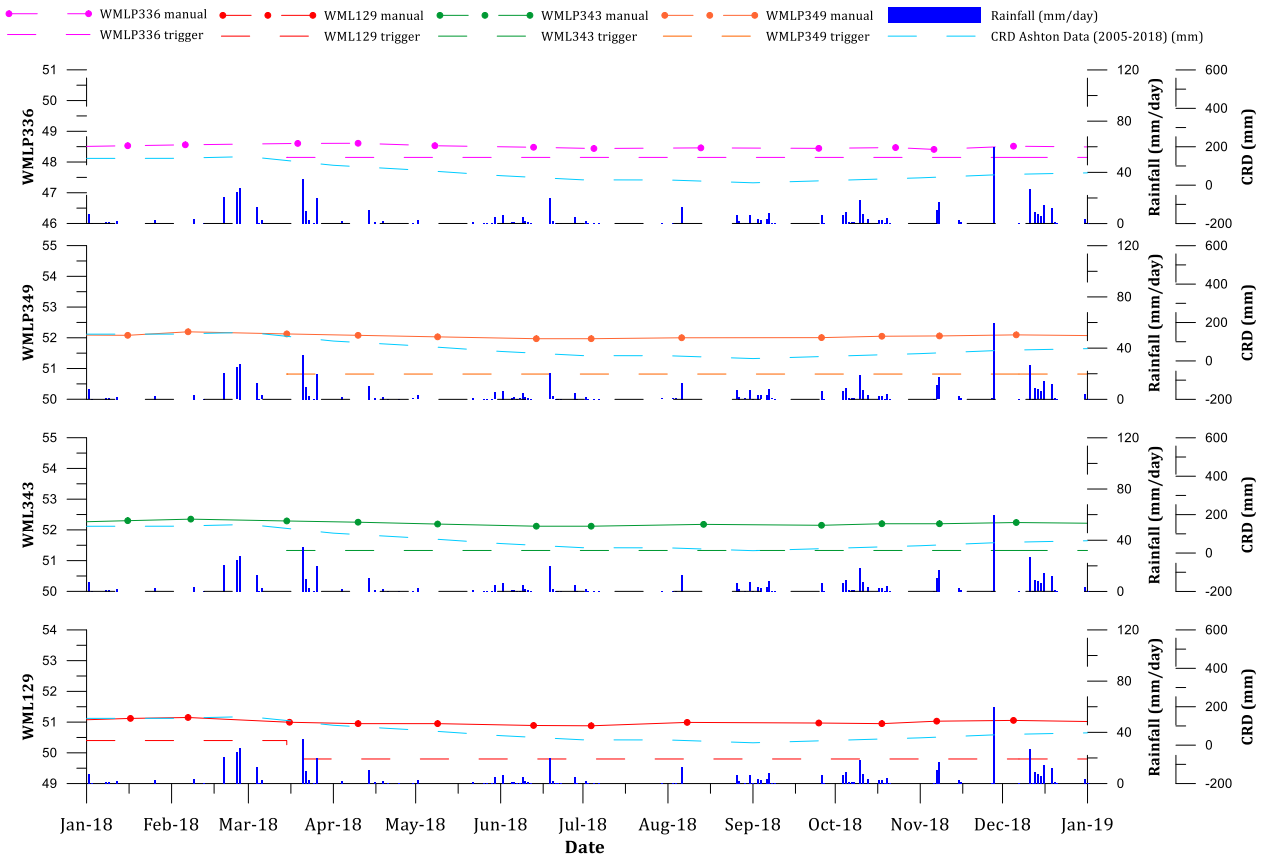

Figure 4.3 Glennies Creek alluvium trigger bores hydrograph (2)

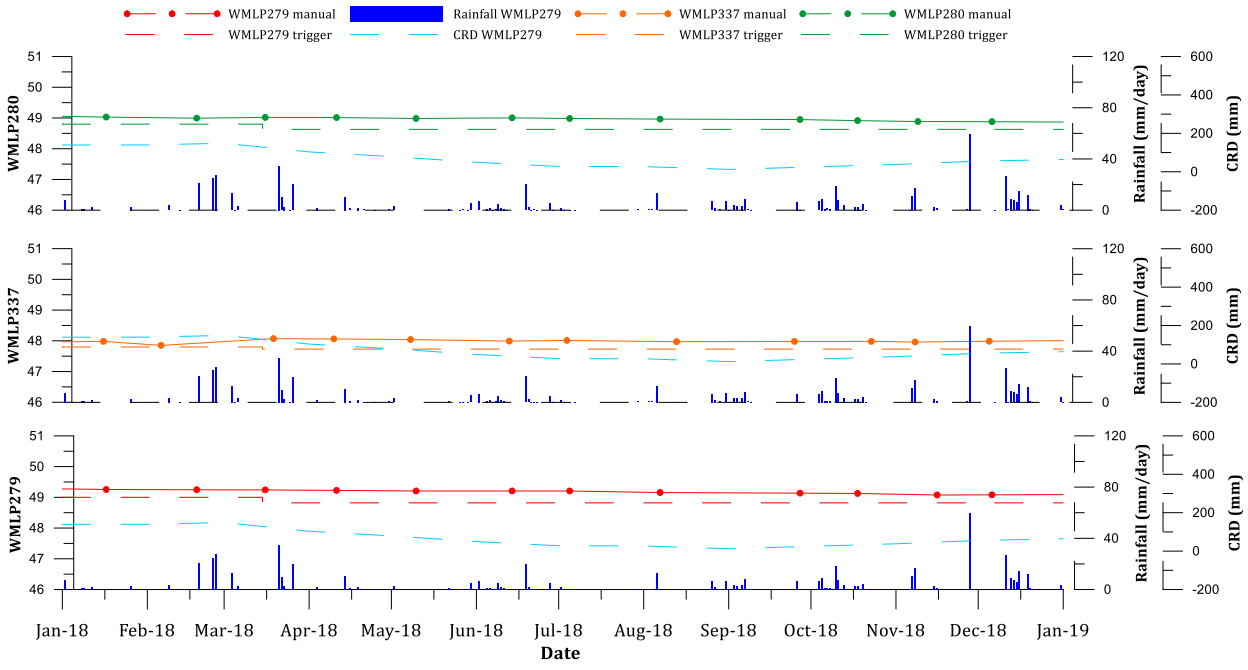

Figure 4.4 Hunter River alluvium trigger bores hydrograph

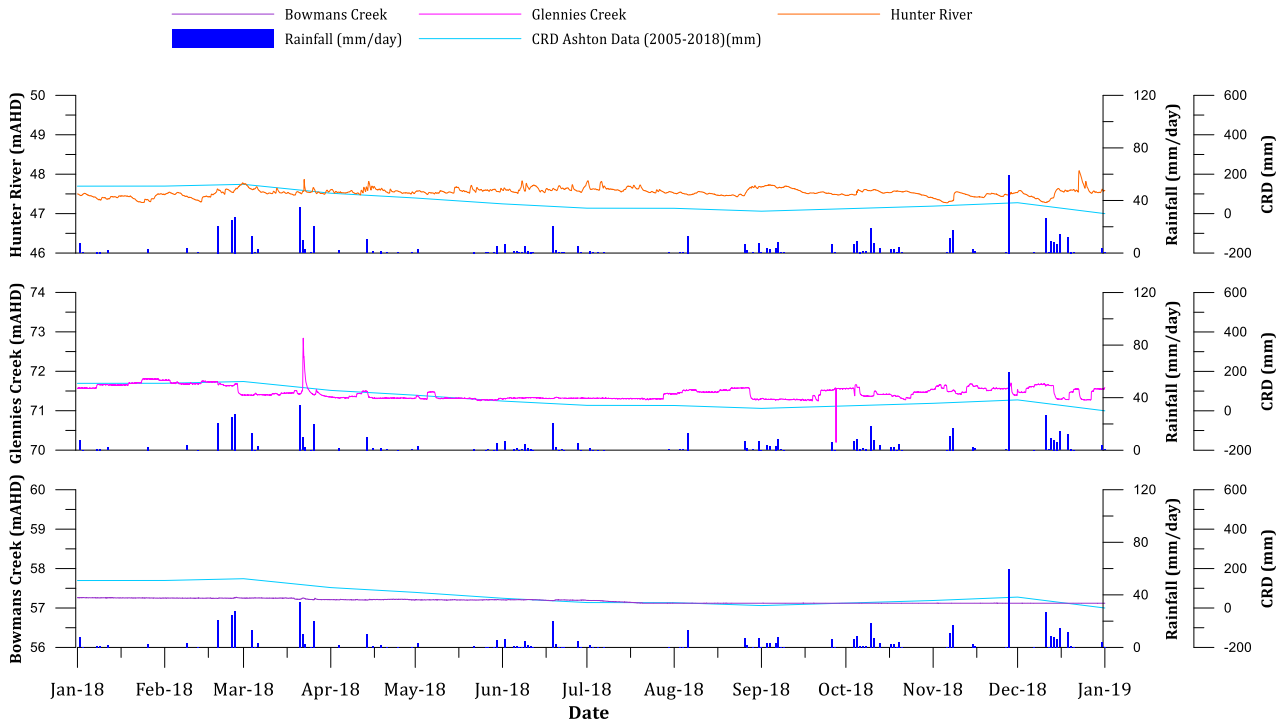

Figure 4.5 River/creek water level trends

4.1.2 Other alluvium groundwater levels

The groundwater level trends and trigger levels for other BCA, GCA and HRA monitoring bores across the wider site monitoring network are presented in Figure 4.6, and Figure 4.7, respectively. Daily rainfall measurements and CRD have also been plotted and used to compare water level trends. The groundwater levels across the network follow similar trends as the nominated trigger monitoring bore sites in the BCA, GCA and HRA (Figure 4.1, Figure 4.2, Figure 4.3, and Figure 4.4). No mining impacts are observable in these bores.

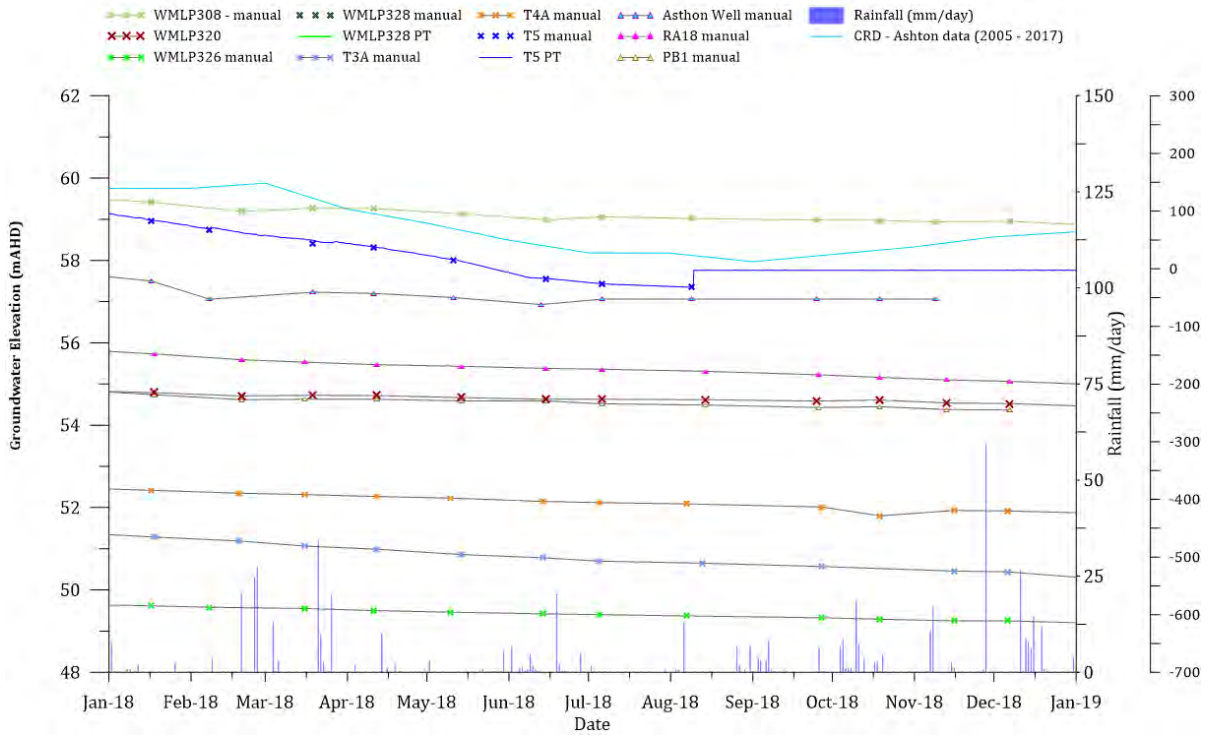

Figure 4.6 Other site alluvium monitoring bores hydrogaphs (1)

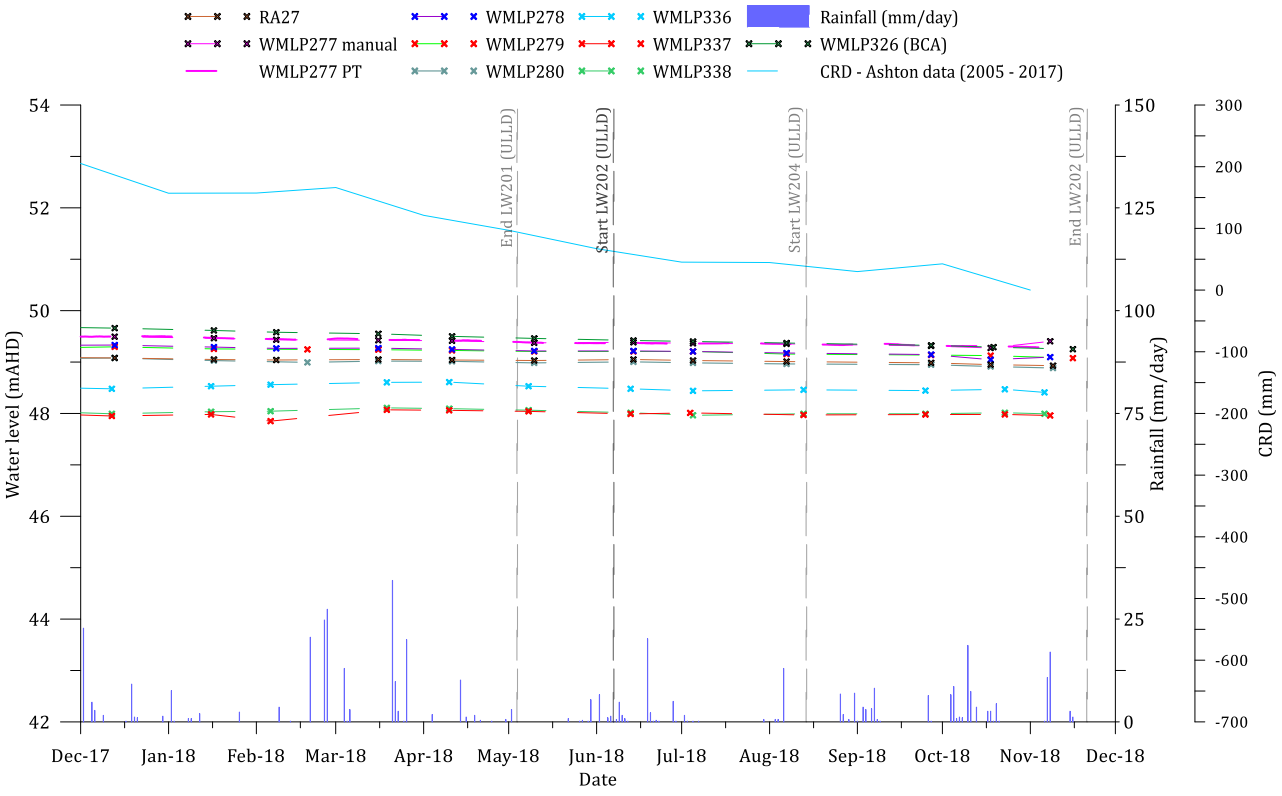

Figure 4.7 Other site alluvium monitoring bores hydrogaphs (2)

4.1.3 pH, electrical conductivity, major ions

All monitoring bores across the wider site monitoring network have also been reviewed and are presented graphically in Figure 4.8 to Figure 4.20. A full list of sample results for pH, EC, major ions and dissolved metals from the annual sampling, completed in August 2018, is presented in Appendix D. All laboratory files can be found in Appendix F.

Generally, groundwater **pH** is slightly acidic to neutral in the alluvial aquifer, and there were no pH exceedances in any of the monitoring bores across the site. Groundwater pH values within the BCA, GCA and HRA were stable and follow the similar general trends throughout 2018, with minor localised variations. There were two individual exceedances of the trigger values of two bores, WML337 and WMLP358. As these bores did not exceed the trigger for three consecutive readings the WMP response protocol was not enacted. Generally, the values are slightly acidic to neutral and range from:

- BCA - 6.81 (WMLP311) – 7.54 (WMLP328);
- GCA – 6.34 (WMLP358) – 7.25 (WMLP343); and
- HRA – 6.48 (WMLP337) – 7.54 (WMLP336).

Groundwater **EC** is fresh to slightly brackish across the BCA, GCA and HRA monitoring network. There were three EC trigger exceedances during 2018 measured in WMLP328, WMLP311, and WMLP323, all located in BCA. The river and creek EC levels (sourced from NSW Office of Water on-line database[2]) are presented in the same figures for each water source. Generally, values were fresh to slightly brackish and range from:

- BCA - 1012 (WML113C) – 1437 (WMLP326);
- GCA – 368.2 (WMLP358) – 921.5 (WMLP349); and
- HRA – 631.5 (WMLP336) – 2876 (WMLP337).

The trend analysis indicates:

- **BCA** groundwater EC (Figure 4.14) decreases after several days of rainfall in April (as does the surface water) indicating some rainfall recharge occurring. For most bores EC has remained stable throughout the year and comparable to historical results. There was a return to background levels, around 1,200 µS/cm, following the rainfall event in April.
- Slightly elevated EC, above the WMP specified trigger levels, have been continuously measured in WMLP328, WMLP311, and WMLP323 since June. An initial investigation of WMLP328 was completed in August 2018 to address the exceedance. The investigation concluded that the northern area of the BCA receives low levels of recharge from Bowmans Creek, and experienced below average rainfall. Combined, this led to dry conditions and falling groundwater elevation, therefore the exceedances were contributed to climatic conditions. Additional investigations were completed when WMLP328, and WMLP311 also exceeded their WMP (2018) specified trigger levels three consecutive times. When further exceedances were identified in these bores over the following months (e.g. October to January), they were considered to be due to the same sustained dry conditions that triggered the initial notification. As such, no further action was considered necessary.
- Other EC values in monitoring bores screening the BCA have either increased or are stable.
- **GCA** groundwater EC levels have been stable throughout the year with very little variation. All values were below the trigger levels specified in the WMP.

[2] http://realtimedata.water.nsw.gov.au/water

- **HRA** groundwater EC levels throughout the year were stable and showed little fluctuation; however, the HRA EC does not follow the surface water EC measured in the Hunter River (station #210127) which fluctuates throughout the year. All values were below the trigger levels specified in the WMP.
- In general, Groundwater pH and EC across the network follow similar trends as the trigger monitoring bore sites in the BCA, GCA and HRA.

Hunter River and Glennie's Creek surface water EC levels have remained stable or fluctuated slightly over the past year. The surface water EC level in Bowman's Creek was relatively stable until July when the creek ran dry and monitoring was discontinued.

A piper diagram of water types is presented in Appendix E. The cation water type at all monitoring bores is dominated by Na. With respect to anions, Cl clearly dominates over the SO_4 ions in the alluvial monitoring bores.

No mining related impacts to alluvium groundwater quality were measured. As such, the measured quality was within the approved ranges.

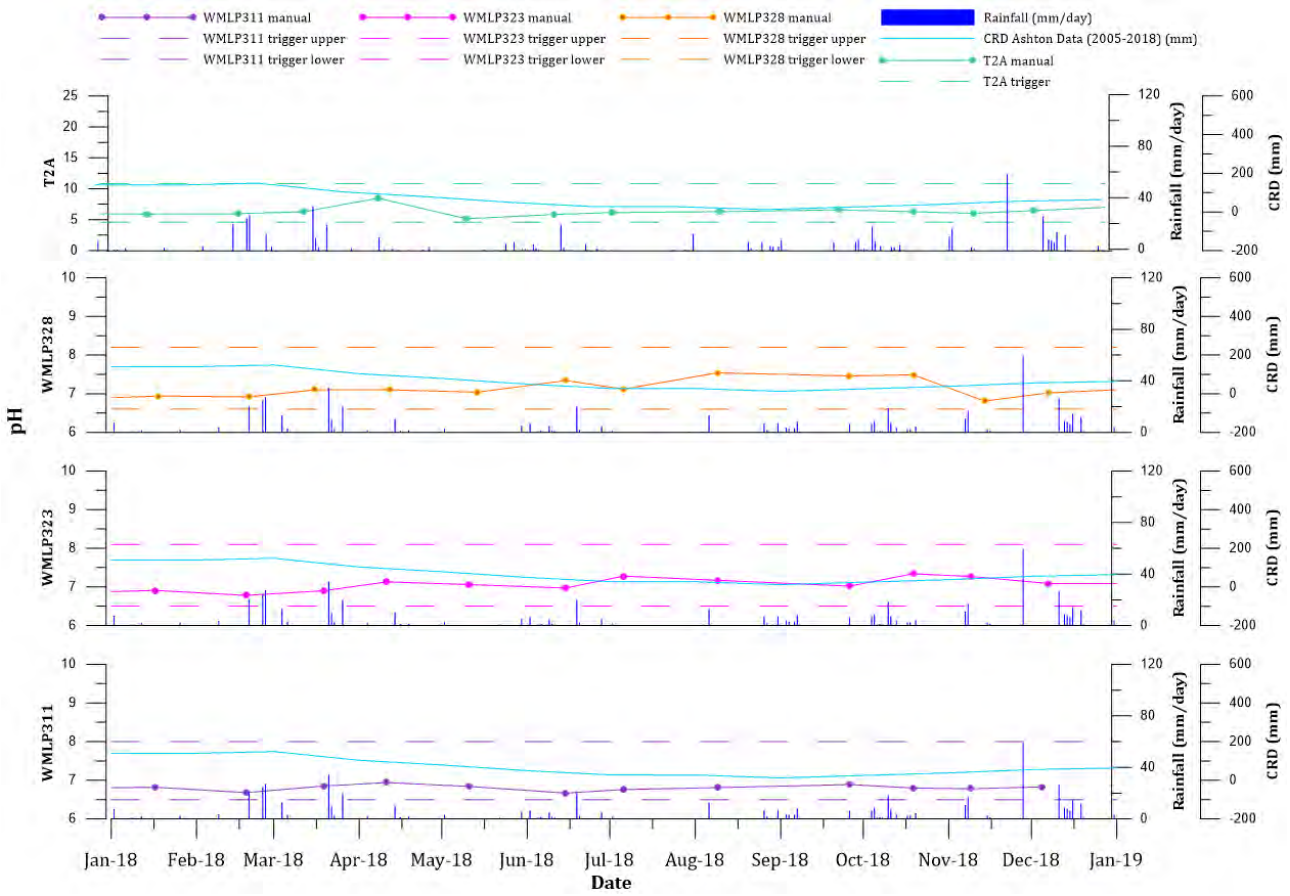

Figure 4.8 Bowmans Creek alluvium compliance bores pH trends

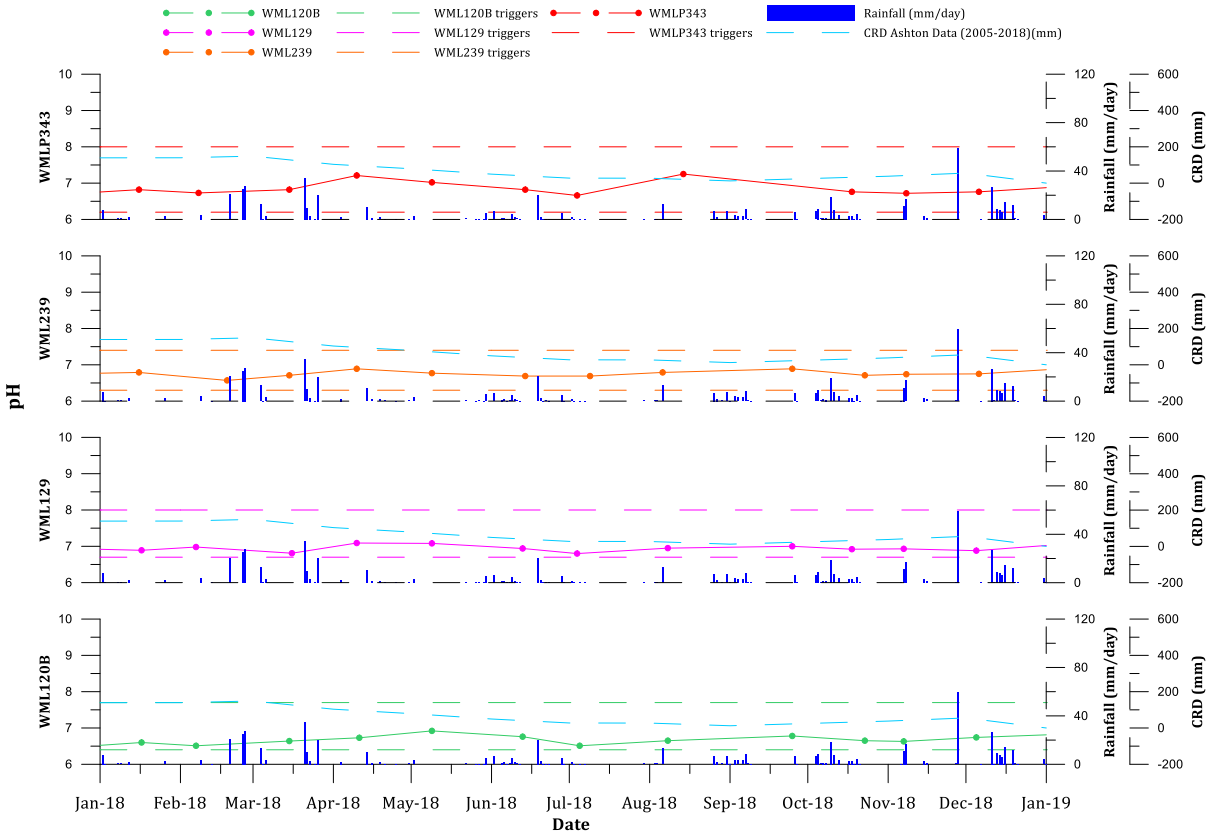

Figure 4.9 Glennies Creek alluvium compliance bores pH trends (1)

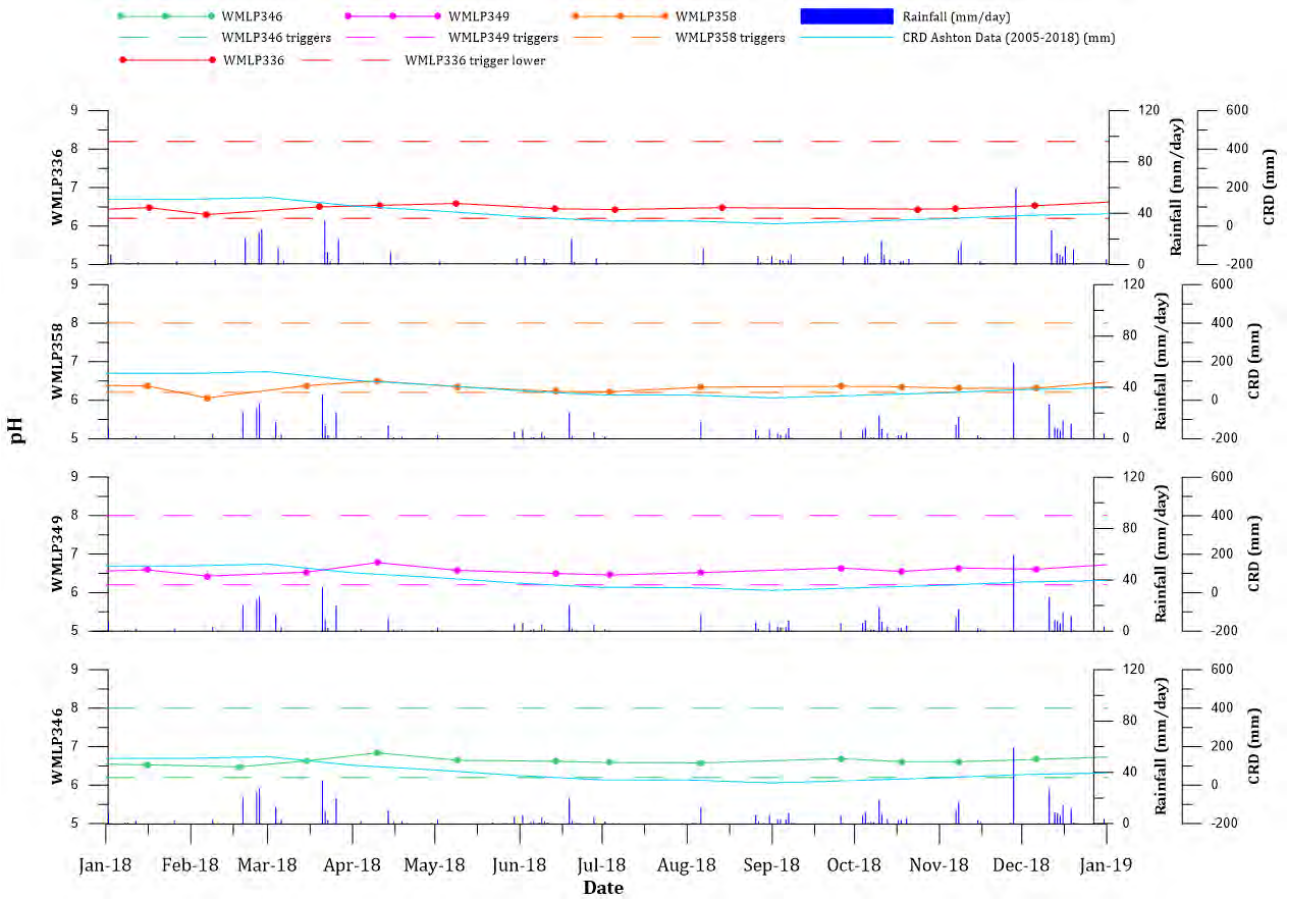

Figure 4.10 Glennies Creek alluvium compliance bores pH trends (2)

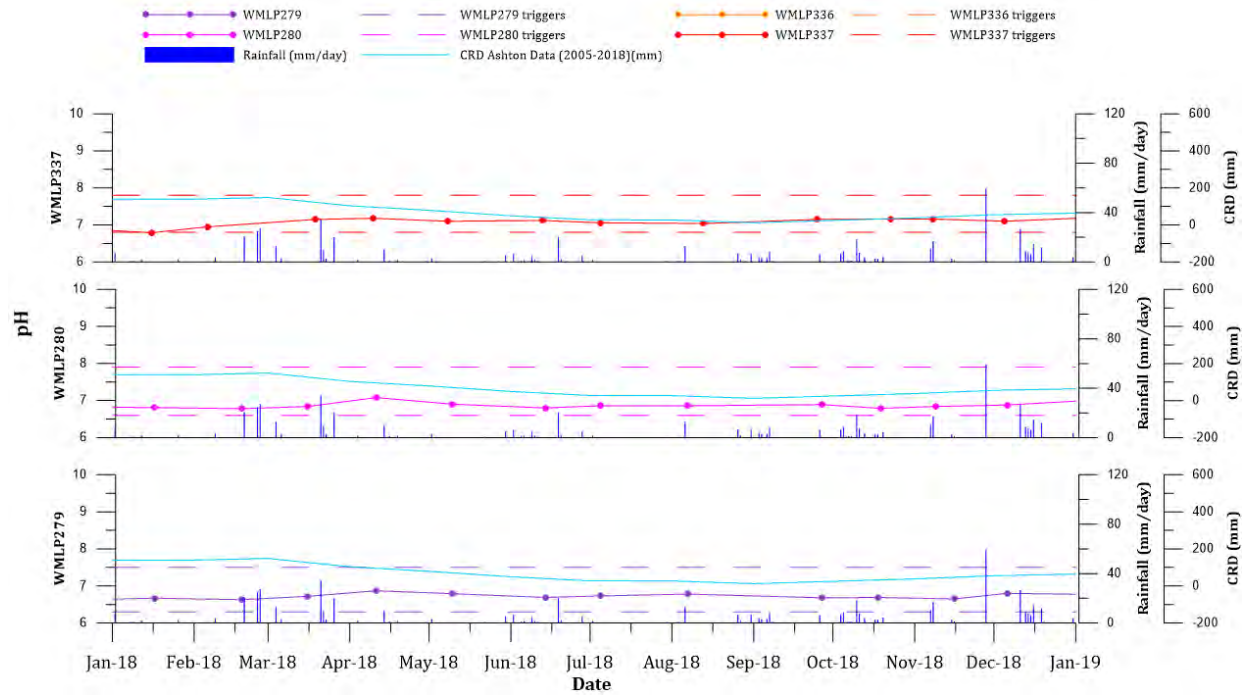

Figure 4.11 Hunter River alluvium compliance bores pH trends

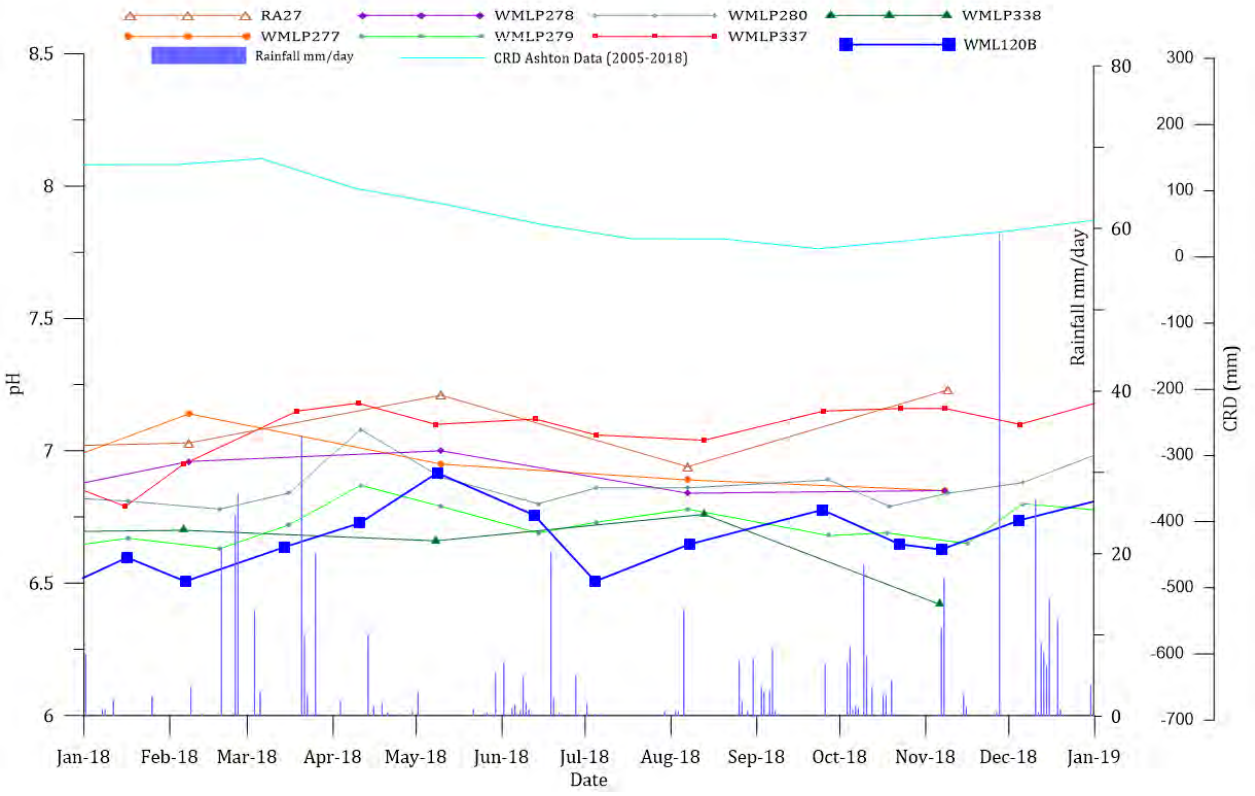

Figure 4.12 Other alluvium bores pH trends (1)

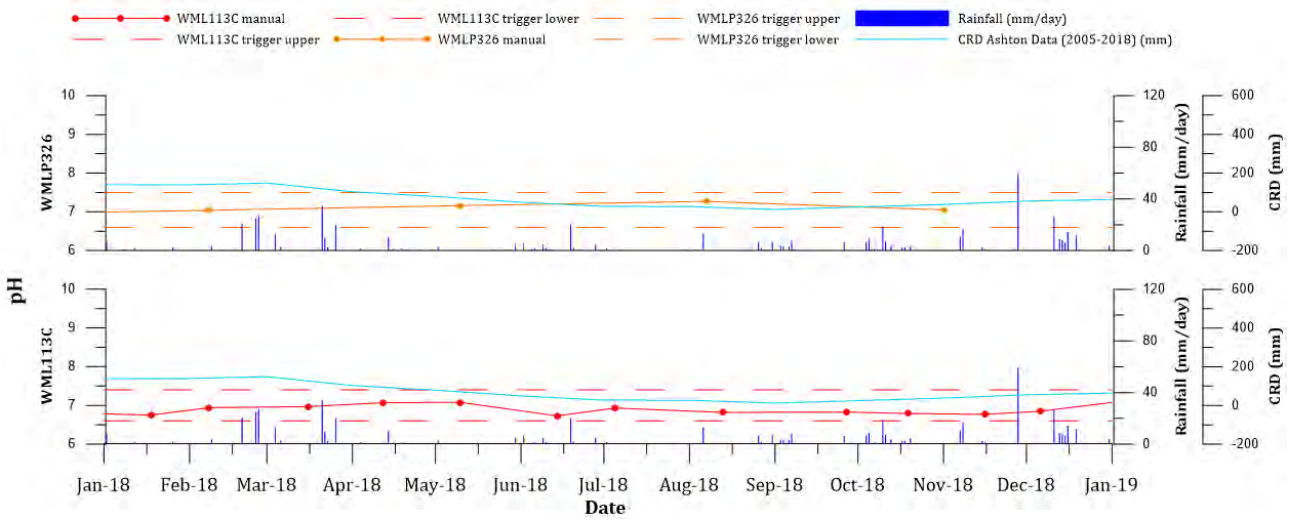

Figure 4.13 Other alluvium bores pH trends (2)

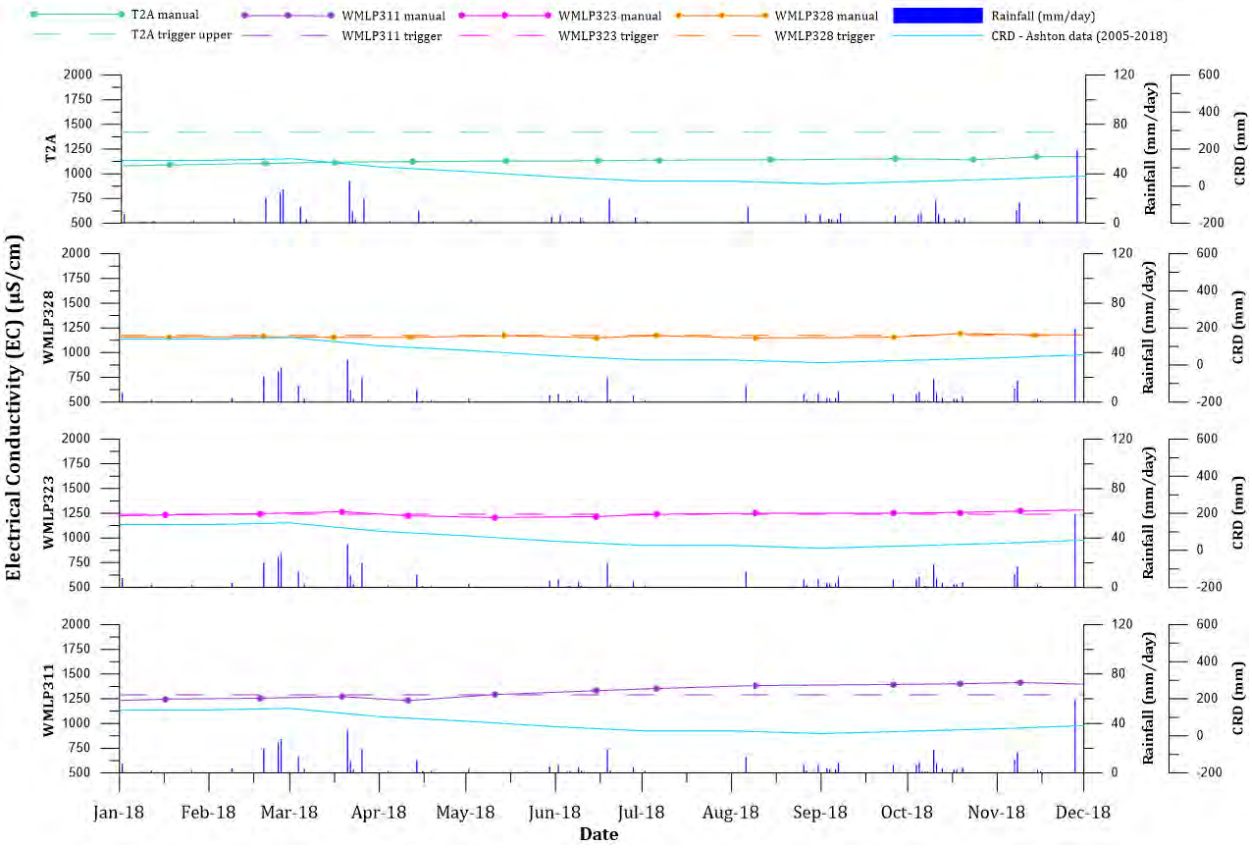

Figure 4.14 Bowmans Creek alluvium compliance bores EC trends

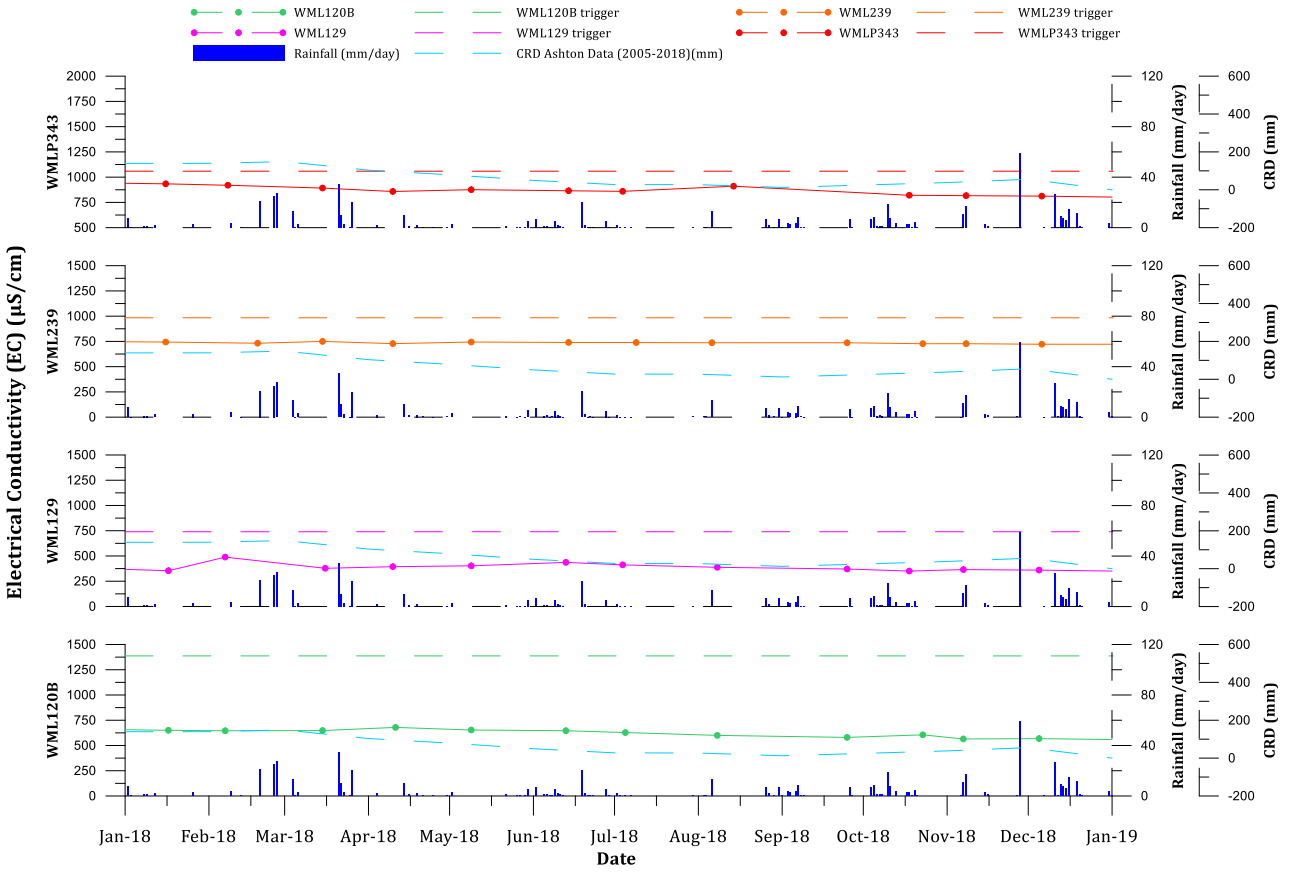

Figure 4.15 Glennies Creek alluvium compliance bores EC trends (1)

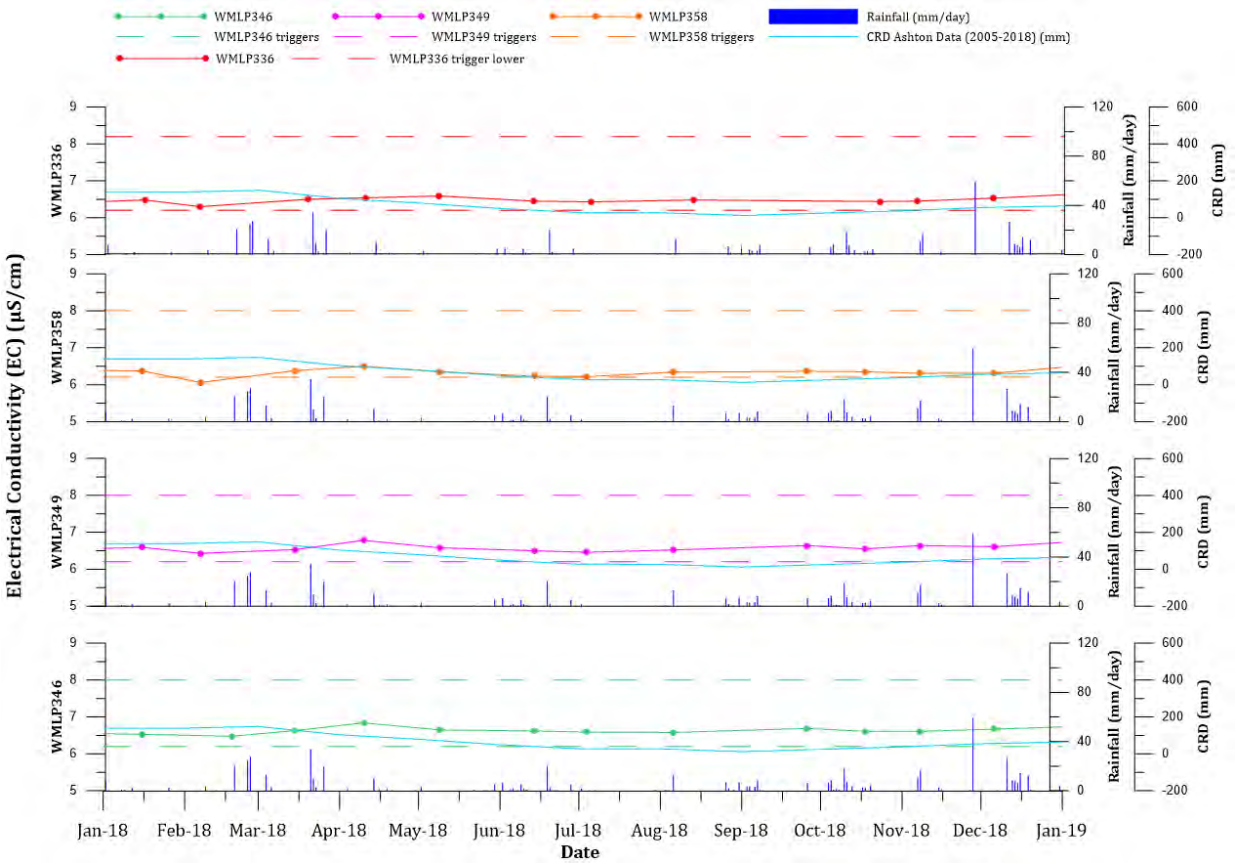

Figure 4.16 Glennies Creek alluvium compliance bores EC trends (2)

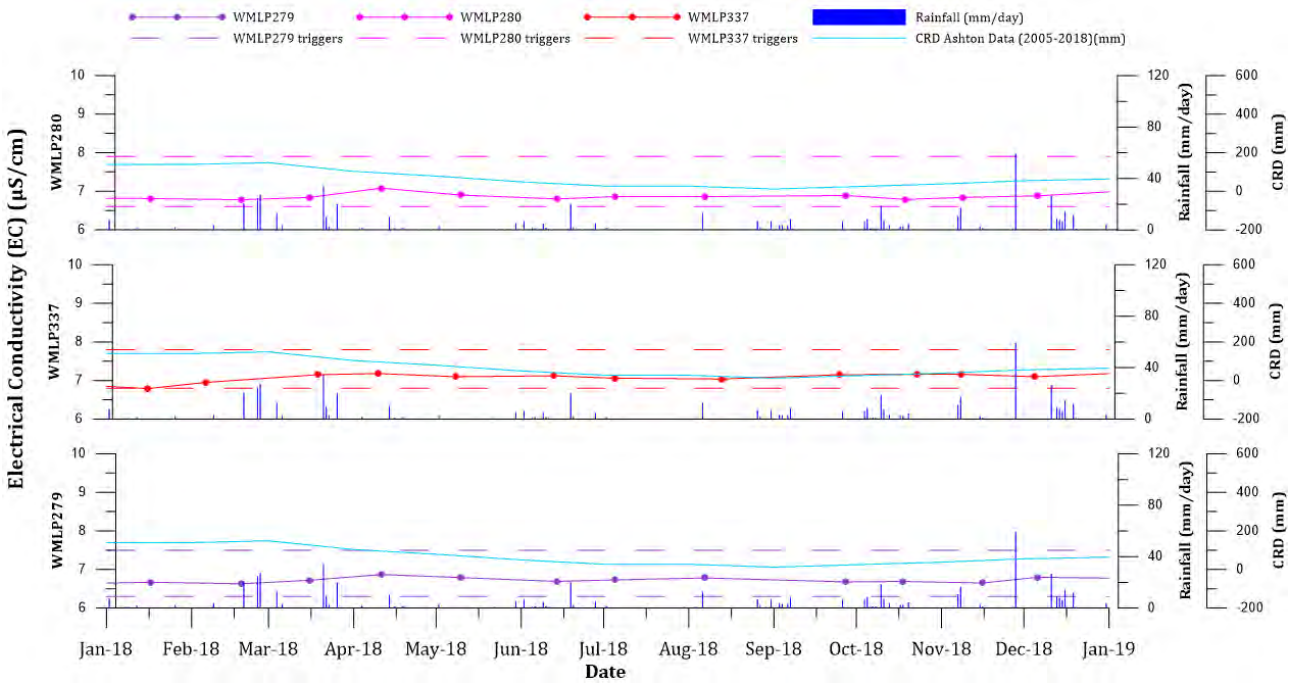

Figure 4.17 Hunter River alluvium compliance bores EC trends

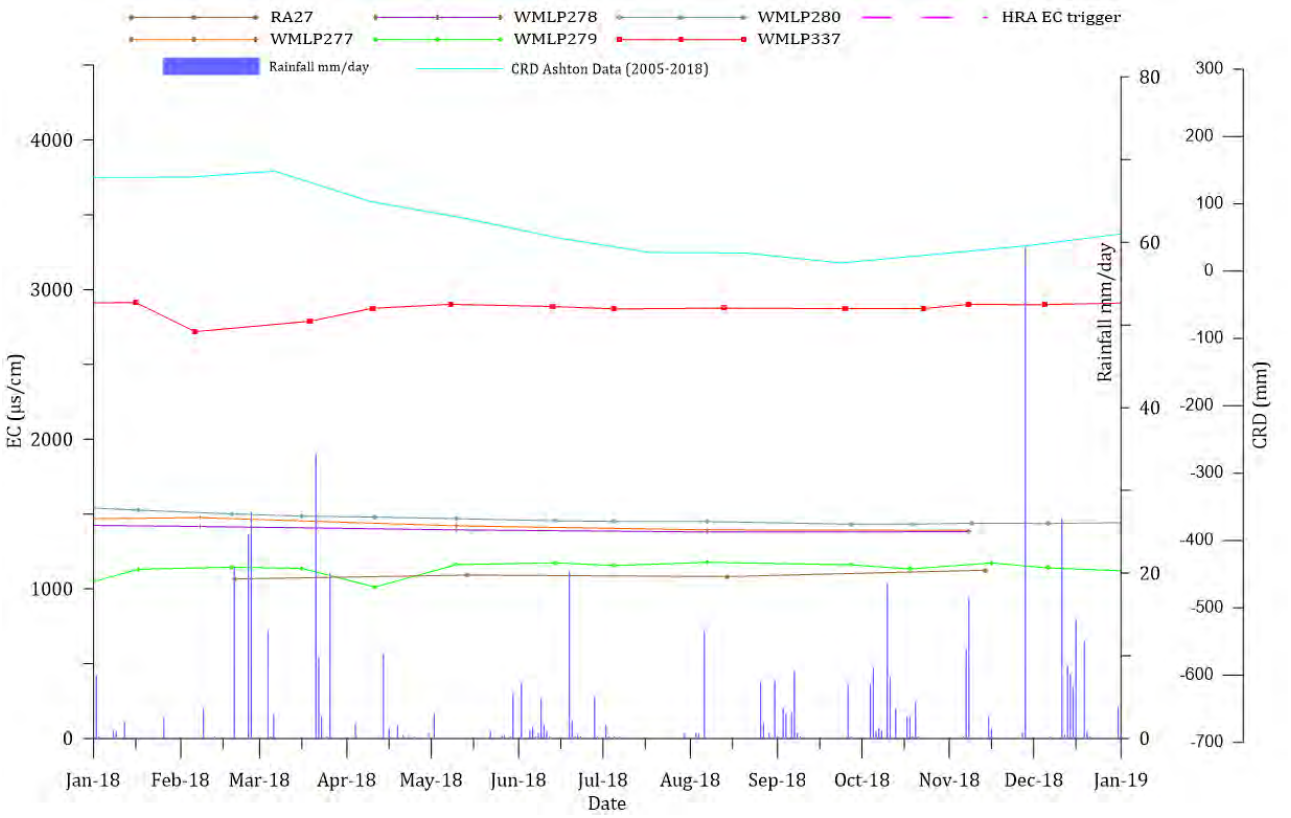

Figure 4.18 Other alluvium bores EC trends (1)

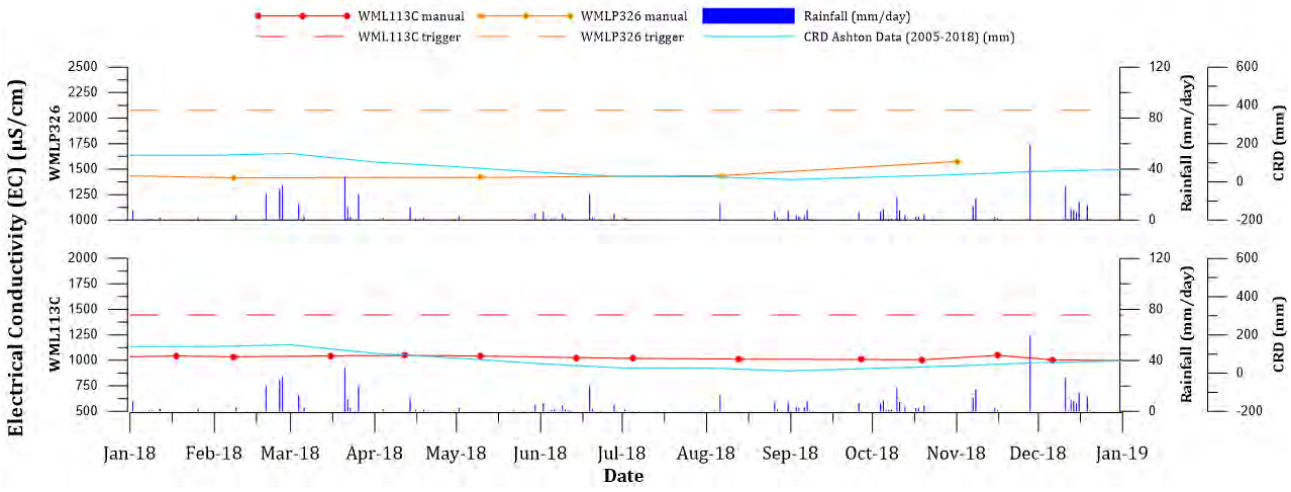

Figure 4.19 Other alluvium bores EC trends (2)

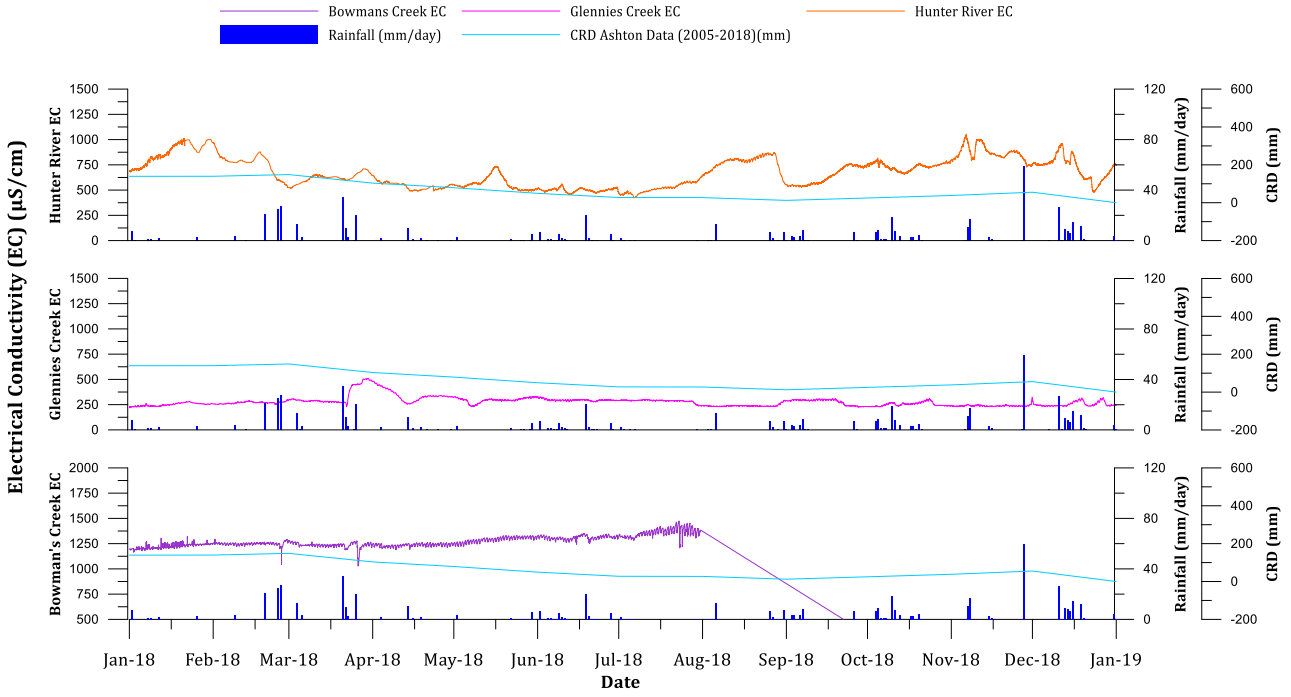

Figure 4.20 River/creek EC trends

4.1.4 Dissolved metals, nitrates and total phosphorous

Dissolved metals results indicate a majority of the results are below the laboratory limit of detection. Manganese, zinc, and iron were detected at very low concentrations. Zinc remained below the ANZECC|ARMCANZ livestock limits; and neither manganese nor iron are sufficiently toxic, and no trigger value is listed in the livestock drinking water guidelines (ANZECC & ARMCANZ, 2000). Low concentrations of Nitrate as N, Total Kjeldahl Nitrogen as N, and total phosphorous were detected; however, all concentrations were well below the livestock drinking water guidelines (ANZECC & ARMCANZ, 2000) of 400 mg/L.

A summary of groundwater analysis results is presented in Appendix D.

4.2 Coal measure aquifer monitoring

Groundwater monitoring and sampling for coal measures and coal measure interburden monitoring bores was completed at the frequency specified in the WMP version 8 (Section 3), and as of March 2018, the revised WMP, version 10 (Section 7.3). Groundwater levels and quality trends for monitoring points relevant to LW202 are presented in the following sections.

4.2.1 Groundwater levels

Groundwater level measurements for longwall specific (LW202) monitoring bores are presented in Figure 4.21; vibrating wire piezometer (VWP) heads in vicinity of LW202 are presented in Figure 4.22; and groundwater levels in all other coal measure bores and VWPs are presented in Figure 4.23 through Figure 4.25. The following observations are noted:

- Groundwater levels in the LW202 longwall monitoring bores (Figure 4.21) remained stable throughout the year.
- Groundwater levels in other site coal measure monitoring bores (Figure 4.23) have a general decline throughout the year, which corresponds to the declining CRD.
- Coal measure VWPs are relatively stable, with the following trends noted:
    - VWP measurements in WML248 (Figure 4.22) are generally steady with the exception of water levels in the ULLD seam, which has declined since December.
    - Groundwater levels in alluvial and coal measure overburden monitoring bores in the Bowmans Creek area have declined (including T2P, T3P, WMLP325 and WMLP327) with the exception of WMLP324, which has increased slightly (Figure 4.23). There has been no mining in the area since the end of May 2017, therefore groundwater declines are likely due to external stress such as the drought conditions. Faults in WMLP324 and WMLP325 pressure transducers are being addressed.
    - VWP measurements in WML213 (Figure 4.24) are generally steady with the exception of water levels in the ULD and the ULLD seams, which have declined.
    - VWP measurements in WML363 (Figure 4.25) are generally steady with the exception of water levels in the Lemington 8, overburden, and Middle Liddell seam roof (170 m) sensors, which have declined gradually throughout the year.

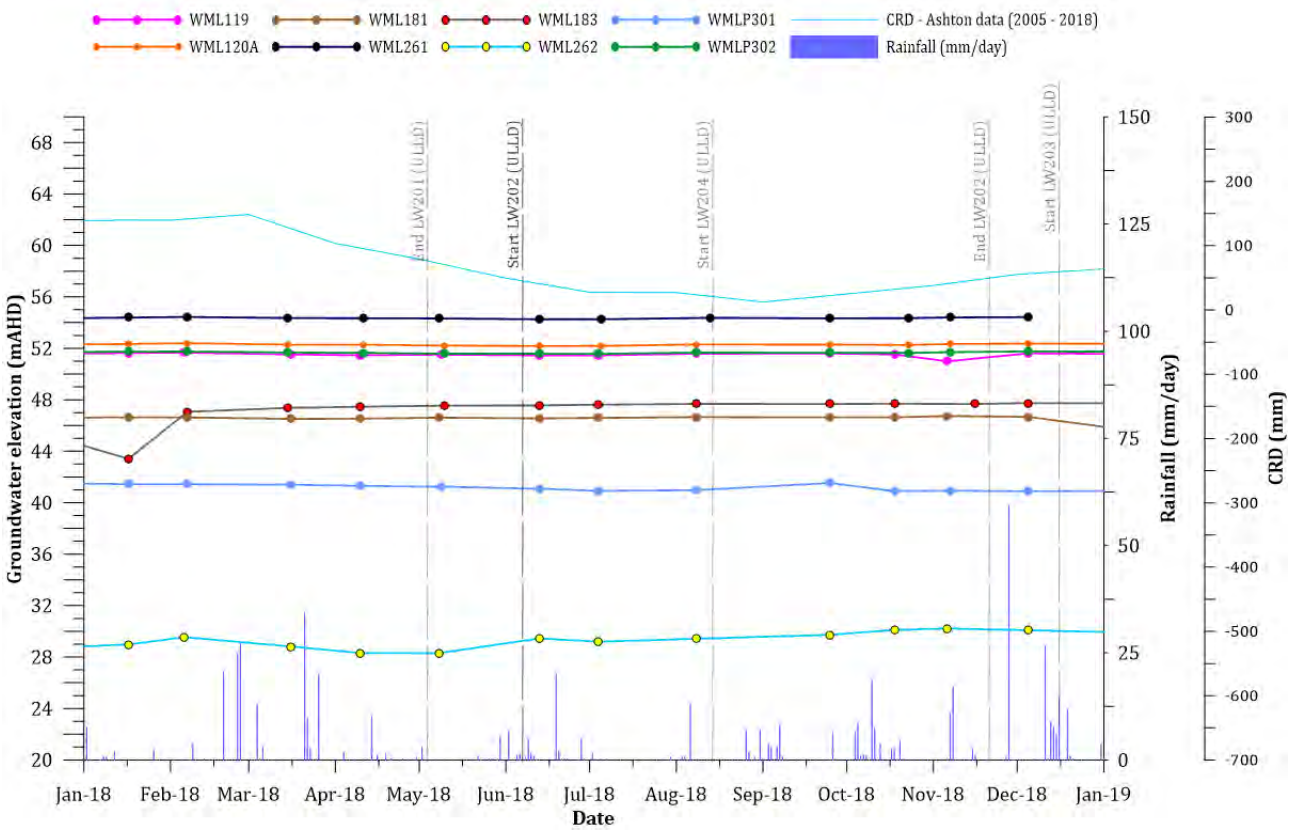

Figure 4.21 Hydrographs for monitoring bores in vicinity of LW202

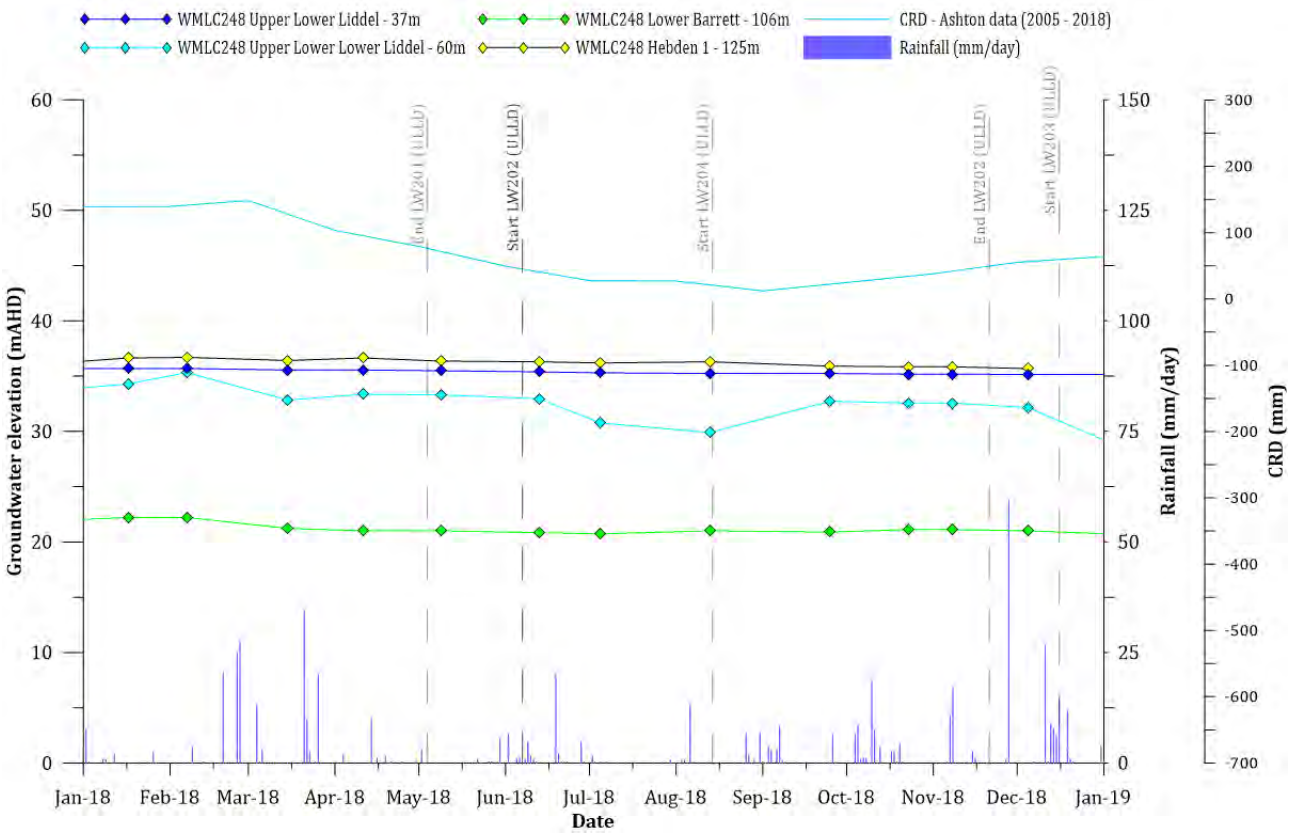

Figure 4.22 Hydrographs for VWP WMLC248 in vicinity of LW202

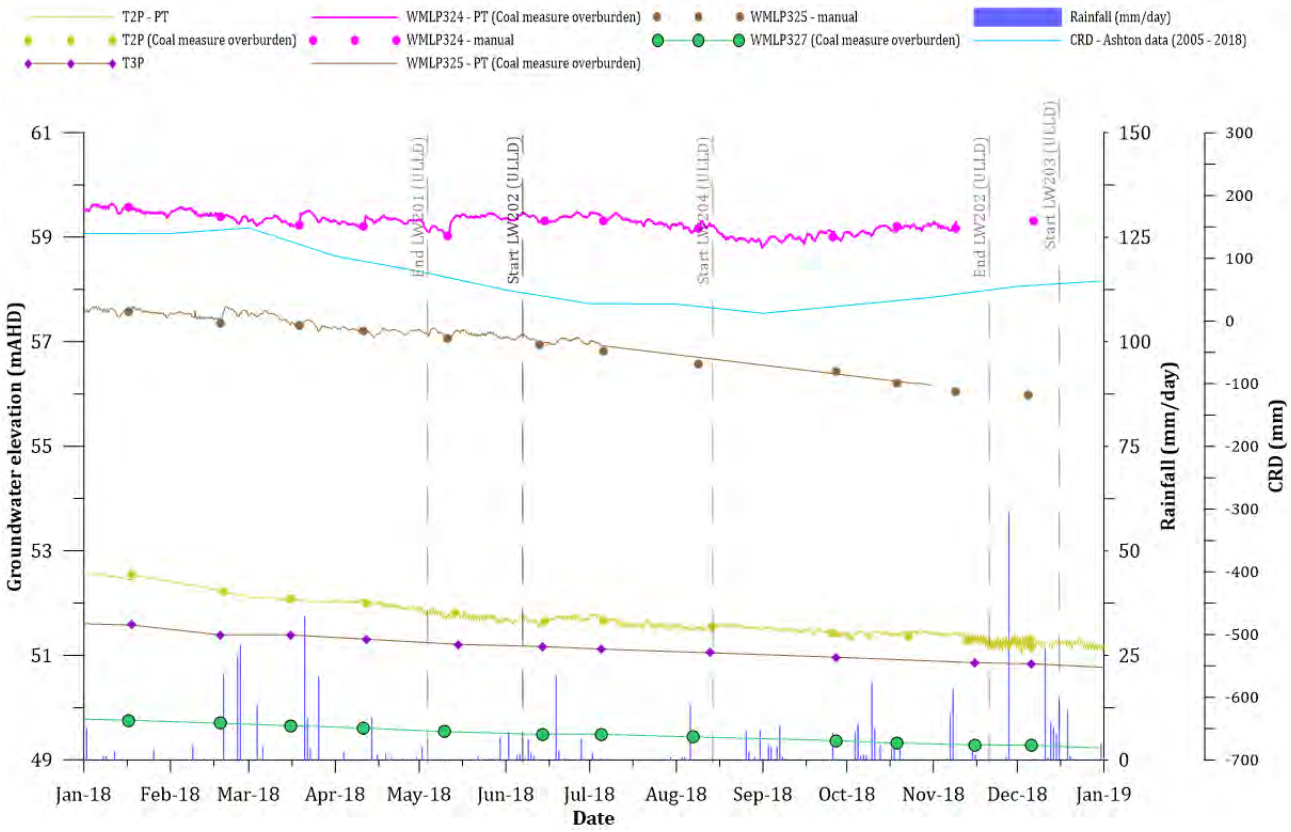

Figure 4.23 Hydrographs for other site coal measure monitoring bores

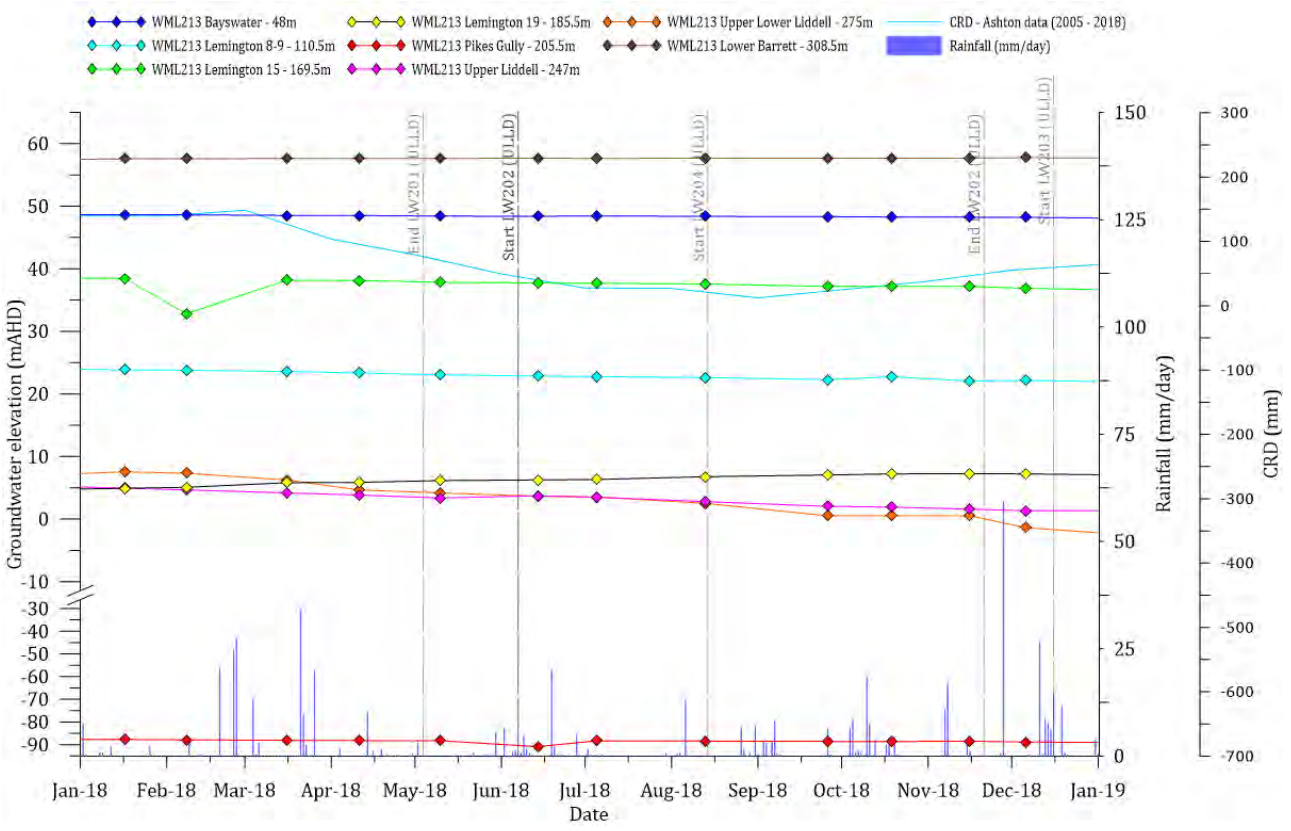

Figure 4.24 Hydrographs for other site coal measure VWP installations (1)

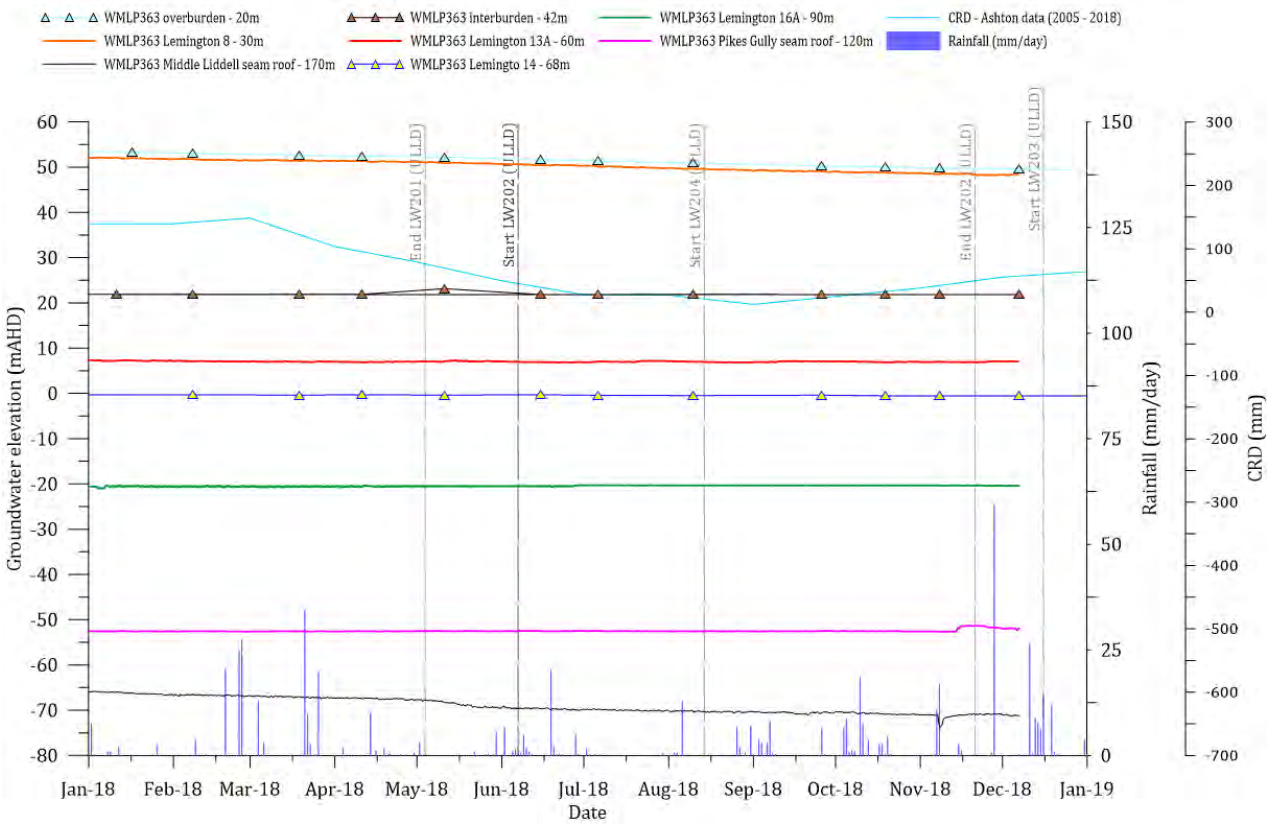

Figure 4.25 Hydrographs for other site coal measure VWP installations (2)

4.2.2 pH, electrical conductivity, major ions

Coal measure monitoring bores across the wider site monitoring network have also been reviewed. Temporal charts of pH and EC for all coal measure monitoring bores are presented graphically in Figure 4.26 and Figure 4.27. A full list of sample results for major ions and dissolved metals from the annual sampling, which was completed in August, is presented in Appendix D. All laboratory files can be found in Appendix F.

Monitoring results and a trend analysis indicates that pH (Figure 4.26) has remained relatively stable throughout the year, with values within range of historic results. Water quality is slightly acidic to slightly alkaline with pH values ranging from 6.32 (WMLP302) to 8.08 (WML301). pH levels in RSGM1, EPL monitoring bore, increased from 7.33 to 7.75 by August.

Monitoring results and a trend analysis indicates EC (Figure 4.27) across the coal measure monitoring network is generally brackish to moderately saline with EC values ranging from 875 µS/cm (WML120A) to 3,753 µS/cm (WML301). Most EC values were stable throughout the year, with only minor fluctuations. WMLP301, WML262, and WML181 had a gradually increasing trend throughout the year (Figure 4.27).

A piper diagram of water types is presented in Appendix E. The cation water type at all monitoring bores is dominated by Na, except WMLP358 which is slightly calcium dominant. With respect to anions, Cl clearly dominates over the SO_4 ions, with HCO_3 dominant in ULD bores.

All mining related impacts to coal measure water quality were within the approved ranges.

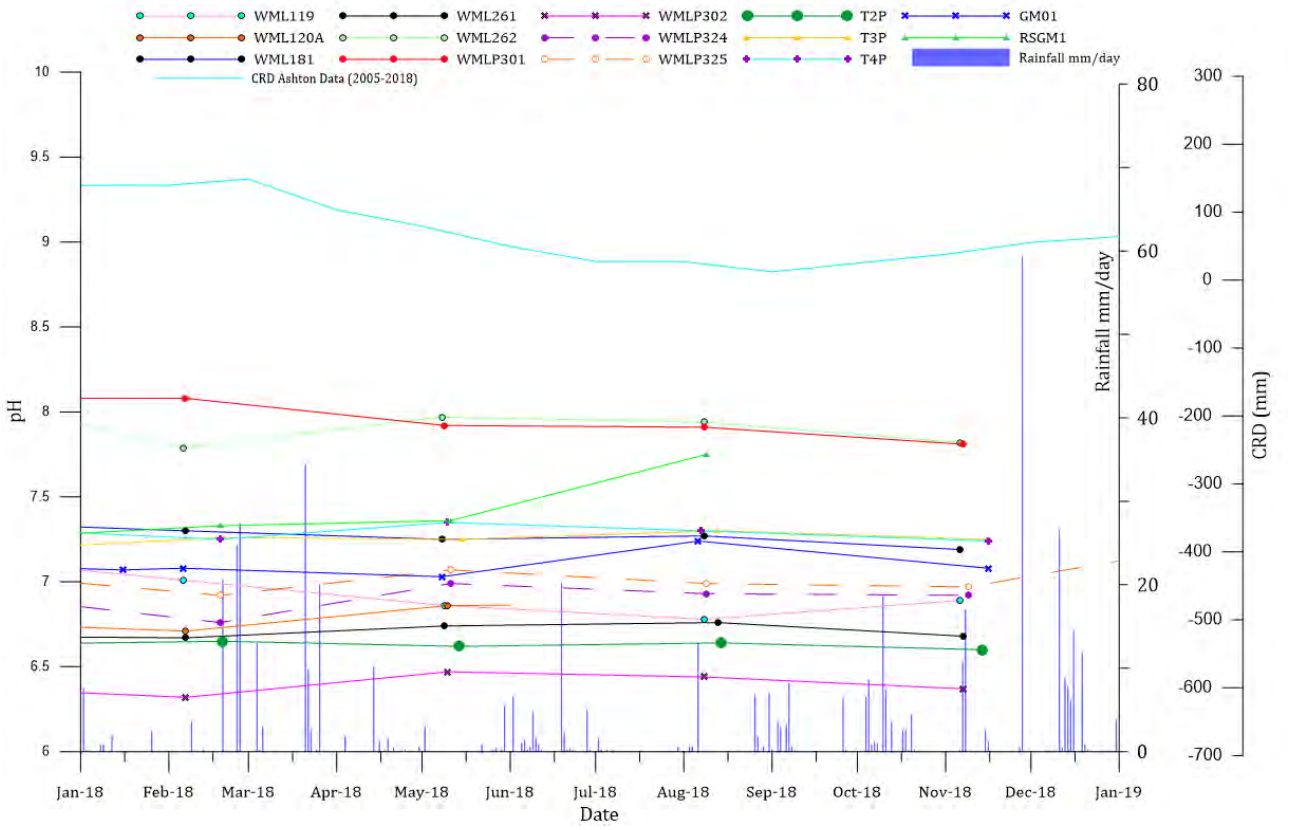

Figure 4.26 Coal measure pH trends

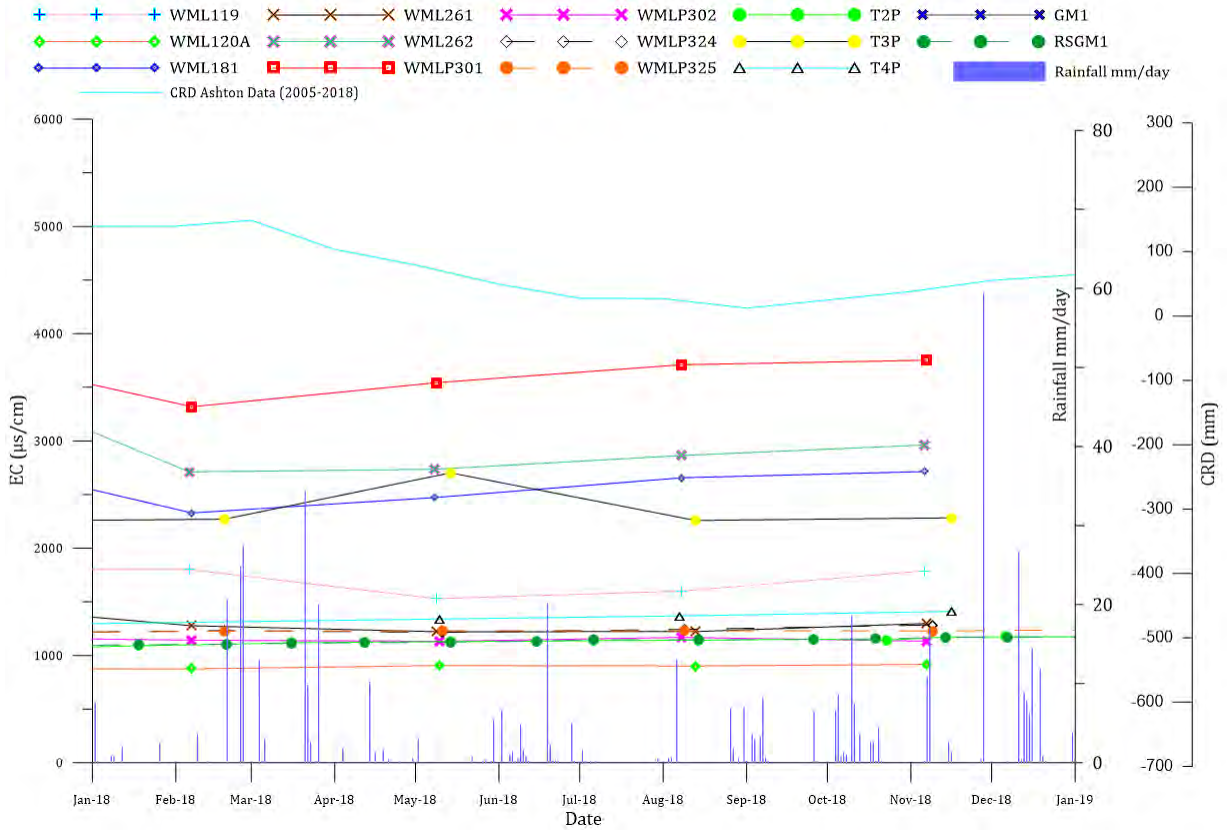

Figure 4.27 Coal measure EC trends

4.2.3 Dissolved metals, nitrates and total phosphorous

A summary of groundwater analysis results is presented in Appendix D.

Dissolved metals results indicate a majority of the results are below the laboratory limit of detection. Manganese, zinc, and iron were detected at very low concentrations. Zinc was well below the ANZECC|ARMCANZ livestock guideline (ANZECC & ARMCANZ, 2000) of 20 mg/L; and neither manganese nor iron are sufficiently toxic, and no trigger value is listed in the livestock drinking water guidelines (ANZECC & ARMCANZ, 2000). Low concentrations of Nitrate as N, Total Kjeldahl Nitrogen as N, and total phosphorous were detected, however all concentrations were well below the livestock drinking water guidelines of 400 mg/L (ANZECC & ARMCANZ, 2000).

5 EPL11879 monitoring bores

Results for 2018 monitoring of EPL11879 monitoring bores are summarised in Table 5.1 (levels) and Table 5.2 (EC). Several of the monitoring bores listed in EPL11879 have been destroyed (RA02, RM1, RM4, RM5, RM6, RM7 and RM9) and can no longer be monitored.

Table 5.1 Groundwater Levels

Monitoring bore	Jan 2018	Mid 2018	Dec 2018
	Groundwater levels (mBGL)		
GM1	8.11	8.37	9.27
GM3A	16.12	16.06[1]	dry[2]
GM3B	dry[2]	dry[2]	dry[2]
PB1	6.36	6.58	6.73
RA02	destroyed	destroyed	destroyed
RM01	destroyed	destroyed	destroyed
RM2	11.34	12.69	dry[2]
RM03	dry	dry	dry
RM4	destroyed	destroyed	destroyed
RM5	destroyed	destroyed	destroyed
RM6	destroyed	destroyed	destroyed
RM7	destroyed	destroyed	destroyed
RM9	destroyed	destroyed	destroyed
RM10	6.97	7.17	7.36
RSGM1	6.95	7.77	8.13

Notes: *[1] Last measurement taken in May before bore went dry.*

[2] Water level tagged was below the sump, so declared 'effectively dry'.

Table 5.2 Groundwater EC

Monitoring bore	Feb 2018	Mid 2018	Nov 2018
	Groundwater EC (µS/cm)		
GM1	2,036	2,020	2,042
GM3A	insufficient water for representative sample	insufficient water for representative sample	dry
GM3B	dry	dry	dry
PB1	1,179	1,270	1,341
RA02	destroyed	destroyed	destroyed
RM01	destroyed	destroyed	destroyed
RM2	no data	no data	no data
RM03	dry	dry	dry
RM4	destroyed	destroyed	destroyed
RM5	destroyed	destroyed	destroyed
RM6	destroyed	destroyed	destroyed
RM7	destroyed	destroyed	destroyed
RM9	destroyed	destroyed	destroyed
RM10	1,105	1,124	1,168
RSGM1	2,123	2,143	dry #

Note: # *Too dry to sample.*

6 Mine inflow

Ashton underground mine inflows are calculated through a review of dewatering abstraction volumes and a water balance assessment. The water balance assessment is the most appropriate tool to assess mine inflows as the volume of abstracted water comprises water from a number of sources, including but not limited to groundwater, surface water, incidental take and groundwater transitioning from the point of entry to the abstraction point. The transition time of this "stored" water is assumed to be in the order of years and is normally not considered inflow that has occurred in the past year. It is considered that the stored water is largely from the groundwater sources (predominantly hardrock) rather than surface water. A proportion of abstracted water is understood to have in-flowed prior to 2018 and was stored temporarily in the goaf. A proportion of the 2018 incidental take has continued to be stored underground or was lost through coal moisture and water vapour via outgoing air.

Data utilised in the assessment includes:

- metered water volumes pumped to the mine from the various sources;
- metered water abstracted from the mine;
- partitioned water takes (from the groundwater modelling) from the surface water sources and the separate groundwater sources; and
- estimate of stored water pumped from the mine.

These volumes are summarised in Table 6.1. In 2016, Ashton abstracted 334.4 ML of water in 2018. Of that volume, 201.6 ML was introduced into the mine as operational water; therefore, the difference of 132.8 ML is considered a portion of the incidental water take. The remainder of the predicted incidental water (285.3 ML) is considered to be stored in the underground working or to have been lost through the coal moisture and water vapour in out-by. The value for estimated stored volume of incidental take of 285.3 ML is considered large and the water level in the underground workings has not increased recently. Therefore, we suggest that this value is not entirely representative of the inflow and that further investigation needs to be undertaken. Additionally, the site abstraction rate and metering should also be reviewed.

The groundwater model (AGE, 2016) predicted that the underground inflow rate into the mine for the period of 2018 would have been 11.4 L/sec. The average 2018 water abstraction rate was 10.52 L/sec.

Table 6.1 Breakdown of abstracted water volumes

Total water abstracted from mine via BH5, BH6 and Portal	334.4 ML	Mine water input (metered)	201.6 ML		
		Estimate of abstracted water considered inflow water	132.8 ML	418.1 ML	Total predicted incidental water-take for 2018 (from 2016 GW model – Scenario 5: mining LW101-106A, followed by LW201-LW204)
		Portion of incidental water take considered stored in underground and/or lost via coal moisture and water vapour in out-by air	285.3 ML		

7 Summary

Groundwater monitoring over the 2018 reporting period was consistent with the requirements outlined in the 2016 & 2018 WMP. A summary of the findings of this report is as follows:

- WMP version 10 was approved and implemented as of March 2018.
- A number of water level and EC trigger exceedances were noted during the year. Trigger exceedances in these bores had been investigated previously and the current exceedances were considered to be due to the same sustained dry conditions that triggered the initial notification. As such, no further action was considered necessary.
- Groundwater levels at Bowman's Creek bores have declined throughout the year, corresponding with the declining CRD and drought conditions. The declines in the BCA water levels are within approved limits.
- Groundwater levels at GCA and HRA were within predicted limits across the site during the year.
- Groundwater levels in the coal seams and coal seam overburden adjacent LW202 (ULLD) have generally remained stable and have not been significantly impacted by longwall mining in LW202.
- VWP measurements in WML248, WML363, and WML213 have generally remained stable with the exception of ULLD seam (WML248), Lemington 8 (WML363), overburden (WML363), Middle Liddell seam roof – 170 m (WML213), ULD (WML213), and the ULLD seams (WML213) sensors which show declining trends during mid to late 2018 to present. The trends show ongoing pressurization of coal seams due to longwall mining. The impact is within the predicted limits.
- Groundwater levels in the alluvium and coal seam overburden at coal measure bores in the Bowmans creek area have general declined throughout the year corresponding to the declining CRD and drought conditions; however, as mining has not occurred in the area since 2016, the trends are not considered to be impacted by longwall mining.
- Dissolved metals were typically below the laboratory detection limit, except for manganese, zinc, and iron which had low concentrations. Zinc remained well below the ANZECC|ARMCANZ livestock guidelines, and the measured concentrations of manganese and iron were well below the ANZECC|ARMCANZ (2000) guideline value of 400 mg/L (ANZECC & ARMCANZ, 2000).
- Underground mine inflows are within predicted limits, but a review is recommended to confirm the accuracy of abstraction volume estimates.

Generally, the site has experienced no mining impact to the alluvial aquifers and impacts are within predictions in the coal measures. The impact of drought conditions can be seen in the Bowmans Creek alluvium and some of the shallower coal measure bores.

8 References

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Appendix A Summary of WMP monitoring locations

Table A1 GWMP monitoring bore locations

Monitoring target	Bore	Easting (MGA94 Zone56)	Northing (MGA94 Zone56)	Collar (mAHD)
Bowmans Creek Alluvium (BCA)	RSGM1	317655	6406302	65.6
Bowmans Creek Alluvium (BCA)	T2-A	317583.4*	6405217.4*	60.7*
Bowmans Creek Alluvium (BCA)	T3-A	317654.2*	6404708.1*	59.6*
Bowmans Creek Alluvium (BCA)	T4-A	317686.1*	6404323.2*	58.2*
Bowmans Creek Alluvium (BCA)	T5	317946	6406549.4	65.33
Bowmans Creek Alluvium (BCA)	PB1	317545	6405301	61.1
Bowmans Creek Alluvium (BCA)	WML113C	317377	6404526	60.2
Bowmans Creek Alluvium (BCA)	WML115B	317881	6406704	66.4
Bowmans Creek Alluvium (BCA)	WMLP311	318179	6406048	63.64
Bowmans Creek Alluvium (BCA)	WMLP323	318242	6406595	64.47
Bowmans Creek Alluvium (BCA)	WMLP326	317571	6404103	59.29
Bowmans Creek Alluvium (BCA)	WMLP328	317927	6405611	62.76
Bowmans Creek Alluvium (BCA)	YAP016	318438	6407195	66.8
Glennies Creek Alluvium (GCA)	WML120B	319294	6404588	60.12
Glennies Creek Alluvium (GCA)	WML129	319468	6403528	55.34
Glennies Creek Alluvium (GCA)	WML239	319345	6404045	60.14
Glennies Creek Alluvium (GCA)	WMLP336	318965	6402842	60.64
Glennies Creek Alluvium (GCA)	WMLP343	319623	6404606	61.0
Glennies Creek Alluvium (GCA)	WMLP346	319366.5	6404457.23	60.68
Glennies Creek Alluvium (GCA)	WMLP349	319516	6404198	58.3
Glennies Creek Alluvium (GCA)	WMLP358	319560	6403704	59.66
Hunter River Alluvium (HRA)	RA27	317952	6403738	59.79
Hunter River Alluvium (HRA)	WMLP277	317643	6403958	60.184
Hunter River Alluvium (HRA)	WMLP278	317626	6403894	59.916
Hunter River Alluvium (HRA)	WMLP279	317299	6403992	62.196
Hunter River Alluvium (HRA)	WMLP280	317798	6403793	59.92
Hunter River Alluvium (HRA)	WMLP337	318418	6403129	59.9
Hunter River Alluvium (HRA)	WMLP338	318625	6402794	58.8
Coal Measures	GM1	319266	6406944	73.44
Coal Measures	WML115B			
Coal Measures	WML119	319255	6403930	75.5
Coal Measures	WML120A	319292	6404580	61.5
Coal Measures	WML181	319215	6403958	59
Coal Measures	WML183	319188	6404325	71.8

Monitoring target	Bore	Easting (MGA94 Zone56)	Northing (MGA94 Zone56)	Collar (mAHD)
Coal Measures	WML261	319320	6404706	62.40
Coal Measures	WML262	319220	6403928	63.2
Coal Measures – VWP	WMLP334	318589	6403087	75.92
Permian Overburden (regolith)	RM02	317942	6404506	61.05
Permian Overburden (regolith)	RM10	317585.9^	6405291.4^	61.55
Permian Overburden (regolith)	T2-P	317587.2*	6405222.4*	60.8*
Permian Overburden (regolith)	T3-P	317650.1*	6404701.6*	59.6*
Permian Overburden (regolith)	T4-P	317682.6*	6404319.1*	58.2*
Permian Overburden (regolith)	WMLP324	318240	6406594	64.5
Permian Overburden (regolith)	WMLP325	318181	6406050	64.5
Permian Overburden (regolith)	WMLP327	317573	6404103	64.5
Alluvium	Ashton well	318355	6406029	62
Alluvium	RA18	317821.8*	6405434.2*	62.6*
Alluvium	WMLP308	318223	6406373	65.69
Alluvium	WMLP320	317457	6405388	61.5
Coal Measures	WMLP301	319235	6403858	60.2
Coal Measures	WMLP302	319300	6404600	59.7
Coal Measures – VWP	WML213	317210	6404154	61.5
Coal Measures – VWP	WMLP335	318892	6402936	64.53
Coal Measures – VWP	WMLP361	317744	6405963	63.95
Coal Measures – VWP	WMLP363	317944	6406442	66

Notes: ** Resurveyed post mining.*
^ Field coordinates not surveyed.

Appendix B Summary of WMP Plan – parameters and frequency

Table B1 Summary of monthly groundwater monitoring program

Bore ID	Data logger	Bore purpose	Lithology	Parameters
Ashton Well	No	Piezometer	Bowmans Creek alluvium	Water level only
GM01	No	Piezometer	Coal measures	Water level only
PB1	No	Piezometer	Bowmans Creek alluvium	Water level only
RA18	No	Piezometer	Bowmans Creek alluvium	Water level only
RA27 (WML179)	No	Piezometer	Hunter River alluvium	Water level only
RSGM1*	No	Piezometer	Coal measures	Water level only
T2A	Yes	Piezometer	Bowmans Creek alluvium	Water level and field parameters
T2P	No	Piezometer	Coal measures overburden	Water level only
T3A	No	Piezometer	Bowmans Creek alluvium	Water level only
T3P	No	Piezometer	Coal measures overburden	Water level only
T4A	No	Piezometer	Bowmans Creek alluvium	Water level only
T4P	No	Piezometer	Coal measures overburden	Water level only
T5*	No	Piezometer	Bowmans Creek alluvium	Water level only
WML113C	No	Piezometer	Bowmans Creek alluvium	Water level and field parameters
WML115B	No	Piezometer	Coal measures overburden, Lem3-4	Water level only
WML119	No	Piezometer	Pikes Gully	Water level only
WML120A	No	Piezometer	Pikes Gully	Water level only
WML120B	Yes	Piezometer	Glennies Creek alluvium	Water level and field parameters
WML129	No	Piezometer	Glennies Creek alluvium	Water level and field parameters
WML181	No	Piezometer	Pikes Gully	Water level only
WML213	No	VWP†	BW, Lem8-9, Lem15, Lem19, PG ULD, ULLD, LB	Pressure head
WML239	No	Piezometer	Glennies Creek alluvium	Water level and field parameters
WML261	No	Piezometer	Upper Liddell	Water level only
WML262	No	Piezometer	Upper Liddell	Water level only
WMLP277	No	Piezometer	Hunter River alluvium	Water level only
WMLP278	No	Piezometer	Hunter River alluvium	Water level only
WMLP279	Yes	Piezometer	Hunter River alluvium	Water level and field parameters

Bore ID	Data logger	Bore purpose	Lithology	Parameters
WMLP280	Yes	Piezometer	Hunter River alluvium	Water level and field parameters
WMLP301	No	Piezometer	Arties	Water level only
WMLP302	No	Piezometer	Arties	Water level only
WMLP308	No	Piezometer	Bowmans Creek alluvium	Water level only
WMLP311	Yes	Piezometer	Bowmans Creek alluvium	Water level and field parameters
WMLP320	No	Piezometer	Bowmans Creek alluvium	Water level only
WMLP323	Yes	Piezometer	Bowmans Creek alluvium	Water level and field parameters
WMLP324	No	Piezometer	Coal measures overburden	Water level only
WMLP325	No	Piezometer	Coal measures overburden	Water level only
WMLP326	No	Piezometer	Bowmans Creek alluvium	Water level only
WMLP327	No	Piezometer	Coal measures overburden	Water level only
WMLP328	Yes	Piezometer	Bowmans Creek alluvium	Water level and field parameters
WMLC334	No	VWP†	Lem10, Lem15, Lem19, ART, ULD, ULLD, UB, LB	Pressure head
WMLC335	No	VWP†	Lem15A, Lem17, UPG, ART, ULD, ULLD, UB, LB	Pressure head
WMLP336	No	Piezometer	Hunter River alluvium/Coal measures	Water level only
WMLP337	No	Piezometer	Hunter River alluvium	Water level and field parameters
WMLP338	No	Piezometer	Hunter River alluvium	Water level only
WMLP343	Yes	Piezometer	Glennies Creek alluvium	Water level and field parameters
WMLP346	No	Piezometer	Glennies Creek alluvium	Water level and field parameters
WMLP349	No	Piezometer	Glennies Creek alluvium	Water level and field parameters
WMLP358	No	Piezometer	Glennies Creek alluvium	Water level and field parameters
WMLP361	No	VWP†	Lem5-6, ULD, ART, Lem 15A, Lem 8	Pressure head
WMLP363	Yes	VWP†	COB, Lem6, Lem7, Lem 8, Lem 13, Lem15, Lem19, ART	Pressure head
YAP016	Yes	Piezometer	Bowmans Creek alluvium	Water level and field parameters

Notes: ** Per EPL 11879.*

† Vibrating Wire Piezometer.

Table B2 Summary of quarterly groundwater monitoring program

Bore ID	Data logger	Bore purpose	Lithology	Parameters
Ashton Well	No	Piezometer	Bowmans Creek alluvium	Water level only
GM01	No	Piezometer	Coal measures	Water level and field parameters
PB1	No	Piezometer	Bowmans Creek alluvium	Water level and field parameters
RA02*	No	Piezometer	Bowmans Creek alluvium/Coal measures	Water level and field parameters
RA18	No	Piezometer	Bowmans Creek alluvium	Water level only
RA27 (WML179)	No	Piezometer	Hunter River alluvium	Water level and field parameters
RM01*	No	Piezometer	Bowmans Creek alluvium	Water level and field parameters
RM03*	No	Piezometer	Bowmans Creek alluvium/Coal measures	Water level and field parameters
RSGM1*	No	Piezometer	Coal measures	Water level and field parameters
T2A	Yes	Piezometer	Bowmans Creek alluvium	Water level and field parameters
T2P	No	Piezometer	Coal measures overburden	Water level and field parameters
T3A	No	Piezometer	Bowmans Creek alluvium	Water level and field parameters
T3P	No	Piezometer	Coal measures overburden	Water level and field parameters
T4A	No	Piezometer	Bowmans Creek alluvium	Water level and field parameters
T4P	No	Piezometer	Coal measures overburden	Water level and field parameters
T5*	No	Piezometer	Bowmans Creek alluvium	Water level and field parameters
WML113C	No	Piezometer	Bowmans Creek alluvium	Water level, field parameters, and minor lab analysis
WML115B	No	Piezometer	Coal measures overburden, Lem3-4	Water level and field parameters
WML119	No	Piezometer	Pikes Gully	Water level and field parameters
WML120A	No	Piezometer	Pikes Gully	Water level and field parameters
WML120B	Yes	Piezometer	Glennies Creek alluvium	Water level and field parameters
WML129	No	Piezometer	Glennies Creek alluvium	Water level and field parameters
WML181	No	Piezometer	Pikes Gully	Water level and field parameters
WML213	No	VWP	BW, Lem8-9, Lem15, Lem19, PG ULD, ULLD, LB	Pressure head

Bore ID	Data logger	Bore purpose	Lithology	Parameters
WML239	No	Piezometer	Glennies Creek alluvium	Water level and field parameters
WML261	No	Piezometer	Upper Liddell	Water level and field parameters
WML262	No	Piezometer	Upper Liddell	Water level and field parameters
WMLP277	No	Piezometer	Hunter River alluvium	Water level and field parameters
WMLP278	No	Piezometer	Hunter River alluvium	Water level and field parameters
WMLP279	Yes	Piezometer	Hunter River alluvium	Water level and field parameters
WMLP280	Yes	Piezometer	Hunter River alluvium	Water level and field parameters
WMLP301	No	Piezometer	Arties	Water level and field parameters
WMLP302	No	Piezometer	Arties	Water level and field parameters
WMLP308	No	Piezometer	Bowmans Creek alluvium	Water level and field parameters
WMLP311	Yes	Piezometer	Bowmans Creek alluvium	Water level and field parameters
WMLP320	No	Piezometer	Bowmans Creek alluvium	Water level only
WMLP323	Yes	Piezometer	Bowmans Creek alluvium	Water level and field parameters
WMLP324	No	Piezometer	Coal measures overburden	Water level and field parameters
WMLP325	No	Piezometer	Coal measures overburden	Water level and field parameters
WMLP326*	No	Piezometer	Bowmans Creek alluvium	Water level and field parameters
WMLP327	No	Piezometer	Coal measures overburden	Water level only
WMLP328	Yes	Piezometer	Bowmans Creek alluvium	Water level and field parameters
WMLC334	No	VWP	Lem10, Lem15, Lem19, ART, ULD, ULLD, UB, LB	Pressure head
WMLC335	No	VWP	Lem15A, Lem17, UPG, ART, ULD, ULLD, UB, LB	Pressure head
WMLP336	No	Piezometer	Hunter River alluvium/Coal measures	Water level and field parameters
WMLP337	No	Piezometer	Hunter River alluvium	Water level and field parameters
WMLP338	No	Piezometer	Hunter River alluvium	Water level and field parameters
WMLP343	Yes	Piezometer	Glennies Creek alluvium	Water level, field parameters, and minor lab analysis
WMLP346	No	Piezometer	Glennies Creek alluvium	Water level, field parameters, and minor lab analysis

Bore ID	Data logger	Bore purpose	Lithology	Parameters
WMLP349	No	Piezometer	Glennies Creek alluvium	Water level, field parameters, and minor lab analysis
WMLP358	No	Piezometer	Glennies Creek alluvium	Water level, field parameters, and minor lab analysis
WMLP361	No	VWP	Lem5-6, ULD, ART, Lem 15A, Lem 8	Pressure head
WMLP363	Yes	VWP	COB, Lem6, LEm7, Lem 8, Lem 13, Lem15, Lem19, ART	Pressure head
YAP016	Yes	Piezometer	Bowmans Creek alluvium	Water level, field parameters, and minor lab analysis

Note: **Per EPL 11879.*

Table B3 Summary of annual groundwater monitoring program

Ashton Well	Datalogger	Piezometer	Bowmans creek alluvium	Water level only
GM01	No	Piezometer	Coal measures	Water level, field parameters and comprehensive analysis
PB1	No	Piezometer	Bowmans Creek alluvium	Water level, field parameters, and minor lab analysis
RA02*	No	Piezometer	Bowmans Creek alluvium/Coal measures	Water level and field parameters
RA18	No	Piezometer	Bowmans Creek alluvium	Water level only
RA27 (WML179)	No	Piezometer	Hunter River alluvium	Water level, field parameters and comprehensive analysis
RM01*	No	Piezometer	Bowmans Creek alluvium	Water level and field parameters
RM03*	No	Piezometer	Bowmans Creek alluvium/Coal measures	Water level and field parameters
RSGM1*	No	Piezometer	Coal measures	Water level, field parameters and comprehensive analysis
T2A	Yes	Piezometer	Bowmans Creek alluvium	Water level, field parameters and comprehensive analysis
T2P	No	Piezometer	Coal measures overburden	Water level, field parameters and comprehensive analysis
T3A	No	Piezometer	Bowmans Creek alluvium	Water level, field parameters and comprehensive analysis
T3P	No	Piezometer	Coal measures overburden	Water level, field parameters and comprehensive analysis
T4A	No	Piezometer	Bowmans Creek alluvium	Water level, field parameters and comprehensive analysis
T4P	No	Piezometer	Coal measures overburden	Water level, field parameters and comprehensive analysis
T5*	No	Piezometer	Bowmans Creek alluvium	Water level, field parameters and comprehensive analysis
WML113C	No	Piezometer	Bowmans Creek alluvium	Water level, field parameters, and comprehensive analysis
WML115B	No	Piezometer	Coal measures overburden, Lem3-4	Water level, field parameters, and minor lab analysis

Ashton Well	Datalogger	Piezometer	Bowmans creek alluvium	Water level only
WML119	No	Piezometer	Pikes Gully	Water level, field parameters and comprehensive analysis
WML120A	No	Piezometer	Pikes Gully	Water level, field parameters and comprehensive analysis
WML120B	Yes	Piezometer	Glennies Creek alluvium	Water level, field parameters and comprehensive analysis
WML129	No	Piezometer	Glennies Creek alluvium	Water level, field parameters and comprehensive analysis
WML181	No	Piezometer	Pikes Gully	Water level, field parameters and comprehensive analysis
WML213	No	VWP	BW, Lem8-9, Lem15, Lem19, PG ULD, ULLD, LB	Pressure head
WML239	No	Piezometer	Glennies Creek alluvium	Water level, field parameters and comprehensive analysis
WML261	No	Piezometer	Upper Liddell	Water level, field parameters and comprehensive analysis
WML262	No	Piezometer	Upper Liddell	Water level, field parameters and comprehensive analysis
WMLP277	No	Piezometer	Hunter River alluvium	Water level, field parameters and comprehensive analysis
WMLP278	No	Piezometer	Hunter River alluvium	Water level, field parameters and comprehensive analysis
WMLP279	Yes	Piezometer	Hunter River alluvium	Water level, field parameters and comprehensive analysis
WMLP280	Yes	Piezometer	Hunter River alluvium	Water level, field parameters and comprehensive analysis
WMLP301	No	Piezometer	Arties	Water level, field parameters and comprehensive analysis
WMLP302	No	Piezometer	Arties	Water level, field parameters and comprehensive analysis
WMLP308	No	Piezometer	Bowmans Creek alluvium	Water level, field parameters and comprehensive analysis
WMLP311	Yes	Piezometer	Bowmans Creek alluvium	Water level, field parameters and comprehensive analysis
WMLP320	No	Piezometer	Bowmans Creek alluvium	Water level, field parameters and comprehensive analysis
WMLP323	Yes	Piezometer	Bowmans Creek alluvium	Water level, field parameters and comprehensive analysis
WMLP324	No	Piezometer	Coal measures overburden	Water level, field parameters and comprehensive analysis
WMLP325	No	Piezometer	Coal measures overburden	Water level, field parameters and comprehensive analysis
WMLP326*	No	Piezometer	Bowmans Creek alluvium	Water level and field parameters
WMLP327	No	Piezometer	Coal measures overburden	Water level only
WMLP328	Yes	Piezometer	Bowmans Creek alluvium	Water level, field parameters and comprehensive analysis
WMLC334	No	VWP	Lem10, Lem15, Lem19, ART, ULD, ULLD, UB, LB	Pressure head

Ashton Well	Datalogger	Piezometer	Bowmans creek alluvium	Water level only
WMLC335	No	VWP	Lem15A, Lem17, UPG, ART, ULD, ULLD, UB, LB	Pressure head
WMLP336	No	Piezometer	Hunter River alluvium/Coal measures	Water level, field parameters and comprehensive analysis
WMLP337	No	Piezometer	Hunter River alluvium	Water level, field parameters and comprehensive analysis
WMLP338	No	Piezometer	Hunter River alluvium	Water level, field parameters and comprehensive analysis
WMLP343	Yes	Piezometer	Glennies Creek alluvium	Water level, field parameters, and comprehensive analysis
WMLP346	No	Piezometer	Glennies Creek alluvium	Water level, field parameters, and comprehensive analysis
WMLP349	No	Piezometer	Glennies Creek alluvium	Water level, field parameters, and comprehensive analysis
WMLP358	No	Piezometer	Glennies Creek alluvium	Water level, field parameters, and comprehensive analysis
WMLP361	No	VWP	Lem5-6, ULD, ART, Lem 15A, Lem 8	Pressure head
WMLP363	No	VWP	COB, Lem6, Lem7, Lem 8, Lem 13, Lem15, Lem19, ART	Pressure head
YAP016	Yes	Piezometer	Bowmans Creek alluvium	Water level, field parameters, and comprehensive lab analysis

Note: **Per EPL 11879.*

Appendix C WMP protocol for exceedance of groundwater trigger values (Yancoal 2018)

In the event of a groundwater assessment criterion being exceeded, the following

protocol will be followed:

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

Appendix D Annual groundwater quality laboratory results

Table D1 Groundwater quality – pH, EC, and Relative Percent Difference (RPD)

Bore ID	Sample date	Field pH	Lab pH	pH RPD	pH trigger (lower)	pH trigger (upper)	Field Electrical Conductivity	Lab Electrical Conductivity	EC RPD	EC trigger	Total Dissolved Solids @180°C
Units		**pH unit**	**pH Unit**	**%**			**µS/cm**	**µS/cm**	**%**	**µS/cm**	**mg/L**
ANZECC/ARMCANZ Livestock Limits							**5970**	**5970**			**4000**
Limit of Reporting (LOR)			**0.01**					**1**			**10**
GM1	6/08/2018	7.24	7.44	-1.82			2007	2030	-1.14		1030
PB1	14/08/2018	7.08	7.17	-0.84			1307	1310	-0.23		----
RA18	14/08/2018	7.08	7.25	-1.59			1082	1090	-0.74		622
RA18-DUP	14/08/2018	7.08	7.23	-1.40			1082	1080	0.19		626
RA27	7/08/2018	6.94	7.12	-1.71			1505	1520	-0.99		802
T2A	14/08/2018	6.97	7.19	-2.08	6.7	7.7	1142	1150	-0.70	1422	626
T2P	14/08/2018	6.64	6.83	-1.89			1042	1040	0.19		630
T2P-DUP	14/08/2018	6.64	6.81	-1.69			1042	1040	0.19		670
T3A	13/08/2018	7.33	6.84	4.56			2259	2280	-0.93		1350
T3P	13/08/2018	7.3	7.36	-0.55			1838	1870	-1.73		1010
T4A	7/08/2018	6.9	7.03	-1.25			1369	1400	-2.24		763
T4P	7/08/2018	7.3	7.44	-1.27			1851	1880	-1.55		1020
WML113C	13/08/2018	6.82	6.92	-0.97	6.6	7.4	1012	1030	-1.76	1445	616
WML115B	14/08/2018	7.02	6.9	1.15			3301	3280	0.64		----
WML119	8/08/2018	6.78	7.03	-2.43			1601	1630	-1.80		888
WML120A	8/08/2018	6.87	7.05	-1.73			901.9	898	0.43		486
WML120B	8/08/2018	6.65	6.84	-1.89	6.4	7.7	600	609	-1.49	1387	328
WML129	8/08/2018	6.95	7.16	-1.99	6.7	8	387.7	393	-1.36	740	207
WML181	8/08/2018	7.27	7.51	-2.18			2657	2700	-1.61		1550
WML183	8/08/2018	6.83	7	-1.65			4458	4550	-2.04		2640
WML261	13/08/2018	6.76	6.86	-0.98			1223	1250	-2.18		686
WML262	8/08/2018	7.94	8.2	-2.16			2865	2920	-1.90		1670

Bore ID	Sample date	Field pH	Lab pH	pH RPD	pH trigger (lower)	pH trigger (upper)	Field Electrical Conductivity	Lab Electrical Conductivity	EC RPD	EC trigger	Total Dissolved Solids @180°C
Units		pH unit	pH Unit	%			µS/cm	µS/cm	%	µS/cm	mg/L
ANZECC/ARMCANZ Livestock Limits							5970	5970			4000
Limit of Reporting (LOR)			0.01					1			10
WML239	6/08/2018	6.79	6.87	-0.78	6.3	7.4	736.8	736	0.11	984	372
WMLP277	7/08/2018	6.89	7.08	-1.82			1394	1420	-1.85		769
WMLP278	7/08/2018	6.84	7.06	-2.12			1380	1400	-1.44		762
WMLP279	7/08/2018	6.78	6.93	-1.46	6.3	7.5	1177	1200	-1.94	1276	635
WMLP280	7/08/2018	6.86	7.02	-1.54	6.6	7.9	1450	1460	-0.69	2034	728
WMLP301	8/08/2018	7.91	8.18	-2.25			3711	3770	-1.58		2320
WMLP302	8/08/2018	6.44	6.61	-1.74			1169	1180	-0.94		602
WMLP308	9/08/2018	6.95	7.31	-3.39			1250	1260	-0.80		760
WMLP311	9/08/2018	6.81	7.01	-1.94	6.5	8	1384	1390	-0.43	1289	788
WMLP320	14/08/2018	7.01	7.1	-0.85			1176	1170	0.51		----
WMLP323	9/08/2018	7.17	7.26	-0.83	6.5	8.1	1249	1280	-2.45	1241	897
WMLP324	9/08/2018	6.93	7.17	-2.28			1243	1250	-0.56		746
WMLP325	9/08/2018	6.99	7.26	-2.54			1231	1230	0.08		646
WMLP326	7/08/2018	7.27	7.23	0.37	6.6	7.5	1437	1450	-0.90		830
WMLP327	7/08/2018	6.83	7.02	-1.84			1921	1950	-1.50		1030
WMLP336	13/08/2018	6.48	6.65	-1.73	6.2	8.2	631.5	640	-1.34	1708	392
WMLP337	13/08/2018	7.04	7.36	-2.99	6.8	7.8	2876	2900	-0.83	3254	1880
WMLP338	13/08/2018	6.76	7.03	-2.63			1618	1680	-3.76		1320
WMLP343	14/08/2018	7.25	7.03	2.04	6.2	8	910.4	840	8.04	1059	488
WMLP343-DUP	14/08/2018	7.25	6.98	2.51	6.2	8	910.4	840	8.04	1059	510
WMLP346	6/08/2018	6.58	6.76	-1.81			695.6	699	-0.49	1005	374
WMLP349	6/08/2018	6.52	6.67	-1.52			921.5	924	-0.27	2900	502
WMLP358	6/08/2018	6.34	6.5	-1.67			368.2	368	0.05	600	189
YAP016	6/08/2018	6.96	7.1	-1.33			1252	1250	0.16		652

Table D2 Groundwater quality – turbidity/alkalinity

Bore ID	Sample date	Turbidity	Hydroxide Alkalinity as CaCO3	Carbonate Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO3	Total Alkalinity as CaCO3	Sulfate as SO4 - Turbidimetric
Units		**NTU**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
ANZECC/ARMCANZ Livestock Limits							**1000**
Limit of Reporting (LOR)		**0.1**	**1**	**1**	**1**	**1**	**1**
GM1	6/08/2018	191	<1	<1	286	286	183
PB1	14/08/2018	----	<1	<1	209	209	125
RA18	14/08/2018	4.4	<1	<1	182	182	99
RA18-DUP	14/08/2018	3.7	<1	<1	180	180	100
RA27	7/08/2018	1.2	<1	<1	264	264	111
T2A	14/08/2018	12.6	<1	<1	176	176	108
T2P	14/08/2018	11.6	<1	<1	132	132	89
T2P-DUP	14/08/2018	8	<1	<1	132	132	88
T3A	13/08/2018	453	<1	<1	143	143	126
T3P	13/08/2018	4.3	<1	<1	340	340	106
T4A	7/08/2018	10.7	<1	<1	227	227	113
T4P	7/08/2018	123	<1	<1	389	389	110
WML113C	13/08/2018	3.9	<1	<1	153	153	92
WML115B	14/08/2018	----	<1	<1	552	552	337
WML119	8/08/2018	166	<1	<1	480	480	13
WML120A	8/08/2018	14.5	<1	<1	233	233	17
WML120B	8/08/2018	2.1	<1	<1	164	164	19
WML129	8/08/2018	3.3	<1	<1	105	105	14
WML181	8/08/2018	71.2	<1	<1	799	799	<10
WML183	8/08/2018	13.5	<1	<1	953	953	371
WML261	13/08/2018	5.2	<1	<1	241	241	42
WML262	8/08/2018	28.3	<1	26	1020	1040	<10
WML239	6/08/2018	27	<1	<1	164	164	20
WMLP277	7/08/2018	7.6	<1	<1	278	278	109

Bore ID	Sample date	Turbidity	Hydroxide Alkalinity as CaCO3	Carbonate Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO3	Total Alkalinity as CaCO3	Sulfate as SO4 - Turbidimetric
Units		**NTU**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
ANZECC/ARMCANZ Livestock Limits							**1000**
Limit of Reporting (LOR)		**0.1**	**1**	**1**	**1**	**1**	**1**
WMLP278	7/08/2018	1.8	<1	<1	262	262	112
WMLP279	7/08/2018	5.4	<1	<1	222	222	90
WMLP280	7/08/2018	3	<1	<1	263	263	112
WMLP301	8/08/2018	824	<1	<1	1100	1100	10
WMLP302	8/08/2018	6.2	<1	<1	262	262	33
WMLP308	9/08/2018	3090	<1	<1	236	236	128
WMLP311	9/08/2018	0.7	<1	<1	225	225	148
WMLP320	14/08/2018	----	<1	<1	226	226	79
WMLP323	9/08/2018	6750	<1	<1	267	267	140
WMLP324	9/08/2018	415	<1	<1	249	249	137
WMLP325	9/08/2018	8.3	<1	<1	234	234	83
WMLP326	7/08/2018	301	<1	<1	311	311	103
WMLP327	7/08/2018	55.9	<1	<1	347	347	88
WMLP336	13/08/2018	6.9	<1	<1	154	154	22
WMLP337	13/08/2018	3180	<1	<1	438	438	113
WMLP338	13/08/2018	7790	<1	<1	276	276	64
WMLP343	14/08/2018	432	<1	<1	201	201	13
WMLP343-DUP	14/08/2018	928	<1	<1	187	187	13
WMLP346	6/08/2018	2.3	<1	<1	175	175	5
WMLP349	6/08/2018	6.6	<1	<1	177	177	29
WMLP358	6/08/2018	0.6	<1	<1	106	106	4
YAP016	6/08/2018	1.5	<1	<1	214	214	121

Table D3 Groundwater quality – dissolved metals

Bore ID	Sample date	Chloride	Calcium	Magnesium	Sodium	Potassium	Arsenic	Cadmium	Chromium	Copper	Lead	Manganese	Nickel	Selenium
Units		**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
ANZECC/ARMCANZ Livestock Limits			**1000**				**0.5**	**0.01**	**1**	**1**	**0.1**		**1**	**0.02**
Limit of Reporting (LOR)		**1**	**1**	**1**	**1**	**1**	**0.001**	**0.0001**	**0.001**	**0.001**	**0.001**	**0.001**	**0.001**	**0.01**
GM1	6/08/2018	372	64	49	289	3	<0.001	<0.0001	<0.001	<0.001	<0.001	0.338	<0.001	<0.01
PB1	14/08/2018	240	60	31	162	2	----	----	----	----	----	----	----	----
RA18	14/08/2018	188	42	21	153	<1	<0.001	<0.0001	<0.001	<0.001	<0.001	0.004	0.004	<0.01
RA18-DUP	14/08/2018	187	45	22	161	1	<0.001	<0.0001	<0.001	<0.001	<0.001	0.005	0.003	<0.01
RA27	7/08/2018	272	44	32	234	<1	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.001	0.002	<0.01
T2A	14/08/2018	205	55	28	155	2	<0.001	<0.0001	<0.001	<0.001	<0.001	0.001	<0.001	<0.01
T2P	14/08/2018	216	75	35	92	2	0.005	<0.0001	<0.001	<0.001	<0.001	0.332	<0.001	<0.01
T2P-DUP	14/08/2018	215	68	32	87	1	0.003	<0.0001	<0.001	<0.001	<0.001	0.294	<0.001	<0.01
T3A	13/08/2018	583	59	53	324	<1	<0.001	<0.0001	<0.001	<0.001	<0.001	0.014	0.003	0.01
T3P	13/08/2018	363	44	38	299	3	<0.001	<0.0001	<0.001	<0.001	<0.001	0.028	<0.001	<0.01
T4A	7/08/2018	248	52	29	190	<1	<0.001	<0.0001	<0.001	<0.001	<0.001	0.009	0.001	<0.01
T4P	7/08/2018	323	54	36	283	3	<0.001	<0.0001	<0.001	<0.001	<0.001	0.034	0.001	<0.01
WML113C	13/08/2018	186	51	20	123	1	<0.001	<0.0001	<0.001	<0.001	<0.001	0.002	0.002	<0.01
WML115B	14/08/2018	609	103	52	556	2	----	----	----	----	----	----	----	----
WML119	8/08/2018	280	47	36	256	6	<0.001	<0.0001	0.003	<0.001	<0.001	0.124	0.002	<0.01
WML120A	8/08/2018	158	39	36	94	2	<0.001	<0.0001	<0.001	<0.001	<0.001	0.138	<0.001	<0.01
WML120B	8/08/2018	79	32	23	64	<1	<0.001	<0.0001	<0.001	0.008	<0.001	0.002	<0.001	<0.01
WML129	8/08/2018	51	19	12	48	2	0.001	<0.0001	0.002	<0.001	<0.001	0.174	0.002	<0.01
WML181	8/08/2018	464	16	17	570	4	<0.001	<0.0001	<0.001	<0.001	<0.001	0.022	<0.001	<0.01
WML183	8/08/2018	808	136	170	650	11	<0.001	<0.0001	<0.001	<0.001	<0.001	0.137	0.002	<0.01
WML261	13/08/2018	247	33	31	178	2	<0.001	<0.0001	<0.001	<0.001	<0.001	0.034	<0.001	<0.01
WML262	8/08/2018	437	12	14	608	4	<0.001	<0.0001	<0.001	<0.001	<0.001	0.026	<0.001	<0.01
WML239	6/08/2018	120	43	18	75	1	<0.001	<0.0001	<0.001	<0.001	<0.001	0.013	<0.001	<0.01
WMLP277	7/08/2018	232	38	25	200	<1	<0.001	<0.0001	<0.001	<0.001	<0.001	0.018	0.002	<0.01
WMLP278	7/08/2018	234	54	28	183	<1	0.001	<0.0001	<0.001	<0.001	<0.001	0.068	0.001	<0.01
WMLP279	7/08/2018	208	64	29	142	<1	<0.001	<0.0001	0.002	<0.001	<0.001	0.035	0.003	<0.01

Bore ID	Sample date	Chloride	Calcium	Magnesium	Sodium	Potassium	Arsenic	Cadmium	Chromium	Copper	Lead	Manganese	Nickel	Selenium
Units		**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
ANZECC/ARMCANZ Livestock Limits			**1000**				**0.5**	**0.01**	**1**	**1**	**0.1**		**1**	**0.02**
Limit of Reporting (LOR)		**1**	**1**	**1**	**1**	**1**	**0.001**	**0.0001**	**0.001**	**0.001**	**0.001**	**0.001**	**0.001**	**0.01**
WMLP280	7/08/2018	257	52	30	215	<1	<0.001	<0.0001	0.003	<0.001	<0.001	0.058	0.004	<0.01
WMLP301	8/08/2018	651	10	7	814	4	0.002	<0.0001	0.011	<0.001	0.003	0.073	0.016	<0.01
WMLP302	8/08/2018	230	32	32	159	3	<0.001	<0.0001	<0.001	<0.001	<0.001	0.026	0.001	<0.01
WMLP308	9/08/2018	214	44	24	159	2	0.003	<0.0001	0.003	<0.001	<0.001	0.214	0.002	<0.01
WMLP311	9/08/2018	256	54	34	162	2	<0.001	<0.0001	<0.001	<0.001	<0.001	0.002	<0.001	<0.01
WMLP320	14/08/2018	210	55	29	156	2	----	----	----	----	----	----	----	----
WMLP323	9/08/2018	194	59	32	162	2	<0.001	<0.0001	0.008	0.023	0.002	0.134	0.008	<0.01
WMLP324	9/08/2018	198	54	29	138	2	<0.001	<0.0001	<0.001	<0.001	<0.001	0.11	0.001	<0.01
WMLP325	9/08/2018	230	51	25	149	2	<0.001	<0.0001	<0.001	<0.001	<0.001	0.308	<0.001	<0.01
WMLP326	7/08/2018	238	60	28	201	1	<0.001	<0.0001	<0.001	<0.001	<0.001	0.15	0.005	<0.01
WMLP327	7/08/2018	372	74	38	278	4	0.001	<0.0001	<0.001	<0.001	<0.001	0.097	<0.001	<0.01
WMLP336	13/08/2018	72	35	17	58	1	<0.001	<0.0001	<0.001	0.002	<0.001	0.011	0.002	<0.01
WMLP337	13/08/2018	654	91	110	318	5	<0.001	<0.0001	<0.001	<0.001	<0.001	0.185	0.003	<0.01
WMLP338	13/08/2018	356	69	47	182	2	<0.001	<0.0001	<0.001	<0.001	<0.001	0.452	0.004	<0.01
WMLP343	14/08/2018	158	50	25	77	<1	<0.001	<0.0001	<0.001	0.001	<0.001	0.008	0.002	<0.01
WMLP343-DUP	14/08/2018	157	51	25	79	<1	<0.001	<0.0001	<0.001	<0.001	<0.001	0.01	0.002	<0.01
WMLP346	6/08/2018	107	38	22	69	<1	<0.001	<0.0001	<0.001	<0.001	<0.001	0.095	0.001	<0.01
WMLP349	6/08/2018	163	33	18	128	<1	0.001	<0.0001	0.004	0.002	<0.001	0.156	0.004	<0.01
WMLP358	6/08/2018	50	28	12	24	<1	<0.001	<0.0001	<0.001	0.001	<0.001	0.004	0.001	<0.01
YAP016	6/08/2018	193	29	19	215	2	<0.001	<0.0001	<0.001	0.002	<0.001	0.005	<0.001	<0.01

Table D4 Groundwater quality – cyanide, nitrates, ion balance

Bore ID	Sample date	Zinc	Iron	Total Cyanide	Nitrite + Nitrate as N	Total Kjeldahl Nitrogen as N	Total Nitrogen as N	Total Phosphorus as P	Total Anions	Total Cations	Ionic Balance
Units		**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**meq/L**	**meq/L**	**%**
ANZECC/ARMCANZ Livestock Limits		**20**									
Limit of Reporting (LOR)		**0.005**	**0.05**	**0.004**	**0.01**	**0.1**	**0.1**	**0.01**	**0.01**	**0.01**	**0.01**
GM1	6/08/2018	<0.005	1.1	<0.004	0.01	0.4	0.4	0.09	20	19.9	0.36
PB1	14/08/2018	----	----	----	----	----	----	----	13.5	12.6	3.46
RA18	14/08/2018	0.008	<0.05	<0.004	0.17	<0.1	0.2	0.16	11	10.5	2.43
RA18-DUP	14/08/2018	0.007	<0.05	<0.004	0.17	<0.1	0.2	0.02	11	11.1	0.6
RA27	7/08/2018	0.006	<0.05	<0.004	0.44	<0.1	0.4	0.18	15.2	15	0.83
T2A	14/08/2018	0.01	<0.05	<0.004	0.17	<0.1	0.2	0.01	11.5	11.8	1.26
T2P	14/08/2018	0.011	3.95	<0.004	0.01	<0.1	<0.1	<0.01	10.6	10.7	0.44
T2P-DUP	14/08/2018	0.012	2.34	<0.004	<0.01	<0.1	<0.1	<0.01	10.5	9.84	3.42
T3A	13/08/2018	0.015	<0.05	<0.004	1.5	2.2	3.7	0.5	21.9	21.4	1.22
T3P	13/08/2018	<0.005	0.27	<0.004	<0.01	0.5	0.5	<0.01	19.2	18.4	2.22
T4A	7/08/2018	0.009	<0.05	<0.004	1.09	0.1	1.2	0.12	13.9	13.2	2.35
T4P	7/08/2018	0.006	0.24	<0.004	0.02	0.6	0.6	0.07	19.2	18	3.04
WML113C	13/08/2018	0.008	<0.05	<0.004	0.29	<0.1	0.3	<0.01	10.2	9.57	3.3
WML115B	14/08/2018	----	----	----	----	----	----	----	35.2	33.6	2.28
WML119	8/08/2018	0.008	0.38	<0.004	0.05	2.1	2.2	0.11	17.8	16.6	3.38
WML120A	8/08/2018	<0.005	0.88	<0.004	0.05	<0.1	<0.1	0.05	9.47	9.05	2.25
WML120B	8/08/2018	0.007	<0.05	<0.004	0.07	<0.1	<0.1	0.04	5.9	6.27	3.06
WML129	8/08/2018	<0.005	0.36	<0.004	0.04	<0.1	<0.1	0.1	3.83	4.07	3.12
WML181	8/08/2018	<0.005	0.18	<0.004	0.08	1.1	1.2	0.05	29	27.1	3.49
WML183	8/08/2018	0.01	0.16	<0.004	0.09	1.1	1.2	<0.01	49.6	49.3	0.23
WML261	13/08/2018	0.006	0.93	<0.004	<0.01	<0.1	<0.1	0.03	12.6	12	2.7
WML262	8/08/2018	<0.005	0.11	<0.004	0.04	1.2	1.2	0.2	33.1	28.3	7.83
WML239	6/08/2018	0.012	0.12	<0.004	<0.01	<0.1	<0.1	0.03	7.08	6.92	1.16
WMLP277	7/08/2018	0.007	0.06	<0.004	0.28	<0.1	0.3	0.09	14.4	12.6	6.35

Bore ID	Sample date	Zinc	Iron	Total Cyanide	Nitrite + Nitrate as N	Total Kjeldahl Nitrogen as N	Total Nitrogen as N	Total Phosphorus as P	Total Anions	Total Cations	Ionic Balance
Units		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	meq/L	meq/L	%
ANZECC/ARMCANZ Livestock Limits		20									
Limit of Reporting (LOR)		0.005	0.05	0.004	0.01	0.1	0.1	0.01	0.01	0.01	0.01
WMLP278	7/08/2018	0.008	0.34	<0.004	0.32	<0.1	0.3	0.04	14.2	13	4.45
WMLP279	7/08/2018	0.015	0.15	<0.004	0.28	<0.1	0.3	0.03	12.2	11.8	1.75
WMLP280	7/08/2018	0.008	0.17	<0.004	0.38	<0.1	0.4	0.08	14.8	14.4	1.44
WMLP301	8/08/2018	0.025	1.38	<0.004	0.06	2	2.1	0.66	40.6	36.6	5.14
WMLP302	8/08/2018	0.009	1.64	<0.004	0.06	0.3	0.4	0.05	12.4	11.2	5.02
WMLP308	9/08/2018	0.056	0.23	<0.004	0.2	8	8.2	1.15	13.4	11.1	9.28
WMLP311	9/08/2018	0.007	<0.05	<0.004	0.19	<0.1	0.2	<0.01	14.8	12.6	8.06
WMLP320	14/08/2018	----	----	----	----	----	----	----	12.1	12	0.48
WMLP323	9/08/2018	0.024	0.92	<0.004	0.2	7.1	7.3	2.88	13.7	12.7	3.96
WMLP324	9/08/2018	0.007	<0.05	<0.004	0.04	1.2	1.2	0.76	13.4	11.1	9.28
WMLP325	9/08/2018	0.01	0.78	<0.004	0.01	0.2	0.2	0.05	12.9	11.1	7.31
WMLP326	7/08/2018	0.036	<0.05	----	0.3	0.7	1	0.31	15.1	14.1	3.45
WMLP327	7/08/2018	0.006	0.6	----	0.03	0.2	0.2	0.08	19.2	19	0.64
WMLP336	13/08/2018	0.012	0.08	<0.004	0.88	0.1	1	0.07	5.56	5.69	1.14
WMLP337	13/08/2018	0.041	0.09	<0.004	0.07	3	3.1	2.48	29.6	27.6	3.5
WMLP338	13/08/2018	0.025	0.13	<0.004	1.12	4.2	5.3	1.58	16.9	15.3	5
WMLP343	14/08/2018	0.047	<0.05	<0.004	0.08	0.2	0.3	1.8	8.74	7.9	5.06
WMLP343-DUP	14/08/2018	0.023	<0.05	<0.004	0.07	0.4	0.5	2.2	8.44	8.04	2.41
WMLP346	6/08/2018	<0.005	0.26	<0.004	0.02	<0.1	<0.1	0.01	6.62	6.71	0.67
WMLP349	6/08/2018	0.018	1.38	<0.004	0.02	<0.1	<0.1	0.04	8.74	8.7	0.24
WMLP358	6/08/2018	0.012	<0.05	<0.004	0.03	<0.1	<0.1	<0.01	3.61	3.43	2.6
YAP016	6/08/2018	0.014	<0.05	<0.004	0.22	<0.1	0.2	<0.01	12.2	12.4	0.71

Table D5 Groundwater quality – Relative Percentage Differences

Bore ID	Units	RA18	RA18 intralab	RPD	RA18	RA18 inter-lab	RPD	T2P	T2P intra-lab	RPD	WMLP 343	WMLP 343 intra-lab	RPD	WMLP 343	WMLP 343 inter-lab	RPD
Sample date		**14 Aug. '18**			**14 Aug. '18**			**14 Aug. '18**			**14 Aug. '18**			**14 Aug. '18**		
pH	pH unit	7.08	7.25	2%	7.08	7.4	-	6.64	6.81	3%	7.25	6.98	4%	7.25	7.03	-
Electrical Conductivity	µS/cm	1082	1090	1%	1082	1100	-	1042	1040	0%	910.4	840	8%	910.4	830	9%
Total Dissolved Solids @180°C	mg/L	622	626	1%	622	570	9%	630	670	6%	488	510	4%	488	420	15%
Turbidity	NTU	4.4	3.7	17%	4.4	4.6	4%	11.6	8	37%	432	928	73%	432	760	55%
Arsenic	mg/L	<0.001	<0.001	0%	<0.001	<1	0%	0.005	0.003	50%	<0.001	<0.001	0%	<0.001	<1	0%
Cadmium	mg/L	<0.0001	<0.0001	0%	<0.0001	<0.1	0%	<0.0001	<0.0001	0%	<0.0001	<0.0001	0%	<0.0001	<0.1	0%
Chromium	mg/L	<0.001	<0.001	0%	<0.001	<1	0%	<0.001	<0.001	0%	<0.001	<0.001	0%	<0.001	<1	0%
Copper	mg/L	<0.001	<0.001	0%	<0.001	<1	0%	<0.001	<0.001	0%	0.001	<0.001	67%	0.001	1	200%
Iron	mg/L	<0.05	<0.05	0%	<0.05	11	199%	3.95	2.34	51%	<0.05	<0.05	0%	<0.05	<10	0%
Lead	mg/L	<0.001	<0.001	0%	<0.001	<1	0%	<0.001	<0.001	0%	<0.001	<0.001	0%	<0.001	<1	0%
Manganese	mg/L	0.004	0.005	22%	0.004	6	200%	0.332	0.294	12%	0.008	0.01	22%	0.008	9	200%
Nickel	mg/L	0.004	0.003	29%	0.004	<0.05	145%	<0.001	<0.001	0%	0.002	0.002	0%	0.002	<0.05	170%
Selenium	mg/L	<0.01	<0.01	0%	<0.01	3	199%	<0.01	<0.01	0%	<0.01	<0.01	0%	<0.01	2	199%
Zinc	mg/L	0.008	0.007	13%	0.008	<1	194%	0.011	0.012	9%	0.047	0.023	69%	0.047	<1	166%
Nitrite + Nitrate as N	mg/L	0.17	0.17	0%	0.17	4	184%	0.01	<0.01	67%	0.08	0.07	13%	0.08	22	199%
Nitrate as N in water															0.19	
Total Kjeldahl Nitrogen as N	mg/L	<0.1	<0.1	0%	<0.1		-	<0.1	<0.1	0%	0.2	0.4	67%	0.2	-	-
Total Nitrogen as N	mg/L	0.2	0.2	0%	0.2	0.1	67%	<0.1	<0.1	0%	0.3	0.5	50%	0.3	0.6	67%
Total Phosphorus as P	mg/L	0.16	0.02	156%	0.16	<0.05	146%	<0.01	<0.01	0%	1.8	2.2	20%	1.8	0.7	88%
Total Cyanide	mg/L	<0.004	<0.004	0%	<0.004	<0.004	0%	<0.004	<0.004	0%	<0.004	<0.004	0%	<0.004	<0.004	0%
Calcium	mg/L	42	45	7%	42	38	10%	75	68	10%	50	51	2%	50	51	2%
Chloride	mg/L	188	187	1%	188	150	22%	216	215	0%	158	157	1%	158	130	19%
Magnesium	mg/L	21	22	5%	21	21	0%	35	32	9%	25	25	0%	25	25	0%
Potassium	mg/L	<1	1	67%	<1	1.2	82%	2	1	67%	<1	<1	0%	<1	1	67%
Sodium	mg/L	153	161	5%	153	150	2%	92	87	6%	77	79	3%	77	74	4%
Sulfate as SO4 - Turbidimetric	mg/L	99	100	1%	99	97	2%	89	88	1%	13	13	0%	13	12	8%
Bicarbonate Alkalinity as CaCO3	mg/L	182	180	1%	182	190	4%	132	132	0%	201	187	7%	201	200	0%
Carbonate Alkalinity as CaCO3	mg/L	<1	<1	0%	<1	<5	0%	<1	<1	0%	<1	<1	0%	<1	<5	0%
Hydroxide Alkalinity as CaCO3	mg/L	<1	<1	0%	<1	<5	0%	<1	<1	0%	<1	<1	0%	<1	<5	0%
Total Alkalinity as CaCO3	mg/L	182	180	1%	182	190	4%	132	132	0%	201	187	7%	201	200	0%
Total Anions	meq/L	11	11	0%	11	-	-	10.6	10.5	1%	8.74	8.44	3%	8.74	-	-
Total Cations	meq/L	10.5	11.1	6%	10.5	-	-	10.7	9.84	8%	7.9	8.04	2%	7.9	-	-

Appendix E Groundwater chemistry – piper plot

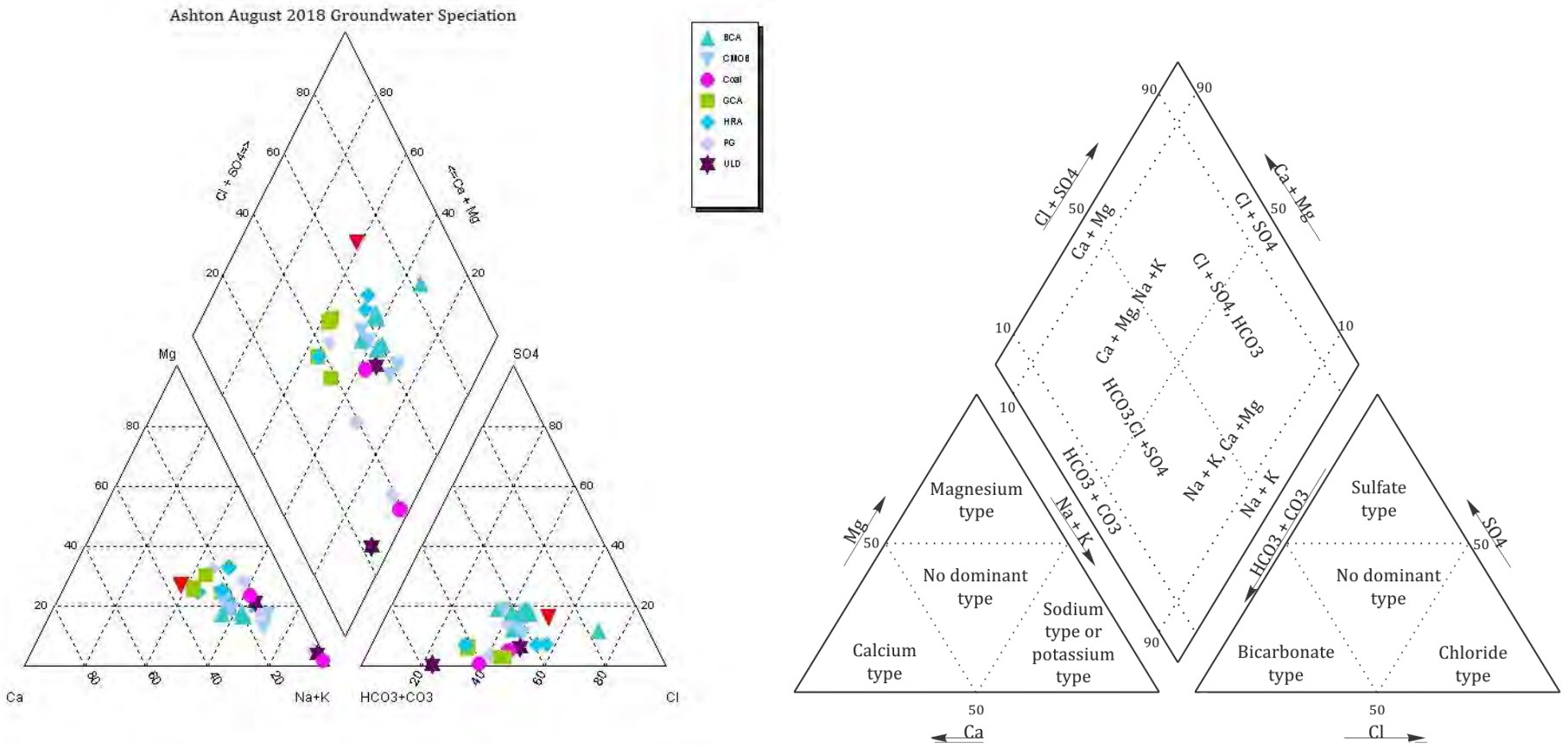


Figure E1 August 2018 groundwater piper plot

Appendix F Laboratory certificate of analysis and chain of custody

ALS Environmental

QUALITY CONTROL REPORT

Work Order	: **ES1822953**	Page	: 1 of 7
Client	: **AUSTRALASIAN GROUNDWATER AND ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR KADE HANCOCK	Contact	: Customer Services ES
Address	: 4 HUDSON STREET HAMILTON NSW 2303	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: +61-2-8784 8555
Project	: G1922B AUGUST 2018	Date Samples Received	: 06-Aug-2018
Order number	:	Date Analysis Commenced	: 06-Aug-2018
C-O-C number	: ----	Issue Date	: 09-Aug-2018
Sampler	: KADE HANCOCK		
Site	: ----		
Quote number	: SY/374/17		
No. of samples received	: 6		
No. of samples analysed	: 6		

ilac-MRA NATA
Accreditation No. 825
Accredited for compliance with ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Neil Martin	Team Leader - Chemistry	Chemistry, Newcastle West, NSW
Raymond Commodore	Instrument Chemist	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EA005: pH (QC Lot: 1853775)									
WN1804081-003	Anonymous	EA005: pH Value	----	0.01	pH Unit	7.85	7.85	0.00	0% - 20%
ES1822886-001	Anonymous	EA005: pH Value	----	0.01	pH Unit	7.50	7.49	0.133	0% - 20%
EA010P: Conductivity by PC Titrator (QC Lot: 1854846)									
ES1822953-005	WMLP239-001	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	736	742	0.822	0% - 20%
ES1822916-001	Anonymous	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	28200	28100	0.375	0% - 20%
EA015: Total Dissolved Solids dried at 180 ± 5 °C (QC Lot: 1858966)									
ES1822756-003	Anonymous	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	378	372	1.47	0% - 20%
ES1822953-002	GM1-001	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	1030	1070	3.43	0% - 20%
EA045: Turbidity (QC Lot: 1859803)									
ES1822943-001	Anonymous	EA045: Turbidity	----	0.1	NTU	256	255	0.391	0% - 20%
ES1822953-005	WMLP239-001	EA045: Turbidity	----	0.1	NTU	27.0	26.5	1.87	0% - 20%
ED037P: Alkalinity by PC Titrator (QC Lot: 1854847)									
ES1822953-005	WMLP239-001	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	164	160	1.92	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	164	160	1.92	0% - 20%
ES1822916-001	Anonymous	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	53	65	19.9	0% - 20%
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	2650	2610	1.33	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	2700	2680	0.832	0% - 20%
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QC Lot: 1855842)									
ES1822953-001	YAP016-001	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	121	120	0.00	0% - 20%
EW1803139-008	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	40	39	0.00	0% - 20%
ED045G: Chloride by Discrete Analyser (QC Lot: 1855843)									

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
ED045G: Chloride by Discrete Analyser (QC Lot: 1855843) - continued									
ES1822953-001	YAP016-001	ED045G: Chloride	16887-00-6	1	mg/L	193	193	0.00	0% - 20%
EW1803139-008	Anonymous	ED045G: Chloride	16887-00-6	1	mg/L	38	38	0.00	0% - 20%
ED093F: Dissolved Major Cations (QC Lot: 1855416)									
ES1822901-001	Anonymous	ED093F: Calcium	7440-70-2	1	mg/L	86	88	1.86	0% - 20%
		ED093F: Magnesium	7439-95-4	1	mg/L	18	19	0.00	0% - 50%
		ED093F: Sodium	7440-23-5	1	mg/L	256	258	0.771	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	74	75	0.00	0% - 20%
ES1822953-001	YAP016-001	ED093F: Calcium	7440-70-2	1	mg/L	29	29	0.00	0% - 20%
		ED093F: Magnesium	7439-95-4	1	mg/L	19	20	0.00	0% - 50%
		ED093F: Sodium	7440-23-5	1	mg/L	215	214	0.00	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	2	2	0.00	No Limit
EG020F: Dissolved Metals by ICP-MS (QC Lot: 1855417)									
ES1822953-001	YAP016-001	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	0.002	0.002	0.00	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	0.005	0.004	0.00	No Limit
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	0.014	0.012	15.3	No Limit
		EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.00	No Limit
ES1822954-005	Anonymous	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	1.90	1.79	5.92	0% - 20%
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	245	254	3.43	0% - 20%
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	0.318	0.311	2.25	0% - 20%
		EG020A-F: Copper	7440-50-8	0.001	mg/L	47.3	44.8	5.38	0% - 20%
		EG020A-F: Lead	7439-92-1	0.001	mg/L	0.013	0.013	0.00	No Limit
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	16.4	16.1	2.30	0% - 20%
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	0.636	0.602	5.48	0% - 20%
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	278	268	3.52	0% - 20%
		EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.10	<0.10	0.00	No Limit
		EG020A-F: Iron	7439-89-6	0.05	mg/L	3480	3420	1.57	0% - 20%
EK026SF: Total CN by Segmented Flow Analyser (QC Lot: 1855032)									
ES1822943-005	Anonymous	EK026SF: Total Cyanide	57-12-5	0.004	mg/L	0.039	0.032	21.0	No Limit
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 1855845)									
ES1822967-002	Anonymous	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	0.00	No Limit
ES1822953-001	YAP016-001	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 1857530)									
ES1822929-004	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.01	0.00	No Limit

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 1857530) - continued									
ES1822941-002	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	0.01	<0.01	0.00	No Limit
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 1857535)									
ES1822941-001	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.2	0.2	0.00	No Limit
ES1822957-001	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	79.0	78.0	1.27	0% - 20%
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 1857534)									
ES1822929-004	Anonymous	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.18	0.19	0.00	No Limit
ES1822957-001	Anonymous	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.14	0.14	0.00	0% - 50%

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Spike (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EA005: pH (QCLot: 1853775)								
EA005: pH Value	----	----	pH Unit	----	7.6 pH Unit	100	99	102
EA010P: Conductivity by PC Titrator (QCLot: 1854846)								
EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	<1	2000 µS/cm	102	95	113
EA015: Total Dissolved Solids dried at 180 ± 5 °C (QCLot: 1858966)								
EA015H: Total Dissolved Solids @180°C	----	10	mg/L	<10	2000 mg/L	101	87	109
				<10	293 mg/L	88.2	66	126
EA045: Turbidity (QCLot: 1859803)								
EA045: Turbidity	----	0.1	NTU	<0.1	40 NTU	100	91	105
ED037P: Alkalinity by PC Titrator (QCLot: 1854847)								
ED037-P: Total Alkalinity as CaCO3	----	----	mg/L	----	200 mg/L	92.2	81	111
				----	50 mg/L	100	70	130
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 1855842)								
ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	25 mg/L	105	82	122
ED045G: Chloride by Discrete Analyser (QCLot: 1855843)								
ED045G: Chloride	16887-00-6	1	mg/L	<1	10 mg/L	107	81	127
				<1	1000 mg/L	88.3	81	127
ED093F: Dissolved Major Cations (QCLot: 1855416)								
ED093F: Calcium	7440-70-2	1	mg/L	<1	50 mg/L	94.9	80	114
ED093F: Magnesium	7439-95-4	1	mg/L	<1	50 mg/L	97.7	90	116
ED093F: Sodium	7440-23-5	1	mg/L	<1	50 mg/L	96.8	82	120
ED093F: Potassium	7440-09-7	1	mg/L	<1	50 mg/L	96.6	85	113
EG020F: Dissolved Metals by ICP-MS (QCLot: 1855417)								
EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	95.3	85	114
EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	86.5	84	110
EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	91.4	85	111
EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	0.1 mg/L	93.3	81	111
EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	93.2	83	111
EG020A-F: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	88.4	82	110
EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	92.3	82	112
EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	0.1 mg/L	96.2	85	115
EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	0.1 mg/L	92.8	81	117
EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	97.0	82	112
EK026SF: Total CN by Segmented Flow Analyser (QCLot: 1855032)								

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report: Result	Laboratory Control Spike (LCS) Report: Spike Concentration	Spike Recovery (%): LCS	Recovery Limits (%): Low	Recovery Limits (%): High
EK026SF: Total CN by Segmented Flow Analyser (QCLot: 1855032) - continued								
EK026SF: Total Cyanide	57-12-5	0.004	mg/L	<0.004	0.2 mg/L	111	73	133
EK057G: Nitrite as N by Discrete Analyser (QCLot: 1855845)								
EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	0.5 mg/L	106	82	114
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 1857530)								
EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.5 mg/L	104	91	113
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 1857535)								
EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	10 mg/L	93.0	69	101
				<0.1	1 mg/L	96.4	70	118
				<0.1	5 mg/L	96.0	74	118
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 1857534)								
EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	4.42 mg/L	92.7	71	101
				<0.01	0.442 mg/L	90.4	72	108
				<0.01	1 mg/L	97.2	78	118

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report: Spike Concentration	SpikeRecovery(%): MS	Recovery Limits (%): Low	Recovery Limits (%): High
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 1855842)							
ES1822953-001	YAP016-001	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	10 mg/L	# Not Determined	70	130
ED045G: Chloride by Discrete Analyser (QCLot: 1855843)							
ES1822953-001	YAP016-001	ED045G: Chloride	16887-00-6	250 mg/L	92.7	70	130
EG020F: Dissolved Metals by ICP-MS (QCLot: 1855417)							
ES1822953-002	GM1-001	EG020A-F: Arsenic	7440-38-2	1 mg/L	92.1	70	130
		EG020A-F: Cadmium	7440-43-9	0.25 mg/L	82.8	70	130
		EG020A-F: Chromium	7440-47-3	1 mg/L	91.5	70	130
		EG020A-F: Copper	7440-50-8	1 mg/L	91.0	70	130
		EG020A-F: Lead	7439-92-1	1 mg/L	88.2	70	130
		EG020A-F: Manganese	7439-96-5	1 mg/L	82.8	70	130
		EG020A-F: Nickel	7440-02-0	1 mg/L	91.8	70	130
		EG020A-F: Zinc	7440-66-6	1 mg/L	91.4	70	130
EK026SF: Total CN by Segmented Flow Analyser (QCLot: 1855032)							
ES1822943-005	Anonymous	EK026SF: Total Cyanide	57-12-5	1 mg/L	109	70	130

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*Concentration*	*MS*	*Low*	*High*
EK057G: Nitrite as N by Discrete Analyser (QCLot: 1855845)							
ES1822953-001	YAP016-001	EK057G: Nitrite as N	14797-65-0	0.5 mg/L	106	70	130
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 1857530)							
ES1822929-004	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.5 mg/L	104	70	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 1857535)							
ES1822941-002	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	5 mg/L	91.4	70	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 1857534)							
ES1822929-006	Anonymous	EK067G: Total Phosphorus as P	----	1 mg/L	99.8	70	130

ALS Environmental

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **ES1822953**	Page	: 1 of 8
Client	: **AUSTRALASIAN GROUNDWATER AND ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR KADE HANCOCK	Telephone	: +61-2-8784 8555
Project	: G1922B AUGUST 2018	Date Samples Received	: 06-Aug-2018
Site	: ----	Issue Date	: 09-Aug-2018
Sampler	: KADE HANCOCK	No. of samples received	: 6
Order number	:	No. of samples analysed	: 6

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **Matrix Spike outliers exist - please see following pages for full details.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **NO Analysis Holding Time Outliers exist.**

Outliers : Frequency of Quality Control Samples

- **NO Quality Control Sample Frequency Outliers exist.**

Outliers : Quality Control Samples

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **WATER**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Matrix Spike (MS) Recoveries							
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA	ES1822953--001	YAP016-001	**Sulfate as SO4 - Turbidimetric**	14808-79-8	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA005: pH							
Clear Plastic Bottle - Natural (EA005)							
YAP016-001, GM1-001, WMLP358-001, WMLP349-001, WMLP239-001, WMLP346-001	**06-Aug-2018**	**----**	----	----	**06-Aug-2018**	06-Aug-2018	✓
EA010P: Conductivity by PC Titrator							
Clear Plastic Bottle - Natural (EA010-P)							
YAP016-001, GM1-001, WMLP358-001, WMLP349-001, WMLP239-001, WMLP346-001	**06-Aug-2018**	**----**	----	----	**06-Aug-2018**	03-Sep-2018	✓
EA015: Total Dissolved Solids dried at 180 ± 5 °C							
Clear Plastic Bottle - Natural (EA015H)							
YAP016-001, GM1-001, WMLP358-001, WMLP349-001, WMLP239-001, WMLP346-001	**06-Aug-2018**	**----**	----	----	**08-Aug-2018**	13-Aug-2018	✓
EA045: Turbidity							
Clear Plastic Bottle - Natural (EA045)							
YAP016-001, GM1-001, WMLP358-001, WMLP349-001, WMLP239-001, WMLP346-001	**06-Aug-2018**	**----**	----	----	**08-Aug-2018**	08-Aug-2018	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
ED037P: Alkalinity by PC Titrator							
Clear Plastic Bottle - Natural (ED037-P)							
YAP016-001, GM1-001, WMLP358-001, WMLP349-001, WMLP239-001, WMLP346-001	**06-Aug-2018**	**----**	----	----	**06-Aug-2018**	20-Aug-2018	✓
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA							
Clear Plastic Bottle - Natural (ED041G)							
YAP016-001, GM1-001, WMLP358-001, WMLP349-001, WMLP239-001, WMLP346-001	**06-Aug-2018**	**----**	----	----	**07-Aug-2018**	03-Sep-2018	✓
ED045G: Chloride by Discrete Analyser							
Clear Plastic Bottle - Natural (ED045G)							
YAP016-001, GM1-001, WMLP358-001, WMLP349-001, WMLP239-001, WMLP346-001	**06-Aug-2018**	**----**	----	----	**07-Aug-2018**	03-Sep-2018	✓
ED093F: Dissolved Major Cations							
Clear Plastic Bottle - Natural (ED093F)							
WMLP346-001	**06-Aug-2018**	**----**	----	----	**07-Aug-2018**	13-Aug-2018	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F)							
YAP016-001, GM1-001, WMLP358-001, WMLP349-001, WMLP239-001	**06-Aug-2018**	**----**	----	----	**07-Aug-2018**	03-Sep-2018	✓
EG020F: Dissolved Metals by ICP-MS							
Clear Plastic Bottle - Natural (EG020A-F)							
WMLP346-001	**06-Aug-2018**	**----**	----	----	**07-Aug-2018**	02-Feb-2019	✓
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F)							
YAP016-001, GM1-001, WMLP358-001, WMLP349-001, WMLP239-001	**06-Aug-2018**	**----**	----	----	**07-Aug-2018**	02-Feb-2019	✓
EK026SF: Total CN by Segmented Flow Analyser							
Opaque plastic bottle - NaOH (EK026SF)							
YAP016-001, GM1-001, WMLP358-001, WMLP349-001, WMLP239-001, WMLP346-001	**06-Aug-2018**	**----**	----	----	**07-Aug-2018**	20-Aug-2018	✓
EK057G: Nitrite as N by Discrete Analyser							
Clear Plastic Bottle - Natural (EK057G)							
YAP016-001, GM1-001, WMLP358-001, WMLP349-001, WMLP239-001, WMLP346-001	**06-Aug-2018**	**----**	----	----	**07-Aug-2018**	08-Aug-2018	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK059G)							
YAP016-001, GM1-001, WMLP358-001, WMLP349-001, WMLP239-001, WMLP346-001	**06-Aug-2018**	**----**	----	----	**07-Aug-2018**	03-Sep-2018	✓
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK061G)							
YAP016-001, GM1-001, WMLP358-001, WMLP349-001, WMLP239-001, WMLP346-001	**06-Aug-2018**	**07-Aug-2018**	03-Sep-2018	✓	**07-Aug-2018**	03-Sep-2018	✓
EK067G: Total Phosphorus as P by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK067G)							
YAP016-001, GM1-001, WMLP358-001, WMLP349-001, WMLP239-001, WMLP346-001	**06-Aug-2018**	**07-Aug-2018**	03-Sep-2018	✓	**07-Aug-2018**	03-Sep-2018	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Alkalinity by PC Titrator	ED037-P	2	17	**11.76**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	16	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	2	7	**28.57**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH	EA005	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	16	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Cyanide by Segmented Flow Analyser	EK026SF	1	7	**14.29**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	2	17	**11.76**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Turbidity	EA045	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Alkalinity by PC Titrator	ED037-P	2	17	**11.76**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	16	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH	EA005	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	16	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Cyanide by Segmented Flow Analyser	EK026SF	2	7	**28.57**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	2	17	**11.76**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	3	20	**15.00**	**15.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	3	20	**15.00**	**15.00**	✓	NEPM 2013 B3 & ALS QC Standard
Turbidity	EA045	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Chloride by Discrete Analyser	ED045G	1	16	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Method Blanks (MB) - Continued							
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	16	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Cyanide by Segmented Flow Analyser	EK026SF	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Turbidity	EA045	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Chloride by Discrete Analyser	ED045G	1	16	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	16	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Cyanide by Segmented Flow Analyser	EK026SF	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
pH	EA005	WATER	In house: Referenced to APHA 4500 H+ B. pH of water samples is determined by ISE either manually or by automated pH meter. This method is compliant with NEPM (2013) Schedule B(3)
Conductivity by PC Titrator	EA010-P	WATER	In house: Referenced to APHA 2510 B. This procedure determines conductivity by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Total Dissolved Solids (High Level)	EA015H	WATER	In house: Referenced to APHA 2540C. A gravimetric procedure that determines the amount of `filterable` residue in an aqueous sample. A well-mixed sample is filtered through a glass fibre filter (1.2um). The filtrate is evaporated to dryness and dried to constant weight at 180+/-5C. This method is compliant with NEPM (2013) Schedule B(3)
Turbidity	EA045	WATER	In house: Referenced to APHA 2130 B. This method is compliant with NEPM (2013) Schedule B(3)
Alkalinity by PC Titrator	ED037-P	WATER	In house: Referenced to APHA 2320 B This procedure determines alkalinity by automated measurement (e.g. PC Titrate) using pH 4.5 for indicating the total alkalinity end-point. This method is compliant with NEPM (2013) Schedule B(3)
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	WATER	In house: Referenced to APHA 4500-SO4. Dissolved sulfate is determined in a 0.45um filtered sample. Sulfate ions are converted to a barium sulfate suspension in an acetic acid medium with barium chloride. Light absorbance of the BaSO4 suspension is measured by a photometer and the SO4-2 concentration is determined by comparison of the reading with a standard curve. This method is compliant with NEPM (2013) Schedule B(3)
Chloride by Discrete Analyser	ED045G	WATER	In house: Referenced to APHA 4500 Cl - G.The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride.in the presence of ferric ions the librated thiocynate forms highly-coloured ferric thiocynate which is measured at 480 nm APHA 21st edition seal method 2 017-1-L april 2003
Major Cations - Dissolved	ED093F	WATER	In house: Referenced to APHA 3120 and 3125; USEPA SW 846 - 6010 and 6020; Cations are determined by either ICP-AES or ICP-MS techniques. This method is compliant with NEPM (2013) Schedule B(3) Sodium Adsorption Ratio is calculated from Ca, Mg and Na which determined by ALS in house method QWI-EN/ED093F. This method is compliant with NEPM (2013) Schedule B(3) Hardness parameters are calculated based on APHA 2340 B. This method is compliant with NEPM (2013) Schedule B(3)
Dissolved Metals by ICP-MS - Suite A	EG020A-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45µm filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.

Analytical Methods	Method	Matrix	Method Descriptions
Total Cyanide by Segmented Flow Analyser	EK026SF	WATER	In house: Referenced to APHA 4500-CN C / ASTM D7511. Sodium hydroxide preserved samples are introduced into an automated segmented flow analyser. Complex bound cyanide is decomposed in a continuously flowing stream, at a pH of 3.8, by the effect of UV light. A UV-B lamp (312 nm) and a decomposition spiral of borosilicate glass are used to filter out UV light with a wavelength of less than 290 nm thus preventing the conversion of thiocyanate into cyanide. The hydrogen cyanide present at a pH of 3.8 is separated by gas dialysis. The hydrogen cyanide is then determined photometrically, based on the reaction of cyanide with chloramine-T to form cyanogen chloride. This then reacts with 4-pyridine carboxylic acid and 1,3-dimethylbarbituric acid to give a red colour which is measured at 600 nm. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite as N by Discrete Analyser	EK057G	WATER	In house: Referenced to APHA 4500-NO2- B. Nitrite is determined by direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrate as N by Discrete Analyser	EK058G	WATER	In house: Referenced to APHA 4500-NO3- F. Nitrate is reduced to nitrite by way of a chemical reduction followed by quantification by Discrete Analyser. Nitrite is determined seperately by direct colourimetry and result for Nitrate calculated as the difference between the two results. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	WATER	In house: Referenced to APHA 4500-NO3- F. Combined oxidised Nitrogen (NO2+NO3) is determined by Chemical Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	WATER	In house: Referenced to APHA 4500-Norg D (In house). An aliquot of sample is digested using a high temperature Kjeldahl digestion to convert nitrogenous compounds to ammonia. Ammonia is determined colorimetrically by discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Nitrogen as N (TKN + Nox) By Discrete Analyser	EK062G	WATER	In house: Referenced to APHA 4500-Norg / 4500-NO3-. This method is compliant with NEPM (2013) Schedule B(3)
Total Phosphorus as P By Discrete Analyser	EK067G	WATER	In house: Referenced to APHA 4500-P H, Jirka et al (1976), Zhang et al (2006). This procedure involves sulphuric acid digestion of a sample aliquot to break phosphorus down to orthophosphate. The orthophosphate reacts with ammonium molybdate and antimony potassium tartrate to form a complex which is then reduced and its concentration measured at 880nm using discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Ionic Balance by PCT DA and Turbi SO4 DA	EN055 - PG	WATER	In house: Referenced to APHA 1030F. This method is compliant with NEPM (2013) Schedule B(3)

Preparation Methods	Method	Matrix	Method Descriptions
TKN/TP Digestion	EK061/EK067	WATER	In house: Referenced to APHA 4500 Norg - D; APHA 4500 P - H. This method is compliant with NEPM (2013) Schedule B(3)

SAMPLE RECEIPT NOTIFICATION (SRN)

Work Order : **ES1822953**

Client	: **AUSTRALASIAN GROUNDWATER AND ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR KADE HANCOCK	Contact	: Customer Services ES
Address	: 4 HUDSON STREET HAMILTON NSW 2303	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: kade@ageconsultants.com.au	E-mail	: ALSEnviro.Sydney@alsglobal.com
Telephone	: ----	Telephone	: +61-2-8784 8555
Facsimile	: ----	Facsimile	: +61-2-8784 8500
Project	: G1922B AUGUST 2018	Page	: 1 of 3
Order number	:	Quote number	: ES2017AUSGRO0002 (SY/374/17)
C-O-C number	: ----	QC Level	: NEPM 2013 B3 & ALS QC Standard
Site	: ----		
Sampler	: KADE HANCOCK		

Dates

Date Samples Received	: 06-Aug-2018 15:07	Issue Date	: 06-Aug-2018
Client Requested Due Date	: 10-Aug-2018	Scheduled Reporting Date	: **10-Aug-2018**

Delivery Details

Mode of Delivery	: Undefined	Security Seal	: Not Available
No. of coolers/boxes	: 1	Temperature	: -0.3'C - Ice present
Receipt Detail	:	No. of samples received / analysed	: 6 / 6

General Comments

- This report contains the following information:
  - Sample Container(s)/Preservation Non-Compliances
  - Summary of Sample(s) and Requested Analysis
  - Proactive Holding Time Report
  - Requested Deliverables
- **Please refer to the Proactive Holding Time Report table below which summarises breaches of recommended holding times that have occurred prior to samples/instructions being received at the laboratory. The absence of this summary table indicates that all samples have been received within the recommended holding times for the analysis requested.**
- **pH analysis will be conducted by ALS Newcastle-Water.**
- Please direct any queries you have regarding this work order to the above ALS laboratory contact.
- Analytical work for this work order will be conducted at ALS Sydney.
- Sample Disposal - Aqueous (3 weeks), Solid (2 months) from receipt of samples.

Sample Container(s)/Preservation Non-Compliances

All comparisons are made against pretreatment/preservation AS, APHA, USEPA standards.

Method Client sample ID	Sample Container Received	Preferred Sample Container for Analysis
Dissolved Metals by ICP-MS - Suite A : EG020A-F		
WMLP346-001	- Clear Plastic Bottle - Natural	- Clear Plastic Bottle - Nitric Acid; Filtered

Summary of Sample(s) and Requested Analysis

Some items described below may be part of a laboratory process necessary for the execution of client requested tasks. Packages may contain additional analyses, such as the determination of moisture content and preparation tasks, that are included in the package.
If no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory and displayed in brackets without a time component

Matrix: **WATER**

Laboratory sample ID	Client sampling date / time	Client sample ID	WATER - EA005: pH pH	WATER - EA010P Electrical Conductivity (PCT)	WATER - EG020F Dissolved Metals by ICP/MS	WATER - EK026SF Total Cyanide by Segmented Flow Analyser	WATER - EK058G Nitrate as N by Discrete Analyser	WATER - NT-01 & 02 Ca, Mg, Na, K, Cl, SO4, Alkalinity	WATER - NT-11 Total Nitrogen and Total Phosphorus
ES1822953-001	06-Aug-2018 08:25	YAP016-001	✓	✓	✓	✓	✓	✓	✓
ES1822953-002	06-Aug-2018 10:17	GM1-001	✓	✓	✓	✓	✓	✓	✓
ES1822953-003	06-Aug-2018 11:22	WMLP358-001	✓	✓	✓	✓	✓	✓	✓
ES1822953-004	06-Aug-2018 12:05	WMLP349-001	✓	✓	✓	✓	✓	✓	✓
ES1822953-005	06-Aug-2018 12:57	WMLP239-001	✓	✓	✓	✓	✓	✓	✓
ES1822953-006	06-Aug-2018 13:27	WMLP346-001	✓	✓	✓	✓	✓	✓	✓

Matrix: **WATER**

Laboratory sample ID	Client sampling date / time	Client sample ID	WATER - EA015H Total Dissolved Solids - Standard Level	WATER - EA045 Turbidity
ES1822953-001	06-Aug-2018 08:25	YAP016-001	✓	✓
ES1822953-002	06-Aug-2018 10:17	GM1-001	✓	✓
ES1822953-003	06-Aug-2018 11:22	WMLP358-001	✓	✓
ES1822953-004	06-Aug-2018 12:05	WMLP349-001	✓	✓
ES1822953-005	06-Aug-2018 12:57	WMLP239-001	✓	✓
ES1822953-006	06-Aug-2018 13:27	WMLP346-001	✓	✓

Proactive Holding Time Report

Sample(s) have been received within the recommended holding times for the requested analysis.

Requested Deliverables

ALL INVOICES

- A4 - AU Tax Invoice (INV)	Email	brisbane@ageconsultants.com.au

KADE HANCOCK

- *AU Certificate of Analysis - NATA (COA)	Email	kade@ageconsultants.com.au
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	kade@ageconsultants.com.au
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	kade@ageconsultants.com.au
- A4 - AU Sample Receipt Notification - Environmental HT (SRN)	Email	kade@ageconsultants.com.au
- A4 - AU Tax Invoice (INV)	Email	kade@ageconsultants.com.au
- Chain of Custody (CoC) (COC)	Email	kade@ageconsultants.com.au
- EDI Format - ENMRG (ENMRG)	Email	kade@ageconsultants.com.au
- EDI Format - ESDAT (ESDAT)	Email	kade@ageconsultants.com.au

ALS Environmental

QUALITY CONTROL REPORT

Work Order	: **ES1823061**	Page	: 1 of 7
Client	: **AUSTRALASIAN GROUNDWATER AND ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR KADE HANCOCK	Contact	: Customer Services ES
Address	: 4 HUDSON STREET HAMILTON NSW 2303	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: +61-2-8784 8555
Project	: G1922B AUGUST 2018	Date Samples Received	: 07-Aug-2018
Order number	:	Date Analysis Commenced	: 07-Aug-2018
C-O-C number	: ----	Issue Date	: 10-Aug-2018
Sampler	: KADE HANCOCK		
Site	: ----		
Quote number	: SY/374/17		
No. of samples received	: 9		
No. of samples analysed	: 9		

Accreditation No. 825
Accredited for compliance with ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW
Neil Martin	Team Leader - Chemistry	Chemistry, Newcastle West, NSW

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EA005: pH (QC Lot: 1858548)									
ES1823054-010	Anonymous	EA005: pH Value	----	0.01	pH Unit	5.51	5.49	0.364	0% - 20%
ES1823061-001	WMLP278-001	EA005: pH Value	----	0.01	pH Unit	7.06	7.06	0.00	0% - 20%
EA010P: Conductivity by PC Titrator (QC Lot: 1857823)									
ES1823046-001	Anonymous	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	2800	2810	0.357	0% - 20%
ES1823054-004	Anonymous	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	745	747	0.267	0% - 20%
EA010P: Conductivity by PC Titrator (QC Lot: 1857825)									
ES1823061-005	WMLP279-001	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	1200	1200	0.415	0% - 20%
EA015: Total Dissolved Solids dried at 180 ± 5 °C (QC Lot: 1861436)									
ES1823061-001	WMLP278-001	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	762	736	3.47	0% - 20%
EW1803139-008	Anonymous	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	171	159	7.27	0% - 50%
EA045: Turbidity (QC Lot: 1863308)									
ES1822984-002	Anonymous	EA045: Turbidity	----	0.1	NTU	1.0	1.0	0.00	No Limit
ES1823061-008	T4P-001	EA045: Turbidity	----	0.1	NTU	123	121	1.64	0% - 20%
ED037P: Alkalinity by PC Titrator (QC Lot: 1857822)									
ES1823054-004	Anonymous	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	89	89	0.00	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	89	89	0.00	0% - 20%
ES1823027-006	Anonymous	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	468	464	0.816	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	468	464	0.816	0% - 20%
ED037P: Alkalinity by PC Titrator (QC Lot: 1857824)									
ES1823071-012	Anonymous	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.00	No Limit

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
ED037P: Alkalinity by PC Titrator (QC Lot: 1857824) - continued									
ES1823071-012	Anonymous	ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	222	225	1.21	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	222	225	1.21	0% - 20%
ES1823061-005	WMLP279-001	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	222	202	9.23	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	222	202	9.23	0% - 20%
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QC Lot: 1858536)									
ES1823054-009	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	31	31	0.00	0% - 20%
ES1823054-001	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	26	26	0.00	0% - 20%
ED045G: Chloride by Discrete Analyser (QC Lot: 1858537)									
ES1823054-009	Anonymous	ED045G: Chloride	16887-00-6	1	mg/L	339	345	1.55	0% - 20%
ES1823054-001	Anonymous	ED045G: Chloride	16887-00-6	1	mg/L	120	120	0.00	0% - 20%
ED045G: Chloride by Discrete Analyser (QC Lot: 1858539)									
ES1823071-010	Anonymous	ED045G: Chloride	16887-00-6	1	mg/L	52	53	0.00	0% - 20%
ED093F: Dissolved Major Cations (QC Lot: 1859381)									
ES1823024-001	Anonymous	ED093F: Calcium	7440-70-2	1	mg/L	5	5	0.00	No Limit
		ED093F: Magnesium	7439-95-4	1	mg/L	6	6	0.00	No Limit
		ED093F: Sodium	7440-23-5	1	mg/L	45	42	5.63	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	2	2	0.00	No Limit
ES1823054-006	Anonymous	ED093F: Calcium	7440-70-2	1	mg/L	3	3	0.00	No Limit
		ED093F: Magnesium	7439-95-4	1	mg/L	5	5	0.00	No Limit
		ED093F: Sodium	7440-23-5	1	mg/L	28	27	0.00	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	3	3	0.00	No Limit
ED093F: Dissolved Major Cations (QC Lot: 1859384)									
ES1823061-006	WMLP327-001	ED093F: Calcium	7440-70-2	1	mg/L	74	75	1.57	0% - 20%
		ED093F: Magnesium	7439-95-4	1	mg/L	38	38	0.00	0% - 20%
		ED093F: Sodium	7440-23-5	1	mg/L	278	274	1.12	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	4	4	0.00	No Limit
EG020F: Dissolved Metals by ICP-MS (QC Lot: 1859383)									
ES1823054-001	Anonymous	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.001	0.00	No Limit
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	0.012	0.014	22.4	0% - 50%
		EG020A-F: Lead	7439-92-1	0.001	mg/L	0.002	0.003	0.00	No Limit
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	0.009	0.008	0.00	No Limit
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	0.002	0.002	0.00	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	0.023	0.021	9.39	No Limit
		EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EG020F: Dissolved Metals by ICP-MS (QC Lot: 1859383) - continued									
ES1823054-001	Anonymous	EG020A-F: Iron	7439-89-6	0.05	mg/L	1.46	1.45	0.977	0% - 20%
ES1823061-001	WMLP278-001	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	0.001	0.001	0.00	No Limit
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	0.068	0.065	4.58	0% - 20%
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	0.001	0.001	0.00	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	0.008	0.008	0.00	No Limit
		EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Iron	7439-89-6	0.05	mg/L	0.34	0.33	3.06	No Limit
EK026SF: Total CN by Segmented Flow Analyser (QC Lot: 1857885)									
ES1822926-001	Anonymous	EK026SF: Total Cyanide	57-12-5	0.004	mg/L	<0.004	<0.004	0.00	No Limit
ES1823058-001	Anonymous	EK026SF: Total Cyanide	57-12-5	0.004	mg/L	1.13	1.09	3.56	0% - 50%
EK026SF: Total CN by Segmented Flow Analyser (QC Lot: 1857888)									
ES1823061-002	WMLP277-001	EK026SF: Total Cyanide	57-12-5	0.004	mg/L	<0.004	<0.004	0.00	No Limit
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 1858222)									
ES1823061-001	WMLP278-001	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	0.32	0.32	0.00	0% - 20%
EW1803113-001	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 1858219)									
ES1823061-001	WMLP278-001	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	<0.1	0.00	No Limit
EW1803113-002	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	100	95.0	5.46	0% - 20%
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 1858218)									
ES1823061-001	WMLP278-001	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.04	0.04	0.00	No Limit
EW1803113-002	Anonymous	EK067G: Total Phosphorus as P	----	0.01	mg/L	2.02	1.93	4.52	0% - 20%

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Spike (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EA005: pH (QCLot: 1858548)								
EA005: pH Value	----	----	pH Unit	----	7.6 pH Unit	100	99	102
EA010P: Conductivity by PC Titrator (QCLot: 1857823)								
EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	<1	2000 µS/cm	103	95	113
EA010P: Conductivity by PC Titrator (QCLot: 1857825)								
EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	<1	2000 µS/cm	101	95	113
EA015: Total Dissolved Solids dried at 180 ± 5 °C (QCLot: 1861436)								
EA015H: Total Dissolved Solids @180°C	----	10	mg/L	<10	2000 mg/L	95.3	87	109
				<10	293 mg/L	89.9	66	126
EA045: Turbidity (QCLot: 1863308)								
EA045: Turbidity	----	0.1	NTU	<0.1	40 NTU	100	91	105
ED037P: Alkalinity by PC Titrator (QCLot: 1857822)								
ED037-P: Total Alkalinity as CaCO3	----	----	mg/L	----	200 mg/L	106	81	111
				----	50 mg/L	108	70	130
ED037P: Alkalinity by PC Titrator (QCLot: 1857824)								
ED037-P: Total Alkalinity as CaCO3	----	----	mg/L	----	200 mg/L	105	81	111
				----	50 mg/L	110	70	130
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 1858536)								
ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	25 mg/L	102	82	122
ED045G: Chloride by Discrete Analyser (QCLot: 1858537)								
ED045G: Chloride	16887-00-6	1	mg/L	<1	10 mg/L	113	81	127
				<1	1000 mg/L	91.9	81	127
ED045G: Chloride by Discrete Analyser (QCLot: 1858539)								
ED045G: Chloride	16887-00-6	1	mg/L	<1	10 mg/L	112	81	127
				<1	1000 mg/L	93.7	81	127
ED093F: Dissolved Major Cations (QCLot: 1859381)								
ED093F: Calcium	7440-70-2	1	mg/L	<1	50 mg/L	99.5	80	114
ED093F: Magnesium	7439-95-4	1	mg/L	<1	50 mg/L	99.4	90	116
ED093F: Sodium	7440-23-5	1	mg/L	<1	50 mg/L	102	82	120
ED093F: Potassium	7440-09-7	1	mg/L	<1	50 mg/L	98.4	85	113
ED093F: Dissolved Major Cations (QCLot: 1859384)								
ED093F: Calcium	7440-70-2	1	mg/L	<1	50 mg/L	105	80	114
ED093F: Magnesium	7439-95-4	1	mg/L	<1	50 mg/L	104	90	116
ED093F: Sodium	7440-23-5	1	mg/L	<1	50 mg/L	106	82	120

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report: Result	Laboratory Control Spike (LCS) Report: Spike Concentration	Spike Recovery (%): LCS	Recovery Limits (%): Low	Recovery Limits (%): High
ED093F: Dissolved Major Cations (QCLot: 1859384) - continued								
ED093F: Potassium	7440-09-7	1	mg/L	<1	50 mg/L	107	85	113
EG020F: Dissolved Metals by ICP-MS (QCLot: 1859383)								
EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	94.6	85	114
EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	94.8	84	110
EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	90.9	85	111
EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	0.1 mg/L	92.6	81	111
EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	92.3	83	111
EG020A-F: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	96.9	82	110
EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	90.3	82	112
EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	0.1 mg/L	99.2	85	115
EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	0.1 mg/L	90.9	81	117
EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	90.0	82	112
EK026SF: Total CN by Segmented Flow Analyser (QCLot: 1857885)								
EK026SF: Total Cyanide	57-12-5	0.004	mg/L	<0.004	0.2 mg/L	120	73	133
EK026SF: Total CN by Segmented Flow Analyser (QCLot: 1857888)								
EK026SF: Total Cyanide	57-12-5	0.004	mg/L	<0.004	0.2 mg/L	101	73	133
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 1858222)								
EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.5 mg/L	103	91	113
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 1858219)								
EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	10 mg/L	91.1	69	101
				<0.1	1 mg/L	89.2	70	118
				<0.1	5 mg/L	79.8	74	118
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 1858218)								
EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	4.42 mg/L	87.5	71	101
				<0.01	0.442 mg/L	85.0	72	108
				<0.01	1 mg/L	78.8	78	118

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report: Spike Concentration	SpikeRecovery(%): MS	Recovery Limits (%): Low	Recovery Limits (%): High
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 1858536)							
ES1823054-001	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	10 mg/L	98.0	70	130
ED045G: Chloride by Discrete Analyser (QCLot: 1858537)							

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
ED045G: Chloride by Discrete Analyser (QCLot: 1858537) - continued							
ES1823054-001	Anonymous	ED045G: Chloride	16887-00-6	250 mg/L	99.0	70	130
ED045G: Chloride by Discrete Analyser (QCLot: 1858539)							
ES1823071-010	Anonymous	ED045G: Chloride	16887-00-6	250 mg/L	103	70	130
EG020F: Dissolved Metals by ICP-MS (QCLot: 1859383)							
ES1823054-002	Anonymous	EG020A-F: Arsenic	7440-38-2	1 mg/L	89.5	70	130
		EG020A-F: Cadmium	7440-43-9	0.25 mg/L	88.6	70	130
		EG020A-F: Chromium	7440-47-3	1 mg/L	85.0	70	130
		EG020A-F: Copper	7440-50-8	1 mg/L	87.6	70	130
		EG020A-F: Lead	7439-92-1	1 mg/L	83.4	70	130
		EG020A-F: Manganese	7439-96-5	1 mg/L	84.1	70	130
		EG020A-F: Nickel	7440-02-0	1 mg/L	92.0	70	130
		EG020A-F: Zinc	7440-66-6	1 mg/L	89.8	70	130
EK026SF: Total CN by Segmented Flow Analyser (QCLot: 1857885)							
ES1822926-001	Anonymous	EK026SF: Total Cyanide	57-12-5	0.2 mg/L	74.3	70	130
EK026SF: Total CN by Segmented Flow Analyser (QCLot: 1857888)							
ES1823061-002	WMLP277-001	EK026SF: Total Cyanide	57-12-5	0.2 mg/L	94.7	70	130
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 1858222)							
ES1823061-001	WMLP278-001	EK059G: Nitrite + Nitrate as N	----	0.5 mg/L	97.1	70	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 1858219)							
ES1823061-002	WMLP277-001	EK061G: Total Kjeldahl Nitrogen as N	----	5 mg/L	77.0	70	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 1858218)							
ES1823061-002	WMLP277-001	EK067G: Total Phosphorus as P	----	1 mg/L	80.6	70	130

ALS Environmental

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **ES1823061**	Page	: 1 of 8
Client	: **AUSTRALASIAN GROUNDWATER AND ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR KADE HANCOCK	Telephone	: +61-2-8784 8555
Project	: G1922B AUGUST 2018	Date Samples Received	: 07-Aug-2018
Site	: ----	Issue Date	: 10-Aug-2018
Sampler	: KADE HANCOCK	No. of samples received	: 9
Order number	:	No. of samples analysed	: 9

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **NO Matrix Spike outliers occur.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **NO Analysis Holding Time Outliers exist.**

Outliers : Frequency of Quality Control Samples

- **NO Quality Control Sample Frequency Outliers exist.**

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA005: pH							
Clear Plastic Bottle - Natural (EA005)							
WMLP278-001, WMLP280-001, WMLP279-001, WMLP326-001, T4A-001, WMLP277-001, RA27-001, WMLP327-001, T4P-001,	**07-Aug-2018**	**----**	----	----	**07-Aug-2018**	07-Aug-2018	✓
EA010P: Conductivity by PC Titrator							
Clear Plastic Bottle - Natural (EA010-P)							
WMLP278-001, WMLP280-001, WMLP279-001, WMLP326-001, T4A-001, WMLP277-001, RA27-001, WMLP327-001, T4P-001,	**07-Aug-2018**	**----**	----	----	**08-Aug-2018**	04-Sep-2018	✓
EA015: Total Dissolved Solids dried at 180 ± 5 °C							
Clear Plastic Bottle - Natural (EA015H)							
WMLP278-001, WMLP280-001, WMLP279-001, WMLP326-001, T4A-001, WMLP277-001, RA27-001, WMLP327-001, T4P-001,	**07-Aug-2018**	**----**	----	----	**09-Aug-2018**	14-Aug-2018	✓
EA045: Turbidity							
Clear Plastic Bottle - Natural (EA045)							
WMLP278-001, WMLP280-001, WMLP279-001, WMLP326-001, T4A-001, WMLP277-001, RA27-001, WMLP327-001, T4P-001,	**07-Aug-2018**	**----**	----	----	**09-Aug-2018**	09-Aug-2018	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
ED037P: Alkalinity by PC Titrator							
Clear Plastic Bottle - Natural (ED037-P)							
WMLP278-001, WMLP277-001, WMLP280-001, RA27-001, WMLP279-001, WMLP327-001, WMLP326-001, T4P-001, T4A-001	**07-Aug-2018**	**----**	----	----	**08-Aug-2018**	21-Aug-2018	✓
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA							
Clear Plastic Bottle - Natural (ED041G)							
WMLP278-001, WMLP277-001, WMLP280-001, RA27-001, WMLP279-001, WMLP327-001, WMLP326-001, T4P-001, T4A-001	**07-Aug-2018**	**----**	----	----	**08-Aug-2018**	04-Sep-2018	✓
ED045G: Chloride by Discrete Analyser							
Clear Plastic Bottle - Natural (ED045G)							
WMLP278-001, WMLP277-001, WMLP280-001, RA27-001, WMLP279-001, WMLP327-001, WMLP326-001, T4P-001, T4A-001	**07-Aug-2018**	**----**	----	----	**08-Aug-2018**	04-Sep-2018	✓
ED093F: Dissolved Major Cations							
Clear Plastic Bottle - Natural (ED093F)							
WMLP327-001, WMLP326-001	**07-Aug-2018**	**----**	----	----	**08-Aug-2018**	14-Aug-2018	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F)							
WMLP278-001, WMLP277-001, WMLP280-001, RA27-001, WMLP279-001, T4P-001, T4A-001	**07-Aug-2018**	**----**	----	----	**08-Aug-2018**	04-Sep-2018	✓
EG020F: Dissolved Metals by ICP-MS							
Clear Plastic Bottle - Natural (EG020A-F)							
WMLP327-001, WMLP326-001	**07-Aug-2018**	**----**	----	----	**08-Aug-2018**	03-Feb-2019	✓
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F)							
WMLP278-001, WMLP277-001, WMLP280-001, RA27-001, WMLP279-001, T4P-001, T4A-001	**07-Aug-2018**	**----**	----	----	**08-Aug-2018**	03-Feb-2019	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK026SF: Total CN by Segmented Flow Analyser							
Opaque plastic bottle - NaOH (EK026SF)							
WMLP278-001, WMLP277-001, WMLP280-001, RA27-001, WMLP279-001, T4P-001, T4A-001	**07-Aug-2018**	**----**	----	----	**08-Aug-2018**	21-Aug-2018	✓
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser							
Clear Plastic Bottle - Natural (EK059G)							
WMLP327-001, WMLP326-001	**07-Aug-2018**	**----**	----	----	**08-Aug-2018**	09-Aug-2018	✓
Clear Plastic Bottle - Sulfuric Acid (EK059G)							
WMLP278-001, WMLP277-001, WMLP280-001, RA27-001, WMLP279-001, T4P-001, T4A-001	**07-Aug-2018**	**----**	----	----	**08-Aug-2018**	04-Sep-2018	✓
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser							
Clear Plastic Bottle - Natural (EK061G)							
WMLP327-001, WMLP326-001	**07-Aug-2018**	**08-Aug-2018**	08-Aug-2018	✓	**08-Aug-2018**	05-Sep-2018	✓
Clear Plastic Bottle - Sulfuric Acid (EK061G)							
WMLP278-001, WMLP277-001, WMLP280-001, RA27-001, WMLP279-001, T4P-001, T4A-001	**07-Aug-2018**	**08-Aug-2018**	04-Sep-2018	✓	**08-Aug-2018**	04-Sep-2018	✓
EK067G: Total Phosphorus as P by Discrete Analyser							
Clear Plastic Bottle - Natural (EK067G)							
WMLP327-001, WMLP326-001	**07-Aug-2018**	**08-Aug-2018**	09-Aug-2018	✓	**08-Aug-2018**	05-Sep-2018	✓
Clear Plastic Bottle - Sulfuric Acid (EK067G)							
WMLP278-001, WMLP277-001, WMLP280-001, RA27-001, WMLP279-001, T4P-001, T4A-001	**07-Aug-2018**	**08-Aug-2018**	04-Sep-2018	✓	**08-Aug-2018**	04-Sep-2018	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Alkalinity by PC Titrator	ED037-P	4	27	**14.81**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	3	25	**12.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	3	29	**10.34**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	3	24	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	18	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH	EA005	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Cyanide by Segmented Flow Analyser	EK026SF	3	27	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	2	12	**16.67**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	2	18	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Turbidity	EA045	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Alkalinity by PC Titrator	ED037-P	4	27	**14.81**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	4	25	**16.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	2	29	**6.90**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	2	24	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH	EA005	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Cyanide by Segmented Flow Analyser	EK026SF	4	27	**14.81**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	2	12	**16.67**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	3	18	**16.67**	**15.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	3	20	**15.00**	**15.00**	✓	NEPM 2013 B3 & ALS QC Standard
Turbidity	EA045	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Chloride by Discrete Analyser	ED045G	2	25	**8.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	2	29	**6.90**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	2	24	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Cyanide by Segmented Flow Analyser	EK026SF	2	27	**7.41**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Method Blanks (MB) - Continued							
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Turbidity	EA045	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Chloride by Discrete Analyser	ED045G	2	25	**8.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Cyanide by Segmented Flow Analyser	EK026SF	2	27	**7.41**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
pH	EA005	WATER	In house: Referenced to APHA 4500 H+ B. pH of water samples is determined by ISE either manually or by automated pH meter. This method is compliant with NEPM (2013) Schedule B(3)
Conductivity by PC Titrator	EA010-P	WATER	In house: Referenced to APHA 2510 B. This procedure determines conductivity by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Total Dissolved Solids (High Level)	EA015H	WATER	In house: Referenced to APHA 2540C. A gravimetric procedure that determines the amount of `filterable` residue in an aqueous sample. A well-mixed sample is filtered through a glass fibre filter (1.2um). The filtrate is evaporated to dryness and dried to constant weight at 180+/-5C. This method is compliant with NEPM (2013) Schedule B(3)
Turbidity	EA045	WATER	In house: Referenced to APHA 2130 B. This method is compliant with NEPM (2013) Schedule B(3)
Alkalinity by PC Titrator	ED037-P	WATER	In house: Referenced to APHA 2320 B This procedure determines alkalinity by automated measurement (e.g. PC Titrate) using pH 4.5 for indicating the total alkalinity end-point. This method is compliant with NEPM (2013) Schedule B(3)
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	WATER	In house: Referenced to APHA 4500-SO4. Dissolved sulfate is determined in a 0.45um filtered sample. Sulfate ions are converted to a barium sulfate suspension in an acetic acid medium with barium chloride. Light absorbance of the BaSO4 suspension is measured by a photometer and the SO4-2 concentration is determined by comparison of the reading with a standard curve. This method is compliant with NEPM (2013) Schedule B(3)
Chloride by Discrete Analyser	ED045G	WATER	In house: Referenced to APHA 4500 Cl - G.The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride.in the presence of ferric ions the librated thiocynate forms highly-coloured ferric thiocynate which is measured at 480 nm APHA 21st edition seal method 2 017-1-L april 2003
Major Cations - Dissolved	ED093F	WATER	In house: Referenced to APHA 3120 and 3125; USEPA SW 846 - 6010 and 6020; Cations are determined by either ICP-AES or ICP-MS techniques. This method is compliant with NEPM (2013) Schedule B(3) Sodium Adsorption Ratio is calculated from Ca, Mg and Na which determined by ALS in house method QWI-EN/ED093F. This method is compliant with NEPM (2013) Schedule B(3) Hardness parameters are calculated based on APHA 2340 B. This method is compliant with NEPM (2013) Schedule B(3)
Dissolved Metals by ICP-MS - Suite A	EG020A-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45µm filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.

Analytical Methods	Method	Matrix	Method Descriptions
Total Cyanide by Segmented Flow Analyser	EK026SF	WATER	In house: Referenced to APHA 4500-CN C / ASTM D7511. Sodium hydroxide preserved samples are introduced into an automated segmented flow analyser. Complex bound cyanide is decomposed in a continuously flowing stream, at a pH of 3.8, by the effect of UV light. A UV-B lamp (312 nm) and a decomposition spiral of borosilicate glass are used to filter out UV light with a wavelength of less than 290 nm thus preventing the conversion of thiocyanate into cyanide. The hydrogen cyanide present at a pH of 3.8 is separated by gas dialysis. The hydrogen cyanide is then determined photometrically, based on the reaction of cyanide with chloramine-T to form cyanogen chloride. This then reacts with 4-pyridine carboxylic acid and 1,3-dimethylbarbituric acid to give a red colour which is measured at 600 nm. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	WATER	In house: Referenced to APHA 4500-NO3- F. Combined oxidised Nitrogen (NO2+NO3) is determined by Chemical Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	WATER	In house: Referenced to APHA 4500-Norg D (In house). An aliquot of sample is digested using a high temperature Kjeldahl digestion to convert nitrogenous compounds to ammonia. Ammonia is determined colorimetrically by discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Nitrogen as N (TKN + Nox) By Discrete Analyser	EK062G	WATER	In house: Referenced to APHA 4500-Norg / 4500-NO3-. This method is compliant with NEPM (2013) Schedule B(3)
Total Phosphorus as P By Discrete Analyser	EK067G	WATER	In house: Referenced to APHA 4500-P H, Jirka et al (1976), Zhang et al (2006). This procedure involves sulphuric acid digestion of a sample aliquot to break phosphorus down to orthophosphate. The orthophosphate reacts with ammonium molybdate and antimony potassium tartrate to form a complex which is then reduced and its concentration measured at 880nm using discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Ionic Balance by PCT DA and Turbi SO4 DA	EN055 - PG	WATER	In house: Referenced to APHA 1030F. This method is compliant with NEPM (2013) Schedule B(3)

Preparation Methods	Method	Matrix	Method Descriptions
TKN/TP Digestion	EK061/EK067	WATER	In house: Referenced to APHA 4500 Norg - D; APHA 4500 P - H. This method is compliant with NEPM (2013) Schedule B(3)

SAMPLE RECEIPT NOTIFICATION (SRN)

Work Order	: **ES1823061**		
Client	: **AUSTRALASIAN GROUNDWATER AND ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR KADE HANCOCK	Contact	: Customer Services ES
Address	: 4 HUDSON STREET HAMILTON NSW 2303	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: kade@ageconsultants.com.au	E-mail	: ALSEnviro.Sydney@alsglobal.com
Telephone	: ----	Telephone	: +61-2-8784 8555
Facsimile	: ----	Facsimile	: +61-2-8784 8500
Project	: G1922B AUGUST 2018	Page	: 1 of 3
Order number	:	Quote number	: ES2017AUSGRO0002 (SY/374/17)
C-O-C number	: ----	QC Level	: NEPM 2013 B3 & ALS QC Standard
Site	: ----		
Sampler	: KADE HANCOCK		

Dates

Date Samples Received	: 07-Aug-2018 15:29	Issue Date	: 07-Aug-2018
Client Requested Due Date	: 13-Aug-2018	Scheduled Reporting Date	: **13-Aug-2018**

Delivery Details

Mode of Delivery	: Undefined	Security Seal	: Not Available
No. of coolers/boxes	: 1	Temperature	: 2.9'C - Ice present
Receipt Detail	:	No. of samples received / analysed	: 9 / 9

General Comments

- This report contains the following information:
  - Sample Container(s)/Preservation Non-Compliances
  - Summary of Sample(s) and Requested Analysis
  - Proactive Holding Time Report
  - Requested Deliverables
- **Due to appropriately preserved container not being supplied for Cyanide for sample WMLP327-001 and WML326-001, the analysis could not be conducted.**
- **Please refer to the Proactive Holding Time Report table below which summarises breaches of recommended holding times that have occurred prior to samples/instructions being received at the laboratory. The absence of this summary table indicates that all samples have been received within the recommended holding times for the analysis requested.**
- **pH analysis will be conducted by ALS Newcastle-Water.**
- Please direct any queries you have regarding this work order to the above ALS laboratory contact.
- Analytical work for this work order will be conducted at ALS Sydney.
- Sample Disposal - Aqueous (3 weeks), Solid (2 months) from receipt of samples.

Sample Container(s)/Preservation Non-Compliances

All comparisons are made against pretreatment/preservation AS, APHA, USEPA standards.

Method Client sample ID	Sample Container Received	Preferred Sample Container for Analysis
Dissolved Metals by ICP-MS - Suite A : EG020A-F		
WMLP327-001	- Clear Plastic Bottle - Natural	- Clear Plastic Bottle - Nitric Acid; Filtered
WMLP326-001	- Clear Plastic Bottle - Natural	- Clear Plastic Bottle - Nitric Acid; Filtered

Summary of Sample(s) and Requested Analysis

Some items described below may be part of a laboratory process necessary for the execution of client requested tasks. Packages may contain additional analyses, such as the determination of moisture content and preparation tasks, that are included in the package.
If no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory and displayed in brackets without a time component

Matrix: **WATER**

Laboratory sample ID	Client sampling date / time	Client sample ID	WATER - EA005: pH pH	WATER - EA010P Electrical Conductivity (PCT)	WATER - EA015H Total Dissolved Solids - Standard Level	WATER - EG020F Dissolved Metals by ICP/MS	WATER - EK026SF Total Cyanide by Segmented Flow Analyser	WATER - NT-01 & 02 Ca, Mg, Na, K, Cl, SO4, Alkalinity	WATER - NT-11 Total Nitrogen and Total Phosphorus
ES1823061-001	07-Aug-2018 08:14	WMLP278-001	✓	✓	✓	✓	✓	✓	✓
ES1823061-002	07-Aug-2018 08:46	WMLP277-001	✓	✓	✓	✓	✓	✓	✓
ES1823061-003	07-Aug-2018 09:36	WMLP280-001	✓	✓	✓	✓	✓	✓	✓
ES1823061-004	07-Aug-2018 10:22	RA27-001	✓	✓	✓	✓	✓	✓	✓
ES1823061-005	07-Aug-2018 11:02	WMLP279-001	✓	✓	✓	✓	✓	✓	✓
ES1823061-006	07-Aug-2018 12:20	WMLP327-001	✓	✓	✓	✓		✓	✓
ES1823061-007	07-Aug-2018 12:45	WMLP326-001	✓	✓	✓	✓		✓	✓
ES1823061-008	07-Aug-2018 13:32	T4P-001	✓	✓	✓	✓	✓	✓	✓
ES1823061-009	07-Aug-2018 13:50	T4A-001	✓	✓	✓	✓	✓	✓	✓

Matrix: **WATER**

Laboratory sample ID	Client sampling date / time	Client sample ID	WATER - EA045 Turbidity
ES1823061-001	07-Aug-2018 08:14	WMLP278-001	✓
ES1823061-002	07-Aug-2018 08:46	WMLP277-001	✓
ES1823061-003	07-Aug-2018 09:36	WMLP280-001	✓
ES1823061-004	07-Aug-2018 10:22	RA27-001	✓
ES1823061-005	07-Aug-2018 11:02	WMLP279-001	✓
ES1823061-006	07-Aug-2018 12:20	WMLP327-001	✓
ES1823061-007	07-Aug-2018 12:45	WMLP326-001	✓
ES1823061-008	07-Aug-2018 13:32	T4P-001	✓
ES1823061-009	07-Aug-2018 13:50	T4A-001	✓

Proactive Holding Time Report

Sample(s) have been received within the recommended holding times for the requested analysis.

Requested Deliverables

ALL INVOICES

- A4 - AU Tax Invoice (INV)	Email	brisbane@ageconsultants.com.au

KADE HANCOCK

- *AU Certificate of Analysis - NATA (COA)	Email	kade@ageconsultants.com.au
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	kade@ageconsultants.com.au
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	kade@ageconsultants.com.au
- A4 - AU Sample Receipt Notification - Environmental HT (SRN)	Email	kade@ageconsultants.com.au
- A4 - AU Tax Invoice (INV)	Email	kade@ageconsultants.com.au
- Chain of Custody (CoC) (COC)	Email	kade@ageconsultants.com.au
- EDI Format - ENMRG (ENMRG)	Email	kade@ageconsultants.com.au
- EDI Format - ESDAT (ESDAT)	Email	kade@ageconsultants.com.au

ALS Environmental

QUALITY CONTROL REPORT

Work Order	: **ES1823191**	Page	: 1 of 8
Client	: **AUSTRALASIAN GROUNDWATER AND ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR KADE HANCOCK	Contact	: Customer Services ES
Address	: 4 HUDSON STREET HAMILTON NSW 2303	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: +61-2-8784 8555
Project	: G1922B AUGUST 2018	Date Samples Received	: 08-Aug-2018
Order number	:	Date Analysis Commenced	: 08-Aug-2018
C-O-C number	: ----	Issue Date	: 13-Aug-2018
Sampler	: KADE HANCOCK		
Site	: ----		
Quote number	: SY/374/17		
No. of samples received	: 9		
No. of samples analysed	: 9		

ilac-MRA NATA
Accreditation No. 825
Accredited for compliance with ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW
Neil Martin	Team Leader - Chemistry	Chemistry, Newcastle West, NSW

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EA005: pH (QC Lot: 1861644)									
ES1823185-001	Anonymous	EA005: pH Value	----	0.01	pH Unit	7.19	7.17	0.278	0% - 20%
ES1823185-012	Anonymous	EA005: pH Value	----	0.01	pH Unit	7.66	7.66	0.00	0% - 20%
EA005: pH (QC Lot: 1861645)									
ES1823191-009	WMLP302-001	EA005: pH Value	----	0.01	pH Unit	6.61	7.86	17.3	0% - 20%
EA010P: Conductivity by PC Titrator (QC Lot: 1860624)									
ES1823155-001	Anonymous	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	1890	1890	0.00	0% - 20%
ES1823185-005	Anonymous	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	478	478	0.00	0% - 20%
EA010P: Conductivity by PC Titrator (QC Lot: 1860627)									
ES1823191-004	WMLP301-001	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	3770	3800	0.793	0% - 20%
EW1803176-001	Anonymous	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	50700	50600	0.211	0% - 20%
EA015: Total Dissolved Solids dried at 180 ± 5 °C (QC Lot: 1864456)									
ES1823191-001	WML181-001	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	1550	1370	12.3	0% - 20%
ES1823193-002	Anonymous	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	482	536	10.8	0% - 20%
EA045: Turbidity (QC Lot: 1865692)									
ES1823185-001	Anonymous	EA045: Turbidity	----	0.1	NTU	6.8	6.7	1.48	0% - 20%
ES1823185-010	Anonymous	EA045: Turbidity	----	0.1	NTU	58.4	58.8	0.682	0% - 20%
EA045: Turbidity (QC Lot: 1865693)									
ES1823191-009	WMLP302-001	EA045: Turbidity	----	0.1	NTU	6.2	6.8	8.58	0% - 20%
ES1823307-002	Anonymous	EA045: Turbidity	----	0.1	NTU	2.3	2.3	0.00	0% - 20%
EA045: Turbidity (QC Lot: 1866659)									
ES1823191-005	WML129-001	EA045: Turbidity	----	0.1	NTU	3.3	3.3	0.00	0% - 20%
ME1801045-008	Anonymous	EA045: Turbidity	----	0.1	NTU	44.8	44.9	0.223	0% - 20%
ED037P: Alkalinity by PC Titrator (QC Lot: 1860625)									

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
ED037P: Alkalinity by PC Titrator (QC Lot: 1860625) - continued									
ES1823155-001	Anonymous	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	258	259	0.549	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	258	259	0.549	0% - 20%
ES1823185-005	Anonymous	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	85	84	0.00	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	85	84	0.00	0% - 20%
ED037P: Alkalinity by PC Titrator (QC Lot: 1860626)									
ES1823191-004	WMLP301-001	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	1100	1130	2.99	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	1100	1130	2.99	0% - 20%
ES1823207-001	Anonymous	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	2	82.0	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	340	315	7.76	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	340	317	7.01	0% - 20%
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QC Lot: 1862517)									
ES1823191-001	WML181-001	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<10	<10	0.00	No Limit
ES1823206-001	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	33	34	0.00	0% - 20%
ED045G: Chloride by Discrete Analyser (QC Lot: 1862518)									
ES1823191-001	WML181-001	ED045G: Chloride	16887-00-6	1	mg/L	464	467	0.586	0% - 20%
ES1823206-001	Anonymous	ED045G: Chloride	16887-00-6	1	mg/L	34	34	0.00	0% - 20%
ED093F: Dissolved Major Cations (QC Lot: 1862384)									
ES1823072-001	Anonymous	ED093F: Calcium	7440-70-2	1	mg/L	430	446	3.71	0% - 20%
		ED093F: Magnesium	7439-95-4	1	mg/L	3	3	0.00	No Limit
		ED093F: Sodium	7440-23-5	1	mg/L	15	15	0.00	0% - 50%
		ED093F: Potassium	7440-09-7	1	mg/L	8	8	0.00	No Limit
ES1823191-001	WML181-001	ED093F: Calcium	7440-70-2	1	mg/L	16	15	0.00	0% - 50%
		ED093F: Magnesium	7439-95-4	1	mg/L	17	17	0.00	0% - 50%
		ED093F: Sodium	7440-23-5	1	mg/L	570	563	1.30	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	4	4	0.00	No Limit
ED093F: Dissolved Major Cations (QC Lot: 1862386)									
ES1823191-005	WML129-001	ED093F: Calcium	7440-70-2	1	mg/L	19	17	9.24	0% - 50%
		ED093F: Magnesium	7439-95-4	1	mg/L	12	10	10.2	0% - 50%
		ED093F: Sodium	7440-23-5	1	mg/L	48	43	10.3	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	2	2	0.00	No Limit
ES1823212-002	Anonymous	ED093F: Calcium	7440-70-2	1	mg/L	<1	<1	0.00	No Limit
		ED093F: Magnesium	7439-95-4	1	mg/L	8	8	0.00	No Limit

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
ED093F: Dissolved Major Cations (QC Lot: 1862386) - continued									
ES1823212-002	Anonymous	ED093F: Sodium	7440-23-5	1	mg/L	36	36	0.00	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	1	1	0.00	No Limit
EG020F: Dissolved Metals by ICP-MS (QC Lot: 1862385)									
ES1823191-001	WML181-001	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	0.022	0.022	0.00	0% - 20%
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	0.00	No Limit
		EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Iron	7439-89-6	0.05	mg/L	0.18	0.19	6.64	No Limit
ES1823212-002	Anonymous	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	0.002	0.002	0.00	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	0.005	0.005	0.00	No Limit
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	0.477	0.478	0.251	0% - 20%
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	0.008	0.008	0.00	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	0.033	0.033	0.00	No Limit
		EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.00	No Limit
EK026SF: Total CN by Segmented Flow Analyser (QC Lot: 1860959)									
ES1823191-001	WML181-001	EK026SF: Total Cyanide	57-12-5	0.004	mg/L	<0.004	<0.004	0.00	No Limit
ES1823262-001	Anonymous	EK026SF: Total Cyanide	57-12-5	0.004	mg/L	<0.050	<0.050	0.00	No Limit
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 1861342)									
ES1823185-004	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	0.03	0.03	0.00	No Limit
ES1823168-001	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	0.94	0.94	0.00	0% - 20%
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 1861344)									
ES1823191-003	WML-262-001	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	0.04	0.03	0.00	No Limit
ES1823200-008	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	3.48	3.68	5.56	0% - 20%
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 1861338)									
ES1823135-001	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	<0.1	0.00	No Limit
ES1823185-004	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.4	0.3	0.00	No Limit
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 1861341)									
ES1823200-014	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.4	0.3	0.00	No Limit
ES1823191-002	WML119-001	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	2.1	2.1	0.00	0% - 20%
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 1861339)									

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 1861339) - continued									
ES1823135-001	Anonymous	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.03	0.03	0.00	No Limit
ES1823185-004	Anonymous	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.02	0.02	0.00	No Limit
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 1861340)									
ES1823200-008	Anonymous	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.19	0.19	0.00	0% - 50%
ES1823191-002	WML119-001	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.11	0.11	0.00	0% - 50%

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Spike (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EA005: pH (QCLot: 1861644)								
EA005: pH Value	----	----	pH Unit	----	7.6 pH Unit	100	99	102
EA005: pH (QCLot: 1861645)								
EA005: pH Value	----	----	pH Unit	----	7.6 pH Unit	100	99	102
EA010P: Conductivity by PC Titrator (QCLot: 1860624)								
EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	<1	2000 µS/cm	101	95	113
EA010P: Conductivity by PC Titrator (QCLot: 1860627)								
EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	<1	2000 µS/cm	100	95	113
EA015: Total Dissolved Solids dried at 180 ± 5 °C (QCLot: 1864456)								
EA015H: Total Dissolved Solids @180°C	----	10	mg/L	<10	2000 mg/L	98.6	87	109
				<10	293 mg/L	98.5	66	126
EA045: Turbidity (QCLot: 1865692)								
EA045: Turbidity	----	0.1	NTU	<0.1	40 NTU	97.2	91	105
EA045: Turbidity (QCLot: 1865693)								
EA045: Turbidity	----	0.1	NTU	<0.1	40 NTU	94.8	91	105
EA045: Turbidity (QCLot: 1866659)								
EA045: Turbidity	----	0.1	NTU	<0.1	40 NTU	98.2	91	105
ED037P: Alkalinity by PC Titrator (QCLot: 1860625)								
ED037-P: Total Alkalinity as CaCO3	----	----	mg/L	----	200 mg/L	105	81	111
				----	50 mg/L	110	70	130
ED037P: Alkalinity by PC Titrator (QCLot: 1860626)								
ED037-P: Total Alkalinity as CaCO3	----	----	mg/L	----	200 mg/L	106	81	111
				----	50 mg/L	107	70	130
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 1862517)								
ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	25 mg/L	103	82	122
ED045G: Chloride by Discrete Analyser (QCLot: 1862518)								
ED045G: Chloride	16887-00-6	1	mg/L	<1	10 mg/L	107	81	127
				<1	1000 mg/L	95.3	81	127
ED093F: Dissolved Major Cations (QCLot: 1862384)								
ED093F: Calcium	7440-70-2	1	mg/L	<1	50 mg/L	110	80	114
ED093F: Magnesium	7439-95-4	1	mg/L	<1	50 mg/L	97.9	90	116
ED093F: Sodium	7440-23-5	1	mg/L	<1	50 mg/L	96.7	82	120
ED093F: Potassium	7440-09-7	1	mg/L	<1	50 mg/L	97.5	85	113
ED093F: Dissolved Major Cations (QCLot: 1862386)								

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report: Result	Laboratory Control Spike (LCS) Report: Spike Concentration	Spike Recovery (%): LCS	Recovery Limits (%): Low	Recovery Limits (%): High
ED093F: Dissolved Major Cations (QCLot: 1862386) - continued								
ED093F: Calcium	7440-70-2	1	mg/L	<1	50 mg/L	109	80	114
ED093F: Magnesium	7439-95-4	1	mg/L	<1	50 mg/L	97.2	90	116
ED093F: Sodium	7440-23-5	1	mg/L	<1	50 mg/L	95.2	82	120
ED093F: Potassium	7440-09-7	1	mg/L	<1	50 mg/L	98.6	85	113
EG020F: Dissolved Metals by ICP-MS (QCLot: 1862385)								
EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	94.1	85	114
EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	93.4	84	110
EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	90.5	85	111
EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	0.1 mg/L	91.7	81	111
EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	97.8	83	111
EG020A-F: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	92.9	82	110
EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	90.2	82	112
EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	0.1 mg/L	91.5	85	115
EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	0.1 mg/L	92.5	81	117
EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	95.4	82	112
EK026SF: Total CN by Segmented Flow Analyser (QCLot: 1860959)								
EK026SF: Total Cyanide	57-12-5	0.004	mg/L	<0.004	0.2 mg/L	123	73	133
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 1861342)								
EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.5 mg/L	100	91	113
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 1861344)								
EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.5 mg/L	104	91	113
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 1861338)								
EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	10 mg/L	90.5	69	101
				<0.1	1 mg/L	75.0	70	118
				<0.1	5 mg/L	92.1	74	118
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 1861341)								
EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	10 mg/L	86.4	69	101
				<0.1	1 mg/L	89.0	70	118
				<0.1	5 mg/L	102	74	118
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 1861339)								
EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	4.42 mg/L	86.2	71	101
				<0.01	0.442 mg/L	89.8	72	108
				<0.01	1 mg/L	98.6	78	118
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 1861340)								
EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	4.42 mg/L	85.5	71	101
				<0.01	0.442 mg/L	83.0	72	108
				<0.01	1 mg/L	94.0	78	118

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 1862517)							
ES1823191-001	WML181-001	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	10 mg/L	130	70	130
ED045G: Chloride by Discrete Analyser (QCLot: 1862518)							
ES1823191-001	WML181-001	ED045G: Chloride	16887-00-6	250 mg/L	85.4	70	130
EG020F: Dissolved Metals by ICP-MS (QCLot: 1862385)							
ES1823191-002	WML119-001	EG020A-F: Arsenic	7440-38-2	1 mg/L	90.5	70	130
		EG020A-F: Cadmium	7440-43-9	0.25 mg/L	89.6	70	130
		EG020A-F: Chromium	7440-47-3	1 mg/L	87.1	70	130
		EG020A-F: Copper	7440-50-8	1 mg/L	97.8	70	130
		EG020A-F: Lead	7439-92-1	1 mg/L	75.8	70	130
		EG020A-F: Manganese	7439-96-5	1 mg/L	81.7	70	130
		EG020A-F: Nickel	7440-02-0	1 mg/L	88.6	70	130
		EG020A-F: Zinc	7440-66-6	1 mg/L	87.7	70	130
EK026SF: Total CN by Segmented Flow Analyser (QCLot: 1860959)							
ES1823191-001	WML181-001	EK026SF: Total Cyanide	57-12-5	0.2 mg/L	79.9	70	130
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 1861342)							
ES1823168-001	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.5 mg/L	122	70	130
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 1861344)							
ES1823191-003	WML-262-001	EK059G: Nitrite + Nitrate as N	----	0.5 mg/L	98.6	70	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 1861338)							
ES1823142-001	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	5 mg/L	# Not Determined	70	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 1861341)							
ES1823191-003	WML-262-001	EK061G: Total Kjeldahl Nitrogen as N	----	5 mg/L	91.0	70	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 1861339)							
ES1823142-001	Anonymous	EK067G: Total Phosphorus as P	----	1 mg/L	# Not Determined	70	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 1861340)							
ES1823191-003	WML-262-001	EK067G: Total Phosphorus as P	----	1 mg/L	95.0	70	130

ALS Environmental

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **ES1823191**	Page	: 1 of 8
Client	: **AUSTRALASIAN GROUNDWATER AND ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR KADE HANCOCK	Telephone	: +61-2-8784 8555
Project	: G1922B AUGUST 2018	Date Samples Received	: 08-Aug-2018
Site	: ----	Issue Date	: 13-Aug-2018
Sampler	: KADE HANCOCK	No. of samples received	: 9
Order number	:	No. of samples analysed	: 9

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **Matrix Spike outliers exist - please see following pages for full details.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **Analysis Holding Time Outliers exist - please see following pages for full details.**

Outliers : Frequency of Quality Control Samples

- **NO Quality Control Sample Frequency Outliers exist.**

Outliers : Quality Control Samples

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **WATER**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Matrix Spike (MS) Recoveries							
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser	ES1823142--001	Anonymous	**Total Kjeldahl Nitrogen as N**	----	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
EK067G: Total Phosphorus as P by Discrete Analyser	ES1823142--001	Anonymous	**Total Phosphorus as P**	----	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**

Outliers : Analysis Holding Time Compliance

Matrix: **WATER**

Method / Container / Client Sample ID(s)		Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Days overdue	Date analysed	Due for analysis	Days overdue
EA005: pH							
Clear Plastic Bottle - Natural							
WML120B-001, WMLP302-001	WML120A-001,	----	----	----	09-Aug-2018	08-Aug-2018	**1**

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA005: pH								
Clear Plastic Bottle - Natural (EA005)								
WML181-001, WML-262-001, WML129-001,	WML119-001, WMLP301-001, WML183-001	**08-Aug-2018**	**----**	----	----	**08-Aug-2018**	08-Aug-2018	✓
Clear Plastic Bottle - Natural (EA005)								
WML120B-001, WMLP302-001	WML120A-001,	**08-Aug-2018**	**----**	----	----	**09-Aug-2018**	08-Aug-2018	×

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA010P: Conductivity by PC Titrator							
Clear Plastic Bottle - Natural (EA010-P)							
WML181-001, WML119-001, WML-262-001, WMLP301-001, WML129-001, WML183-001, WML120B-001, WML120A-001, WMLP302-001	**08-Aug-2018**	**----**	----	----	**08-Aug-2018**	05-Sep-2018	✓
EA015: Total Dissolved Solids dried at 180 ± 5 °C							
Clear Plastic Bottle - Natural (EA015H)							
WML181-001, WML119-001, WML-262-001, WMLP301-001, WML129-001, WML183-001, WML120B-001, WML120A-001, WMLP302-001	**08-Aug-2018**	**----**	----	----	**10-Aug-2018**	15-Aug-2018	✓
EA045: Turbidity							
Clear Plastic Bottle - Natural (EA045)							
WML181-001, WML119-001, WML-262-001, WMLP301-001, WML129-001, WML183-001, WML120B-001, WML120A-001, WMLP302-001	**08-Aug-2018**	**----**	----	----	**10-Aug-2018**	10-Aug-2018	✓
ED037P: Alkalinity by PC Titrator							
Clear Plastic Bottle - Natural (ED037-P)							
WML181-001, WML119-001, WML-262-001, WMLP301-001, WML129-001, WML183-001, WML120B-001, WML120A-001, WMLP302-001	**08-Aug-2018**	**----**	----	----	**08-Aug-2018**	22-Aug-2018	✓
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA							
Clear Plastic Bottle - Natural (ED041G)							
WML181-001, WML119-001, WML-262-001, WMLP301-001, WML129-001, WML183-001, WML120B-001, WML120A-001, WMLP302-001	**08-Aug-2018**	**----**	----	----	**09-Aug-2018**	05-Sep-2018	✓
ED045G: Chloride by Discrete Analyser							
Clear Plastic Bottle - Natural (ED045G)							
WML181-001, WML119-001, WML-262-001, WMLP301-001, WML129-001, WML183-001, WML120B-001, WML120A-001, WMLP302-001	**08-Aug-2018**	**----**	----	----	**09-Aug-2018**	05-Sep-2018	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
ED093F: Dissolved Major Cations							
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F)							
WML181-001, WML119-001, WML-262-001, WMLP301-001, WML129-001, WML183-001, WML120B-001, WML120A-001, WMLP302-001	**08-Aug-2018**	**----**	----	----	**09-Aug-2018**	05-Sep-2018	✓
EG020F: Dissolved Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F)							
WML181-001, WML119-001, WML-262-001, WMLP301-001, WML129-001, WML183-001, WML120B-001, WML120A-001, WMLP302-001	**08-Aug-2018**	**----**	----	----	**09-Aug-2018**	04-Feb-2019	✓
EK026SF: Total CN by Segmented Flow Analyser							
Opaque plastic bottle - NaOH (EK026SF)							
WML181-001, WML119-001, WML-262-001, WMLP301-001, WML129-001, WML183-001, WML120B-001, WML120A-001, WMLP302-001	**08-Aug-2018**	**----**	----	----	**09-Aug-2018**	22-Aug-2018	✓
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK059G)							
WML181-001, WML119-001, WML-262-001, WMLP301-001, WML129-001, WML183-001, WML120B-001, WML120A-001, WMLP302-001	**08-Aug-2018**	**----**	----	----	**09-Aug-2018**	05-Sep-2018	✓
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK061G)							
WML181-001, WML119-001, WML-262-001, WMLP301-001, WML129-001, WML183-001, WML120B-001, WML120A-001, WMLP302-001	**08-Aug-2018**	**09-Aug-2018**	05-Sep-2018	✓	**09-Aug-2018**	05-Sep-2018	✓
EK067G: Total Phosphorus as P by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK067G)							
WML181-001, WML119-001, WML-262-001, WMLP301-001, WML129-001, WML183-001, WML120B-001, WML120A-001, WMLP302-001	**08-Aug-2018**	**09-Aug-2018**	05-Sep-2018	✓	**09-Aug-2018**	05-Sep-2018	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Alkalinity by PC Titrator	ED037-P	4	40	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	4	39	**10.26**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	12	**16.67**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	4	40	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	4	33	**12.12**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH	EA005	3	28	**10.71**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Cyanide by Segmented Flow Analyser	EK026SF	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	4	35	**11.43**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	4	37	**10.81**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Turbidity	EA045	6	54	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Alkalinity by PC Titrator	ED037-P	4	40	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	2	39	**5.13**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	2	40	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	33	**6.06**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH	EA005	2	28	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Cyanide by Segmented Flow Analyser	EK026SF	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	6	35	**17.14**	**15.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	6	37	**16.22**	**15.00**	✓	NEPM 2013 B3 & ALS QC Standard
Turbidity	EA045	3	54	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Chloride by Discrete Analyser	ED045G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	2	39	**5.13**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	2	40	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	33	**6.06**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Cyanide by Segmented Flow Analyser	EK026SF	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Method Blanks (MB) - Continued							
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	2	35	**5.71**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	2	37	**5.41**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Turbidity	EA045	3	54	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Chloride by Discrete Analyser	ED045G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	33	**6.06**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Cyanide by Segmented Flow Analyser	EK026SF	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	2	35	**5.71**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	2	37	**5.41**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
pH	EA005	WATER	In house: Referenced to APHA 4500 H+ B. pH of water samples is determined by ISE either manually or by automated pH meter. This method is compliant with NEPM (2013) Schedule B(3)
Conductivity by PC Titrator	EA010-P	WATER	In house: Referenced to APHA 2510 B. This procedure determines conductivity by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Total Dissolved Solids (High Level)	EA015H	WATER	In house: Referenced to APHA 2540C. A gravimetric procedure that determines the amount of `filterable` residue in an aqueous sample. A well-mixed sample is filtered through a glass fibre filter (1.2um). The filtrate is evaporated to dryness and dried to constant weight at 180+/-5C. This method is compliant with NEPM (2013) Schedule B(3)
Turbidity	EA045	WATER	In house: Referenced to APHA 2130 B. This method is compliant with NEPM (2013) Schedule B(3)
Alkalinity by PC Titrator	ED037-P	WATER	In house: Referenced to APHA 2320 B This procedure determines alkalinity by automated measurement (e.g. PC Titrate) using pH 4.5 for indicating the total alkalinity end-point. This method is compliant with NEPM (2013) Schedule B(3)
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	WATER	In house: Referenced to APHA 4500-SO4. Dissolved sulfate is determined in a 0.45um filtered sample. Sulfate ions are converted to a barium sulfate suspension in an acetic acid medium with barium chloride. Light absorbance of the BaSO4 suspension is measured by a photometer and the SO4-2 concentration is determined by comparison of the reading with a standard curve. This method is compliant with NEPM (2013) Schedule B(3)
Chloride by Discrete Analyser	ED045G	WATER	In house: Referenced to APHA 4500 Cl - G.The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride.in the presence of ferric ions the librated thiocynate forms highly-coloured ferric thiocynate which is measured at 480 nm APHA 21st edition seal method 2 017-1-L april 2003
Major Cations - Dissolved	ED093F	WATER	In house: Referenced to APHA 3120 and 3125; USEPA SW 846 - 6010 and 6020; Cations are determined by either ICP-AES or ICP-MS techniques. This method is compliant with NEPM (2013) Schedule B(3) Sodium Adsorption Ratio is calculated from Ca, Mg and Na which determined by ALS in house method QWI-EN/ED093F. This method is compliant with NEPM (2013) Schedule B(3) Hardness parameters are calculated based on APHA 2340 B. This method is compliant with NEPM (2013) Schedule B(3)
Dissolved Metals by ICP-MS - Suite A	EG020A-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45µm filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.

Analytical Methods	Method	Matrix	Method Descriptions
Total Cyanide by Segmented Flow Analyser	EK026SF	WATER	In house: Referenced to APHA 4500-CN C / ASTM D7511. Sodium hydroxide preserved samples are introduced into an automated segmented flow analyser. Complex bound cyanide is decomposed in a continuously flowing stream, at a pH of 3.8, by the effect of UV light. A UV-B lamp (312 nm) and a decomposition spiral of borosilicate glass are used to filter out UV light with a wavelength of less than 290 nm thus preventing the conversion of thiocyanate into cyanide. The hydrogen cyanide present at a pH of 3.8 is separated by gas dialysis. The hydrogen cyanide is then determined photometrically, based on the reaction of cyanide with chloramine-T to form cyanogen chloride. This then reacts with 4-pyridine carboxylic acid and 1,3-dimethylbarbituric acid to give a red colour which is measured at 600 nm. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	WATER	In house: Referenced to APHA 4500-NO3- F. Combined oxidised Nitrogen (NO2+NO3) is determined by Chemical Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	WATER	In house: Referenced to APHA 4500-Norg D (In house). An aliquot of sample is digested using a high temperature Kjeldahl digestion to convert nitrogenous compounds to ammonia. Ammonia is determined colorimetrically by discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Nitrogen as N (TKN + Nox) By Discrete Analyser	EK062G	WATER	In house: Referenced to APHA 4500-Norg / 4500-NO3-. This method is compliant with NEPM (2013) Schedule B(3)
Total Phosphorus as P By Discrete Analyser	EK067G	WATER	In house: Referenced to APHA 4500-P H, Jirka et al (1976), Zhang et al (2006). This procedure involves sulphuric acid digestion of a sample aliquot to break phosphorus down to orthophosphate. The orthophosphate reacts with ammonium molybdate and antimony potassium tartrate to form a complex which is then reduced and its concentration measured at 880nm using discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Ionic Balance by PCT DA and Turbi SO4 DA	EN055 - PG	WATER	In house: Referenced to APHA 1030F. This method is compliant with NEPM (2013) Schedule B(3)

Preparation Methods	Method	Matrix	Method Descriptions
TKN/TP Digestion	EK061/EK067	WATER	In house: Referenced to APHA 4500 Norg - D; APHA 4500 P - H. This method is compliant with NEPM (2013) Schedule B(3)

SAMPLE RECEIPT NOTIFICATION (SRN)

Work Order	: **ES1823191**		
Client	: **AUSTRALASIAN GROUNDWATER AND ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR KADE HANCOCK	Contact	: Customer Services ES
Address	: 4 HUDSON STREET HAMILTON NSW 2303	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: kade@ageconsultants.com.au	E-mail	: ALSEnviro.Sydney@alsglobal.com
Telephone	: ----	Telephone	: +61-2-8784 8555
Facsimile	: ----	Facsimile	: +61-2-8784 8500
Project	: G1922B AUGUST 2018	Page	: 1 of 3
Order number	:	Quote number	: ES2017AUSGRO0002 (SY/374/17)
C-O-C number	: ----	QC Level	: NEPM 2013 B3 & ALS QC Standard
Site	: ----		
Sampler	: KADE HANCOCK		

Dates

Date Samples Received	: 08-Aug-2018 15:37	Issue Date	: 08-Aug-2018
Client Requested Due Date	: 14-Aug-2018	Scheduled Reporting Date	: **14-Aug-2018**

Delivery Details

Mode of Delivery	: Undefined	Security Seal	: Not Available
No. of coolers/boxes	: 1	Temperature	: -0.9'C - Ice present
Receipt Detail	:	No. of samples received / analysed	: 9 / 9

General Comments

- This report contains the following information:
  - Sample Container(s)/Preservation Non-Compliances
  - Summary of Sample(s) and Requested Analysis
  - Proactive Holding Time Report
  - Requested Deliverables
- **Please refer to the Proactive Holding Time Report table below which summarises breaches of recommended holding times that have occurred prior to samples/instructions being received at the laboratory. The absence of this summary table indicates that all samples have been received within the recommended holding times for the analysis requested.**
- **pH analysis will be conducted by ALS Newcastle-Water.**
- Please direct any queries you have regarding this work order to the above ALS laboratory contact.
- Analytical work for this work order will be conducted at ALS Sydney.
- Sample Disposal - Aqueous (3 weeks), Solid (2 months) from receipt of samples.

Sample Container(s)/Preservation Non-Compliances

All comparisons are made against pretreatment/preservation AS, APHA, USEPA standards.

- **No sample container / preservation non-compliance exists.**

Summary of Sample(s) and Requested Analysis

Some items described below may be part of a laboratory process necessary for the execution of client requested tasks. Packages may contain additional analyses, such as the determination of moisture content and preparation tasks, that are included in the package.
If no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory and displayed in brackets without a time component

Matrix: **WATER**

Laboratory sample ID	Client sampling date / time	Client sample ID	WATER - EA005: pH pH	WATER - EA010P Electrical Conductivity (PCT)	WATER - EA015H Total Dissolved Solids - Standard Level	WATER - EG020F Dissolved Metals by ICP/MS	WATER - EK026SF Total Cyanide by Segmented Flow Analyser	WATER - NT-01 & 02 Ca, Mg, Na, K, Cl, SO4, Alkalinity	WATER - NT-11 Total Nitrogen and Total Phosphorus
ES1823191-001	08-Aug-2018 08:43	WML181-001	✓	✓	✓	✓	✓	✓	✓
ES1823191-002	08-Aug-2018 09:16	WML119-001	✓	✓	✓	✓	✓	✓	✓
ES1823191-003	08-Aug-2018 10:02	WML-262-001	✓	✓	✓	✓	✓	✓	✓
ES1823191-004	08-Aug-2018 10:40	WMLP301-001	✓	✓	✓	✓	✓	✓	✓
ES1823191-005	08-Aug-2018 11:22	WML129-001	✓	✓	✓	✓	✓	✓	✓
ES1823191-006	08-Aug-2018 11:37	WML183-001	✓	✓	✓	✓	✓	✓	✓
ES1823191-007	08-Aug-2018 13:17	WML120B-001	✓	✓	✓	✓	✓	✓	✓
ES1823191-008	08-Aug-2018 13:38	WML120A-001	✓	✓	✓	✓	✓	✓	✓
ES1823191-009	08-Aug-2018 14:05	WMLP302-001	✓	✓	✓	✓	✓	✓	✓

Matrix: **WATER**

Laboratory sample ID	Client sampling date / time	Client sample ID	WATER - EA045 Turbidity
ES1823191-001	08-Aug-2018 08:43	WML181-001	✓
ES1823191-002	08-Aug-2018 09:16	WML119-001	✓
ES1823191-003	08-Aug-2018 10:02	WML-262-001	✓
ES1823191-004	08-Aug-2018 10:40	WMLP301-001	✓
ES1823191-005	08-Aug-2018 11:22	WML129-001	✓
ES1823191-006	08-Aug-2018 11:37	WML183-001	✓
ES1823191-007	08-Aug-2018 13:17	WML120B-001	✓
ES1823191-008	08-Aug-2018 13:38	WML120A-001	✓
ES1823191-009	08-Aug-2018 14:05	WMLP302-001	✓

Proactive Holding Time Report

Sample(s) have been received within the recommended holding times for the requested analysis.

Requested Deliverables

ALL INVOICES

- A4 - AU Tax Invoice (INV)	Email	brisbane@ageconsultants.com.au

KADE HANCOCK

- *AU Certificate of Analysis - NATA (COA)	Email	kade@ageconsultants.com.au
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	kade@ageconsultants.com.au
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	kade@ageconsultants.com.au
- A4 - AU Sample Receipt Notification - Environmental HT (SRN)	Email	kade@ageconsultants.com.au
- A4 - AU Tax Invoice (INV)	Email	kade@ageconsultants.com.au
- Chain of Custody (CoC) (COC)	Email	kade@ageconsultants.com.au
- EDI Format - ENMRG (ENMRG)	Email	kade@ageconsultants.com.au
- EDI Format - ESDAT (ESDAT)	Email	kade@ageconsultants.com.au

CHAIN OF CUSTODY

ALS Environmental

ALS Laboratory: please tick →

☐ADELAIDE 21 Burma Road Pooraka SA 5095 Ph: 08 8359 0890 E: adelaide@alsglobal.com

☐BRISBANE 32 Shand Street Stafford QLD 4053 Ph: 07 3243 7222 E: samples.brisbane@alsglobal.com

☐GLADSTONE 46 Callemondah Drive Clinton QLD 4680 Ph: 07 7471 5600 E: gladstone@alsglobal.com

☐MACKAY 78 Harbour Road Mackay QLD 4740 Ph: 07 4944 0177 E: mackay@alsglobal.com

☐MELBOURNE 2-4 Westall Road Springvale VIC 3171 Ph: 03 8549 9600 E: samples.melbourne@alsglobal.com

☐MUDGEE 27 Sydney Road Mudgee NSW 2850 Ph: 02 6372 6735 E: mudgee.mail@alsglobal.com

☐NEWCASTLE 5/585 Maitland Rd Mayfield West NSW 2304 Ph: 02 4014 2500 E: samples.newcastle@alsglobal.com

☐NOWRA 4/13 Geary Place North Nowra NSW 2541 Ph: 024423 2063 E: nowra@alsglobal.com

☐PERTH 10 Hod Way Malaga WA 6090 Ph: 08 9209 7655 E: samples.perth@alsglobal.com

☐SYDNEY 277-289 Woodpark Road Smithfield NSW 2164 Ph: 02 8784 8555 E: samples.sydney@alsglobal.com

☐TOWNSVILLE 14-15 Desma Court Bohle QLD 4818 Ph: 07 4796 0600 E: townsville.environmental@alsglobal.com

☐WOLLONGONG 99 Kenny Street Wollongong NSW 2500 Ph: 02 4225 3125 E: portkembla@alsglobal.com

CLIENT: AGE Consultants	**TURNAROUND REQUIREMENTS:** (Standard TAT may be longer for some tests e.g., Ultra Trace Organics)	☐ Standard TAT (List due date):	**FOR LABORATORY USE ONLY (Circle)**
OFFICE: Newcastle		☐ Non Standard or urgent TAT (List due date):	Custody Seal Intact? Yes No N/A
PROJECT: G1922B August 2018	**ALS QUOTE NO.:** SY/374/17	**COC SEQUENCE NUMBER (Circle)** COC: 1 2 3 OF: 1 2 3 4 5 6 7	Free Ice / Ice Bricks present upon receipt? Yes No N/A
ORDER NUMBER:			Random Sample Temperature on Receipt: -0.9 °C
PROJECT MANAGER: Costante Conte	**CONTACT PH:** 02 4962 2091		Offset comment:
SAMPLER: Kade Hancock	**SAMPLER MOBILE:** 0448 175 718		
COC emailed to ALS? (YES / NO)	**EDD FORMAT (or default):**		
Email Reports to (will default to PM if no other addresses are listed): Kade@ageconsultants.com.au			
Email Invoice to (will default to PM if no other addresses are listed):			

RELINQUISHED BY:	RECEIVED BY:	RELINQUISHED BY:	RECEIVED BY:
DATE/TIME: 8.8.18 3:35	DATE/TIME: 8/8/18 15:35	DATE/TIME:	DATE/TIME: 8/8/18 7.30

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE	SAMPLE DETAILS MATRIX: SOLID (S) WATER (W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).										Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL CONTAINERS	EA005P - pH	EA010P - EC	NT1 & NT2 - Ca, Mg, Na, K, Cl, S04, alkalinity	W-1 (7 metals)	EG020 - Fe, Mn, Se	EA015H - TDS	EA045 - turbidity	NT-11 - Total P, Total N	EK058G - NOx	ED035 - HCO3	EK026SF - Cyanide	Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.
1	WML181-001	8-8-18 8:43	W		5	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
2	WML119-001	8-8-18 9:16	W		5	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	PW@WN
3	WML262-001	8-8-18 10:02	W		5	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
4	WMLP301-001	8-8-18 10:40	W		5	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
5	WML129-001	8-8-18 11:22	W		5	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
6	WML183-001	8-8-18 11:37	W		5	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
7	WML208-001	8-8-18 11:17	W		5	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
8	WML120A-001	8-8-18 1:38	W		5	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
9	WMLP302-001	8-8-18 2:00	W		5	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
				TOTAL													

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP = Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

LAB OF ORIGIN: NEWCASTLE

EMAILED

LAB OF ORIGIN: NEWCASTLE

Environmental Division Sydney

Work Order Reference

ES1823191

Telephone : + 61-2-8784 8555

ALS Environmental

QUALITY CONTROL REPORT

Work Order	: **ES1823369**	Page	: 1 of 7
Client	: **AUSTRALASIAN GROUNDWATER AND ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR KADE HANCOCK	Contact	: Customer Services ES
Address	: 4 HUDSON STREET HAMILTON NSW 2303	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: +61-2-8784 8555
Project	: G1922B AUGUST 2018	Date Samples Received	: 09-Aug-2018
Order number	:	Date Analysis Commenced	: 09-Aug-2018
C-O-C number	: ----	Issue Date	: 15-Aug-2018
Sampler	: KADE HANCOCK		
Site	: ----		
Quote number	: SY/374/17		
No. of samples received	: 5		
No. of samples analysed	: 5		

ilac-MRA NATA
Accreditation No. 825
Accredited for compliance with ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW
Neil Martin	Team Leader - Chemistry	Chemistry, Newcastle West, NSW

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EA005: pH (QC Lot: 1864722)									
ES1823369-001	WMLP325-001	EA005: pH Value	----	0.01	pH Unit	7.26	7.26	0.00	0% - 20%
ES1823378-001	Anonymous	EA005: pH Value	----	0.01	pH Unit	8.39	8.39	0.00	0% - 20%
EA010P: Conductivity by PC Titrator (QC Lot: 1866887)									
ES1823306-001	Anonymous	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	26900	26800	0.398	0% - 20%
ES1823369-004	WMLP324-001	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	1250	1260	0.395	0% - 20%
EA015: Total Dissolved Solids dried at 180 ± 5 °C (QC Lot: 1871070)									
ES1823296-003	Anonymous	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	352	422	17.9	0% - 20%
ES1823296-013	Anonymous	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	1300	1450	10.5	0% - 20%
EA045: Turbidity (QC Lot: 1867116)									
ES1823318-005	Anonymous	EA045: Turbidity	----	0.1	NTU	148	147	0.678	0% - 20%
ES1823370-003	Anonymous	EA045: Turbidity	----	0.1	NTU	14.9	14.6	2.03	0% - 20%
ED037P: Alkalinity by PC Titrator (QC Lot: 1866886)									
ES1823157-001	Anonymous	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	<1	<1	0.00	No Limit
ES1823369-004	WMLP324-001	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	249	250	0.00	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	249	250	0.00	0% - 20%
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QC Lot: 1866159)									
ES1823298-008	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	1700	1800	5.30	0% - 20%
EW1803117-007	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	23	23	0.00	0% - 20%
ED045G: Chloride by Discrete Analyser (QC Lot: 1866158)									

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
ED045G: Chloride by Discrete Analyser (QC Lot: 1866158) - continued									
ES1823298-008	Anonymous	ED045G: Chloride	16887-00-6	1	mg/L	5910	5910	0.0824	0% - 20%
EW1803117-007	Anonymous	ED045G: Chloride	16887-00-6	1	mg/L	432	424	1.84	0% - 20%
ED093F: Dissolved Major Cations (QC Lot: 1867653)									
ES1823345-003	Anonymous	ED093F: Calcium	7440-70-2	1	mg/L	2	2	0.00	No Limit
		ED093F: Magnesium	7439-95-4	1	mg/L	1	1	0.00	No Limit
		ED093F: Sodium	7440-23-5	1	mg/L	23	25	7.34	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	2	2	0.00	No Limit
ES1823157-001	Anonymous	ED093F: Calcium	7440-70-2	1	mg/L	63	72	13.0	0% - 20%
		ED093F: Magnesium	7439-95-4	1	mg/L	97	108	11.0	0% - 20%
		ED093F: Sodium	7440-23-5	1	mg/L	649	755	15.2	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	12	14	18.8	0% - 50%
EG020F: Dissolved Metals by ICP-MS (QC Lot: 1867650)									
ES1823312-002	Anonymous	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	0.007	148	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	0.078	0.082	4.12	0% - 20%
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	0.001	0.00	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	0.192	0.196	1.94	0% - 20%
		EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Iron	7439-89-6	0.05	mg/L	0.58	0.59	0.00	0% - 50%
ES1823038-001	Anonymous	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	0.021	0.022	0.00	0% - 20%
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	0.00	No Limit
		EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.00	No Limit
EG020F: Dissolved Metals by ICP-MS (QC Lot: 1867655)									
ES1823369-005	WMLP323-001	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	0.008	0.008	0.00	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	0.023	0.022	4.99	0% - 20%
		EG020A-F: Lead	7439-92-1	0.001	mg/L	0.002	0.002	0.00	No Limit
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	0.134	0.131	2.27	0% - 20%
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	0.008	0.008	0.00	No Limit

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EG020F: Dissolved Metals by ICP-MS (QC Lot: 1867655) - continued									
ES1823369-005	WMLP323-001	EG020A-F: Zinc	7440-66-6	0.005	mg/L	0.024	0.022	7.11	No Limit
		EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Iron	7439-89-6	0.05	mg/L	0.92	0.90	2.51	0% - 50%
EW1803170-002	Anonymous	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	0.002	0.002	0.00	No Limit
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	0.00	No Limit
		EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.00	No Limit
EK026SF: Total CN by Segmented Flow Analyser (QC Lot: 1864123)									
ES1823298-008	Anonymous	EK026SF: Total Cyanide	57-12-5	0.004	mg/L	<0.004	<0.004	0.00	No Limit
EW1803178-002	Anonymous	EK026SF: Total Cyanide	57-12-5	0.004	mg/L	<0.004	<0.004	0.00	No Limit
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 1867556)									
ES1823352-001	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	2.98	3.32	10.9	0% - 20%
ES1823138-001	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.02	86.0	No Limit
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 1867559)									
ES1823138-001	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	5.7	5.9	2.45	0% - 20%
ES1823362-001	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	66.8	61.8	7.78	0% - 20%
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 1867558)									
ES1823138-001	Anonymous	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.14	0.15	7.30	0% - 50%
ES1823362-001	Anonymous	EK067G: Total Phosphorus as P	----	0.01	mg/L	8.61	8.87	3.02	0% - 20%

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Spike (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EA005: pH (QCLot: 1864722)								
EA005: pH Value	----	----	pH Unit	----	7.6 pH Unit	100	99	102
EA010P: Conductivity by PC Titrator (QCLot: 1866887)								
EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	<1	2000 µS/cm	101	95	113
EA015: Total Dissolved Solids dried at 180 ± 5 °C (QCLot: 1871070)								
EA015H: Total Dissolved Solids @180°C	----	10	mg/L	<10	2000 mg/L	104	87	109
				<10	293 mg/L	86.9	66	126
EA045: Turbidity (QCLot: 1867116)								
EA045: Turbidity	----	0.1	NTU	<0.1	40 NTU	101	91	105
ED037P: Alkalinity by PC Titrator (QCLot: 1866886)								
ED037-P: Total Alkalinity as CaCO3	----	----	mg/L	----	200 mg/L	# 119	81	111
				----	50 mg/L	111	70	130
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 1866159)								
ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	25 mg/L	96.4	82	122
ED045G: Chloride by Discrete Analyser (QCLot: 1866158)								
ED045G: Chloride	16887-00-6	1	mg/L	<1	10 mg/L	88.6	81	127
				<1	1000 mg/L	105	81	127
ED093F: Dissolved Major Cations (QCLot: 1867653)								
ED093F: Calcium	7440-70-2	1	mg/L	<1	50 mg/L	97.7	80	114
ED093F: Magnesium	7439-95-4	1	mg/L	<1	50 mg/L	93.9	90	116
ED093F: Sodium	7440-23-5	1	mg/L	<1	50 mg/L	91.6	82	120
ED093F: Potassium	7440-09-7	1	mg/L	<1	50 mg/L	95.8	85	113
EG020F: Dissolved Metals by ICP-MS (QCLot: 1867650)								
EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	92.3	85	114
EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	90.8	84	110
EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	89.4	85	111
EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	0.1 mg/L	86.3	81	111
EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	89.6	83	111
EG020A-F: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	93.3	82	110
EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	86.4	82	112
EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	0.1 mg/L	95.0	85	115
EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	0.1 mg/L	86.5	81	117
EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	92.1	82	112
EG020F: Dissolved Metals by ICP-MS (QCLot: 1867655)								

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report: Result	Laboratory Control Spike (LCS) Report: Spike Concentration	Spike Recovery (%): LCS	Recovery Limits (%): Low	Recovery Limits (%): High
EG020F: Dissolved Metals by ICP-MS (QCLot: 1867655) - continued								
EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	86.6	85	114
EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	88.1	84	110
EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	87.5	85	111
EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	0.1 mg/L	85.8	81	111
EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	85.4	83	111
EG020A-F: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	87.6	82	110
EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	86.0	82	112
EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	0.1 mg/L	85.4	85	115
EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	0.1 mg/L	86.6	81	117
EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	89.3	82	112
EK026SF: Total CN by Segmented Flow Analyser (QCLot: 1864123)								
EK026SF: Total Cyanide	57-12-5	0.004	mg/L	<0.004	0.2 mg/L	109	73	133
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 1867556)								
EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.5 mg/L	101	91	113
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 1867559)								
EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	10 mg/L	87.8	69	101
				<0.1	1 mg/L	110	70	118
				<0.1	5 mg/L	95.0	74	118
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 1867558)								
EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	4.42 mg/L	96.4	71	101
				<0.01	0.442 mg/L	108	72	108
				<0.01	1 mg/L	106	78	118

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report: Spike Concentration	SpikeRecovery(%): MS	Recovery Limits (%): Low	Recovery Limits (%): High
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 1866159)							
ES1823298-008	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	10 mg/L	# Not Determined	70	130
ED045G: Chloride by Discrete Analyser (QCLot: 1866158)							
ES1823298-008	Anonymous	ED045G: Chloride	16887-00-6	250 mg/L	# Not Determined	70	130
EG020F: Dissolved Metals by ICP-MS (QCLot: 1867650)							
ES1823157-001	Anonymous	EG020A-F: Arsenic	7440-38-2	1 mg/L	90.5	70	130

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EG020F: Dissolved Metals by ICP-MS (QCLot: 1867650) - continued							
ES1823157-001	Anonymous	EG020A-F: Cadmium	7440-43-9	0.25 mg/L	85.6	70	130
		EG020A-F: Chromium	7440-47-3	1 mg/L	88.7	70	130
		EG020A-F: Copper	7440-50-8	1 mg/L	80.4	70	130
		EG020A-F: Lead	7439-92-1	1 mg/L	80.7	70	130
		EG020A-F: Manganese	7439-96-5	1 mg/L	70.5	70	130
		EG020A-F: Nickel	7440-02-0	1 mg/L	82.1	70	130
		EG020A-F: Zinc	7440-66-6	1 mg/L	82.2	70	130
EG020F: Dissolved Metals by ICP-MS (QCLot: 1867655)							
ES1823370-001	Anonymous	EG020A-F: Arsenic	7440-38-2	1 mg/L	88.2	70	130
		EG020A-F: Cadmium	7440-43-9	0.25 mg/L	90.5	70	130
		EG020A-F: Chromium	7440-47-3	1 mg/L	97.8	70	130
		EG020A-F: Copper	7440-50-8	1 mg/L	87.3	70	130
		EG020A-F: Lead	7439-92-1	1 mg/L	85.5	70	130
		EG020A-F: Manganese	7439-96-5	1 mg/L	88.1	70	130
		EG020A-F: Nickel	7440-02-0	1 mg/L	86.6	70	130
		EG020A-F: Zinc	7440-66-6	1 mg/L	87.1	70	130
EK026SF: Total CN by Segmented Flow Analyser (QCLot: 1864123)							
ES1823298-008	Anonymous	EK026SF: Total Cyanide	57-12-5	0.4 mg/L	98.6	70	130
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 1867556)							
ES1823138-001	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.5 mg/L	103	70	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 1867559)							
ES1823138-002	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	5 mg/L	93.6	70	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 1867558)							
ES1823138-002	Anonymous	EK067G: Total Phosphorus as P	----	1 mg/L	112	70	130

ALS Environmental

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **ES1823369**	Page	: 1 of 8
Client	: **AUSTRALASIAN GROUNDWATER AND ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR KADE HANCOCK	Telephone	: +61-2-8784 8555
Project	: G1922B AUGUST 2018	Date Samples Received	: 09-Aug-2018
Site	: ----	Issue Date	: 15-Aug-2018
Sampler	: KADE HANCOCK	No. of samples received	: 5
Order number	:	No. of samples analysed	: 5

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **Laboratory Control outliers exist - please see following pages for full details.**
- **Matrix Spike outliers exist - please see following pages for full details.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **NO Analysis Holding Time Outliers exist.**

Outliers : Frequency of Quality Control Samples

- **NO Quality Control Sample Frequency Outliers exist.**

Outliers : Quality Control Samples

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **WATER**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Laboratory Control Spike (LCS) Recoveries							
ED037P: Alkalinity by PC Titrator	QC-1866886-001	----	**Total Alkalinity as CaCO3**	----	119 %	81-111%	**Recovery greater than upper control limit**
Matrix Spike (MS) Recoveries							
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA	ES1823298--008	Anonymous	**Sulfate as SO4 - Turbidimetric**	14808-79-8	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
ED045G: Chloride by Discrete Analyser	ES1823298--008	Anonymous	**Chloride**	16887-00-6	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA005: pH							
Clear Plastic Bottle - Natural (EA005)							
WMLP325-001, WMLP311-001, WMLP308-001, WMLP324-001, WMLP323-001	**09-Aug-2018**	**----**	----	----	**09-Aug-2018**	09-Aug-2018	✓
EA010P: Conductivity by PC Titrator							
Clear Plastic Bottle - Natural (EA010-P)							
WMLP325-001, WMLP311-001, WMLP308-001, WMLP324-001, WMLP323-001	**09-Aug-2018**	**----**	----	----	**10-Aug-2018**	06-Sep-2018	✓
EA015: Total Dissolved Solids dried at 180 ± 5 °C							
Clear Plastic Bottle - Natural (EA015H)							
WMLP325-001, WMLP311-001, WMLP308-001, WMLP324-001, WMLP323-001	**09-Aug-2018**	**----**	----	----	**14-Aug-2018**	16-Aug-2018	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA045: Turbidity							
Clear Plastic Bottle - Natural (EA045)							
WMLP325-001, WMLP311-001, WMLP308-001, WMLP324-001, WMLP323-001	**09-Aug-2018**	**----**	----	----	**11-Aug-2018**	11-Aug-2018	✓
ED037P: Alkalinity by PC Titrator							
Clear Plastic Bottle - Natural (ED037-P)							
WMLP325-001, WMLP311-001, WMLP308-001, WMLP324-001, WMLP323-001	**09-Aug-2018**	**----**	----	----	**10-Aug-2018**	23-Aug-2018	✓
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA							
Clear Plastic Bottle - Natural (ED041G)							
WMLP325-001, WMLP311-001, WMLP308-001, WMLP324-001, WMLP323-001	**09-Aug-2018**	**----**	----	----	**10-Aug-2018**	06-Sep-2018	✓
ED045G: Chloride by Discrete Analyser							
Clear Plastic Bottle - Natural (ED045G)							
WMLP325-001, WMLP311-001, WMLP308-001, WMLP324-001, WMLP323-001	**09-Aug-2018**	**----**	----	----	**10-Aug-2018**	06-Sep-2018	✓
ED093F: Dissolved Major Cations							
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F)							
WMLP325-001, WMLP311-001, WMLP308-001, WMLP324-001, WMLP323-001	**09-Aug-2018**	**----**	----	----	**13-Aug-2018**	06-Sep-2018	✓
EG020F: Dissolved Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F)							
WMLP325-001, WMLP311-001, WMLP308-001, WMLP324-001, WMLP323-001	**09-Aug-2018**	**----**	----	----	**13-Aug-2018**	05-Feb-2019	✓
EK026SF: Total CN by Segmented Flow Analyser							
Opaque plastic bottle - NaOH (EK026SF)							
WMLP325-001, WMLP311-001, WMLP308-001, WMLP324-001, WMLP323-001	**09-Aug-2018**	**----**	----	----	**10-Aug-2018**	23-Aug-2018	✓
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK059G)							
WMLP325-001, WMLP311-001, WMLP308-001, WMLP324-001, WMLP323-001	**09-Aug-2018**	**----**	----	----	**13-Aug-2018**	06-Sep-2018	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK061G)							
WMLP325-001, WMLP311-001, WMLP308-001, WMLP324-001, WMLP323-001	**09-Aug-2018**	**13-Aug-2018**	06-Sep-2018	✓	**13-Aug-2018**	06-Sep-2018	✓
EK067G: Total Phosphorus as P by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK067G)							
WMLP325-001, WMLP311-001, WMLP308-001, WMLP324-001, WMLP323-001	**09-Aug-2018**	**13-Aug-2018**	06-Sep-2018	✓	**13-Aug-2018**	06-Sep-2018	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Alkalinity by PC Titrator	ED037-P	2	18	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	4	32	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	2	17	**11.76**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH	EA005	2	14	**14.29**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Cyanide by Segmented Flow Analyser	EK026SF	2	11	**18.18**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Turbidity	EA045	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Alkalinity by PC Titrator	ED037-P	2	18	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	32	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH	EA005	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Cyanide by Segmented Flow Analyser	EK026SF	2	11	**18.18**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	3	20	**15.00**	**15.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	3	20	**15.00**	**15.00**	✓	NEPM 2013 B3 & ALS QC Standard
Turbidity	EA045	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Chloride by Discrete Analyser	ED045G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	32	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Cyanide by Segmented Flow Analyser	EK026SF	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Method Blanks (MB) - Continued							
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Turbidity	EA045	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Chloride by Discrete Analyser	ED045G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	32	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Cyanide by Segmented Flow Analyser	EK026SF	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
pH	EA005	WATER	In house: Referenced to APHA 4500 H+ B. pH of water samples is determined by ISE either manually or by automated pH meter. This method is compliant with NEPM (2013) Schedule B(3)
Conductivity by PC Titrator	EA010-P	WATER	In house: Referenced to APHA 2510 B. This procedure determines conductivity by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Total Dissolved Solids (High Level)	EA015H	WATER	In house: Referenced to APHA 2540C. A gravimetric procedure that determines the amount of `filterable` residue in an aqueous sample. A well-mixed sample is filtered through a glass fibre filter (1.2um). The filtrate is evaporated to dryness and dried to constant weight at 180+/-5C. This method is compliant with NEPM (2013) Schedule B(3)
Turbidity	EA045	WATER	In house: Referenced to APHA 2130 B. This method is compliant with NEPM (2013) Schedule B(3)
Alkalinity by PC Titrator	ED037-P	WATER	In house: Referenced to APHA 2320 B This procedure determines alkalinity by automated measurement (e.g. PC Titrate) using pH 4.5 for indicating the total alkalinity end-point. This method is compliant with NEPM (2013) Schedule B(3)
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	WATER	In house: Referenced to APHA 4500-SO4. Dissolved sulfate is determined in a 0.45um filtered sample. Sulfate ions are converted to a barium sulfate suspension in an acetic acid medium with barium chloride. Light absorbance of the BaSO4 suspension is measured by a photometer and the SO4-2 concentration is determined by comparison of the reading with a standard curve. This method is compliant with NEPM (2013) Schedule B(3)
Chloride by Discrete Analyser	ED045G	WATER	In house: Referenced to APHA 4500 Cl - G.The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride.in the presence of ferric ions the librated thiocynate forms highly-coloured ferric thiocynate which is measured at 480 nm APHA 21st edition seal method 2 017-1-L april 2003
Major Cations - Dissolved	ED093F	WATER	In house: Referenced to APHA 3120 and 3125; USEPA SW 846 - 6010 and 6020; Cations are determined by either ICP-AES or ICP-MS techniques. This method is compliant with NEPM (2013) Schedule B(3) Sodium Adsorption Ratio is calculated from Ca, Mg and Na which determined by ALS in house method QWI-EN/ED093F. This method is compliant with NEPM (2013) Schedule B(3) Hardness parameters are calculated based on APHA 2340 B. This method is compliant with NEPM (2013) Schedule B(3)
Dissolved Metals by ICP-MS - Suite A	EG020A-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45µm filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.

Analytical Methods	Method	Matrix	Method Descriptions
Total Cyanide by Segmented Flow Analyser	EK026SF	WATER	In house: Referenced to APHA 4500-CN C / ASTM D7511. Sodium hydroxide preserved samples are introduced into an automated segmented flow analyser. Complex bound cyanide is decomposed in a continuously flowing stream, at a pH of 3.8, by the effect of UV light. A UV-B lamp (312 nm) and a decomposition spiral of borosilicate glass are used to filter out UV light with a wavelength of less than 290 nm thus preventing the conversion of thiocyanate into cyanide. The hydrogen cyanide present at a pH of 3.8 is separated by gas dialysis. The hydrogen cyanide is then determined photometrically, based on the reaction of cyanide with chloramine-T to form cyanogen chloride. This then reacts with 4-pyridine carboxylic acid and 1,3-dimethylbarbituric acid to give a red colour which is measured at 600 nm. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	WATER	In house: Referenced to APHA 4500-NO3- F. Combined oxidised Nitrogen (NO2+NO3) is determined by Chemical Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	WATER	In house: Referenced to APHA 4500-Norg D (In house). An aliquot of sample is digested using a high temperature Kjeldahl digestion to convert nitrogenous compounds to ammonia. Ammonia is determined colorimetrically by discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Nitrogen as N (TKN + Nox) By Discrete Analyser	EK062G	WATER	In house: Referenced to APHA 4500-Norg / 4500-NO3-. This method is compliant with NEPM (2013) Schedule B(3)
Total Phosphorus as P By Discrete Analyser	EK067G	WATER	In house: Referenced to APHA 4500-P H, Jirka et al (1976), Zhang et al (2006). This procedure involves sulphuric acid digestion of a sample aliquot to break phosphorus down to orthophosphate. The orthophosphate reacts with ammonium molybdate and antimony potassium tartrate to form a complex which is then reduced and its concentration measured at 880nm using discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Ionic Balance by PCT DA and Turbi SO4 DA	EN055 - PG	WATER	In house: Referenced to APHA 1030F. This method is compliant with NEPM (2013) Schedule B(3)

Preparation Methods	Method	Matrix	Method Descriptions
TKN/TP Digestion	EK061/EK067	WATER	In house: Referenced to APHA 4500 Norg - D; APHA 4500 P - H. This method is compliant with NEPM (2013) Schedule B(3)

SAMPLE RECEIPT NOTIFICATION (SRN)

Work Order	: **ES1823369**		
Client	: **AUSTRALASIAN GROUNDWATER AND ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR KADE HANCOCK	Contact	: Customer Services ES
Address	: 4 HUDSON STREET HAMILTON NSW 2303	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: kade@ageconsultants.com.au	E-mail	: ALSEnviro.Sydney@alsglobal.com
Telephone	: ----	Telephone	: +61-2-8784 8555
Facsimile	: ----	Facsimile	: +61-2-8784 8500
Project	: G1922B AUGUST 2018	Page	: 1 of 2
Order number	:	Quote number	: ES2017AUSGRO0002 (SY/374/17)
C-O-C number	: ----	QC Level	: NEPM 2013 B3 & ALS QC Standard
Site	: ----		
Sampler	: KADE HANCOCK		

Dates

Date Samples Received	: 09-Aug-2018 15:40	Issue Date	: 09-Aug-2018
Client Requested Due Date	: 15-Aug-2018	Scheduled Reporting Date	: **15-Aug-2018**

Delivery Details

Mode of Delivery	: Undefined	Security Seal	: Not Available
No. of coolers/boxes	: 1	Temperature	: -0.1'C - Ice present
Receipt Detail	:	No. of samples received / analysed	: 5 / 5

General Comments

- This report contains the following information:
  - Sample Container(s)/Preservation Non-Compliances
  - Summary of Sample(s) and Requested Analysis
  - Proactive Holding Time Report
  - Requested Deliverables
- **ED035 is not a valid code, alkalinity has been logged.**
- **Please refer to the Proactive Holding Time Report table below which summarises breaches of recommended holding times that have occurred prior to samples/instructions being received at the laboratory. The absence of this summary table indicates that all samples have been received within the recommended holding times for the analysis requested.**
- **pH analysis will be conducted by ALS Newcastle-Water.**
- Please direct any queries you have regarding this work order to the above ALS laboratory contact.
- Analytical work for this work order will be conducted at ALS Sydney.
- Sample Disposal - Aqueous (3 weeks), Solid (2 months) from receipt of samples.

Sample Container(s)/Preservation Non-Compliances

All comparisons are made against pretreatment/preservation AS, APHA, USEPA standards.

- **No sample container / preservation non-compliance exists.**

Summary of Sample(s) and Requested Analysis

Some items described below may be part of a laboratory process necessary for the execution of client requested tasks. Packages may contain additional analyses, such as the determination of moisture content and preparation tasks, that are included in the package.
If no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory and displayed in brackets without a time component

Matrix: **WATER**

Laboratory sample ID	Client sampling date / time	Client sample ID	WATER - EA005: pH pH	WATER - EA010P Electrical Conductivity (PCT)	WATER - EA015H Total Dissolved Solids - Standard Level	WATER - EG020F Dissolved Metals by ICP/MS	WATER - EK026SF Total Cyanide by Segmented Flow Analyser	WATER - NT-01 & 02 Ca, Mg, Na, K, Cl, SO4, Alkalinity	WATER - NT-11 Total Nitrogen and Total Phosphorus
ES1823369-001	09-Aug-2018 08:16	WMLP325-001	✓	✓	✓	✓	✓	✓	✓
ES1823369-002	09-Aug-2018 08:33	WMLP311-001	✓	✓	✓	✓	✓	✓	✓
ES1823369-003	09-Aug-2018 09:30	WMLP308-001	✓	✓	✓	✓	✓	✓	✓
ES1823369-004	09-Aug-2018 10:18	WMLP324-001	✓	✓	✓	✓	✓	✓	✓
ES1823369-005	09-Aug-2018 10:47	WMLP323-001	✓	✓	✓	✓	✓	✓	✓

Matrix: **WATER**

Laboratory sample ID	Client sampling date / time	Client sample ID	WATER - EA045 Turbidity
ES1823369-001	09-Aug-2018 08:16	WMLP325-001	✓
ES1823369-002	09-Aug-2018 08:33	WMLP311-001	✓
ES1823369-003	09-Aug-2018 09:30	WMLP308-001	✓
ES1823369-004	09-Aug-2018 10:18	WMLP324-001	✓
ES1823369-005	09-Aug-2018 10:47	WMLP323-001	✓

Proactive Holding Time Report

Sample(s) have been received within the recommended holding times for the requested analysis.

Requested Deliverables

ALL INVOICES

- A4 - AU Tax Invoice (INV)	Email	brisbane@ageconsultants.com.au

KADE HANCOCK

- *AU Certificate of Analysis - NATA (COA)	Email	kade@ageconsultants.com.au
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	kade@ageconsultants.com.au
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	kade@ageconsultants.com.au
- A4 - AU Sample Receipt Notification - Environmental HT (SRN)	Email	kade@ageconsultants.com.au
- A4 - AU Tax Invoice (INV)	Email	kade@ageconsultants.com.au
- Chain of Custody (CoC) (COC)	Email	kade@ageconsultants.com.au
- EDI Format - ENMRG (ENMRG)	Email	kade@ageconsultants.com.au
- EDI Format - ESDAT (ESDAT)	Email	kade@ageconsultants.com.au

LAB OF ORIGIN: NEWCASTLE

CHAIN OF CUSTODY

ALS Environmental

ALS Laboratory: please tick →

☐ADELAIDE 21 Burma Road Pooraka SA 5095 Ph: 08 8359 0890 E: adelaide@alsglobal.com

☐BRISBANE 32 Shand Street Stafford QLD 4053 Ph: 07 3243 7222 E: samples.brisbane@alsglobal.com

☐GLADSTONE 46 Callemondah Drive Clinton QLD 4680 Ph: 07 7471 5600 E: gladstone@alsglobal.com

☐MACKAY 78 Harbour Road Mackay QLD 4740 Ph: 07 4944 0177 E: mackay@alsglobal.com

☐MELBOURNE 2-4 Westall Road Springvale VIC 3171 Ph: 03 8549 9600 E: samples.melbourne@alsglobal.com

☐MUDGEE 27 Sydney Road Mudgee NSW 2850 Ph: 02 6372 6735 E: mudgee.mail@alsglobal.com

☐NEWCASTLE 5/585 Maitland Rd Mayfield West NSW 2304 Ph: 02 4014 2500 E: samples.newcastle@alsglobal.com

☐NOWRA 4/13 Geary Place North Nowra NSW 2541 Ph: 024423 2063 E: nowra@alsglobal.com

☐PERTH 10 Hod Way Malaga WA 6090 Ph: 08 9209 7655 E: samples.perth@alsglobal.com

☐SYDNEY 277-289 Woodpark Road Smithfield NSW 2164 Ph: 02 8784 8555 E: samples.sydney@alsglobal.com

☐TOWNSVILLE 14-15 Desma Court Bohle QLD 4818 Ph: 07 4796 0600 E: townsville.environmental@alsglobal.com

☐WOLLONGONG 99 Kenny Street Wollongong NSW 2500 Ph: 02 4225 3125 E: portkembla@alsglobal.com

CLIENT: AGE Consultants	TURNAROUND REQUIREMENTS : (Standard TAT may be longer for some tests e.g., Ultra Trace Organics)	☐ Standard TAT (List due date):	FOR LABORATORY USE ONLY (Circle)
OFFICE: [illegible]		☐ Non Standard or urgent TAT (List due date):	Custody Seal Intact? Yes / No / N/A
PROJECT: G1922B August 2018	ALS QUOTE NO.: SY/374/17	COC SEQUENCE NUMBER (Circle) COC: 1 2 3 4 5 6 7	Free ice / frozen ice bricks present upon receipt? Yes / No / N/A
ORDER NUMBER:		OF: 1 2 3 4 5 6 7	Random Sample Temperature on Receipt: -0.1 °C
PROJECT MANAGER: Costante Conte	CONTACT PH: 02 4962 2091		Other comment:
SAMPLER: Kade Hancock	SAMPLER MOBILE: 0448 175 718		
COC emailed to ALS? (YES / NO)	EDD FORMAT (or default):		
Email Reports to (will default to PM if no other addresses are listed): Kade@ageconsultants.com.au			
Email Invoice to (will default to PM if no other addresses are listed):			

RELINQUISHED BY:	RECEIVED BY:	RELINQUISHED BY:	RECEIVED BY:
K Hancock	K A		MC
DATE/TIME: 9·8·18 3.40.	DATE/TIME: 9/8/18 15.40	DATE/TIME:	DATE/TIME: 9/8/18 7:30pm

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE	SAMPLE DETAILS MATRIX: SOLID (S) WATER (W)			CONTAINER INFORMATION	ANALYSIS REQUIRED Including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).										Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL CONTAINERS	EA005P - pH	EA010P - EC	NT1 & NT2 - Ca, Mg, Na, K, Cl, S04, alkalinity	W-1 (7 metals)	EG020 - Fe, Mn, Se	EA015H - TDS	EA045 - turbidity	NT-11 - Total P, Total N	EK058G - NO3	ED036 - HCO3	EK026SF - Cyanide	Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.
	~~Ashton house~~																
	~~Ashton well 001~~	~~9.8.18~~	W		~~2~~	~~X~~	~~X~~	~~X~~									
1	WMLP325 - 001	9.8.18 8:16	W		5	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
2	WMLP311 - 001	9.8.18 8:33	W		5	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
3	WMLP308 - 001	9.8.18 9:30	W		5	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
4	WMLP324 - 001	9.8.18 10:18	W		5	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
5	WMLP323 - 001	9.8.18 10:47	W		5	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
				TOTAL													

E-MAILED

Environmental Division Sydney
Work Order Reference
ES1823369

Telephone : +61-2-8784 8555

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Pr
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

PH@WN

ALS Environmental

QUALITY CONTROL REPORT

Work Order	: **ES1823636**	Page	: 1 of 7
Client	: **AUSTRALASIAN GROUNDWATER AND ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR KADE HANCOCK	Contact	: Customer Services ES
Address	: 4 HUDSON STREET HAMILTON NSW 2303	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: +61-2-8784 8555
Project	: G1922B AUGUST 2018	Date Samples Received	: 13-Aug-2018
Order number	:	Date Analysis Commenced	: 13-Aug-2018
C-O-C number	: ----	Issue Date	: 17-Aug-2018
Sampler	: KADE HANCOCK		
Site	: ----		
Quote number	: SY/374/17		
No. of samples received	: 7		
No. of samples analysed	: 7		

ilac-MRA NATA
Accreditation No. 825
Accredited for compliance with ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW
Katie Draper	Quality Coordinator	Chemistry, Newcastle West, NSW

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EA005: pH (QC Lot: 1869056)									
WN1804298-003	Anonymous	EA005: pH Value	----	0.01	pH Unit	7.84	7.84	0.00	0% - 20%
ES1823695-001	Anonymous	EA005: pH Value	----	0.01	pH Unit	7.23	7.26	0.414	0% - 20%
EA010P: Conductivity by PC Titrator (QC Lot: 1870344)									
ES1823636-007	WML261-001	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	1250	1250	0.0809	0% - 20%
ES1823636-001	WMLP337-001	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	2900	2890	0.351	0% - 20%
EA015: Total Dissolved Solids dried at 180 ± 5 °C (QC Lot: 1873594)									
ES1823584-004	Anonymous	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	120	110	9.11	0% - 50%
ES1823658-001	Anonymous	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	350	356	1.70	0% - 20%
EA045: Turbidity (QC Lot: 1874878)									
ES1823636-001	WMLP337-001	EA045: Turbidity	----	0.1	NTU	3180	3160	0.505	0% - 20%
ES1823698-006	Anonymous	EA045: Turbidity	----	0.1	NTU	20.5	20.0	2.47	0% - 20%
ED037P: Alkalinity by PC Titrator (QC Lot: 1870345)									
ES1823636-001	WMLP337-001	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	438	432	1.32	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	438	432	1.32	0% - 20%
ES1823685-001	Anonymous	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	268	256	4.86	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	268	256	4.86	0% - 20%
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QC Lot: 1870978)									
ES1823662-003	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	2	2	0.00	No Limit
ES1823636-001	WMLP337-001	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	113	118	5.00	0% - 20%
ED045G: Chloride by Discrete Analyser (QC Lot: 1870979)									

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
ED045G: Chloride by Discrete Analyser (QC Lot: 1870979) - continued									
ES1823698-004	Anonymous	ED045G: Chloride	16887-00-6	1	mg/L	456	453	0.629	0% - 20%
ES1823636-001	WMLP337-001	ED045G: Chloride	16887-00-6	1	mg/L	654	652	0.244	0% - 20%
ED093F: Dissolved Major Cations (QC Lot: 1871644)									
ES1823327-001	Anonymous	ED093F: Calcium	7440-70-2	1	mg/L	43	42	2.46	0% - 20%
		ED093F: Magnesium	7439-95-4	1	mg/L	110	109	0.915	0% - 20%
		ED093F: Sodium	7440-23-5	1	mg/L	869	858	1.24	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	21	20	0.00	0% - 20%
ES1823630-001	Anonymous	ED093F: Calcium	7440-70-2	1	mg/L	46	46	0.00	0% - 20%
		ED093F: Magnesium	7439-95-4	1	mg/L	23	23	0.00	0% - 20%
		ED093F: Sodium	7440-23-5	1	mg/L	70	71	0.00	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	14	15	0.00	0% - 50%
EG020F: Dissolved Metals by ICP-MS (QC Lot: 1871643)									
ES1823327-001	Anonymous	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	0.0003	0.0003	0.00	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	6.31	6.35	0.762	0% - 20%
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	0.010	0.010	0.00	0% - 50%
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	0.026	0.026	0.00	No Limit
		EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Iron	7439-89-6	0.05	mg/L	12.3	12.4	0.844	0% - 20%
ES1823630-001	Anonymous	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	0.007	0.006	0.00	No Limit
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	0.001	0.00	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	0.015	0.015	0.00	0% - 50%
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	0.007	0.007	0.00	No Limit
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	0.002	0.003	0.00	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	0.026	0.025	4.01	No Limit
		EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Iron	7439-89-6	0.05	mg/L	0.06	0.07	20.8	No Limit
EK026SF: Total CN by Segmented Flow Analyser (QC Lot: 1870555)									
ES1823618-001	Anonymous	EK026SF: Total Cyanide	57-12-5	0.004	mg/L	<0.004	<0.004	0.00	No Limit
ES1823556-001	Anonymous	EK026SF: Total Cyanide	57-12-5	0.004	mg/L	0.031	0.032	5.51	No Limit
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 1870977)									
ES1823662-003	Anonymous	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<2.00	<2.00	0.00	No Limit
ES1823636-001	WMLP337-001	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 1871100)									

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 1871100) - continued									
ES1823463-001	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	0.00	No Limit
ES1823463-011	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 1873543)									
ES1823552-001	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	5.1	5.7	10.8	0% - 20%
ES1823636-007	WML261-001	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	<0.1	0.00	No Limit
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 1873542)									
ES1823463-001	Anonymous	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.11	0.10	0.00	0% - 50%
ES1823552-001	Anonymous	EK067G: Total Phosphorus as P	----	0.01	mg/L	1.26	1.24	1.77	0% - 20%
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 1873544)									
ES1823636-007	WML261-001	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.03	0.05	55.8	No Limit
EW1803196-003	Anonymous	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.02	<0.01	0.00	No Limit

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Spike (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EA005: pH (QCLot: 1869056)								
EA005: pH Value	----	----	pH Unit	----	7.6 pH Unit	101	99	102
EA010P: Conductivity by PC Titrator (QCLot: 1870344)								
EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	<1	2000 µS/cm	99.7	95	113
EA015: Total Dissolved Solids dried at 180 ± 5 °C (QCLot: 1873594)								
EA015H: Total Dissolved Solids @180°C	----	10	mg/L	<10	2000 mg/L	102	87	109
				<10	293 mg/L	112	66	126
EA045: Turbidity (QCLot: 1874878)								
EA045: Turbidity	----	0.1	NTU	<0.1	40 NTU	100	91	105
ED037P: Alkalinity by PC Titrator (QCLot: 1870345)								
ED037-P: Total Alkalinity as CaCO3	----	----	mg/L	----	200 mg/L	94.6	81	111
				----	50 mg/L	95.8	70	130
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 1870978)								
ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	25 mg/L	113	82	122
ED045G: Chloride by Discrete Analyser (QCLot: 1870979)								
ED045G: Chloride	16887-00-6	1	mg/L	<1	10 mg/L	102	81	127
				<1	1000 mg/L	97.6	81	127
ED093F: Dissolved Major Cations (QCLot: 1871644)								
ED093F: Calcium	7440-70-2	1	mg/L	<1	50 mg/L	94.5	80	114
ED093F: Magnesium	7439-95-4	1	mg/L	<1	50 mg/L	96.6	90	116
ED093F: Sodium	7440-23-5	1	mg/L	<1	50 mg/L	96.1	82	120
ED093F: Potassium	7440-09-7	1	mg/L	<1	50 mg/L	97.0	85	113
EG020F: Dissolved Metals by ICP-MS (QCLot: 1871643)								
EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	99.9	85	114
EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	99.6	84	110
EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	96.9	85	111
EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	0.1 mg/L	98.2	81	111
EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	98.0	83	111
EG020A-F: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	98.5	82	110
EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	102	82	112
EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	0.1 mg/L	100	85	115
EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	0.1 mg/L	100	81	117
EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	101	82	112
EK026SF: Total CN by Segmented Flow Analyser (QCLot: 1870555)								

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report: Result	Laboratory Control Spike (LCS) Report: Spike Concentration	Spike Recovery (%): LCS	Recovery Limits (%): Low	Recovery Limits (%): High
EK026SF: Total CN by Segmented Flow Analyser (QCLot: 1870555) - continued								
EK026SF: Total Cyanide	57-12-5	0.004	mg/L	<0.004	0.2 mg/L	124	73	133
EK057G: Nitrite as N by Discrete Analyser (QCLot: 1870977)								
EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	0.5 mg/L	107	82	114
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 1871100)								
EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.5 mg/L	97.4	91	113
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 1873543)								
EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	10 mg/L	83.1	69	101
				<0.1	1 mg/L	77.0	70	118
				<0.1	5 mg/L	94.3	74	118
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 1873542)								
EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	4.42 mg/L	85.3	71	101
				<0.01	0.442 mg/L	81.4	72	108
				<0.01	1 mg/L	89.9	78	118
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 1873544)								
EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	4.42 mg/L	90.4	71	101
				<0.01	0.442 mg/L	88.1	72	108
				<0.01	1 mg/L	82.3	78	118

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report: Spike Concentration	SpikeRecovery(%): MS	Recovery Limits (%): Low	Recovery Limits (%): High
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 1870978)							
ES1823636-001	WMLP337-001	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	10 mg/L	# Not Determined	70	130
ED045G: Chloride by Discrete Analyser (QCLot: 1870979)							
ES1823636-001	WMLP337-001	ED045G: Chloride	16887-00-6	250 mg/L	73.5	70	130
EG020F: Dissolved Metals by ICP-MS (QCLot: 1871643)							
ES1823467-001	Anonymous	EG020A-F: Arsenic	7440-38-2	1 mg/L	104	70	130
		EG020A-F: Cadmium	7440-43-9	0.25 mg/L	93.2	70	130
		EG020A-F: Chromium	7440-47-3	1 mg/L	89.2	70	130
		EG020A-F: Copper	7440-50-8	1 mg/L	94.8	70	130
		EG020A-F: Lead	7439-92-1	1 mg/L	91.2	70	130
		EG020A-F: Manganese	7439-96-5	1 mg/L	85.8	70	130
		EG020A-F: Nickel	7440-02-0	1 mg/L	95.4	70	130

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EG020F: Dissolved Metals by ICP-MS (QCLot: 1871643) - continued							
ES1823467-001	Anonymous	EG020A-F: Zinc	7440-66-6	1 mg/L	95.2	70	130
EK026SF: Total CN by Segmented Flow Analyser (QCLot: 1870555)							
ES1823556-001	Anonymous	EK026SF: Total Cyanide	57-12-5	0.2 mg/L	112	70	130
EK057G: Nitrite as N by Discrete Analyser (QCLot: 1870977)							
ES1823636-001	WMLP337-001	EK057G: Nitrite as N	14797-65-0	0.5 mg/L	105	70	130
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 1871100)							
ES1823463-001	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.5 mg/L	97.2	70	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 1873543)							
ES1823554-001	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	5 mg/L	# Not Determined	70	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 1873542)							
ES1823463-003	Anonymous	EK067G: Total Phosphorus as P	----	1 mg/L	82.2	70	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 1873544)							
ES1823658-001	Anonymous	EK067G: Total Phosphorus as P	----	1 mg/L	83.0	70	130

ALS Environmental

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **ES1823636**	Page	: 1 of 8
Client	: **AUSTRALASIAN GROUNDWATER AND ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR KADE HANCOCK	Telephone	: +61-2-8784 8555
Project	: G1922B AUGUST 2018	Date Samples Received	: 13-Aug-2018
Site	: ----	Issue Date	: 17-Aug-2018
Sampler	: KADE HANCOCK	No. of samples received	: 7
Order number	:	No. of samples analysed	: 7

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **Matrix Spike outliers exist - please see following pages for full details.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **NO Analysis Holding Time Outliers exist.**

Outliers : Frequency of Quality Control Samples

- **NO Quality Control Sample Frequency Outliers exist.**

Outliers : Quality Control Samples

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **WATER**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Matrix Spike (MS) Recoveries							
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA	ES1823636--001	WMLP337-001	**Sulfate as SO4 - Turbidimetric**	14808-79-8	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser	ES1823554--001	Anonymous	**Total Kjeldahl Nitrogen as N**	----	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA005: pH							
Clear Plastic Bottle - Natural (EA005)							
WMLP337-001, WMLP338-001, WMLP336-001, WML113C-001, T3A-001, T3P-001, WML261-001	**13-Aug-2018**	**----**	----	----	**13-Aug-2018**	13-Aug-2018	✓
EA010P: Conductivity by PC Titrator							
Clear Plastic Bottle - Natural (EA010-P)							
WMLP337-001, WMLP338-001, WMLP336-001, WML113C-001, T3A-001, T3P-001, WML261-001	**13-Aug-2018**	**----**	----	----	**13-Aug-2018**	10-Sep-2018	✓
EA015: Total Dissolved Solids dried at 180 ± 5 °C							
Clear Plastic Bottle - Natural (EA015H)							
WMLP337-001, WMLP338-001, WMLP336-001, WML113C-001, T3A-001, T3P-001, WML261-001	**13-Aug-2018**	**----**	----	----	**15-Aug-2018**	20-Aug-2018	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA045: Turbidity							
Clear Plastic Bottle - Natural (EA045)							
WMLP337-001, WMLP338-001, WMLP336-001, WML113C-001, T3A-001, T3P-001, WML261-001	**13-Aug-2018**	**----**	----	----	**15-Aug-2018**	15-Aug-2018	✓
ED037P: Alkalinity by PC Titrator							
Clear Plastic Bottle - Natural (ED037-P)							
WMLP337-001, WMLP338-001, WMLP336-001, WML113C-001, T3A-001, T3P-001, WML261-001	**13-Aug-2018**	**----**	----	----	**13-Aug-2018**	27-Aug-2018	✓
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA							
Clear Plastic Bottle - Natural (ED041G)							
WMLP337-001, WMLP338-001, WMLP336-001, WML113C-001, T3A-001, T3P-001, WML261-001	**13-Aug-2018**	**----**	----	----	**14-Aug-2018**	10-Sep-2018	✓
ED045G: Chloride by Discrete Analyser							
Clear Plastic Bottle - Natural (ED045G)							
WMLP337-001, WMLP338-001, WMLP336-001, WML113C-001, T3A-001, T3P-001, WML261-001	**13-Aug-2018**	**----**	----	----	**14-Aug-2018**	10-Sep-2018	✓
ED093F: Dissolved Major Cations							
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F)							
WMLP337-001, WMLP338-001, WMLP336-001, WML113C-001, T3A-001, T3P-001, WML261-001	**13-Aug-2018**	**----**	----	----	**14-Aug-2018**	10-Sep-2018	✓
EG020F: Dissolved Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F)							
WMLP337-001, WMLP338-001, WMLP336-001, WML113C-001, T3A-001, T3P-001, WML261-001	**13-Aug-2018**	**----**	----	----	**14-Aug-2018**	09-Feb-2019	✓
EK026SF: Total CN by Segmented Flow Analyser							
Opaque plastic bottle - NaOH (EK026SF)							
WMLP337-001, WMLP338-001, WMLP336-001, WML113C-001, T3A-001, T3P-001, WML261-001	**13-Aug-2018**	**----**	----	----	**14-Aug-2018**	27-Aug-2018	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK057G: Nitrite as N by Discrete Analyser							
Clear Plastic Bottle - Natural (EK057G)							
WMLP337-001, WMLP338-001, WMLP336-001, WML113C-001, T3A-001, T3P-001, WML261-001	**13-Aug-2018**	**----**	----	----	**14-Aug-2018**	15-Aug-2018	✓
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK059G)							
WMLP337-001, WMLP338-001, WMLP336-001, WML113C-001, T3A-001, T3P-001, WML261-001	**13-Aug-2018**	**----**	----	----	**14-Aug-2018**	10-Sep-2018	✓
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK061G)							
WMLP337-001, WMLP338-001, WMLP336-001, WML113C-001, T3A-001, T3P-001, WML261-001	**13-Aug-2018**	**15-Aug-2018**	10-Sep-2018	✓	**15-Aug-2018**	10-Sep-2018	✓
EK067G: Total Phosphorus as P by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK067G)							
WMLP337-001, WMLP338-001, WMLP336-001, WML113C-001, T3A-001, T3P-001, WML261-001	**13-Aug-2018**	**15-Aug-2018**	10-Sep-2018	✓	**15-Aug-2018**	10-Sep-2018	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Alkalinity by PC Titrator	ED037-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	18	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	2	17	**11.76**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	18	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	12	**16.67**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH	EA005	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	17	**11.76**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Cyanide by Segmented Flow Analyser	EK026SF	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	4	32	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Turbidity	EA045	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Alkalinity by PC Titrator	ED037-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH	EA005	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Cyanide by Segmented Flow Analyser	EK026SF	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	3	20	**15.00**	**15.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	6	32	**18.75**	**15.00**	✓	NEPM 2013 B3 & ALS QC Standard
Turbidity	EA045	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Chloride by Discrete Analyser	ED045G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Method Blanks (MB) - Continued							
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Cyanide by Segmented Flow Analyser	EK026SF	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	2	32	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Turbidity	EA045	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Chloride by Discrete Analyser	ED045G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Cyanide by Segmented Flow Analyser	EK026SF	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	2	32	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
pH	EA005	WATER	In house: Referenced to APHA 4500 H+ B. pH of water samples is determined by ISE either manually or by automated pH meter. This method is compliant with NEPM (2013) Schedule B(3)
Conductivity by PC Titrator	EA010-P	WATER	In house: Referenced to APHA 2510 B. This procedure determines conductivity by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Total Dissolved Solids (High Level)	EA015H	WATER	In house: Referenced to APHA 2540C. A gravimetric procedure that determines the amount of `filterable` residue in an aqueous sample. A well-mixed sample is filtered through a glass fibre filter (1.2um). The filtrate is evaporated to dryness and dried to constant weight at 180+/-5C. This method is compliant with NEPM (2013) Schedule B(3)
Turbidity	EA045	WATER	In house: Referenced to APHA 2130 B. This method is compliant with NEPM (2013) Schedule B(3)
Alkalinity by PC Titrator	ED037-P	WATER	In house: Referenced to APHA 2320 B This procedure determines alkalinity by automated measurement (e.g. PC Titrate) using pH 4.5 for indicating the total alkalinity end-point. This method is compliant with NEPM (2013) Schedule B(3)
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	WATER	In house: Referenced to APHA 4500-SO4. Dissolved sulfate is determined in a 0.45um filtered sample. Sulfate ions are converted to a barium sulfate suspension in an acetic acid medium with barium chloride. Light absorbance of the BaSO4 suspension is measured by a photometer and the SO4-2 concentration is determined by comparison of the reading with a standard curve. This method is compliant with NEPM (2013) Schedule B(3)
Chloride by Discrete Analyser	ED045G	WATER	In house: Referenced to APHA 4500 Cl - G.The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride.in the presence of ferric ions the librated thiocynate forms highly-coloured ferric thiocynate which is measured at 480 nm APHA 21st edition seal method 2 017-1-L april 2003
Major Cations - Dissolved	ED093F	WATER	In house: Referenced to APHA 3120 and 3125; USEPA SW 846 - 6010 and 6020; Cations are determined by either ICP-AES or ICP-MS techniques. This method is compliant with NEPM (2013) Schedule B(3) Sodium Adsorption Ratio is calculated from Ca, Mg and Na which determined by ALS in house method QWI-EN/ED093F. This method is compliant with NEPM (2013) Schedule B(3) Hardness parameters are calculated based on APHA 2340 B. This method is compliant with NEPM (2013) Schedule B(3)
Dissolved Metals by ICP-MS - Suite A	EG020A-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45µm filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.

Analytical Methods	Method	Matrix	Method Descriptions
Total Cyanide by Segmented Flow Analyser	EK026SF	WATER	In house: Referenced to APHA 4500-CN C / ASTM D7511. Sodium hydroxide preserved samples are introduced into an automated segmented flow analyser. Complex bound cyanide is decomposed in a continuously flowing stream, at a pH of 3.8, by the effect of UV light. A UV-B lamp (312 nm) and a decomposition spiral of borosilicate glass are used to filter out UV light with a wavelength of less than 290 nm thus preventing the conversion of thiocyanate into cyanide. The hydrogen cyanide present at a pH of 3.8 is separated by gas dialysis. The hydrogen cyanide is then determined photometrically, based on the reaction of cyanide with chloramine-T to form cyanogen chloride. This then reacts with 4-pyridine carboxylic acid and 1,3-dimethylbarbituric acid to give a red colour which is measured at 600 nm. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite as N by Discrete Analyser	EK057G	WATER	In house: Referenced to APHA 4500-NO2- B. Nitrite is determined by direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrate as N by Discrete Analyser	EK058G	WATER	In house: Referenced to APHA 4500-NO3- F. Nitrate is reduced to nitrite by way of a chemical reduction followed by quantification by Discrete Analyser. Nitrite is determined seperately by direct colourimetry and result for Nitrate calculated as the difference between the two results. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	WATER	In house: Referenced to APHA 4500-NO3- F. Combined oxidised Nitrogen (NO2+NO3) is determined by Chemical Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	WATER	In house: Referenced to APHA 4500-Norg D (In house). An aliquot of sample is digested using a high temperature Kjeldahl digestion to convert nitrogenous compounds to ammonia. Ammonia is determined colorimetrically by discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Nitrogen as N (TKN + Nox) By Discrete Analyser	EK062G	WATER	In house: Referenced to APHA 4500-Norg / 4500-NO3-. This method is compliant with NEPM (2013) Schedule B(3)
Total Phosphorus as P By Discrete Analyser	EK067G	WATER	In house: Referenced to APHA 4500-P H, Jirka et al (1976), Zhang et al (2006). This procedure involves sulphuric acid digestion of a sample aliquot to break phosphorus down to orthophosphate. The orthophosphate reacts with ammonium molybdate and antimony potassium tartrate to form a complex which is then reduced and its concentration measured at 880nm using discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Ionic Balance by PCT DA and Turbi SO4 DA	EN055 - PG	WATER	In house: Referenced to APHA 1030F. This method is compliant with NEPM (2013) Schedule B(3)

Preparation Methods	Method	Matrix	Method Descriptions
TKN/TP Digestion	EK061/EK067	WATER	In house: Referenced to APHA 4500 Norg - D; APHA 4500 P - H. This method is compliant with NEPM (2013) Schedule B(3)

SAMPLE RECEIPT NOTIFICATION (SRN)

Work Order	: **ES1823636**		
Client	: **AUSTRALASIAN GROUNDWATER AND ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR KADE HANCOCK	Contact	: Customer Services ES
Address	: 4 HUDSON STREET HAMILTON NSW 2303	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: kade@ageconsultants.com.au	E-mail	: ALSEnviro.Sydney@alsglobal.com
Telephone	: ----	Telephone	: +61-2-8784 8555
Facsimile	: ----	Facsimile	: +61-2-8784 8500
Project	: G1922B AUGUST 2018	Page	: 1 of 3
Order number	:	Quote number	: ES2017AUSGRO0002 (SY/374/17)
C-O-C number	: ----	QC Level	: NEPM 2013 B3 & ALS QC Standard
Site	: ----		
Sampler	: KADE HANCOCK		

Dates

Date Samples Received	: 13-Aug-2018 12:07	Issue Date	: 13-Aug-2018
Client Requested Due Date	: 17-Aug-2018	Scheduled Reporting Date	: **17-Aug-2018**

Delivery Details

Mode of Delivery	: Undefined	Security Seal	: Not Available
No. of coolers/boxes	: 1	Temperature	: 4.5'C - Ice present
Receipt Detail	:	No. of samples received / analysed	: 7 / 7

General Comments

- This report contains the following information:
  - Sample Container(s)/Preservation Non-Compliances
  - Summary of Sample(s) and Requested Analysis
  - Proactive Holding Time Report
  - Requested Deliverables
- **Please refer to the Proactive Holding Time Report table below which summarises breaches of recommended holding times that have occurred prior to samples/instructions being received at the laboratory. The absence of this summary table indicates that all samples have been received within the recommended holding times for the analysis requested.**
- **pH analysis will be conducted by ALS Newcastle-Water.**
- Please direct any queries you have regarding this work order to the above ALS laboratory contact.
- Analytical work for this work order will be conducted at ALS Sydney.
- Sample Disposal - Aqueous (3 weeks), Solid (2 months) from receipt of samples.

Sample Container(s)/Preservation Non-Compliances

All comparisons are made against pretreatment/preservation AS, APHA, USEPA standards.

- **No sample container / preservation non-compliance exists.**

Summary of Sample(s) and Requested Analysis

Some items described below may be part of a laboratory process necessary for the execution of client requested tasks. Packages may contain additional analyses, such as the determination of moisture content and preparation tasks, that are included in the package.
If no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory and displayed in brackets without a time component

Matrix: **WATER**

Laboratory sample ID	Client sampling date / time	Client sample ID	WATER - EA005: pH pH	WATER - EA010P Electrical Conductivity (PCT)	WATER - EG020F Dissolved Metals by ICP/MS	WATER - EK026SF Total Cyanide by Segmented Flow Analyser	WATER - EK058G Nitrate as N by Discrete Analyser	WATER - NT-01 & 02 Ca, Mg, Na, K, Cl, SO4, Alkalinity	WATER - NT-11 Total Nitrogen and Total Phosphorus
ES1823636-001	13-Aug-2018 08:40	WMLP337-001	✓	✓	✓	✓	✓	✓	✓
ES1823636-002	13-Aug-2018 09:26	WMLP338-001	✓	✓	✓	✓	✓	✓	✓
ES1823636-003	13-Aug-2018 10:15	WMLP336-001	✓	✓	✓	✓	✓	✓	✓
ES1823636-004	13-Aug-2018 11:02	WML113C-001	✓	✓	✓	✓	✓	✓	✓
ES1823636-005	13-Aug-2018 12:10	T3A-001	✓	✓	✓	✓	✓	✓	✓
ES1823636-006	13-Aug-2018 12:42	T3P-001	✓	✓	✓	✓	✓	✓	✓
ES1823636-007	13-Aug-2018 13:28	WML261-001	✓	✓	✓	✓	✓	✓	✓

Matrix: **WATER**

Laboratory sample ID	Client sampling date / time	Client sample ID	WATER - EA015H Total Dissolved Solids - Standard Level	WATER - EA045 Turbidity
ES1823636-001	13-Aug-2018 08:40	WMLP337-001	✓	✓
ES1823636-002	13-Aug-2018 09:26	WMLP338-001	✓	✓
ES1823636-003	13-Aug-2018 10:15	WMLP336-001	✓	✓
ES1823636-004	13-Aug-2018 11:02	WML113C-001	✓	✓
ES1823636-005	13-Aug-2018 12:10	T3A-001	✓	✓
ES1823636-006	13-Aug-2018 12:42	T3P-001	✓	✓
ES1823636-007	13-Aug-2018 13:28	WML261-001	✓	✓

Proactive Holding Time Report

Sample(s) have been received within the recommended holding times for the requested analysis.

Requested Deliverables

ALL INVOICES

- A4 - AU Tax Invoice (INV)	Email	brisbane@ageconsultants.com.au

KADE HANCOCK

- *AU Certificate of Analysis - NATA (COA)	Email	kade@ageconsultants.com.au
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	kade@ageconsultants.com.au
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	kade@ageconsultants.com.au
- A4 - AU Sample Receipt Notification - Environmental HT (SRN)	Email	kade@ageconsultants.com.au
- A4 - AU Tax Invoice (INV)	Email	kade@ageconsultants.com.au
- Chain of Custody (CoC) (COC)	Email	kade@ageconsultants.com.au
- EDI Format - ENMRG (ENMRG)	Email	kade@ageconsultants.com.au
- EDI Format - ESDAT (ESDAT)	Email	kade@ageconsultants.com.au

ALS Environmental

QUALITY CONTROL REPORT

Work Order	: **ES1823832**	Page	: 1 of 7
Client	: **AUSTRALASIAN GROUNDWATER AND ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR KADE HANCOCK	Contact	: Customer Services ES
Address	: 4 HUDSON STREET HAMILTON NSW 2303	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: +61-2-8784 8555
Project	: G1922B AUGUST 2018	Date Samples Received	: 14-Aug-2018
Order number	:	Date Analysis Commenced	: 14-Aug-2018
C-O-C number	: ----	Issue Date	: 20-Aug-2018
Sampler	: KADE HANCOCK		
Site	: ----		
Quote number	: SY/374/17		
No. of samples received	: 10		
No. of samples analysed	: 10		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW
Gregory Towers	Technical Officer	Chemistry, Newcastle West, NSW
Wisam Marassa	Inorganics Coordinator	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EA005: pH (QC Lot: 1873644)									
ES1823757-001	Anonymous	EA005: pH Value	----	0.01	pH Unit	8.56	8.53	0.351	0% - 20%
ES1823832-001	T2A-001	EA005: pH Value	----	0.01	pH Unit	7.19	7.17	0.278	0% - 20%
EA010P: Conductivity by PC Titrator (QC Lot: 1873249)									
ES1823830-001	Anonymous	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	1360	1360	0.00	0% - 20%
ES1823832-002	T2P-001	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	1040	1040	0.0967	0% - 20%
EA015: Total Dissolved Solids dried at 180 ± 5 °C (QC Lot: 1876983)									
ES1823821-012	Anonymous	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	155	163	5.02	0% - 50%
ES1823832-011	WMLP343-001-DUP	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	510	498	2.58	0% - 20%
EA045: Turbidity (QC Lot: 1878857)									
ES1823756-002	Anonymous	EA045: Turbidity	----	0.1	NTU	104	102	1.94	0% - 20%
ES1823832-003	T2P-001-DUP	EA045: Turbidity	----	0.1	NTU	8.0	8.0	0.00	0% - 20%
ED037P: Alkalinity by PC Titrator (QC Lot: 1873250)									
ES1823832-001	T2A-001	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	176	180	2.38	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	176	180	2.38	0% - 20%
ES1823832-011	WMLP343-001-DUP	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	187	189	0.935	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	187	189	0.935	0% - 20%
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QC Lot: 1877311)									
ES1823832-001	T2A-001	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	108	108	0.00	0% - 20%
ES1823832-011	WMLP343-001-DUP	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	13	13	0.00	0% - 50%
ED045G: Chloride by Discrete Analyser (QC Lot: 1877312)									

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
ED045G: Chloride by Discrete Analyser (QC Lot: 1877312) - continued									
ES1823832-001	T2A-001	ED045G: Chloride	16887-00-6	1	mg/L	205	205	0.00	0% - 20%
ES1823832-011	WMLP343-001-DUP	ED045G: Chloride	16887-00-6	1	mg/L	157	158	0.992	0% - 20%
ED093F: Dissolved Major Cations (QC Lot: 1873524)									
ES1823832-002	T2P-001	ED093F: Calcium	7440-70-2	1	mg/L	75	73	1.84	0% - 20%
		ED093F: Magnesium	7439-95-4	1	mg/L	35	34	0.00	0% - 20%
		ED093F: Sodium	7440-23-5	1	mg/L	92	91	0.00	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	2	2	0.00	No Limit
ES1823798-001	Anonymous	ED093F: Calcium	7440-70-2	1	mg/L	105	106	0.00	0% - 20%
		ED093F: Magnesium	7439-95-4	1	mg/L	44	44	0.00	0% - 20%
		ED093F: Sodium	7440-23-5	1	mg/L	49	50	0.00	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	3	2	0.00	No Limit
EG020F: Dissolved Metals by ICP-MS (QC Lot: 1873522)									
ES1823832-002	T2P-001	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	0.005	0.005	0.00	No Limit
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	0.332	0.321	3.16	0% - 20%
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	0.011	0.012	0.00	No Limit
		EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Iron	7439-89-6	0.05	mg/L	3.95	3.82	3.17	0% - 20%
ES1823798-001	Anonymous	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	0.001	0.001	0.00	No Limit
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	0.268	0.269	0.498	0% - 20%
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	0.005	0.005	0.00	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	0.00	No Limit
		EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Iron	7439-89-6	0.05	mg/L	0.28	0.28	0.00	No Limit
EK026SF: Total CN by Segmented Flow Analyser (QC Lot: 1873410)									
ES1823832-002	T2P-001	EK026SF: Total Cyanide	57-12-5	0.004	mg/L	<0.004	<0.004	0.00	No Limit
ES1823713-001	Anonymous	EK026SF: Total Cyanide	57-12-5	0.004	mg/L	<0.004	<0.004	0.00	No Limit
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 1875896)									
ES1823798-001	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	0.01	<0.01	0.00	No Limit
ES1823831-002	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	0.23	0.22	0.00	0% - 20%
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 1875897)									

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 1875897) - continued									
EW1803138-002	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	0.00	No Limit
ES1823853-004	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	0.01	0.02	0.00	No Limit
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 1875890)									
ES1823832-001	T2A-001	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	<0.1	0.00	No Limit
ES1823853-004	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	4.8	4.9	0.00	0% - 20%
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 1875891)									
ES1823832-001	T2A-001	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.01	<0.01	0.00	No Limit
ES1823853-004	Anonymous	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.08	0.10	17.2	0% - 50%

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Spike (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EA005: pH (QCLot: 1873644)								
EA005: pH Value	----	----	pH Unit	----	7.6 pH Unit	100	99	102
EA010P: Conductivity by PC Titrator (QCLot: 1873249)								
EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	<1	2000 µS/cm	99.1	95	113
EA015: Total Dissolved Solids dried at 180 ± 5 °C (QCLot: 1876983)								
EA015H: Total Dissolved Solids @180°C	----	10	mg/L	<10	2000 mg/L	95.3	87	109
				<10	293 mg/L	119	66	126
EA045: Turbidity (QCLot: 1878857)								
EA045: Turbidity	----	0.1	NTU	<0.1	40 NTU	100	91	105
ED037P: Alkalinity by PC Titrator (QCLot: 1873250)								
ED037-P: Total Alkalinity as CaCO3	----	----	mg/L	----	200 mg/L	90.9	81	111
				----	50 mg/L	95.3	70	130
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 1877311)								
ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	25 mg/L	100	82	122
ED045G: Chloride by Discrete Analyser (QCLot: 1877312)								
ED045G: Chloride	16887-00-6	1	mg/L	<1	10 mg/L	108	81	127
				<1	1000 mg/L	102	81	127
ED093F: Dissolved Major Cations (QCLot: 1873524)								
ED093F: Calcium	7440-70-2	1	mg/L	<1	50 mg/L	95.9	80	114
ED093F: Magnesium	7439-95-4	1	mg/L	<1	50 mg/L	97.7	90	116
ED093F: Sodium	7440-23-5	1	mg/L	<1	50 mg/L	97.5	82	120
ED093F: Potassium	7440-09-7	1	mg/L	<1	50 mg/L	98.1	85	113
EG020F: Dissolved Metals by ICP-MS (QCLot: 1873522)								
EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	100	85	114
EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	99.2	84	110
EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	97.2	85	111
EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	0.1 mg/L	98.9	81	111
EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	97.2	83	111
EG020A-F: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	99.6	82	110
EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	98.7	82	112
EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	0.1 mg/L	105	85	115
EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	0.1 mg/L	105	81	117
EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	99.7	82	112
EK026SF: Total CN by Segmented Flow Analyser (QCLot: 1873410)								

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report: Result	Laboratory Control Spike (LCS) Report: Spike Concentration	Spike Recovery (%): LCS	Recovery Limits (%): Low	Recovery Limits (%): High
EK026SF: Total CN by Segmented Flow Analyser (QCLot: 1873410) - continued								
EK026SF: Total Cyanide	57-12-5	0.004	mg/L	<0.004	0.2 mg/L	98.7	73	133
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 1875896)								
EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.5 mg/L	102	91	113
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 1875897)								
EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.5 mg/L	104	91	113
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 1875890)								
EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	10 mg/L	90.4	69	101
				<0.1	1 mg/L	87.9	70	118
				<0.1	5 mg/L	97.5	74	118
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 1875891)								
EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	4.42 mg/L	96.2	71	101
				<0.01	0.442 mg/L	95.7	72	108
				<0.01	1 mg/L	98.2	78	118

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report: Spike Concentration	SpikeRecovery(%): MS	Recovery Limits (%): Low	Recovery Limits (%): High
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 1877311)							
ES1823832-001	T2A-001	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	10 mg/L	# Not Determined	70	130
ED045G: Chloride by Discrete Analyser (QCLot: 1877312)							
ES1823832-001	T2A-001	ED045G: Chloride	16887-00-6	250 mg/L	109	70	130
EG020F: Dissolved Metals by ICP-MS (QCLot: 1873522)							
ES1823798-001	Anonymous	EG020A-F: Arsenic	7440-38-2	1 mg/L	94.6	70	130
		EG020A-F: Cadmium	7440-43-9	0.25 mg/L	92.9	70	130
		EG020A-F: Chromium	7440-47-3	1 mg/L	92.6	70	130
		EG020A-F: Copper	7440-50-8	1 mg/L	91.6	70	130
		EG020A-F: Lead	7439-92-1	1 mg/L	93.6	70	130
		EG020A-F: Manganese	7439-96-5	1 mg/L	90.2	70	130
		EG020A-F: Nickel	7440-02-0	1 mg/L	92.0	70	130
		EG020A-F: Zinc	7440-66-6	1 mg/L	93.2	70	130
EK026SF: Total CN by Segmented Flow Analyser (QCLot: 1873410)							
ES1823713-001	Anonymous	EK026SF: Total Cyanide	57-12-5	0.2 mg/L	89.7	70	130

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 1875896)							
ES1823798-001	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.5 mg/L	98.8	70	130
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 1875897)							
ES1823853-004	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.5 mg/L	101	70	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 1875890)							
ES1823832-002	T2P-001	EK061G: Total Kjeldahl Nitrogen as N	----	5 mg/L	87.0	70	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 1875891)							
ES1823832-002	T2P-001	EK067G: Total Phosphorus as P	----	1 mg/L	88.5	70	130

ALS Environmental

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **ES1823832**	Page	: 1 of 8
Client	: **AUSTRALASIAN GROUNDWATER AND ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR KADE HANCOCK	Telephone	: +61-2-8784 8555
Project	: G1922B AUGUST 2018	Date Samples Received	: 14-Aug-2018
Site	: ----	Issue Date	: 20-Aug-2018
Sampler	: KADE HANCOCK	No. of samples received	: 10
Order number	:	No. of samples analysed	: 10

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **Matrix Spike outliers exist - please see following pages for full details.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **NO Analysis Holding Time Outliers exist.**

Outliers : Frequency of Quality Control Samples

- **NO Quality Control Sample Frequency Outliers exist.**

Outliers : Quality Control Samples

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **WATER**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Matrix Spike (MS) Recoveries							
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA	ES1823832--001	T2A-001	**Sulfate as SO4 - Turbidimetric**	14808-79-8	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA005: pH								
Clear Plastic Bottle - Natural (EA005)								
T2A-001,	T2P-001,	**14-Aug-2018**	**----**	----	----	**14-Aug-2018**	14-Aug-2018	✓
T2P-001-DUP,	RH18-001,							
RH18-001-DUP,	WMLP320-001,							
P81-001,	WML115B-001,							
WMLP343-001,	WMLP343-001-DUP							
EA010P: Conductivity by PC Titrator								
Clear Plastic Bottle - Natural (EA010-P)								
T2A-001,	T2P-001,	**14-Aug-2018**	**----**	----	----	**14-Aug-2018**	11-Sep-2018	✓
T2P-001-DUP,	RH18-001,							
RH18-001-DUP,	WMLP320-001,							
P81-001,	WML115B-001,							
WMLP343-001,	WMLP343-001-DUP							
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Clear Plastic Bottle - Natural (EA015H)								
T2A-001,	T2P-001,	**14-Aug-2018**	**----**	----	----	**16-Aug-2018**	21-Aug-2018	✓
T2P-001-DUP,	RH18-001,							
RH18-001-DUP,	WMLP343-001,							
WMLP343-001-DUP								

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA045: Turbidity							
Clear Plastic Bottle - Natural (EA045)							
T2A-001, T2P-001, T2P-001-DUP, RH18-001, RH18-001-DUP, WMLP343-001, WMLP343-001-DUP	**14-Aug-2018**	**----**	----	----	**16-Aug-2018**	16-Aug-2018	✓
ED037P: Alkalinity by PC Titrator							
Clear Plastic Bottle - Natural (ED037-P)							
T2A-001, T2P-001, T2P-001-DUP, RH18-001, RH18-001-DUP, WMLP320-001, P81-001, WML115B-001, WMLP343-001, WMLP343-001-DUP	**14-Aug-2018**	**----**	----	----	**14-Aug-2018**	28-Aug-2018	✓
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA							
Clear Plastic Bottle - Natural (ED041G)							
T2A-001, T2P-001, T2P-001-DUP, RH18-001, RH18-001-DUP, WMLP320-001, P81-001, WML115B-001, WMLP343-001, WMLP343-001-DUP	**14-Aug-2018**	**----**	----	----	**16-Aug-2018**	11-Sep-2018	✓
ED045G: Chloride by Discrete Analyser							
Clear Plastic Bottle - Natural (ED045G)							
T2A-001, T2P-001, T2P-001-DUP, RH18-001, RH18-001-DUP, WMLP320-001, P81-001, WML115B-001, WMLP343-001, WMLP343-001-DUP	**14-Aug-2018**	**----**	----	----	**16-Aug-2018**	11-Sep-2018	✓
ED093F: Dissolved Major Cations							
Clear Plastic Bottle - Natural (ED093F)							
WMLP320-001, P81-001, WML115B-001	**14-Aug-2018**	**----**	----	----	**15-Aug-2018**	21-Aug-2018	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F)							
T2A-001, T2P-001, T2P-001-DUP, RH18-001, RH18-001-DUP, WMLP343-001, WMLP343-001-DUP	**14-Aug-2018**	**----**	----	----	**15-Aug-2018**	11-Sep-2018	✓
EG020F: Dissolved Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F)							
T2A-001, T2P-001, T2P-001-DUP, RH18-001, RH18-001-DUP, WMLP343-001, WMLP343-001-DUP	**14-Aug-2018**	**----**	----	----	**15-Aug-2018**	10-Feb-2019	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK026SF: Total CN by Segmented Flow Analyser							
Opaque plastic bottle - NaOH (EK026SF)							
T2A-001, T2P-001, T2P-001-DUP, RH18-001, RH18-001-DUP, WMLP343-001, WMLP343-001-DUP	**14-Aug-2018**	**----**	----	----	**15-Aug-2018**	28-Aug-2018	✓
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK059G)							
T2A-001, T2P-001, T2P-001-DUP, RH18-001, RH18-001-DUP, WMLP343-001, WMLP343-001-DUP	**14-Aug-2018**	**----**	----	----	**16-Aug-2018**	11-Sep-2018	✓
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK061G)							
T2A-001, T2P-001, T2P-001-DUP, RH18-001, RH18-001-DUP, WMLP343-001, WMLP343-001-DUP	**14-Aug-2018**	**16-Aug-2018**	11-Sep-2018	✓	**16-Aug-2018**	11-Sep-2018	✓
EK067G: Total Phosphorus as P by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK067G)							
T2A-001, T2P-001, T2P-001-DUP, RH18-001, RH18-001-DUP, WMLP343-001, WMLP343-001-DUP	**14-Aug-2018**	**16-Aug-2018**	11-Sep-2018	✓	**16-Aug-2018**	11-Sep-2018	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Alkalinity by PC Titrator	ED037-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	11	**18.18**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	2	17	**11.76**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	4	35	**11.43**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH	EA005	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	11	**18.18**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Cyanide by Segmented Flow Analyser	EK026SF	2	16	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	2	18	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Turbidity	EA045	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Alkalinity by PC Titrator	ED037-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	11	**18.18**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	35	**5.71**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH	EA005	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Cyanide by Segmented Flow Analyser	EK026SF	2	16	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	3	20	**15.00**	**15.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	3	18	**16.67**	**15.00**	✓	NEPM 2013 B3 & ALS QC Standard
Turbidity	EA045	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Chloride by Discrete Analyser	ED045G	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	35	**5.71**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Cyanide by Segmented Flow Analyser	EK026SF	1	16	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Method Blanks (MB) - Continued							
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Turbidity	EA045	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Chloride by Discrete Analyser	ED045G	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	35	**5.71**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Cyanide by Segmented Flow Analyser	EK026SF	1	16	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
pH	EA005	WATER	In house: Referenced to APHA 4500 H+ B. pH of water samples is determined by ISE either manually or by automated pH meter. This method is compliant with NEPM (2013) Schedule B(3)
Conductivity by PC Titrator	EA010-P	WATER	In house: Referenced to APHA 2510 B. This procedure determines conductivity by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Total Dissolved Solids (High Level)	EA015H	WATER	In house: Referenced to APHA 2540C. A gravimetric procedure that determines the amount of `filterable` residue in an aqueous sample. A well-mixed sample is filtered through a glass fibre filter (1.2um). The filtrate is evaporated to dryness and dried to constant weight at 180+/-5C. This method is compliant with NEPM (2013) Schedule B(3)
Turbidity	EA045	WATER	In house: Referenced to APHA 2130 B. This method is compliant with NEPM (2013) Schedule B(3)
Alkalinity by PC Titrator	ED037-P	WATER	In house: Referenced to APHA 2320 B This procedure determines alkalinity by automated measurement (e.g. PC Titrate) using pH 4.5 for indicating the total alkalinity end-point. This method is compliant with NEPM (2013) Schedule B(3)
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	WATER	In house: Referenced to APHA 4500-SO4. Dissolved sulfate is determined in a 0.45um filtered sample. Sulfate ions are converted to a barium sulfate suspension in an acetic acid medium with barium chloride. Light absorbance of the BaSO4 suspension is measured by a photometer and the SO4-2 concentration is determined by comparison of the reading with a standard curve. This method is compliant with NEPM (2013) Schedule B(3)
Chloride by Discrete Analyser	ED045G	WATER	In house: Referenced to APHA 4500 Cl - G.The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride.in the presence of ferric ions the librated thiocynate forms highly-coloured ferric thiocynate which is measured at 480 nm APHA 21st edition seal method 2 017-1-L april 2003
Major Cations - Dissolved	ED093F	WATER	In house: Referenced to APHA 3120 and 3125; USEPA SW 846 - 6010 and 6020; Cations are determined by either ICP-AES or ICP-MS techniques. This method is compliant with NEPM (2013) Schedule B(3) Sodium Adsorption Ratio is calculated from Ca, Mg and Na which determined by ALS in house method QWI-EN/ED093F. This method is compliant with NEPM (2013) Schedule B(3) Hardness parameters are calculated based on APHA 2340 B. This method is compliant with NEPM (2013) Schedule B(3)
Dissolved Metals by ICP-MS - Suite A	EG020A-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45µm filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.

Analytical Methods	Method	Matrix	Method Descriptions
Total Cyanide by Segmented Flow Analyser	EK026SF	WATER	In house: Referenced to APHA 4500-CN C / ASTM D7511. Sodium hydroxide preserved samples are introduced into an automated segmented flow analyser. Complex bound cyanide is decomposed in a continuously flowing stream, at a pH of 3.8, by the effect of UV light. A UV-B lamp (312 nm) and a decomposition spiral of borosilicate glass are used to filter out UV light with a wavelength of less than 290 nm thus preventing the conversion of thiocyanate into cyanide. The hydrogen cyanide present at a pH of 3.8 is separated by gas dialysis. The hydrogen cyanide is then determined photometrically, based on the reaction of cyanide with chloramine-T to form cyanogen chloride. This then reacts with 4-pyridine carboxylic acid and 1,3-dimethylbarbituric acid to give a red colour which is measured at 600 nm. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	WATER	In house: Referenced to APHA 4500-NO3- F. Combined oxidised Nitrogen (NO2+NO3) is determined by Chemical Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	WATER	In house: Referenced to APHA 4500-Norg D (In house). An aliquot of sample is digested using a high temperature Kjeldahl digestion to convert nitrogenous compounds to ammonia. Ammonia is determined colorimetrically by discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Nitrogen as N (TKN + Nox) By Discrete Analyser	EK062G	WATER	In house: Referenced to APHA 4500-Norg / 4500-NO3-. This method is compliant with NEPM (2013) Schedule B(3)
Total Phosphorus as P By Discrete Analyser	EK067G	WATER	In house: Referenced to APHA 4500-P H, Jirka et al (1976), Zhang et al (2006). This procedure involves sulphuric acid digestion of a sample aliquot to break phosphorus down to orthophosphate. The orthophosphate reacts with ammonium molybdate and antimony potassium tartrate to form a complex which is then reduced and its concentration measured at 880nm using discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Ionic Balance by PCT DA and Turbi SO4 DA	EN055 - PG	WATER	In house: Referenced to APHA 1030F. This method is compliant with NEPM (2013) Schedule B(3)

Preparation Methods	Method	Matrix	Method Descriptions
TKN/TP Digestion	EK061/EK067	WATER	In house: Referenced to APHA 4500 Norg - D; APHA 4500 P - H. This method is compliant with NEPM (2013) Schedule B(3)

SAMPLE RECEIPT NOTIFICATION (SRN)

Work Order : **ES1823832**

Client	: **AUSTRALASIAN GROUNDWATER AND ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR KADE HANCOCK	Contact	: Customer Services ES
Address	: 4 HUDSON STREET HAMILTON NSW 2303	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: kade@ageconsultants.com.au	E-mail	: ALSEnviro.Sydney@alsglobal.com
Telephone	: ----	Telephone	: +61-2-8784 8555
Facsimile	: ----	Facsimile	: +61-2-8784 8500
Project	: G1922B AUGUST 2018	Page	: 1 of 3
Order number	:	Quote number	: ES2017AUSGRO0002 (SY/374/17)
C-O-C number	: ----	QC Level	: NEPM 2013 B3 & ALS QC Standard
Site	: ----		
Sampler	: KADE HANCOCK		

Dates

Date Samples Received	: 14-Aug-2018 15:46	Issue Date	: 14-Aug-2018
Client Requested Due Date	: 20-Aug-2018	Scheduled Reporting Date	: **20-Aug-2018**

Delivery Details

Mode of Delivery	: Undefined	Security Seal	: Not Available
No. of coolers/boxes	: 1	Temperature	: 16.5'C
Receipt Detail	:	No. of samples received / analysed	: 10 / 10

General Comments

- This report contains the following information:
  - Sample Container(s)/Preservation Non-Compliances
  - Summary of Sample(s) and Requested Analysis
  - Proactive Holding Time Report
  - Requested Deliverables
- **Sample R118-001-TRIP and WMLP343-001-TRIP to be forwarded to Envirolab as per COC's.**
- **Please refer to the Proactive Holding Time Report table below which summarises breaches of recommended holding times that have occurred prior to samples/instructions being received at the laboratory. The absence of this summary table indicates that all samples have been received within the recommended holding times for the analysis requested.**
- **pH analysis will be conducted by ALS Newcastle-Water.**
- Please direct any queries you have regarding this work order to the above ALS laboratory contact.
- Analytical work for this work order will be conducted at ALS Sydney.
- Sample Disposal - Aqueous (3 weeks), Solid (2 months) from receipt of samples.

Sample Container(s)/Preservation Non-Compliances

All comparisons are made against pretreatment/preservation AS, APHA, USEPA standards.

- **No sample container / preservation non-compliance exists.**

Summary of Sample(s) and Requested Analysis

Some items described below may be part of a laboratory process necessary for the execution of client requested tasks. Packages may contain additional analyses, such as the determination of moisture content and preparation tasks, that are included in the package.
If no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory and displayed in brackets without a time component

Matrix: **WATER**

Laboratory sample ID	Client sampling date / time	Client sample ID	WATER - EA005: pH pH	WATER - EA010P Electrical Conductivity (PCT)	WATER - EA015H Total Dissolved Solids - Standard Level	WATER - EG020F Dissolved Metals by ICP/MS	WATER - EK026SF Total Cyanide by Segmented Flow Analyser	WATER - NT-01 & 02 Ca, Mg, Na, K, Cl, SO4, Alkalinity	WATER - NT-11 Total Nitrogen and Total Phosphorus
ES1823832-001	14-Aug-2018 08:18	T2A-001	✓	✓	✓	✓	✓	✓	✓
ES1823832-002	14-Aug-2018 08:44	T2P-001	✓	✓	✓	✓	✓	✓	✓
ES1823832-003	14-Aug-2018 08:44	T2P-001-DUP	✓	✓	✓	✓	✓	✓	✓
ES1823832-004	14-Aug-2018 09:42	RH18-001	✓	✓	✓	✓	✓	✓	✓
ES1823832-005	14-Aug-2018 09:42	RH18-001-DUP	✓	✓	✓	✓	✓	✓	✓
ES1823832-007	14-Aug-2018 10:50	WMLP320-001	✓	✓				✓	
ES1823832-008	14-Aug-2018 11:16	P81-001	✓	✓				✓	
ES1823832-009	14-Aug-2018 12:30	WML115B-001	✓	✓				✓	
ES1823832-010	14-Aug-2018 13:30	WMLP343-001	✓	✓	✓	✓	✓	✓	✓
ES1823832-011	14-Aug-2018 13:30	WMLP343-001-DUP	✓	✓	✓	✓	✓	✓	✓

Matrix: **WATER**

Laboratory sample ID	Client sampling date / time	Client sample ID	WATER - EA045 Turbidity
ES1823832-001	14-Aug-2018 08:18	T2A-001	✓
ES1823832-002	14-Aug-2018 08:44	T2P-001	✓
ES1823832-003	14-Aug-2018 08:44	T2P-001-DUP	✓
ES1823832-004	14-Aug-2018 09:42	RH18-001	✓
ES1823832-005	14-Aug-2018 09:42	RH18-001-DUP	✓
ES1823832-010	14-Aug-2018 13:30	WMLP343-001	✓
ES1823832-011	14-Aug-2018 13:30	WMLP343-001-DUP	✓

Proactive Holding Time Report

Sample(s) have been received within the recommended holding times for the requested analysis.

Requested Deliverables

ALL INVOICES

- A4 - AU Tax Invoice (INV)	Email	brisbane@ageconsultants.com.au

KADE HANCOCK

- *AU Certificate of Analysis - NATA (COA)	Email	kade@ageconsultants.com.au
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	kade@ageconsultants.com.au
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	kade@ageconsultants.com.au
- A4 - AU Sample Receipt Notification - Environmental HT (SRN)	Email	kade@ageconsultants.com.au
- A4 - AU Tax Invoice (INV)	Email	kade@ageconsultants.com.au
- Chain of Custody (CoC) (COC)	Email	kade@ageconsultants.com.au
- EDI Format - ENMRG (ENMRG)	Email	kade@ageconsultants.com.au
- EDI Format - ESDAT (ESDAT)	Email	kade@ageconsultants.com.au

CHAIN OF CUSTODY

ALS Laboratory: please tick →

ALS Environmental

ADELAIDE 21 Burma Road Pooraka SA 5095 Ph: 08 8359 0890 E: adelaide@alsglobal.com
BRISBANE 32 Shand Street Stafford QLD 4053 Ph: 07 3243 7222 E: samples.brisbane@alsglobal.com
GLADSTONE 46 Callemondah Drive Clinton QLD 4680 Ph: 07 7471 5600 E: gladstone@alsglobal.com
MACKAY 78 Harbour Road Mackay QLD 4740 Ph: 07 4944 0177 E: mackay@alsglobal.com
MELBOURNE 2-4 Westall Road Springvale VIC 3171 Ph: 03 8549 9600 E: samples.melbourne@alsglobal.com
MUDGEE 27 Sydney Road Mudgee NSW 2850 Ph: 02 6372 6735 E: mudgee.mail@alsglobal.com
NEWCASTLE 5/585 Maitland Rd Mayfield West NSW 2304 Ph: 02 4014 2500 E: samples.newcastle@alsglobal.com
NOWRA 4/13 Geary Place North Nowra NSW 2541 Ph: 024423 2063 E: nowra@alsglobal.com
PERTH 10 Hod Way Malaga WA 6090 Ph: 08 9209 7655 E: samples.perth@alsglobal.com
SYDNEY 277-289 Woodpark Road Smithfield NSW 2164 Ph: 02 8784 8555 E: samples.sydney@alsglobal.com
TOWNSVILLE 14-15 Desma Court Bohle QLD 4818 Ph: 07 4796 0600 E: townsville.environmental@alsglobal.com
WOLLONGONG 99 Kenny Street Wollongong NSW 2500 Ph: 02 4225 3125 E: portkembla@alsglobal.com

CLIENT: AGE Consultants	TURNAROUND REQUIREMENTS : (Standard TAT may be longer for some tests e.g., Ultra Trace Organics)	☐ Standard TAT (List due date):	FOR LABORATORY USE ONLY (Circle)
OFFICE: Newcastle		☐ Non Standard or urgent TAT (List due date):	Custody Seal Intact? Yes / No / N/A
PROJECT: G1922B August 2018	ALS QUOTE NO.: SY/374/17	COC SEQUENCE NUMBER (Circle)	Free ice / frozen ice bricks present upon receipt? Yes / No / N/A
ORDER NUMBER:		COC: 1 2 3 4 5 6 7	Random Sample Temperature on Receipt: 16.5 °C
PROJECT MANAGER: Costante Conte	CONTACT PH: 02 4962 2091	OF: 1 2 3 4 5 6 7	Other comment:
SAMPLER: Kade Hancock	SAMPLER MOBILE: 0448 175 718		
COC emailed to ALS? (YES / NO)	EDD FORMAT (or default):		
Email Reports to (will default to PM if no other addresses are listed): Kade@ageconsultants.com.au			
Email Invoice to (will default to PM if no other addresses are listed):			

RELINQUISHED BY:	RECEIVED BY:	RELINQUISHED BY:	RECEIVED BY:
P. Hancock			MC
DATE/TIME: 14.8.18 3:45	DATE/TIME: 14/8/18 15:45	DATE/TIME: 14/8/18 17:00	DATE/TIME: 14/8/18 7:30pm

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE	SAMPLE DETAILS (MATRIX: SOLID (S) WATER (W))			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price). Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).										Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL CONTAINERS	EA005P - pH	EA010P - EC	NT1 & NT2 - Ca, Mg, Na, K, Cl, S04, alkalinity	W-1 (7 metals)	EG020 - Fe, Mn, Se	EA015H - TDS	EA045 - turbidity	NT-11 - Total P, Total N	EK058G - NO3	ED035 - ~~HS03~~	EK026SF - Cyanide	Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.
1	T2A-001	14.8.18 8:18	W		5	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
2	T2P-001	14.8.18 8:44	W		5	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
3	T2P-001 - DUP	14.8.18 8:44	W		5	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
4	RA18-001	14.8.18 9:42	W		5	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
5	RA18-001 - DUP	14.8.18 9:42	W		5	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
6	RA18-001 - TRIP	14.8.18 9:42	W		5	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	Send to Envirolab.
7	WMLP320-001	14.8.18 10:50	W		2	✓	✓	✓									
8	081-001	14.8.18 11:16	W		2	✓	✓	✓									
	~~WMLP110-001~~	14.8.18 11:28	W		2	✓	✓	✓									
9	WMLP158-001	14.8.18 12:30	W		2	✓	✓	✓									
	~~#9~~																
				TOTAL													

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldeh
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

PH @ WN

E-MAILED

Environmental Division Sydney
Work Order Reference
ES1823832

Telephone : + 61-2-8784 8555

CHAIN OF CUSTODY

ALS Environmental

ALS Laboratory: please tick →

☐ADELAIDE 21 Burma Road Pooraka SA 5095 Ph: 08 8359 0890 E: adelaide@alsglobal.com

☐BRISBANE 32 Shand Street Stafford QLD 4053 Ph: 07 3243 7222 E: samples.brisbane@alsglobal.com

☐GLADSTONE 46 Callemondah Drive Clinton QLD 4680 Ph: 07 7471 5600 E: gladstone@alsglobal.com

☐MACKAY 78 Harbour Road Mackay QLD 4740 Ph: 07 4944 0177 E: mackay@alsglobal.com

☐MELBOURNE 2-4 Westall Road Springvale VIC 3171 Ph: 03 8549 9600 E: samples.melbourne@alsglobal.com

☐MUDGEE 27 Sydney Road Mudgee NSW 2850 Ph: 02 6372 6735 E: mudgee.mail@alsglobal.com

☐NEWCASTLE 5/585 Maitland Rd Mayfield West NSW 2304 Ph: 02 4014 2500 E: samples.newcastle@alsglobal.com

☐NOWRA 4/13 Geary Place North Nowra NSW 2541 Ph: 024423 2063 E: nowra@alsglobal.com

☐PERTH 10 Hod Way Malaga WA 6090 Ph: 08 9209 7655 E: samples.perth@alsglobal.com

☐SYDNEY 277-289 Woodpark Road Smithfield NSW 2164 Ph: 02 8784 8555 E: samples.sydney@alsglobal.com

☐TOWNSVILLE 14-15 Desma Court Bohle QLD 4818 Ph: 07 4796 0600 E: townsville.environmental@alsglobal.com

☐WOLLONGONG 99 Kenny Street Wollongong NSW 2500 Ph: 02 4225 3125 E: portkembla@alsglobal.com

CLIENT: AGE Consultants	**TURNAROUND REQUIREMENTS :** (Standard TAT may be longer for some tests e.g., Ultra Trace Organics)	☐ Standard TAT (List due date):	**FOR LABORATORY USE ONLY (Circle)**
OFFICE: [illegible]		☐ Non Standard or urgent TAT (List due date):	Custody Seal Intact? Yes / No / N/A
PROJECT: G1922B August 2018	**ALS QUOTE NO.:** SY/374/17	**COC SEQUENCE NUMBER (Circle)**	Free ice / frozen ice bricks present upon receipt? Yes / No / N/A
ORDER NUMBER:		COC: 1 2 3 4 5 6 7	Random Sample Temperature on Receipt: 16.5 °C
PROJECT MANAGER: Costante Conte	**CONTACT PH:** 02 4962 2091	OF: 1 2 3 4 5 6 7	Other comment:

SAMPLER: Kade Hancock	**SAMPLER MOBILE:** 0448 175 718	**RELINQUISHED BY:** V. Hancock	**RECEIVED BY:**
COC emailed to ALS? (YES / NO)	**EDD FORMAT (or default):**	DATE/TIME: 14.8.18 3:45	DATE/TIME: 14/8/18 15.45
Email Reports to (will default to PM if no other addresses are listed): Kade@ageconsultants.com.au		**RELINQUISHED BY:**	**RECEIVED BY:**
Email Invoice to (will default to PM if no other addresses are listed):		DATE/TIME:	DATE/TIME:

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE	SAMPLE DETAILS MATRIX: SOLID (S) WATER (W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where **Metals** are required, specify **Total** (unfiltered bottle required) or **Dissolved** (field filtered bottle required).										Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL CONTAINERS	EA005P - pH	EA010P - EC	NT1 & NT2 - Ca, Mg, Na, K, Cl, S04, alkalinity	W-1 (7 metals)	EG020 - Fe, Mn, Se	EA015H - TDS	EA045 - turbidity	NT-11 - Total P, Total N	EK058G - NO3	ED035 - HCO3	EK026SF - Cyanide	
10	WMLP343-001	14.8.18 1:30	W		5	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	
11	WMLP343-001-DUP	14.8.18 1:30	W		5	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	
12	WMLP343-001-TRIP	14.8.18 1:30	W		5	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	Send to Envirolab
				TOTAL													

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

PHOWN

SAMPLE RECEIPT NOTIFICATION (SRN)

Work Order : **ES1824147**

Client	: **AUSTRALASIAN GROUNDWATER AND ENVIRONMENTAL CONSULTANTS PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR KADE HANCOCK	Contact	: Customer Services ES
Address	: 4 HUDSON STREET HAMILTON NSW 2303	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: kade@ageconsultants.com.au	E-mail	: ALSEnviro.Sydney@alsglobal.com
Telephone	: ----	Telephone	: +61-2-8784 8555
Facsimile	: ----	Facsimile	: +61-2-8784 8500
Project	: G1922B	Page	: 1 of 3
Order number	:	Quote number	: EB2017AUSGRO0001 (EN/222/17)
C-O-C number	: ----	QC Level	: NEPM 2013 B3 & ALS QC Standard
Site	: ----		
Sampler	: KADE HANCOCK		

Dates

Date Samples Received	: 16-Aug-2018 15:13	Issue Date	: 16-Aug-2018
Client Requested Due Date	: 22-Aug-2018	Scheduled Reporting Date	: **22-Aug-2018**

Delivery Details

Mode of Delivery	: Undefined	Security Seal	: Not Available
No. of coolers/boxes	: 1	Temperature	: 0.7'C - Ice present
Receipt Detail	:	No. of samples received / analysed	: 4 / 4

General Comments

- This report contains the following information:
  - Sample Container(s)/Preservation Non-Compliances
  - Summary of Sample(s) and Requested Analysis
  - Proactive Holding Time Report
  - Requested Deliverables
- **Please refer to the Proactive Holding Time Report table below which summarises breaches of recommended holding times that have occurred prior to samples/instructions being received at the laboratory. The absence of this summary table indicates that all samples have been received within the recommended holding times for the analysis requested.**
- **pH analysis will be conducted by ALS Newcastle-Water.**
- Please direct any queries you have regarding this work order to the above ALS laboratory contact.
- Analytical work for this work order will be conducted at ALS Sydney.
- Sample Disposal - Aqueous (3 weeks), Solid (2 months) from receipt of samples.

Sample Container(s)/Preservation Non-Compliances

All comparisons are made against pretreatment/preservation AS, APHA, USEPA standards.

- **No sample container / preservation non-compliance exists.**

Summary of Sample(s) and Requested Analysis

Some items described below may be part of a laboratory process necessary for the execution of client requested tasks. Packages may contain additional analyses, such as the determination of moisture content and preparation tasks, that are included in the package.
If no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory and displayed in brackets without a time component

Matrix: **WATER**

Laboratory sample ID	Client sampling date / time	Client sample ID	WATER - EA005: pH pH	WATER - EA010P Electrical Conductivity (PCT)	WATER - ED040F Dissolved Major Anions	WATER - ED093F + EA006 Dissolved Major Cations + SAR	WATER - EG020F Dissolved Metals by ICP/MS	WATER - EG035F Dissolved Mercury	WATER - NT-01D & 02A Major Cations & Anions (Ca, Mg, Na, K, Cl, SO4,
ES1824147-001	16-Aug-2018 11:12	MW03-001	✓	✓	✓	✓	✓	✓	✓
ES1824147-002	16-Aug-2018 12:00	MW02-001	✓	✓	✓	✓	✓	✓	✓
ES1824147-003	16-Aug-2018 12:54	MW01-001	✓	✓	✓	✓	✓	✓	✓
ES1824147-004	16-Aug-2018 13:30	MW04-001	✓	✓	✓	✓	✓	✓	✓

Matrix: **WATER**

Laboratory sample ID	Client sampling date / time	Client sample ID	WATER - EA015H Total Dissolved Solids - Standard Level
ES1824147-001	16-Aug-2018 11:12	MW03-001	✓
ES1824147-002	16-Aug-2018 12:00	MW02-001	✓
ES1824147-003	16-Aug-2018 12:54	MW01-001	✓
ES1824147-004	16-Aug-2018 13:30	MW04-001	✓

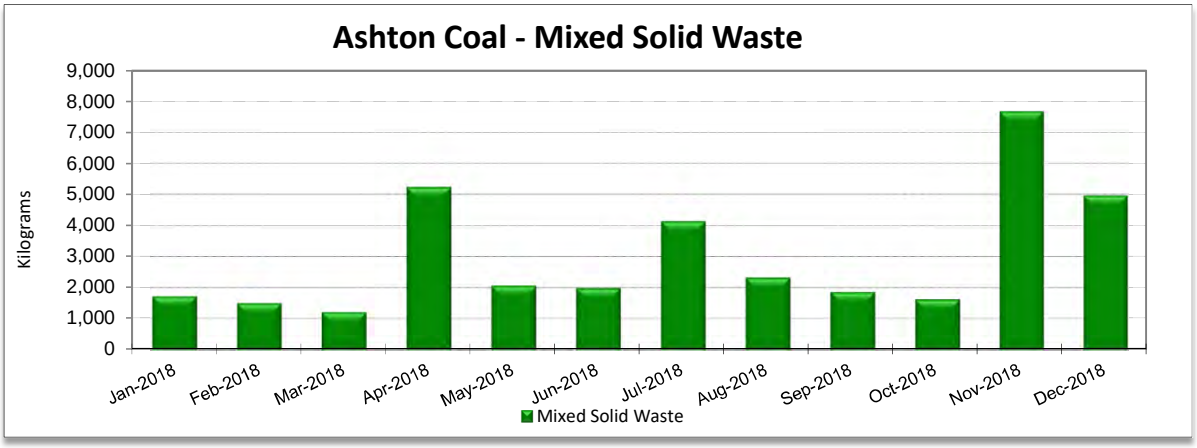
Proactive Holding Time Report

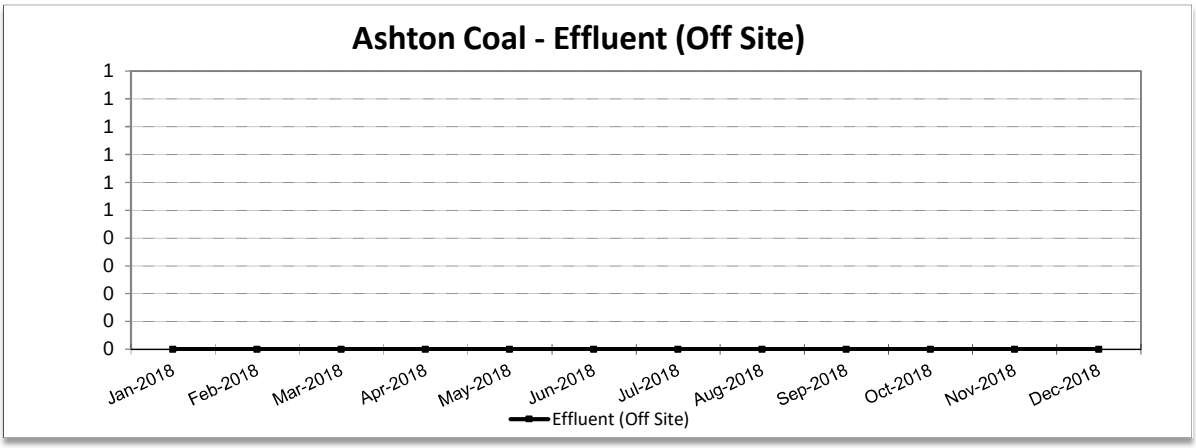
Sample(s) have been received within the recommended holding times for the requested analysis.

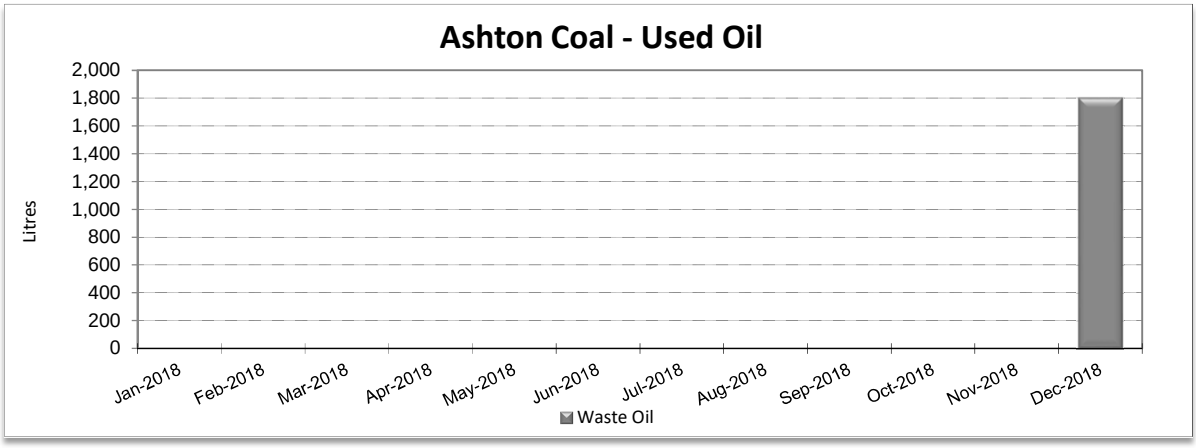
Requested Deliverables

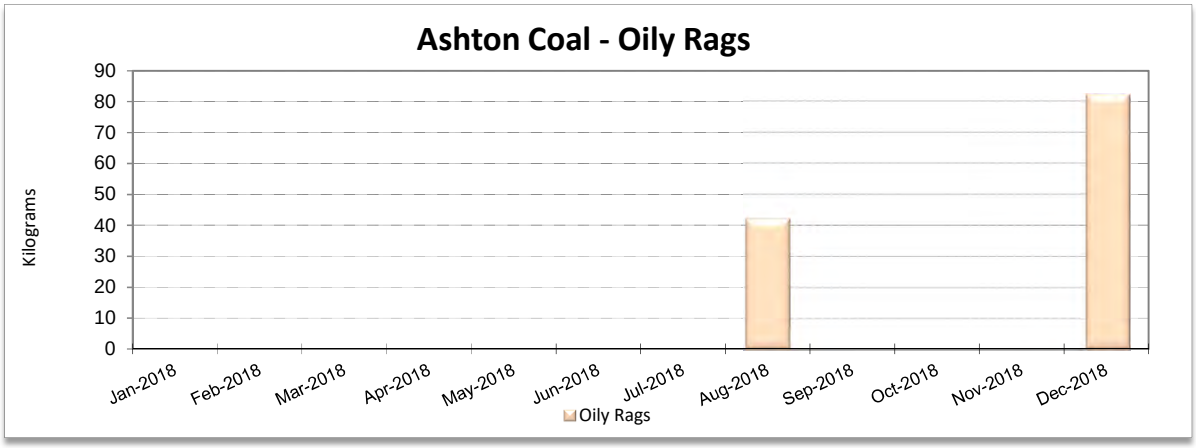
ALL INVOICES		
- A4 - AU Tax Invoice (INV)	Email	brisbane@ageconsultants.com.au
INVOICES BOWEN HILLS		
- A4 - AU Tax Invoice (INV)	Email	brisbane@ageconsultants.com.au
KADE HANCOCK		
- *AU Certificate of Analysis - NATA (COA)	Email	kade@ageconsultants.com.au
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	kade@ageconsultants.com.au
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	kade@ageconsultants.com.au
- A4 - AU Sample Receipt Notification - Environmental HT (SRN)	Email	kade@ageconsultants.com.au
- Chain of Custody (CoC) (COC)	Email	kade@ageconsultants.com.au
- EDI Format - XTab (XTAB)	Email	kade@ageconsultants.com.au
NECASTLE		
- *AU Certificate of Analysis - NATA (COA)	Email	newcastle@ageconsultants.com.au
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	newcastle@ageconsultants.com.au
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	newcastle@ageconsultants.com.au
- A4 - AU Sample Receipt Notification - Environmental HT (SRN)	Email	newcastle@ageconsultants.com.au
- A4 - AU Tax Invoice (INV)	Email	newcastle@ageconsultants.com.au
- Chain of Custody (CoC) (COC)	Email	newcastle@ageconsultants.com.au
- EDI Format - XTab (XTAB)	Email	newcastle@ageconsultants.com.au

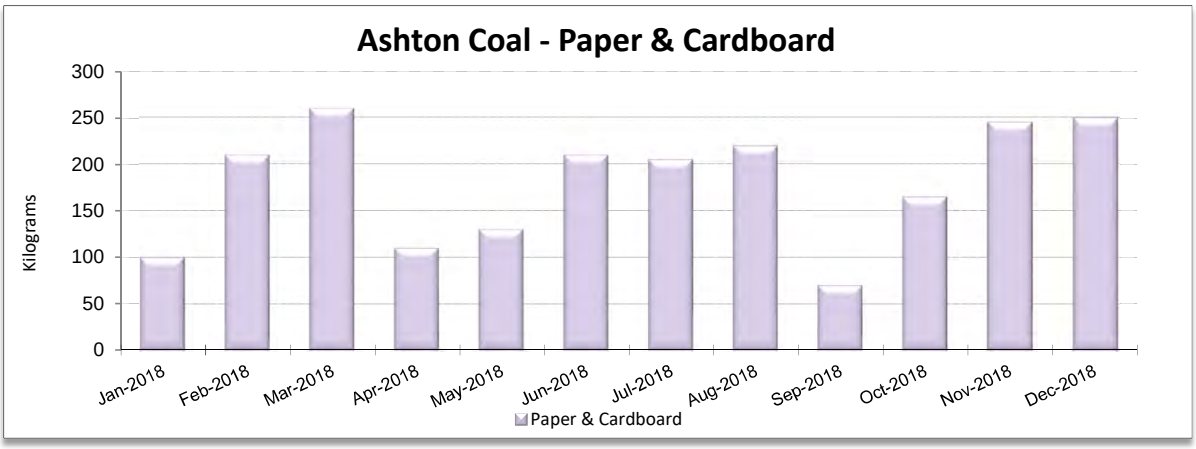
17 Appendix 3 – Waste Volumes, 2018

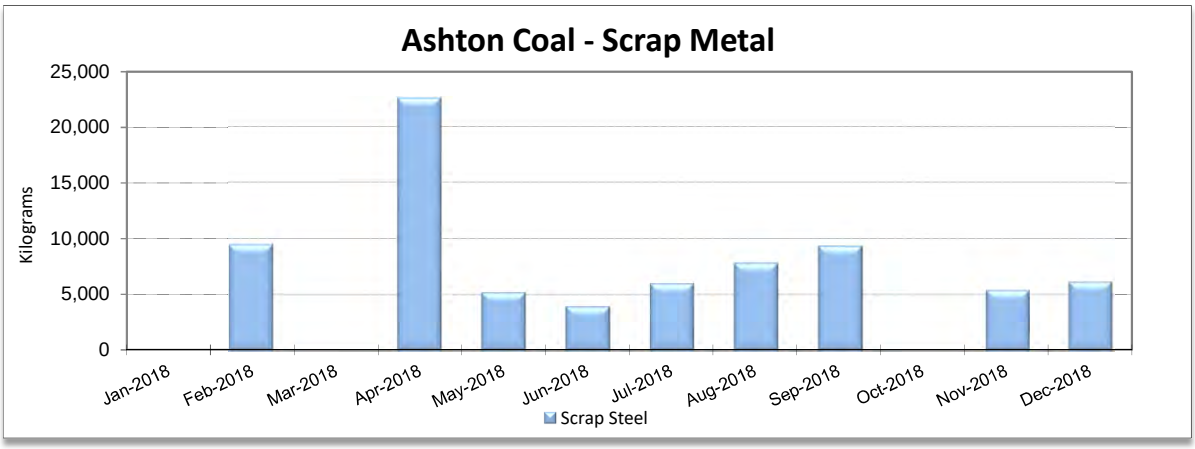

Ashton Coal - Mixed Solid Waste
Kilograms
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
Jan-2018
Feb-2018
Mar-2018
Apr-2018
May-2018
Jun-2018
Jul-2018
Aug-2018
Sep-2018
Oct-2018
Nov-2018
Dec-2018
Mixed Solid Waste

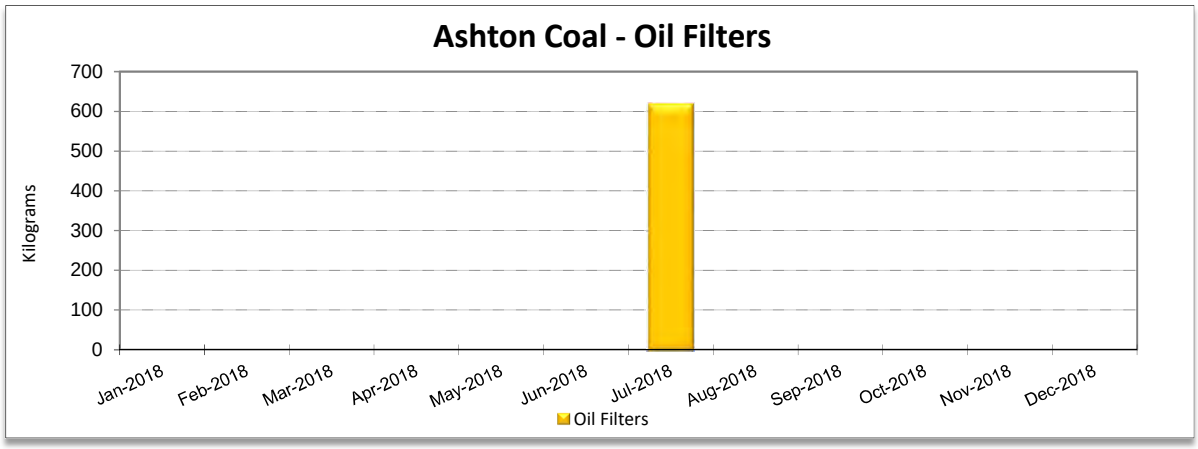

Ashton Coal - Effluent (Off Site)
1
1
1
1
1
1
0
0
0
0
0
Jan-2018
Feb-2018
Mar-2018
Apr-2018
May-2018
Jun-2018
Jul-2018
Aug-2018
Sep-2018
Oct-2018
Nov-2018
Dec-2018
Effluent (Off Site)

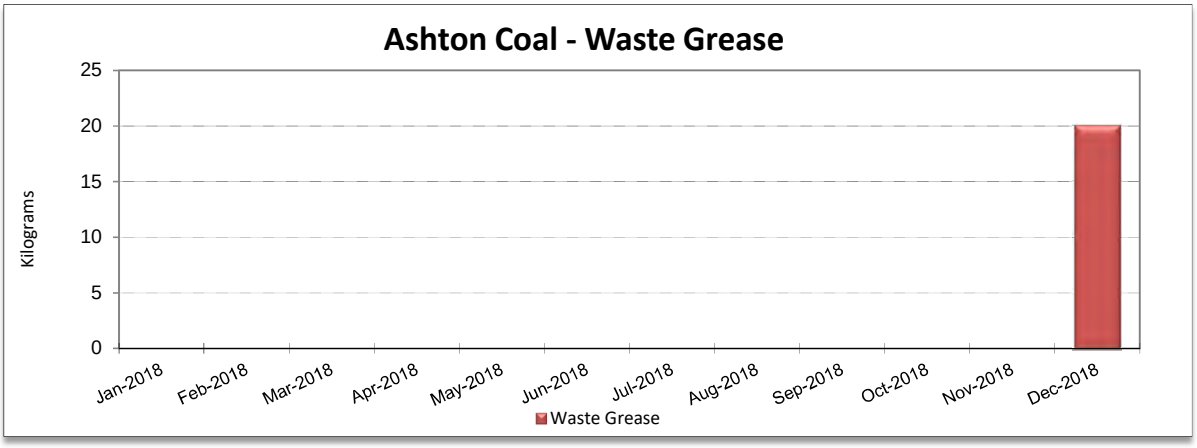

Ashton Coal - Used Oil
Litres
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
Jan-2018
Feb-2018
Mar-2018
Apr-2018
May-2018
Jun-2018
Jul-2018
Aug-2018
Sep-2018
Oct-2018
Nov-2018
Dec-2018
Waste Oil

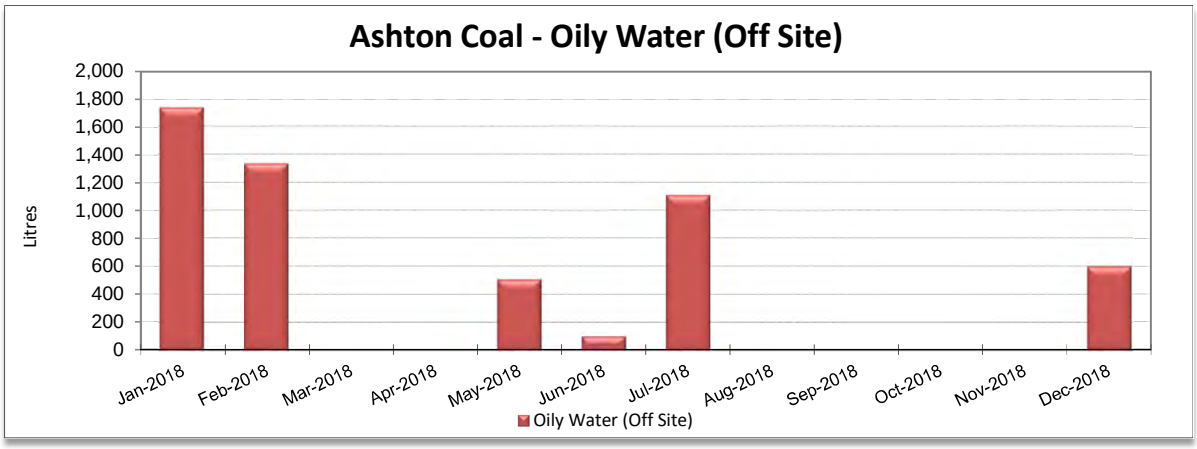

Ashton Coal - Oily Rags
Kilograms
90
80
70
60
50
40
30
20
10
0
Jan-2018
Feb-2018
Mar-2018
Apr-2018
May-2018
Jun-2018
Jul-2018
Aug-2018
Sep-2018
Oct-2018
Nov-2018
Dec-2018
Oily Rags

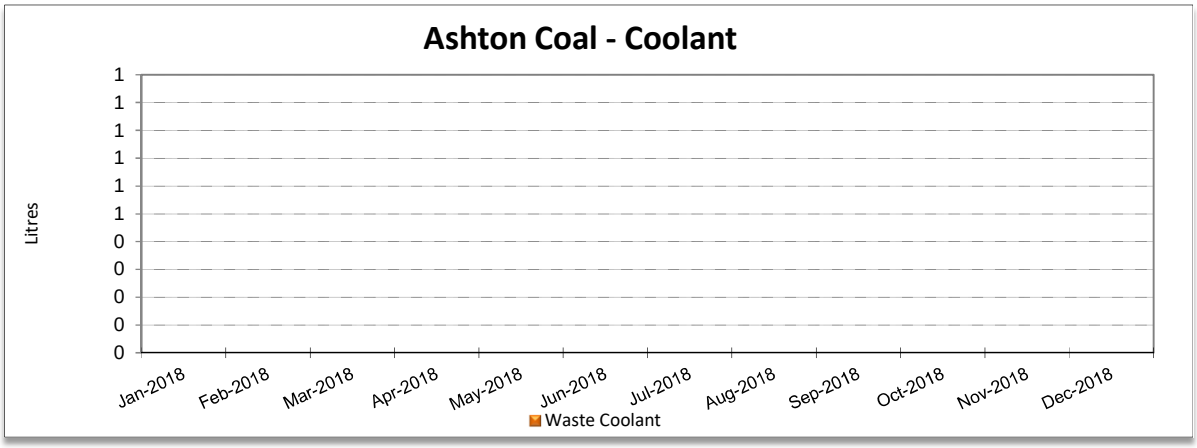

Ashton Coal - Paper & Cardboard
Kilograms
300
250
200
150
100
50
0
Jan-2018
Feb-2018
Mar-2018
Apr-2018
May-2018
Jun-2018
Jul-2018
Aug-2018
Sep-2018
Oct-2018
Nov-2018
Dec-2018
Paper & Cardboard


Ashton Coal - Scrap Metal
Kilograms
25,000
20,000
15,000
10,000
5,000
0
Jan-2018
Feb-2018
Mar-2018
Apr-2018
May-2018
Jun-2018
Jul-2018
Aug-2018
Sep-2018
Oct-2018
Nov-2018
Dec-2018
Scrap Steel


Ashton Coal - Oil Filters
Kilograms
700
600
500
400
300
200
100
0
Jan-2018
Feb-2018
Mar-2018
Apr-2018
May-2018
Jun-2018
Jul-2018
Aug-2018
Sep-2018
Oct-2018
Nov-2018
Dec-2018
Oil Filters


Ashton Coal - Waste Grease
Kilograms
25
20
15
10
5
0
Jan-2018
Feb-2018
Mar-2018
Apr-2018
May-2018
Jun-2018
Jul-2018
Aug-2018
Sep-2018
Oct-2018
Nov-2018
Dec-2018
Waste Grease


Ashton Coal - Oily Water (Off Site)
Litres
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
Jan-2018
Feb-2018
Mar-2018
Apr-2018
May-2018
Jun-2018
Jul-2018
Aug-2018
Sep-2018
Oct-2018
Nov-2018
Dec-2018
Oily Water (Off Site)


Ashton Coal - Coolant
Litres
1
1
1
1
1
1
0
0
0
0
0
Jan-2018
Feb-2018
Mar-2018
Apr-2018
May-2018
Jun-2018
Jul-2018
Aug-2018
Sep-2018
Oct-2018
Nov-2018
Dec-2018
Waste Coolant


Ashton Coal - Recycling acheived
Percentage
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Jan-2018
Feb-2018
Mar-2018
Apr-2018
May-2018
Jun-2018
Jul-2018
Aug-2018
Sep-2018
Oct-2018
Nov-2018
Dec-2018
Recycling %

18 Appendix 4 – OEH monitoring form, VCA

MONITORING REPORT FORM

This form is being completed for the following reason:

- ☐ Annual Report by landholder (self reporting)
- ☒ Routine visit by OEH with landholder
- ☐ Compliance visit by OEH with landholder
- ☐ Change of ownership visit by OEH with landholder
- ☐ Conservation Agreement
- ☐ Wildlife Refuge
- ☐ Property Agreement

Please make three copies of the completed form and any additional information. One to be retained by the landowner, one for the local Area office of NPWS and the third to go to Conservation Partnerships Delivery Unit, OEH, PO Box A290, Sydney South NSW 1232.

A LANDOWNER AND PROPERTY DETAILS

Property Owner	Ashton Coal.
Property Name	Southern VCA
Property Address	New England Hwy, Camberwell.
CA number	
Area (ha)	65
CMA Region	Hunter.
Agreement signed	
Date of last monitoring visit	29 May 2017
Date of visit	19 June 2018
Officer undertaking visit	Trish Robinson.

B LANDHOLDER OVERVIEW SINCE LAST VISIT

1 LANDHOLDER EXPERIENCES RELATING TO THE IMPLEMENTATION OF THE CONSERVATION AGREEMENT /WILDLIFE REFUGE

Points to note	*Comments*

☐ Please place an X in this box if new issue(s)/problem(s) require management help

2 WORKS UNDERTAKEN SINCE LAST VISIT

Description of work undertaken	*Source of funding and amount*	*Date completed*

3 FIRE HISTORY MONITORING

Date of fire	*Area burnt (% of c.a./approx ha)*	*Reason (hazard red./wild)*	*Intensity (low/medium/high)*

4 VISITATION

Average No. of Visitors per year	*Purpose of Visitation*	*Visitation effects*	*Strategies to overcome effects*

5 COMMUNITY CONSULTATION AND INPUT INTO DECISION MAKING

Type of Involvement	*Numbers involved*	*Outcomes*

C CONSERVATION VALUES

	Conservation Values noted in Agreement and its significance	Current condition ** (I = improving M= maintain D= declining) *Anecdotal evidence only available at present*	Current and emerging threats	Level (*severe, high, moderate or low*) and extent (*throughout, widespread, scattered or localised*) of threats	New findings; any other relevant information.
Landscape/ Catchment - World/national heritage listings - Landscape & scenic values					
Biological - Vegetation Communities - Flora - Fauna & habitat - Water bodies	Box - Ironbark Woodland EEC	Maintain	Weeds.	Moderate to High. throughout VCA	
Geological	Erosion Subsidence	M D	Minor. Large cracks	Localised. Localised - NE	
Cultural Heritage - Aboriginal - Historic					
Research/ education					
Other					

** Current Condition: determine change by comparison with previous Condition Assessments (Pages 5 to 8). Carry out new assessment if not done previously. Biometric can also be used.

D MANAGEMENT ISSUES

	Describe the Issue (short description of current extent of impacts, new sightings and any other relevant information	Description of planning and implementation of control measures being and to be undertaken, and duration
Weeds (where applicable, infestation can be given as a % of total vegetation)	African boxthorn -new ~~infestations~~ growth on sprayed plants.	
Pest Animals - Feral - Domestic - Native	Hares Rabbits Cat.	
Fire Management		
Threatened species; endangered ecological communities etc	Box- Ironbark Woodland EEC Grey-crowned babbler Speckled warbler.	
Cultural Heritage Management		
Visitor Impact Management		
Community Consultation and input into decision making.		
Research/ Education programs		
Other permitted uses -vehicle access - use of timber -seed collection - etc		

E WORKPLAN TO ADDRESS MANAGEMENT ISSUES (in priority order)

Action to be completed or ongoing action (discuss on site and where necessary confirm details later)	*Cost and possible funding sources*	*Completion Date*	*Responsibility (landholder, OEH, other)*

F ATTACHMENTS

- ☐ Map showing location of activities referred to above eg weed infestations; fire; location of past and future management actions.

List further attachments if relevant:

- ☐ Photos from previously/new identified photopoints
- ☐ Rapid Assessment Sheets for previous/new sites.
- ☐ Other Monitoring results.

I/we confirm a field inspection has been undertaken and this form is a summary of the conservation values and management issues discussed.

Signature: _____ _____
Landowner Visiting OEH/NPWS Officer, if applicable

Date report completed: _____

Level of threat definition

Table 4 Description of the level of impact categories (adapted from State of the Parks 2007 Guidelines)

Impact of the threat	Description of category
Severe	The threat will lead to loss of property value(s) in the foreseeable future if it continues to operate at current levels
High	The threat will lead to a significant reduction of property e values(s) if it continues to operate at current levels.
Moderate	The threat is having a detectable impact on reserve values(s) but damage is not considered significant.
Mild	The threat is having minor or barely detectable impact on property value(s).

Extent of threat definition For cultural heritage places, sites and objects, classify the extent the impact is having on the place/site/object itself.

Table 5: Description of the extent categories (adapted from State of the Parks 2007 Guidelines)

Extent of the threat	Description of category
Throughout	The impact is occurring in 50% or more of property area/cultural place/site/object.
Widespread	The impact is occurring in more than 15% but less than 50% of reserve area/cultural place/site/object.
Scattered	The impact is occurring in between 5 and 15% of reserve area/cultural place/site/object.
Localised	The impact is occurring is less than 5% of reserve area/cultural place/site/object.

CONDITION ASSESSMENT NATIVE VEGETATION

For native bushland and grassland sites and paddocks containing scattered shade trees

Site number or name: Mfarm 06 Monitoring date: 19/6/18	
Assessment questions	**Answer Yes, No or N/A**
1. Is the area fenced to manage stock access and grazing? *Healthy bush should be rested for long periods to allow regeneration. To achieve this, it should be fenced off.*	Yes.
2. Is there regeneration of native trees and shrubs, or if in grassland, regular germination of native herbs eg perennials such as lilies or orchids and annuals such as daisies? *Regeneration of trees and shrubs is necessary for the bush to maintain health, diversity and a range of habitats. An understorey of shrubs encourages small insect eating birds and other native animals.*	Yes.
3. Is there a diverse range of tree and shrub species present, eg more than 20 (coast), 15 (tablelands), 10 (western slopes and plains)? (Note: healthy river red gum forest may have only one tree and 5-10 shrub species present). *Diversity encourages a range of native animals and helps the bush withstand attacks of insects and other adverse conditions.*	No
4. If grassland, is there a diverse range of grasses and broad leaf herbs present?	N/A.
5. Is there adequate ground cover, eg leaves, bark and twigs, or litter (dead grasses)? *Ground cover indicates whether the area is being disturbed by stock and is a measure of tree canopy density and the domination of exotic grasses and weeds.*	Yes.
6. Are mosses or lichens on rocks, fallen branches and the ground surface, or are these species, along with liverworts, forming a crust on bare soil?	Yes.
7. Are weeds uncommon, sparsely scattered, absent, or mainly around edges of the area? *The understorey may have exotic weeds present. Too many are undesirable and you may need a management plan for their control. Weeds compete with native plants for light, space, water and nutrients.*	No
8. Is there a very low incidence of pest animals, eg foxes and rabbits? *Remnant bush can be a refuge for pest animals as well as natives. The feral animals should be controlled.*	Yes.
9. Is the patch shape a block or part of a corridor more than 30 metres wide rather than a thin strip? *Blocks of native vegetation have less edge area than strips, so they are less influenced by changes in levels of weeds, predators, noise and climatic effects.*	Yes.
10. Is the area greater than 1 ha (coast), 5 ha (tablelands), 10 ha (western slopes), 20 ha (plains), 50 ha (Western Division)?	Yes.
11. Is the remnant linked to other remnants by corridors, eg. roadside vegetation, or scattered trees no more than 50 m apart ? *Corridors provide shelter and pathways for native organisms (other than birds) to move over the landscape for feeding, breeding, roosting and expanding territory.*	Yes.
12. Is there a mix of tree ages present, ie saplings through to old growth with hollows ? *A range of ages and conditions means the bush is regenerating itself and each stage of growth is suitable habitat for native organisms.*	Yes.
13. If trees are present is an understorey also present? *An understorey of shrubs encourages small insect eating birds and other native animals.*	Yes.
14. Is the understorey mostly comprised of native shrubs and / or grasses and broad leaf	Yes.

herbs?	
15. Area there standing trees (alive or dead) with hollows, present in the remnant or paddock ? *Dead trees with hollows are essential for roosting and nesting of a large range of native birds such as parrots and of bats.*	Yes.
16. Are the trees mainly healthy, with little or no dieback? *Dieback is apparent if there are bare twigs at the outer part of the tree canopy. It is usually a sign of severe insect attack.*	Yes.
17. Are there less than 20 % of trees affected by mistletoe? *Mistletoe is a parasite that invades trees and causes them to lose vigour. Where many trees in an area are affected it is likely to indicate that the area of vegetation is under severe stress.*	Yes.
18. Are there logs and fallen timber on the ground? *Logs and dead material are essential habitat for smaller native organisms. But they can also be a harbour for pest animals.*	Yes.
19. If scattered paddock trees are unfenced, are stock camps absent? *Bare ground, bare tree roots or the movement of soil all can indicate erosion which needs to be managed and controlled.*	N/A
20. If scattered paddock trees are unfenced, is evidence of stock ringbarking or rubbing absent?	N/A
21. Is the area free of herbicide, insecticide or fertiliser overspray from adjoining areas? *Herbicides and insecticides can kill native plants and small organisms. Fertiliser encourages exotic species by raising nutrient levels.*	Yes.
22. Is the area free from the threat of salinity and / or high water tables?	Yes.
Total number of 'yes' answers	17

Condition rating - native vegetation

Number of 'yes' answers			Vegetation condition rating	Need for management attention
Remnant bushland	Remnant grassland	Scattered paddock trees		
14 +	9 +	12 +	Healthy	Maintain current management
9 - 13	6 - 8	8 - 11	Good	Needs some management attention
5 - 8	3 - 5	5 - 7	Fair	Needs a significant level of management attention
0 - 4	0 - 2	0 - 4	Poor	Urgent management necessary if you wish to retain area as stock shelter

CONDITION ASSESSMENT NATIVE VEGETATION

For native bushland and grassland sites and paddocks containing scattered shade trees

Site number or name: RWood03 Monitoring date: 19/6/18	
Assessment questions	**Answer Yes, No or N/A**
1. Is the area fenced to manage stock access and grazing? *Healthy bush should be rested for long periods to allow regeneration. To achieve this, it should be fenced off.*	Yes.
2. Is there regeneration of native trees and shrubs, or if in grassland, regular germination of native herbs eg perennials such as lilies or orchids and annuals such as daisies? *Regeneration of trees and shrubs is necessary for the bush to maintain health, diversity and a range of habitats. An understorey of shrubs encourages small insect eating birds and other native animals.*	Yes.
3. Is there a diverse range of tree and shrub species present, eg more than 20 (coast), 15 (tablelands), 10 (western slopes and plains)? (Note: healthy river red gum forest may have only one tree and 5-10 shrub species present). *Diversity encourages a range of native animals and helps the bush withstand attacks of insects and other adverse conditions.*	Yes.
4. If grassland, is there a diverse range of grasses and broad leaf herbs present?	N/A
5. Is there adequate ground cover, eg leaves, bark and twigs, or litter (dead grasses)? *Ground cover indicates whether the area is being disturbed by stock and is a measure of tree canopy density and the domination of exotic grasses and weeds.*	Yes.
6. Are mosses or lichens on rocks, fallen branches and the ground surface, or are these species, along with liverworts, forming a crust on bare soil?	Yes.
7. Are weeds uncommon, sparsely scattered, absent, or mainly around edges of the area? *The understorey may have exotic weeds present. Too many are undesirable and you may need a management plan for their control. Weeds compete with native plants for light, space, water and nutrients.*	Yes.
8. Is there a very low incidence of pest animals, eg foxes and rabbits? *Remnant bush can be a refuge for pest animals as well as natives. The feral animals should be controlled.*	Yes.
9. Is the patch shape a block or part of a corridor more than 30 metres wide rather than a thin strip? *Blocks of native vegetation have less edge area than strips, so they are less influenced by changes in levels of weeds, predators, noise and climatic effects.*	Yes.
10. Is the area greater than 1 ha (coast), 5 ha (tablelands), 10 ha (western slopes), 20 ha (plains), 50 ha (Western Division)?	Yes.
11. Is the remnant linked to other remnants by corridors, eg. roadside vegetation, or scattered trees no more than 50 m apart ? *Corridors provide shelter and pathways for native organisms (other than birds) to move over the landscape for feeding, breeding, roosting and expanding territory.*	Yes.
12. Is there a mix of tree ages present, ie saplings through to old growth with hollows ? *A range of ages and conditions means the bush is regenerating itself and each stage of growth is suitable habitat for native organisms.*	Yes.
13. If trees are present is an understorey also present? *An understorey of shrubs encourages small insect eating birds and other native animals.*	Yes.
14. Is the understorey mostly comprised of native shrubs and / or grasses and broad leaf	Yes.

herbs?	
15. Area there standing trees (alive or dead) with hollows, present in the remnant or paddock ? *Dead trees with hollows are essential for roosting and nesting of a large range of native birds such as parrots and of bats.*	Yes.
16. Are the trees mainly healthy, with little or no dieback? *Dieback is apparent if there are bare twigs at the outer part of the tree canopy. It is usually a sign of severe insect attack.*	Yes.
17. Are there less than 20 % of trees affected by mistletoe? *Mistletoe is a parasite that invades trees and causes them to lose vigour. Where many trees in an area are affected it is likely to indicate that the area of vegetation is under severe stress.*	Yes.
18. Are there logs and fallen timber on the ground? *Logs and dead material are essential habitat for smaller native organisms. But they can also be a harbour for pest animals.*	Yes.
19. If scattered paddock trees are unfenced, are stock camps absent? *Bare ground, bare tree roots or the movement of soil all can indicate erosion which needs to be managed and controlled.*	N/A
20. If scattered paddock trees are unfenced, is evidence of stock ringbarking or rubbing absent?	N/A
21. Is the area free of herbicide, insecticide or fertiliser overspray from adjoining areas? *Herbicides and insecticides can kill native plants and small organisms. Fertiliser encourages exotic species by raising nutrient levels.*	Yes.
22. Is the area free from the threat of salinity and / or high water tables?	Yes.
Total number of 'yes' answers	19.

Condition rating - native vegetation

Number of 'yes' answers			Vegetation condition rating	Need for management attention
Remnant bushland	Remnant grassland	Scattered paddock trees		
14 +	9 +	12 +	Healthy	Maintain current management
9 - 13	6 - 8	8 - 11	Good	Needs some management attention
5 - 8	3 - 5	5 - 7	Fair	Needs a significant level of management attention
0 - 4	0 - 2	0 - 4	Poor	Urgent management necessary if you wish to retain area as stock shelter

CONDITION ASSESSMENT NATIVE VEGETATION

For native bushland and grassland sites and paddocks containing scattered shade trees

Site number or name: RGrass04 Monitoring date: 21/6/18	
Assessment questions	**Answer Yes, No or N/A**
1. Is the area fenced to manage stock access and grazing? *Healthy bush should be rested for long periods to allow regeneration. To achieve this, it should be fenced off.*	Yes.
2. Is there regeneration of native trees and shrubs, or if in grassland, regular germination of native herbs eg perennials such as lilies or orchids and annuals such as daisies? *Regeneration of trees and shrubs is necessary for the bush to maintain health, diversity and a range of habitats. An understorey of shrubs encourages small insect eating birds and other native animals.*	Yes
3. Is there a diverse range of tree and shrub species present, eg more than 20 (coast), 15 (tablelands), 10 (western slopes and plains)? (Note: healthy river red gum forest may have only one tree and 5-10 shrub species present). *Diversity encourages a range of native animals and helps the bush withstand attacks of insects and other adverse conditions.*	N/A
4. If grassland, is there a diverse range of grasses and broad leaf herbs present?	No
5. Is there adequate ground cover, eg leaves, bark and twigs, or litter (dead grasses)? *Ground cover indicates whether the area is being disturbed by stock and is a measure of tree canopy density and the domination of exotic grasses and weeds.*	Yes.
6. Are mosses or lichens on rocks, fallen branches and the ground surface, or are these species, along with liverworts, forming a crust on bare soil?	No
7. Are weeds uncommon, sparsely scattered, absent, or mainly around edges of the area? *The understorey may have exotic weeds present. Too many are undesirable and you may need a management plan for their control. Weeds compete with native plants for light, space, water and nutrients.*	No
8. Is there a very low incidence of pest animals, eg foxes and rabbits? *Remnant bush can be a refuge for pest animals as well as natives. The feral animals should be controlled.*	Yes.
9. Is the patch shape a block or part of a corridor more than 30 metres wide rather than a thin strip? *Blocks of native vegetation have less edge area than strips, so they are less influenced by changes in levels of weeds, predators, noise and climatic effects.*	Yes.
10. Is the area greater than 1 ha (coast), 5 ha (tablelands), 10 ha (western slopes), 20 ha (plains), 50 ha (Western Division)?	Yes.
11. Is the remnant linked to other remnants by corridors, eg. roadside vegetation, or scattered trees no more than 50 m apart ? *Corridors provide shelter and pathways for native organisms (other than birds) to move over the landscape for feeding, breeding, roosting and expanding territory.*	Yes.
12. Is there a mix of tree ages present, ie saplings through to old growth with hollows ? *A range of ages and conditions means the bush is regenerating itself and each stage of growth is suitable habitat for native organisms.*	N/A
13. If trees are present is an understorey also present? *An understorey of shrubs encourages small insect eating birds and other native animals.*	N/A
14. Is the understorey mostly comprised of native shrubs and / or grasses and broad leaf	No

herbs?	
15. Area there standing trees (alive or dead) with hollows, present in the remnant or paddock ? *Dead trees with hollows are essential for roosting and nesting of a large range of native birds such as parrots and of bats.*	No
16. Are the trees mainly healthy, with little or no dieback? *Dieback is apparent if there are bare twigs at the outer part of the tree canopy. It is usually a sign of severe insect attack.*	N/A
17. Are there less than 20 % of trees affected by mistletoe? *Mistletoe is a parasite that invades trees and causes them to lose vigour. Where many trees in an area are affected it is likely to indicate that the area of vegetation is under severe stress.*	N/A.
18. Are there logs and fallen timber on the ground? *Logs and dead material are essential habitat for smaller native organisms. But they can also be a harbour for pest animals.*	No
19. If scattered paddock trees are unfenced, are stock camps absent? *Bare ground, bare tree roots or the movement of soil all can indicate erosion which needs to be managed and controlled.*	N/A
20. If scattered paddock trees are unfenced, is evidence of stock ringbarking or rubbing absent?	N/A
21. Is the area free of herbicide, insecticide or fertiliser overspray from adjoining areas? *Herbicides and insecticides can kill native plants and small organisms. Fertiliser encourages exotic species by raising nutrient levels.*	Yes.
22. Is the area free from the threat of salinity and / or high water tables?	Yes.
Total number of 'yes' answers	9

Condition rating - native vegetation

Number of 'yes' answers			Vegetation condition rating	Need for management attention
Remnant bushland	Remnant grassland	Scattered paddock trees		
14 +	9 +	12 +	Healthy	Maintain current management
9 - 13	6 - 8	8 - 11	Good	Needs some management attention
5 - 8	3 - 5	5 - 7	Fair	Needs a significant level of management attention
0 - 4	0 - 2	0 - 4	Poor	Urgent management necessary if you wish to retain area as stock shelter

Table A11.1 BioBanking Assessment Methodology results and observations at RWood03

Monitoring Point Number	RWood03	**Date**	19 June 2018
Vegetation Community	**Narrow-leaved Ironbark – Bulloak – Grey Box shrub – grass open forest of the Central and Lower Hunter (PCT1603/HU817)**		
Site Photo(s)	**Plate A11.1** and **Plate A11.2**		
Floristic BioMetric attributes			
Native cover			
Overstorey:			7
Midstorey:			0
Groundcover(grass):			32
Groundcover (shrub):			0
Groundcover (other):			20
Exotic cover			0
Native species richness:			33
Proportion of canopy species regenerating			1
Length of fallen logs (m)			0
Observations	**GPS coordinates**	**Photo number**	**Observations**
Natural regeneration of disturbed areas			Natural regeneration present
Threatened species sightings			Grey-crowned babblers (*Pomatostomus temporalis temporalis*)
Fire event/fuel			Nil
Weeds			*Pavonia hastata,* creeping pear *(Opuntia humifusa*), galenia (*Galenia pubescens*), Paddy's lucerne (*Sida rhombifolia*), onion weed (*Nothoscordum gracile*), African boxthorn (*Lycium ferocissimum*), fireweed (*Senecio madagascariensis*), cobblers pegs (*Bidens pilosa*), common sowthistle (*Sonchus oleraceus*)
Pest animals			Evidence of pigs (*Sus scrofa*) observed
Visitor impact/vehicles			Nil
Rubbish dumping			Nil

Plate A11.1 RWood03 from corner of quadrat

Plate A11.2 RWood03 from start of 50 m transect

Table A11.2 BioBanking Assessment Methodology results and observations at MFarm06

Monitoring Point Number	MFarm06	**Date**	19 June 2018
Vegetation Community	**Narrow-leaved Ironbark – Bulloak – Grey Box shrub – grass open forest of the Central and Lower Hunter (PCT1603/HU817)**		
Site Photo(s)	**Plate A7.3** and **Plate A7.4**		
Floristic BioMetric attributes			
Native cover			
Overstorey:			15
Midstorey:			15
Groundcover(grass):			22
Groundcover (shrub):			0
Groundcover (other):			26
Exotic cover			2
Native species richness:			25
Proportion of canopy species regenerating			1
Length fallen logs (m)			3.5
Observations	**GPS coordinates**	**Photo number**	**Observations**
Natural regeneration of disturbed areas			Natural regeneration present
Threatened species sightings			Nil
Fire event/fuel			Leaf litter present
Weeds			African boxthorn (*Lycium ferocissimum*), tiger pear (*Opuntia aurantiaca*), galenia (*Galenia pubescens*), fireweed (*Senecio madagascariensis*)
Pest animals			Nil
Visitor impact/vehicles			Nil
Rubbish dumping			Nil

Plate A11.3 MFarm06 from corner of quadrat

Plate A11.4 MFarm06 from start of 50 m transect

Table A11.3 BioBanking Assessment Methodology results and observations at MGrass04

Monitoring Point Number	RGrass04	**Date**	21 June 2018
Vegetation Community	**Narrow-leaved Ironbark – Bulloak – Grey Box shrub – grass open forest of the Central and Lower Hunter (PCT1603/HU817) – Derived Native Grassland**		
Site Photo(s)	**Plate A11.5** and **Plate A11.6**		
Floristic BioMetric attributes			
Native cover			
Overstorey:			0
Midstorey:			0
Groundcover(grass):			32
Groundcover (shrub):			0
Groundcover (other):			50
Exotic cover			66
Native species richness:			12
Proportion of canopy species regenerating			0
Length fallen logs (m)			0
Observations	**GPS coordinates**	**Photo number**	**Observations**
Natural regeneration of disturbed areas			Nil
Threatened species sightings			Nil
Fire event/fuel			Leaf litter present
Weeds			St Johns wort (*Hypericum perforatum*), galenia (*Galenia pubescens*), plantain (*Plantago lanceolata*), fireweed (*Senecio madagascariensis*), Paspalum (*Paspalum dilatatum*)
Pest animals			Nil
Visitor impact/vehicles			Nil
Rubbish dumping			Nil

Plate A11.5 RGrass04 from corner of quadrat

Plate A11.6 RGrass04 from start of 50 m transect