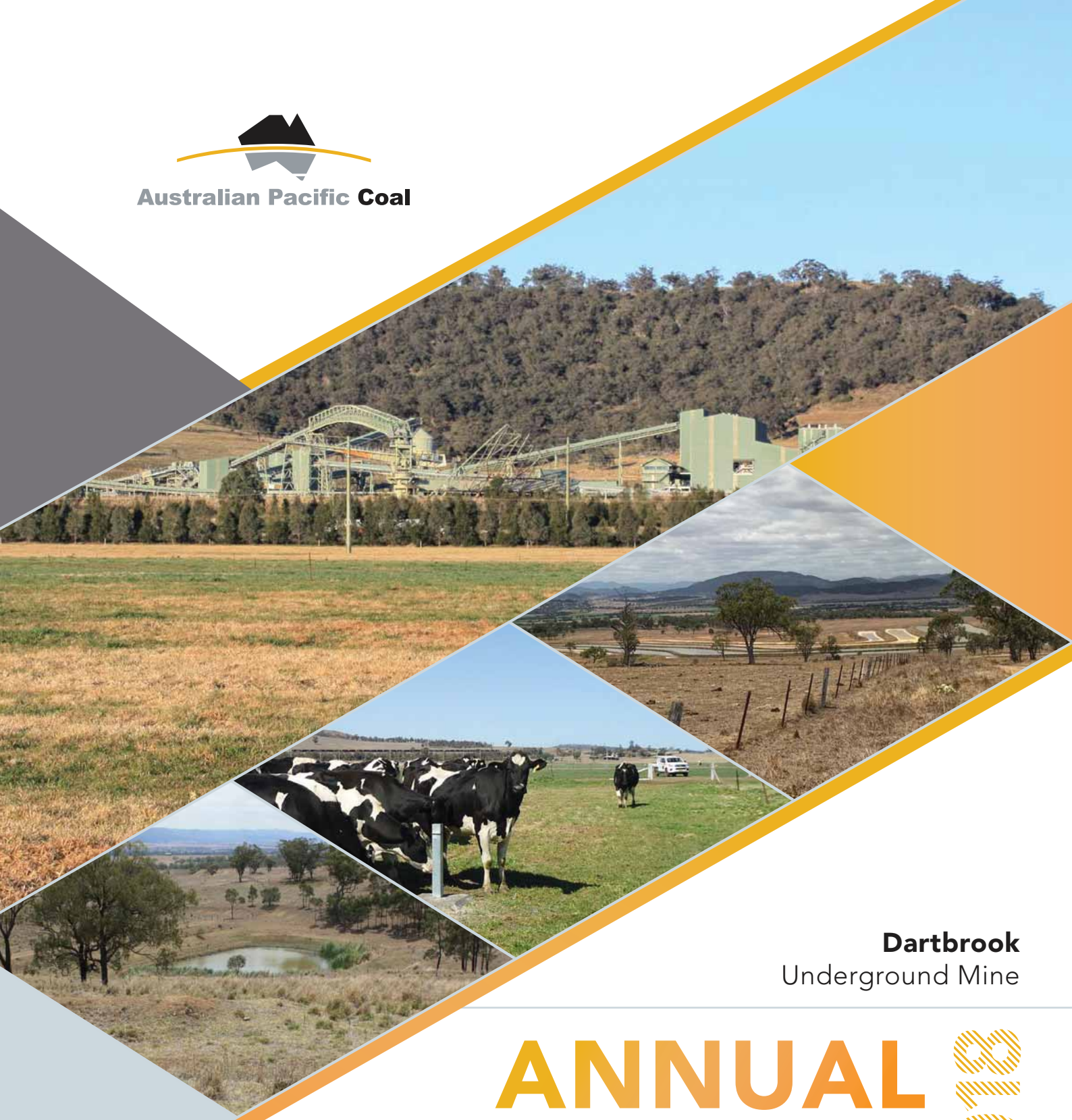
Australian Pacific Coal



Dartbrook
Underground Mine

ANNUAL REVIEW 2018

Hansen Bailey
ENVIRONMENTAL CONSULTANTS

DARTBROOK MINE

ANNUAL REVIEW 2018

Prepared by:

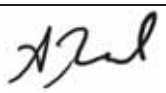
HANSEN BAILEY
127-129 John Street
SINGLETON NSW 2330

March 2019

For:

AQC DARTBROOK MANAGEMENT PTY LIMITED
PO Box 517
MUSWELLBROOK NSW 2333

Annual Review Title Block

Name of operation	Dartbrook Mine
Name of operator	AQC Dartbrook Management Pty Limited
Development consent	DA 231-07-2000
Name of holder of development consent	Dartbrook Coal Pty Limited
Mining Leases	CL 386, MLs 1497, 1381, 1456
Name of holder of mining leases	AQC Dartbrook Pty Ltd
Water licences	See **Table 22**
Name of holder of water licences	AQC Dartbrook Pty Ltd, AQC Dartbrook Management Pty Limited
MOP start date	1 January 2018
MOP end date	31 December 2020
Annual Review start date	1 January 2018
Annual Review end date	31 December 2018
I, Andrew Roach, certify that this audit report is a true and accurate record of the compliance status of AQC Dartbrook Management Pty Limited for the period (2018) and that I am authorised to make this statement on behalf of AQC Dartbrook Management Pty 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	ANDREW ROACH
Title of authorised reporting officer	CFO & Company Secretary
Signature of authorised reporting officer	
Date	29 March 2019

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Scone Library
Aberdeen Library
Dartbrook Community Consultative Committee (CCC) Members

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1 STATEMENT OF COMPLIANCE

This Annual Review has been prepared to provide a summary of the performance of the Dartbrook Underground Coal Mine (Dartbrook) over the period 1 January – 31 December 2018 (the reporting period).

The compliance status of Dartbrook against relevant approvals is summarised in **Table 1**, with a summary on non-compliances provided in **Table 2**.

The non-compliances in **Table 2** relate to the exceedance of surface and groundwater monitoring trigger levels included in the Site Water Management Plan required under DA 231-07-2000 and were not a result of any activities at Dartbrook Mine during the reporting period. It is proposed to review the Site Water Management Plan and associated surface and groundwater trigger levels following the determination of DA 231-07-2000 (MOD7) during the next reporting period (see **Section 7.2.12** and **Section 7.3.3**).

Table 1
Statement of Compliance

Were All the Conditions of the Relevant Approvals Complied With?	Yes/No
Development Consent (DA) 231-07-2000	No
Environmental Protection Licence (EPL) 4885	Yes
Coal Lease 386	Yes
Mining Lease 1497	Yes
Mining Lease 1381	Yes
Mining Lease 1456	Yes

Table 2
Summary of Non-compliances

Approval	Condition	Compliance Status	Comment	Where addressed in Annual Review
DA 231-07-2000	4.1(a)	Non-compliant	Groundwater and surface water monitoring results in exceedance of trigger levels identified in the Site Water Management Plan. Investigation of causes to be completed in the next reporting period.	**Sections 7.2.12** and **7.3.3**

2 INTRODUCTION

This section provides an overview of Dartbrook operations during the reporting period, outlines the purpose of this Annual Review and provides contact details for relevant site personnel.

2.1 BACKGROUND

Dartbrook is owned and managed by AQC Dartbrook Management Pty Limited (AQC). Dartbrook is located 10 kilometres (km) north-west of Muswellbrook and 4.5 km south-west of Aberdeen (see **Figure 1** and **Figure 2**) in New South Wales (NSW). From 1993 until October 2006, Dartbrook operated as an underground longwall coal mine.

Former owners of the mine elected to suspend mining and the operation was placed under Care and Maintenance from 1 January 2007.

Under Care and Maintenance, site activities are generally limited to the maintenance of:

- The Hunter Tunnel, which along with the Kayuga interseam drift, are the only areas of the underground mine that are still accessible. The Hunter Tunnel and Kayuga interseam drift connect to the Eastern and Kayuga Western mine entrances, respectively;
- The Western Facilities (West Site), which is located west of the New England Highway and comprises the administration office, a small workshop, and Wynn and Kayuga mine entrances to the underground mine (see **Figure 3**); and
- The Eastern Facilities (East Site), which is located east of the New England Highway and comprises the Coal Handling and Preparation Plant (CHPP), rail load out facilities, cleared coal stockpiles and the rehabilitated Reject Emplacement Area (REA) (see **Figure 4**).

2.2 PURPOSE

This Annual Review summarises the environmental performance of Dartbrook Mine for the reporting period and has been prepared to meet the requirements of Condition 9.2 of DA 231-07-2000 (as modified) and Condition 3(f) of Coal Lease (CL) 386 and Mining Lease (ML) 1381, ML 1456 and ML 1497.

It has also been prepared generally in accordance with its approvals including:

- DA 231-01-2000;
- ML and Exploration Licence (EL) conditions;
- Environment Protection Licence (EPL) 4885; and
- Continuation of Care and Maintenance Mining Operations Plan (MOP) 2018-2020.

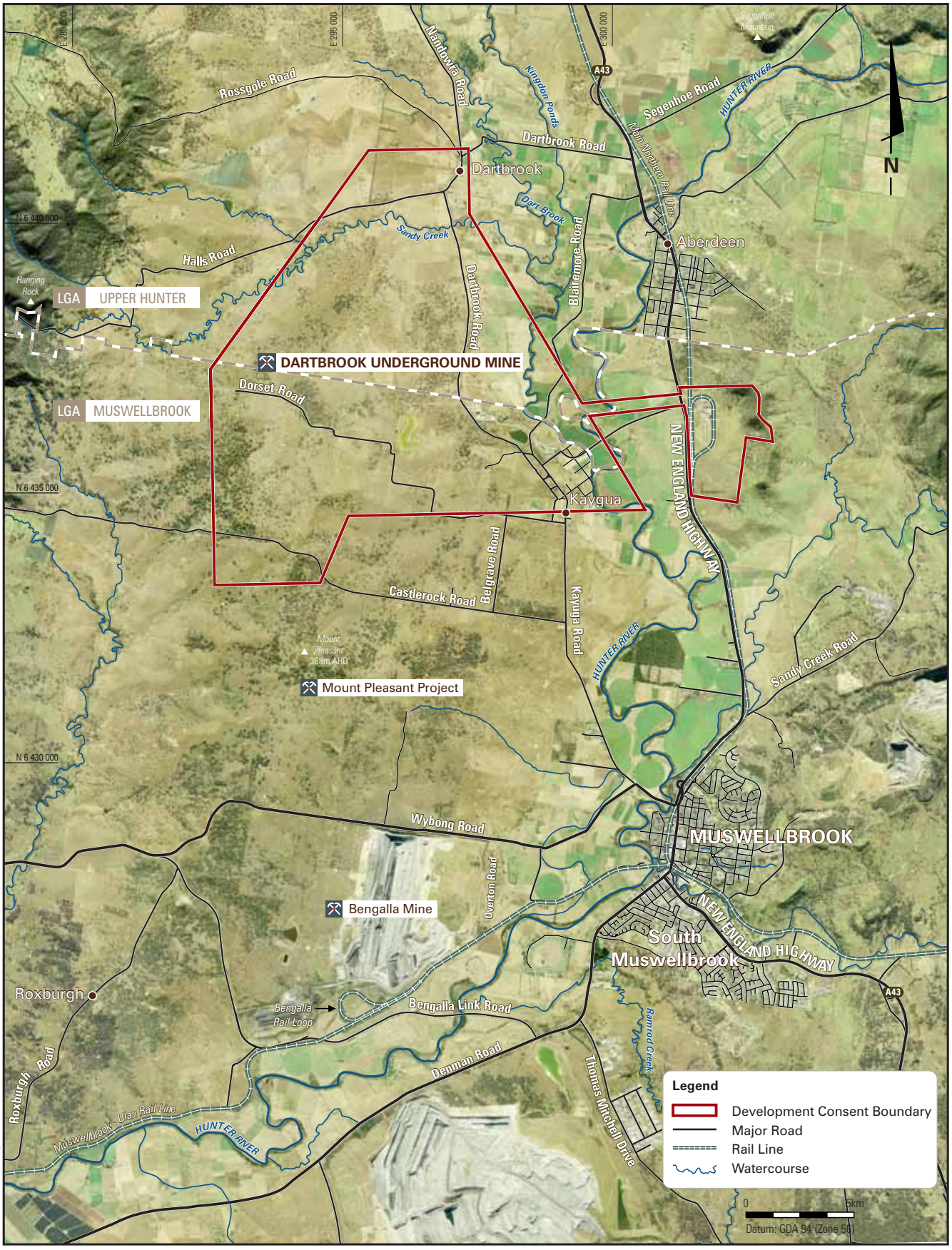
A summary of where the relevant requirements from DA 231-7-2000 and Dartbrook mining authorities has been addressed in this document is provided in **Table 3**. **Figure 5** shows the location of mining authorities held at Dartbrook.

Table 3
Development Consent and Mining Lease requirements for Annual Review

Document	Where Addressed
DA 231-07-2000, Condition 9.2 Environmental Reporting	
Annual Environmental Management Report (AEMR) (a) The Applicant shall, throughout the life of the mine and for a period of at least three years after the completion of mining in the DA area, prepare and submit an Annual Environmental Management Report (AEMR) to the satisfaction of the Director-General and DMR. The AEMR shall review the performance of the mine against the Environmental Management Strategy and the relevant Mining Operations Plans, the conditions of this consent, and other licences and approvals relating to the mine. To enable ready comparison with the predictions made in the EIS, diagrams and tables, the report shall include, but not be limited to, the following matters:	**This document**
(i) an annual compliance audit of the performance of the project against conditions of this consent and statutory approvals;	**This document**
(ii) a review of the effectiveness of the environmental management of the mine in terms of EPA, DLWC, DMR, MSC and SSC requirements;	**Section 5**
(iii) results of all environmental monitoring required under this consent or other approvals, including interpretations and discussion by a suitably qualified person;	**Sections 6 - 9** **Appendix B - F**
(iv) identify trends in monitoring results over the life of the mine;	**Sections 6 - 9** **Appendix B - F**
(v) an assessment of any changes to agricultural land suitability resulting from the mining operations;	**Section 6.12**
(vi) a listing of any variations obtained to approvals applicable to the subject area during the previous year;	**None**
(vii) subsidence during the preceding twelve months;	**Section 6.12**
(viii) socio-economic impact of the development including the workforce characteristics of the previous year;	**Section 9**
(ix) the outcome of the water budget for the year, the quantity of water used from water storages and details of discharge of any water from the site;	**Section 7** **Appendix G**
(x) rehabilitation report;	**Section 8**
(xi) environmental management targets and strategies for the next year, taking into account identified trends in monitoring results; and	**Section 11**
(xii) a report on the surveillance of any prescribed dam on the site to the satisfaction of the DSC.	**Section 7.3**
(b) In preparing the AEMR, the Applicant shall:	
(i) consult with the Director-General and DMR during preparation of each report for any additional requirements;	**Section 5**
(ii) comply with any requirements of the Director-General or other relevant government agency; and	**Section 5**

Document			Where Addressed
	(iii)	ensure that the first report is completed and submitted within twelve months of this consent, or at a date determined by the Director-General in consultation with the DMR and the EPA. Reporting on the Dartbrook Extended Project may be included with the AEMR for the existing Dartbrook development consent.	**N/A**
(c)		The Applicant shall ensure that copies of each AEMR are submitted at the same time to the Director-General, DMR, EPA, DLWC, NPWS, MSC, SSC and CCC, and made available for public information at MSC within fourteen days of submission to these authorities and made available to any landowner within the vicinity of the development upon request.	**This document**
Mining Lease 1381, 1456 and 1497, Condition 3 Mining Operations Plan and Annual Rehabilitation Report			
(f)		The lease holder must prepare a Rehabilitation Report to the satisfaction of the Minister. The report must:	
	(i)	provide a detailed review of the progress of rehabilitation against the performance measures and criteria established in the approved MOP;	**Section 8**
	(ii)	be submitted annually on the grant anniversary date (or at such other times as agreed by the Minister); and	**This document**
	(iii)	be prepared in accordance with any relevant annual reporting guidelines published on the Department's website at www.resourcesandenergy.nsw.gov.au/miners-and-explorers/rules-and-forms/pgf/environmental-guidelines.	**This document**

Note: The Rehabilitation Report replaces the Annual Environmental Management Report.



HB DARTBROOK Underground 2018 Annual Review HB1849 F1 Site Locality 20 02 2019

DARTBROOK MINE

Site Locality

FIGURE 1

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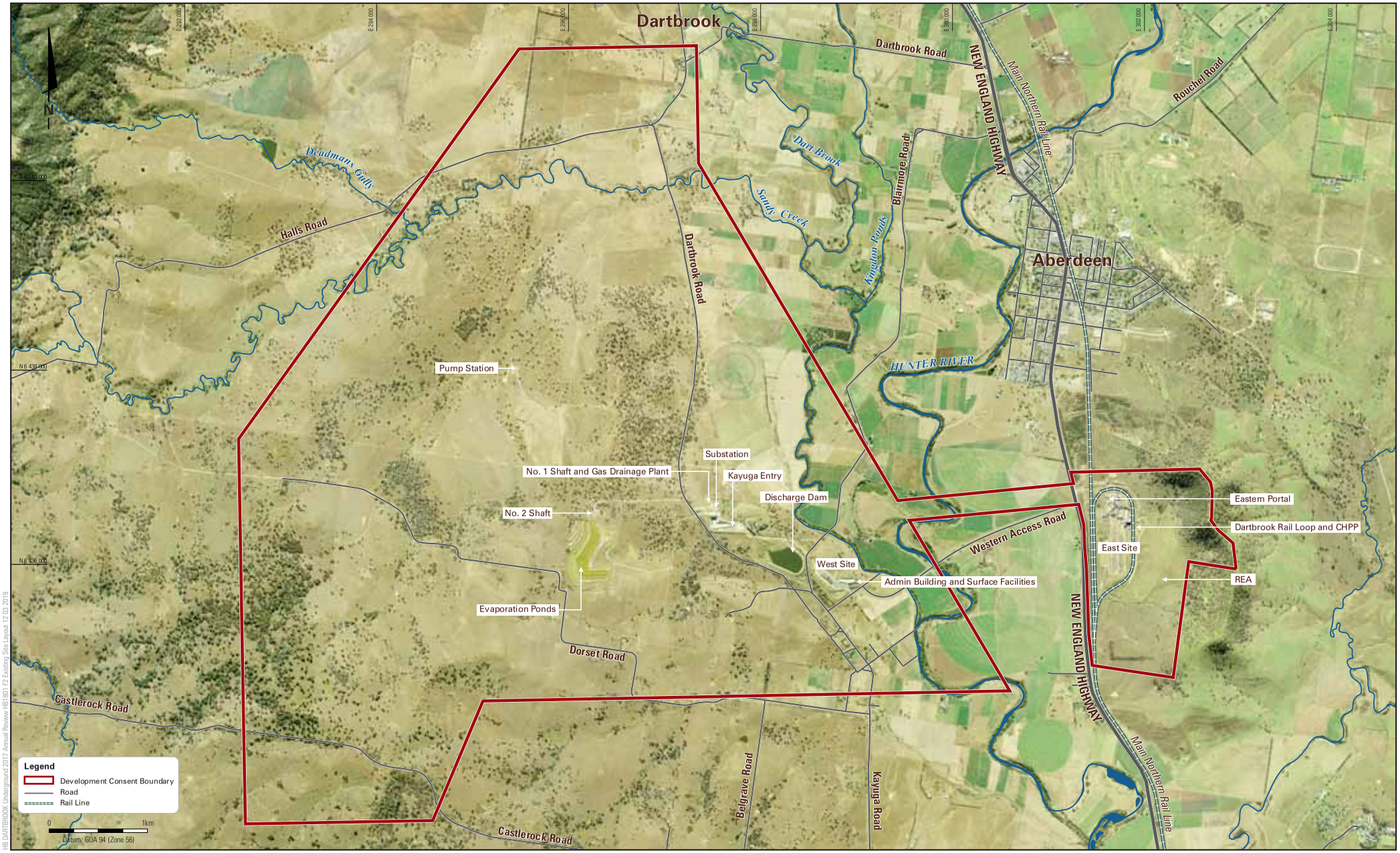

HB DARTBROOK Underground 2017 Annual Review HB1801 F2 Existing Site Layout 12 03 2019

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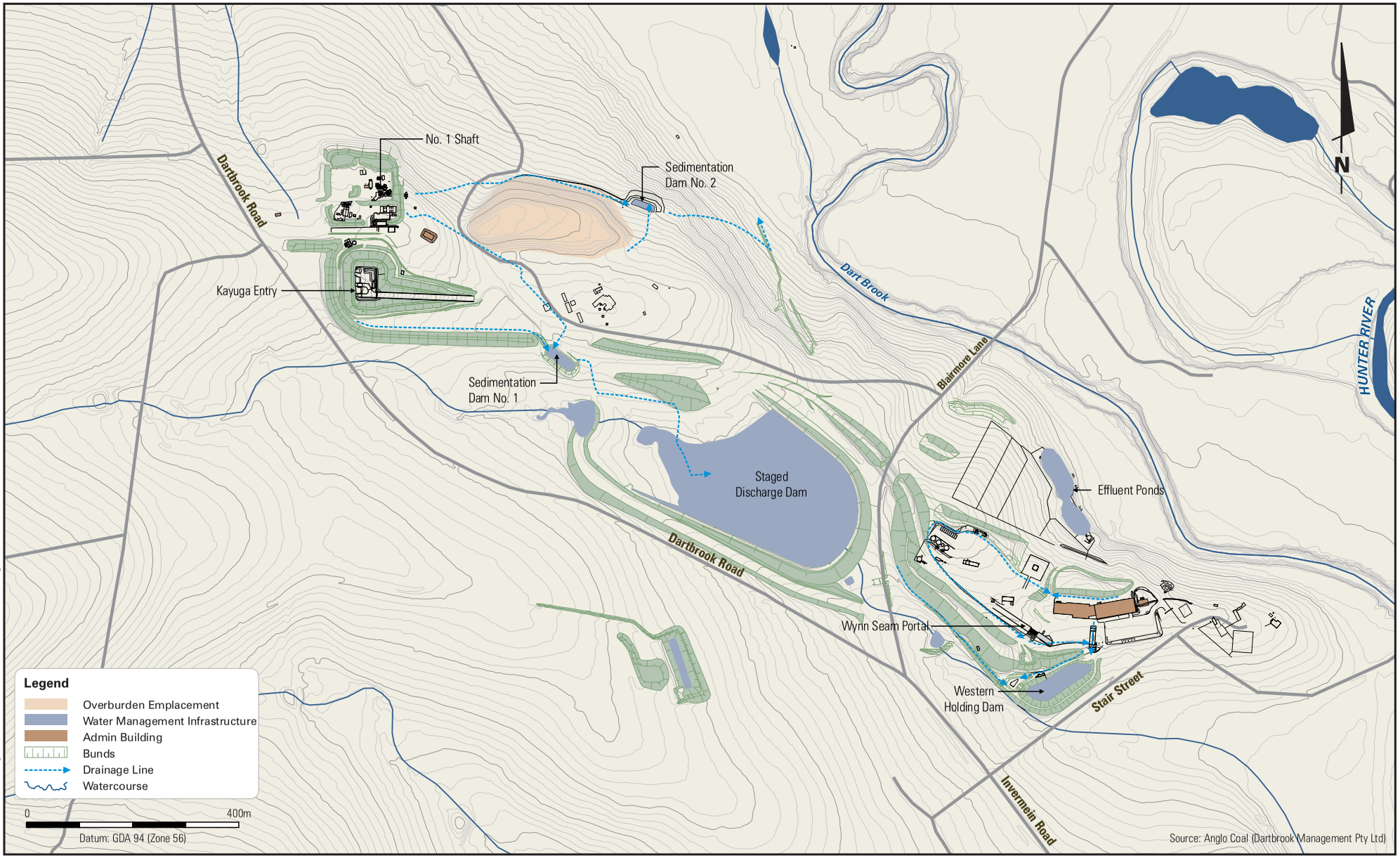
Australian Pacific Coal

DARTBROOK MINE

Existing Site Layout

FIGURE 2



HB DARTBROOK Underground 2017 Annual Review HB1801 F3 Existing Environment - West Site 22 03 2018

DARTBROOK MINE

Existing Environment - West Site

FIGURE 3

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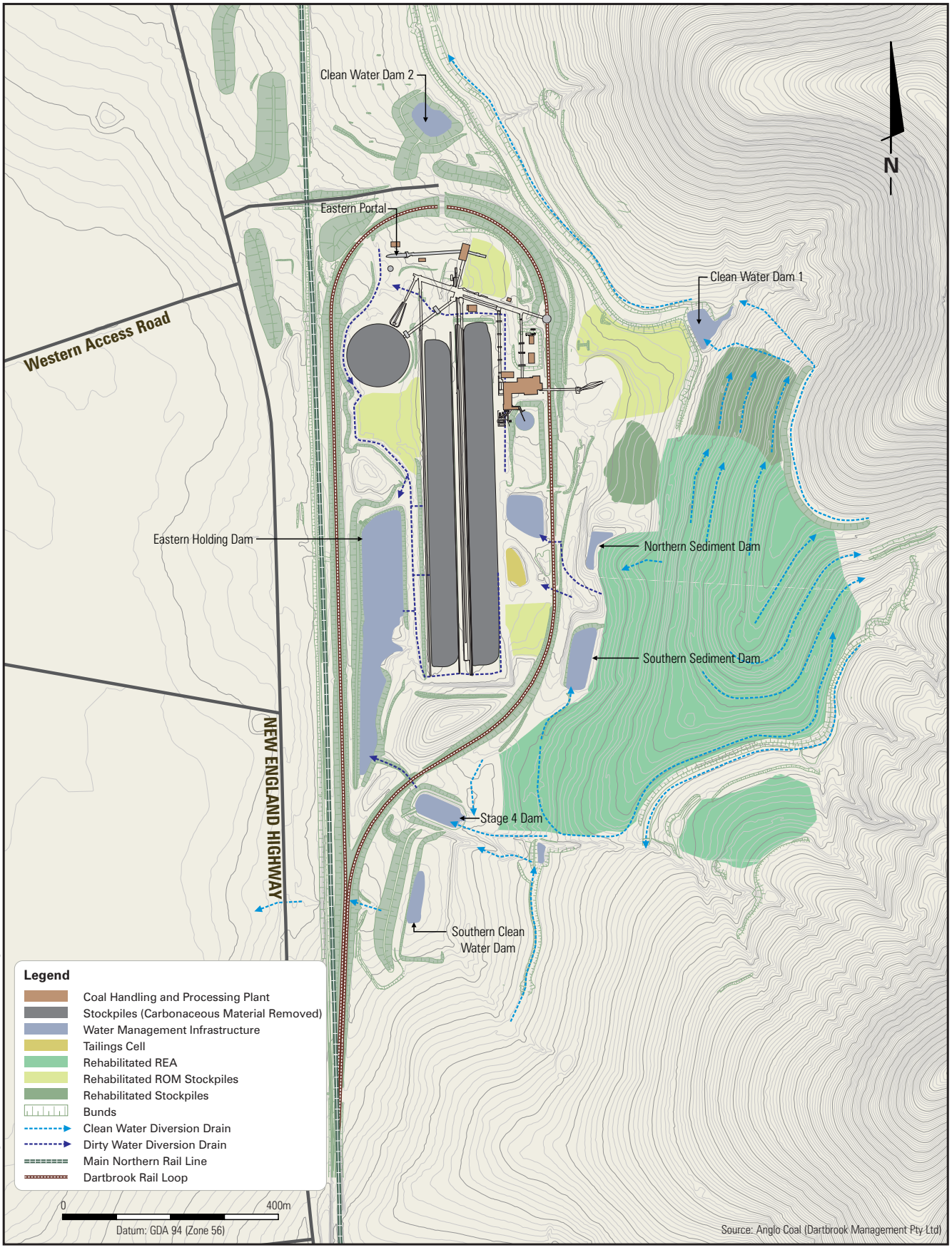

HB DARTBROOK Underground 2017 Annual Review HB1801 F4 Existing Environment - East Site 22 03 2018

DARTBROOK MINE

Existing Environment - East Site

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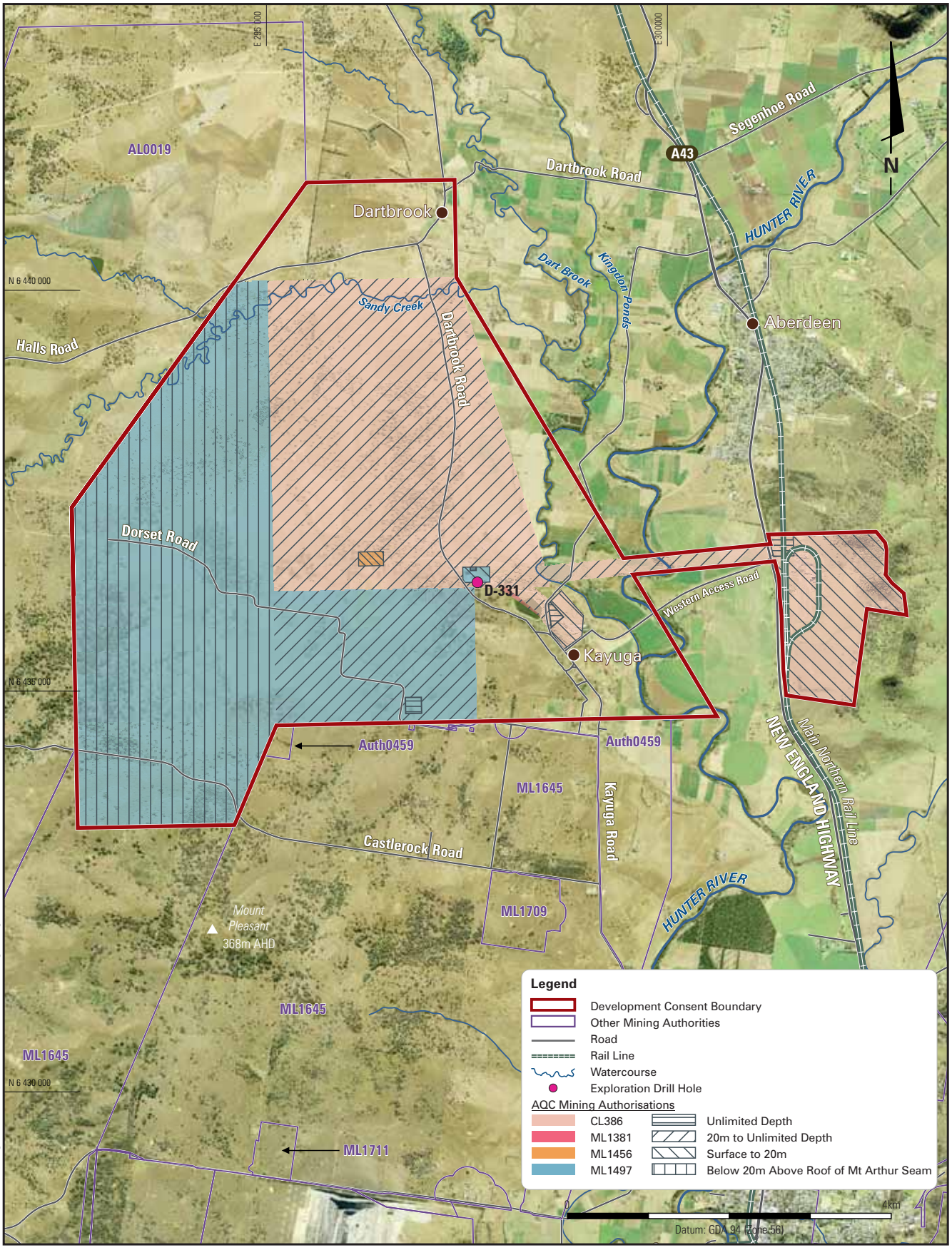
FIGURE 4



HB DARTBROOK Underground 2017 Annual Review HB1801 F5 Existing Mining Leases 12 03 2019

DARTBROOK MINE

Existing Mining Leases

FIGURE 5

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Note: EL4574, EL4575, EL5525 and A256 not shown on figure

2.3 PERFORMANCE SUMMARY

No coal mining or coal processing activities were undertaken at Dartbrook Mine during the reporting period. The specific aspects of Dartbrook Mine environmental performance in 2018 are described further in **Section 6** to **Section 8**.

In February 2018, AQC lodged an application to modify DA 231-7-2000 (MOD 7) to provide further operational options for Dartbrook (in addition to those already approved) to recommence mining via limited bord and pillar underground mining within the Kayuga Seam and extend the approval period under DA 231-7-2000 by 5 years (to 5 December 2027). At the end of the reporting period, the MOD7 application was under assessment by DPE.

Formal and informal communications with neighbours and community stakeholders were continued throughout the reporting period as discussed in **Section 9**.

As noted in **Section 9.1**, no formal complaints were received during reporting period.

The Dartbrook Mine Community Consultative Committee (CCC) continued to meet throughout the year, with meetings held in March, April, July and October 2018. A summary of topics discussed at CCC meetings during the reporting period is provided in **Section 9.2.1**.

2.4 DARTBROOK MINE CONTACTS

AQC has a team of environmental personnel that provide advice in regards to environmental standards and procedures at Dartbrook Mine. The relevant contacts for environmental management at Dartbrook Mine are outlined in **Table 4**.

Table 4
Dartbrook Mine Contacts

Australian Pacific Coal Contacts	
CEO	John Robinson
CFO & Company Secretary	Andrew Roach
Environmental Officer (under secondment from Hansen Bailey)	Dorian Walsh
Statutory Mine Manager	John Swan
Site Contact Details	
Dartbrook Mine Address	Dartbrook Mine Stair St, Kayuga NSW 2333
Dartbrook Postal Address	AQC Dartbrook Management Pty Limited PO Box 517, Muswellbrook NSW 2333
Phone Number	02 6540 8875
Facsimile Number	02 6541 1935
Dartbrook Care and Maintenance Contractor Phone Number	02 6540 8950
Dartbrook 24-hour Environment & Community Hotline	1300 131 058

3 APPROVALS SUMMARY

This section provides a summary of leases, licences and approvals that regulate the operations at Dartbrook Mine.

3.1 OVERVIEW

Dartbrook Mine operates within the Consents, Leases & Licences summarised in **Table 5**. A summary of minor amendments to DA-231-07-2000 that apply while Dartbrook Mine is on Care and Maintenance is provided in **Appendix A**.

The current MOP covers the period of ongoing Care and Maintenance activities from 1 January 2018 to 31 December 2020.

3.2 STATUS OF MANAGEMENT PLANS

Dartbrook Mine is required to develop and implement several Management Plans under DA 231-07-2000. **Table 6** outlines the environmental management plans utilised onsite and the approval date for each.

Table 5
Consents, Leases & Licences

Description	Approval Date	Expiry Date	Status/ Renewal Date	Approval Authority
Mining & Exploration Authorisations				
Authorisation 256	16/12/1980	02/05/2015*	Lodged 02/04/2015	DRG
Coal Lease (CL) 386	19/12/1991	19/12/2033	Due 19/12/2032	DRG
Mining Lease (ML) 1381	23/10/1995	23/10/2016*	Lodged 23/10/2015	DRG
ML 1456	27/09/1999	26/09/2020	Due 26/09/2019	DRG
ML 1497	06/12/2001	05/12/2022	Due 5/12/2021	DRG
Exploration Licence (EL) 4574	13/08/1993	07/04/2015*	Lodged 7/04/2015	DRG
EL 4575	13/08/1993	23/05/2016*	Lodged 23/05/2016	DRG
EL 5525	22/09/1998	21/09/2016*	Lodged 29/09/2016	DRG
Development Consent				
DA 231-07-2000 (as modified)	28/08/2001	05/12/2022	Active	DPE

Description	Approval Date	Expiry Date	Status/ Renewal Date	Approval Authority
Emplacement Area Approvals				
Approval for an Emplacement Area (s126 approval)	13/03/1996	N/A	Active	DPE
Stage 4 Reject Emplacement Approval C95/2265 (s126 approval)	02/01/2000	N/A	Active	DPE
Approval for 14° slopes in the REA Stage 4 (s126 approval)	18/12/2003	N/A	Active	DPE
Application for Discontinuance of Use of Emplacement Areas (s101 approval)	13/08/2007	Ongoing	Active	DPE
Licences				
Environmental Protection Licence 4885	Granted 30/11/2000	N/A	Active	EPA
Notification to Work Cover for storage and handling of Dangerous Goods	10/11/2005	N/A	Active	Safe Work NSW
Notification and Declaration to WorkCover that no dangerous goods stored or handled at Dartbrook Mine	Submitted 13/12/2006	N/A	Active	Safe Work NSW
Radiation Licence 5061080	1/07/2013	14/08/2018	Lodged 20/07/2017	EPA
Surface Water Licences	Various	Various	Active	DoI-Water
Bore Water Licences for Stock, Water and/or Domestic Use	Various	Various	Active	DoI-Water
Other				
Suspension of Mining Operations for Care and Maintenance under Section 70 (1) and Suspension of Conditions under Section 168 (1) of the Mining Act 1992, in respect of CL 386, ML 1381, ML 1456 & ML 1497	Suspension of Mining Operations was extended on 31/12/2014	31/08/2018*	Lodged 31/08/2018	DRG
MOP for Care and Maintenance – Extension	18/12/2017	31/12/2020	Active	DRG

*Note: * Application lodged with DRG*

Table 6
Dartbrook Mine Underground Management Plans and Strategies

Management Plan/Program	Approval Date
Environmental Management Strategy	15/04/2002
Archaeology and Cultural Management Plan	09/12/2002
Blast Management Plan*	09/12/2002
Bushfire Management Plan	19/05/2011
Construction Noise Management Plan*	7/11/2001
Dust Management Plan	24/11/2015
Erosion and Sediment Control Management Plan	21/10/2014
Flora and Fauna Management Plan	02/11/2011
Land Management Plan	27/01/2002
Landowner Communication and Consultation Plan	09/12/2002
Landscape and Lighting Management Plan	02/11/2011
Longwall Subsidence Management Plan(s)*	22/13/2003
Noise Management Plan*	08/11/2007
Property Subsidence Management Plans*	22/12/2003
Site Water Management Plan (SWMP)	15/09/2015
Soil Stripping Management Plan	31/05/2005
Spontaneous Combustion Management Plan	1/11/2016
Waste Management Plan	09/12/2002
Vibration Management Plan*	09/12/2002

** Generally not applicable during Care and Maintenance operations*

4 OPERATIONS SUMMARY

This section provides a summary of the operations undertaken during the reporting period.

4.1 EXPLORATION

Renewal applications for EL 4574, EL 4575 and EL 5525 were lodged with DRG in the 2015 and 2016 reporting periods by the previous owner, Anglo American. **Table 5** denotes the status of each mining authorisation held by AQC as at December 2018.

Approval was granted by DRG on 29 March 2018 to undertake an exploration drilling program within Dartbrook Mine's existing mining leases and on land owned by AQC. The approved program comprised of 10 proposed exploration drill hole sites, of which only one was drilled during 2018 (site D-331 within EL 4574 (see **Figure 5**)).

Following a 2014 Independent Environmental Audit (IEA) by SLR on the condition of existing exploration boreholes, 26 historic open boreholes were identified as requiring rehabilitation. Rehabilitation of these boreholes was completed in October 2018 as part of the exploration program following consultation and approval from DRG (see **Plate 1**). Of the 26 holes, 19 were rehabilitated, three were unable to be located in the field (sites RDH093, RDH153 and RDH154) and four sites (sites RDH156-159 and DDH023) on private land were not available for rehabilitation, following discussions with the relevant landholder/s.

Plate 1
Rehabilitated Historic Borehole Site RDH168

4.2 MINING OPERATIONS

As noted in **Table 5**, an application to extend the suspension of the labour and expenditure conditions of Dartbrook Mine's Coal and Mining Leases was lodged in August 2018. The renewal of two Dartbrook mining authorities (A 256 and ML 1381) was also sought during the reporting period.

Table 7 summarises the coal production and coal processing waste quantities for the reporting period and confirms the volumes forecast for 2019 in the Dartbrook MOP. This confirms that coal was not processed or transported under Care and Maintenance activities in 2018.

4.2.1 Land Preparation

Under Care and Maintenance, land preparation has been restricted to activities associated with the approved drilling programs and general maintenance of the site. A Permit to Disturb is obtained prior to the commencement of any activity that will cause surface disturbance.

The Permit to Disturb considers issues such as land ownership, archaeology, threatened flora and fauna species, surrounding infrastructure and rehabilitation techniques. Any topsoil that is stripped from the area is temporarily stockpiled. On completion, the topsoil is respread and the area is revegetated.

Land preparation work undertaken in 2018 was limited to that associated with the exploration drilling and groundwater monitoring bore programs (see **Section 4.1** and **Section 7.1**). Permits to Disturb were prepared before these works commenced, along with due diligence assessments of each site by qualified ecologists and archaeologists. Topsoil was initially stripped from drill hole areas prior to disturbance.

No topsoil was stripped for mining purposes in 2018. Topsoil and overburden continue to be stockpiled at suitable locations onsite. No topsoil or overburden was moved or actively used in operations during 2018.

Table 7
Production Summary

Material	Unit	Approved Limit	Actual Quantity (2017)	Actual Quantity (2018)	Forecast Quantity (2019)
Waste Rock / Overburden	Mbcm	N/A	0	0	0
ROM Coal	Mt	6 Mtpa	0	0	0
Coarse Reject	Mt	N/A	0	0	0
Fine Reject	Mt	N/A	0	0	0
Product Coal	Mt	N/A	0	0	0

Table 8 provides an estimate of the quantity of topsoil available to be used for future rehabilitation works. A discussion of the topsoil audit undertaken in 2018 is provided in **Section 8.2**.

4.2.2 Operations Summary

Operations were conducted generally in accordance with the existing Care and Maintenance MOP and as a result, no coal was processed in 2018.

Head contractor UGM (until June 2018) and thereafter Terrequip were responsible for Dartbrook Mine's Care and Maintenance operations during the 2018 reporting period. Terrequip is the current Statutory Manager responsible for Care and Maintenance operations at Dartbrook Mine in relation to AQC's obligations under the *Mining Act 1992.*

UGM and Terrequip conducted daily tasks required to maintain the site and the CHPP. These included (but were not limited to) the servicing and maintenance of equipment such as pumps, mine ventilation fans, electrical apparatus and underground mine vehicles.

Routine maintenance of the CHPP was undertaken, which involved the periodic dry running of the plant and associated pumps and conveyors. Minor repairs to structural items and the management of corrosion were also undertaken in 2018.

Other routine tasks included road works, housekeeping, strata control, statutory inspections, monitoring and reporting associated with the underground mine.

Access to the underground mine was retained via the Hunter Tunnel and Wynn Seam Portal from the East and West sites, respectively. The underground air quality is monitored utilising a tube bundle system and CITECT. Statutory inspections of accessible areas were carried out by UGM and Terrequip in 2018.

Table 8
Topsoil and Overburden Stockpile Status

Activity / Area	Cumulative Production (t)		
	Start of Period 01/01/2018	End of Period 31/12/2018	End of next period 31/12/2019
Topsoil Stripped	0	0	0
Topsoil used / spread	0	0	0
Topsoil Stockpile	14,780	14,780	14,780
Overburden Stockpiles and Bunds	655,747	655,747	655,747

4.3 WASTE MANAGEMENT

4.3.1 Process Mineral Waste

Dartbrook Mine did not process any mineral waste in 2018.

Mineral waste at Dartbrook Mine is confined to the REA; the footprint of which covers approximately 29 ha. Final rehabilitation of the majority of the REA was completed in mid-2007, with monitoring and appropriate maintenance works being undertaken since that time.

Temperature monitoring and inspections of the REA are conducted regularly to check for spontaneous combustion potential. Temperature monitoring results for the REA are provided in **Section 6.10**. No elevated results were recorded during the reporting period.

There was no disposal of coarse reject materials in the REA or tailings or fines in the mine goaf during the reporting period.

REA drainage was maintained in 2018. The drainage basin and the trash trap flowing into the underground pipe in the REA were kept clean to ensure that the pipeline was kept in working order.

The Section 126 approval (see **Table 5**) requires *"…an independent engineering assessment to be made...at periods not exceeding three years of the dams and holding structures associated with the rejects disposal project..."*. The latest geotechnical inspection of the REA was undertaken by Douglas Partners in November 2015. The assessed risk of slope failure of the REA was classified as being very low to low in the short to medium term due to the potential for liquefaction of the coal reject under an earthquake loading. This rating will improve to very low in the long term after the coal reject consolidates, provided that drainage is maintained.

The next independent assessment of the REA will be undertaken in early 2019 and discussed in the 2019 Annual Review.

Internal environmental / rehabilitation inspections of the REA were conducted regularly throughout the year. These inspections confirmed that rehabilitated areas of the REA were in good condition throughout the reporting period, despite the ongoing dry conditions.

4.3.2 Non-Process Waste Management

Dartbrook Mine produces a range of non-mineral waste materials as a result of its activities onsite. To maximise recycling opportunities onsite, Dartbrook Mine utilises a colour coded recycling system. Remondis are responsible for the removal and disposal of all non-process waste generated onsite.

Offsite treatment and disposal facilities are used to ensure that all waste is appropriately tracked, disposed of and reported, in accordance with the Dartbrook Mine Waste Management Plan.

During the reporting period, 26.7 tonnes of non-process waste was removed from site. This comprised of approximately 17.8 tonnes of general waste, 0.6 tonnes of co-mingled recyclable materials and 8.3 tonnes of scrap metal. The scrap metal was recycled as part of a scrap steel recycling and removal campaign on site in mid-2018.

Table 9 provides a summary of waste tracked at Dartbrook Mine during the reporting period.

4.3.3 Hazardous Materials Management

No licensable quantities of dangerous goods were stored or used at Dartbrook Mine during the reporting period. There are nominal quantities of hazardous substances required for use at Dartbrook Mine during Care and Maintenance activities.

A permit system is in place for the introduction of chemical substances to site and a register of these is maintained. When substances are no longer required, they are removed from site.

Dartbrook Mine also has a licence to possess radiation apparatus, which is imbedded in the coal quality monitoring equipment required to be used at the CHPP.

4.4 ROM & PRODUCT COAL STOCKPILES

The capacity and current status of the coal stockpile areas is listed in **Table 10**. No coal was stored on any stockpile in 2018.

4.5 CONSTRUCTION & DEMOLITION

Minor maintenance repairs to the Riverview Homestead were undertaken during the reporting period and renovations to Kayuga Homestead were completed.

4.6 NEXT REPORTING PERIOD

Care and Maintenance operations at Dartbrook Mine during the next reporting period will be generally consistent with the Care and Maintenance MOP.

As noted above **Section 4.1** AQC lodged an application to modify DA 231-7-2000 (MOD 7) to recommence underground mining and extend the approval period by 5 years (to 5 December 2027). At the end of the reporting period, the MOD7 application was under assessment by DPE. AQC will review and update relevant approvals, management plans and documents as required when its MOD7 application is determined.

Table 9
Waste Generation

Waste Type	Disposal	Quantity in 2017	Quantity in 2018
General Waste - Non-hazardous (t)	Landfill	9.756	17.8
Scrap Metal (t)	Recycled	3.7	8.3
Office Paper and Co-mingled Recyclables (t)	Recycled	0.209	0.6
Hazardous Waste – Sewage Sludge (Litres)	Treatment	0	0
Waste Oil (Litres)	Recycled / Treatment	0	31.7
Hazardous Waste - Chemical Anchors / Resins (t)	Treatment	0	0
	Approved Landfill	0	0

Table 10
Coal Stockpile Status

Stockpile	Coal Type	Capacity (Tonnes Approx.)	Status
Emergency Stockpile	ROM	50,000	Rehabilitated
Circular Stockpile	ROM	80,000	Cleared of coal material
Eastern ROM stockpile	ROM	185,000	Rehabilitated
Western ROM Stockpile	ROM	90,000	Rehabilitated
Southern ROM Stockpile	ROM	70,000	Rehabilitated
Northern ROM Stockpile	ROM	5,000	Rehabilitated
Rectangular Product Stockpile No. 1	Product	200,000	Cleared of coal material
Rectangular Product Stockpile No. 2	Product	200,000	Cleared of coal material
Reject Stockpile	Reject	20,000	Cleared of coal material
TOTAL		**900,000**	

5 ACTIONS REQUIRED FROM PREVIOUS ANNUAL REVIEW

This section includes a list of actions requested by regulatory agencies following the previous Annual Review and a summary of where each is addressed in this document.

AQC consulted with relevant regulatory agencies throughout the previous reporting period to identify the key issues for consideration in this Annual Review.

Table 11 lists the relevant issues raised by regulatory authorities in the previous reporting period and indicates where these issues are addressed in this Annual Review. Correspondence relevant to the preparation of this Annual Review includes:

- DPE request dated 24 May 2018 for additional information to be provided in future Annual Reviews; and
- DRG letter dated 18 December 2017 in response to submission of the revised Dartbrook Mining Operations Plan, requesting that a topsoil audit be completed in 2018.

Table 11
Issues Raised by Regulatory Authorities in 2018

ID	Issue	Where Addressed	Status
DPE Requests			
1	Include a review of the effectiveness of the environmental management of the mine in terms of requirements specified by regulators, as required by Condition 9.2(a)(ii) of the consent.	**Table 5**, **Section 6**	Complete
2	Include a map showing the Development Consent boundary in accordance with Section 2 of the Department's Annual Review Guideline.	**Figure 1**	Complete
3	Ensure that any water take data provided in the report (refer to Table 7 of the guidelines) covers the 'water year' (1 July- 30 June) in accordance with Section 7 of the Department's Annual Review Guideline.	**Section 7.1**	Complete
4	Ensure the Annual Review identifies the agreed post rehabilitation land use(s) for the mine in accordance with Section 8 of the Department's Annual Review Guideline.	**Section 8**	Ongoing
DRG Requests			
5	AQC Dartbrook Pty Ltd is required to undertake a topsoil audit - a detailed comparison between the identified volumes of available soil with the estimated amounts required to achieve successful rehabilitation. Commentary on the health and suitability of the available soil is also required.	**Section 8.2**	Complete
6	This audit is to be undertaken within the first year of the MOP period and reported in the Annual Environmental Management Report (i.e. 2018 AEMR to be provided by 31 March 2019).	**Section 8.2**	Complete

6 ENVIRONMENTAL MANAGEMENT AND PERFORMANCE

This section describes Dartbrook Mine's environmental monitoring, management and performance for the reporting period. Environmental management actions to be implemented in 2019 are also described, as required.

6.1 OVERVIEW

An internal Environment Management System (EMS) has been developed and implemented for Dartbrook Mine. The EMS has been developed generally in accordance with 'AS/NZS ISO14001: Environmental Management Systems' and 'AS 4801: Occupational Health and Safety Management System'. It provides a systematic risk-based approach to the management of safety, health, and environmental aspects associated with the environment.

The EMS reflects the Care and Maintenance status of the mine and accommodates the relevant procedures for the Statutory Mine Area. Internal operational inspections of rehabilitation, water, biodiversity and hydrocarbon management components of the EMS were undertaken regularly in 2018. These inspections did not identify any operational non-compliances.

Table 12 provides a summary of the environmental management actions undertaken during 2018.

Table 12
Environmental Management Overview

Aspect	Performance during 2018	Trends	Management Actions
Air Quality	• Elevated depositional dust measurements recorded at monitoring site 897 (see **Section 6.3.2**). • Annual Average PM_{10} concentrations were within criteria	• The site has been in Care and Maintenance since 2007. Elevated air quality results are due to external influences and not Dartbrook activities.	• Monitoring of PM_{10} and dust deposition (see **Section 6.3**)
Greenhouse	• 94, 343 tonnes of CO_2 equivalent gas (CO2-e) was emitted (Scope 1 – 3)	• Updated monitoring arrangements put in place during the reporting period.	• Methane and CO_2 from the underground workings are released via Ventilation Shaft No. 1 (see **Section 6.14**)
Noise	• Noise levels produced by Care and Maintenance activities are minimal	• Noise levels have remained relatively low since the suspension of mining in 2006.	• Dartbrook Mine has an exemption from noise monitoring requirements during Care and Maintenance (see **Section 6.6**)

Aspect	Performance during 2018	Trends	Management Actions
Visual	• The tree screen to the west of the New England Highway continued to develop satisfactorily	• The tree screen has steadily developed since it was planted in 2011 (see **Plate 2**)	• Irrigation of the tree screen during dry periods (see **Section 6.7**)
Biodiversity	• River Restoration Project, River Red Gum restoration areas and the Forestry Plantation were progressing	• These areas continue to progress	• Monitoring of the River Restoration and Forestry Plantation • Weed and feral animal control (see **Section 6.5**)
Heritage	• No additional impacts to Aboriginal or European heritage items	• No impacts to heritage items have occurred during the Care and Maintenance period	• General maintenance of European Heritage sites
Subsidence	• No additional subsidence • Previously remediated areas have remained stable	• No subsidence has occurred during the reporting period	• Annual visual monitoring of previously subsided areas (see **Section 6.12**)

6.2 METEOROLOGY

6.2.1 Environmental Management

Dartbrook Mine has two operating meteorological stations, Met-01 and Met-02. The locations of these sites are shown on **Figure 6**.

For reporting purposes, Dartbrook Mine generally uses data from Met-02 due to the availability of long term data (from 1995 to the present).

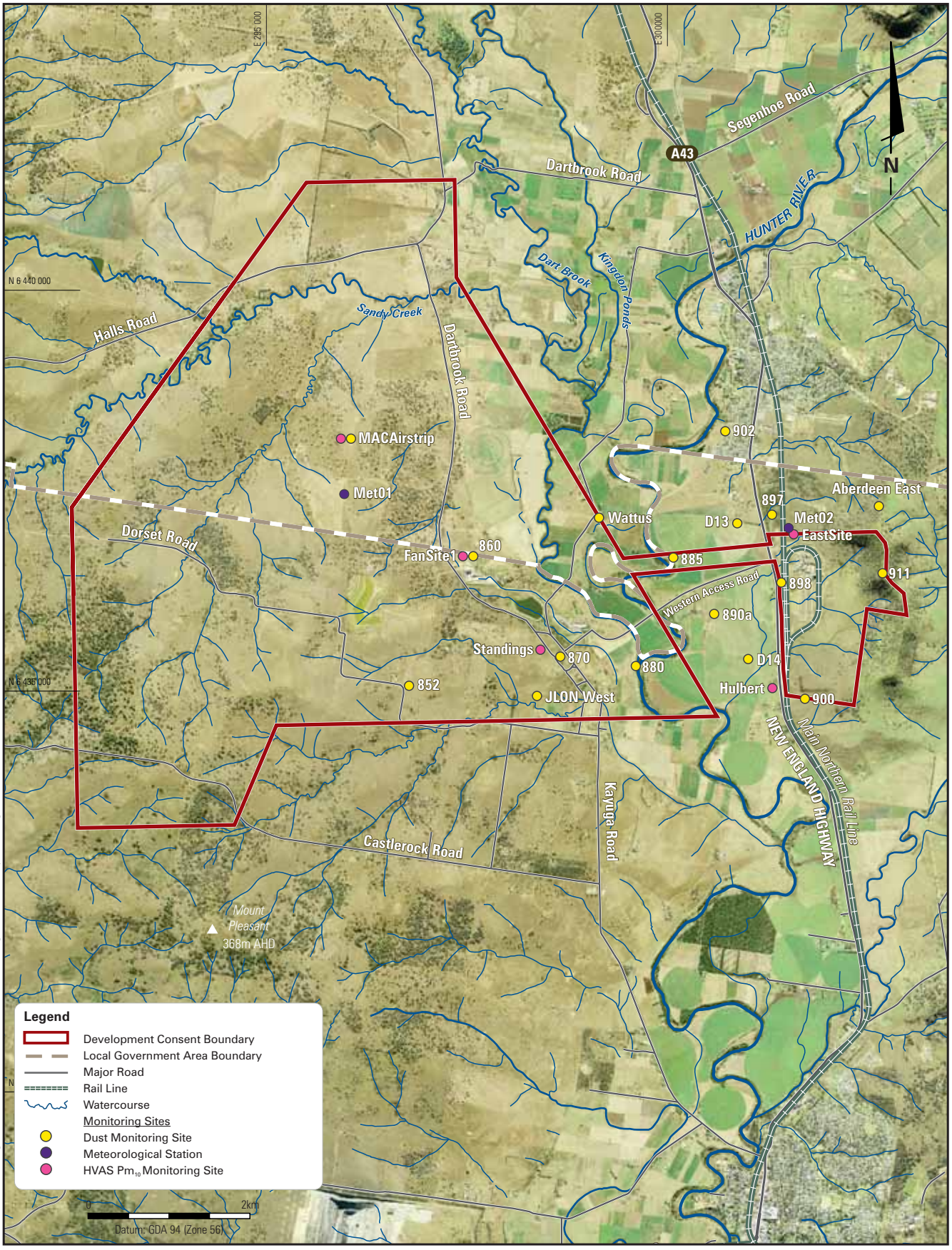
Both meteorological monitoring sites are operated via real-time telemetry to assist with accurate data acquisition.

6.2.2 Environmental Performance

Rainfall

During the reporting period, a total of 380.2 mm of rainfall was recorded over 79 rain days, compared to 406.26 mm over 69 rain days recorded in 2017.

The rainfall received in 2018 was lower than the long-term average annual rainfall of 576 mm. An annual rainfall summary is further provided in **Table 13**. With exception of the rainfall recorded in November and December 2018 (63.8 mm and 70.8 mm respectively), all monthly rainfall volumes were below the respective long-term averages (see **Appendix B**).



HB DARTBROOK Underground 2017 Annual Review HB1801 F6 Meteorological and Air Quality Monitoring Network 12 03 2019

DARTBROOK MINE

Meteorological and Dust Monitoring Locations

FIGURE 6

Hansen Bailey
ENVIRONMENTAL CONSULTANTS

Australian Pacific Coal

Temperature

Monthly maximum, average and minimum temperatures recorded at Dartbrook Mine are presented in **Table 14**. January was the warmest month in 2018 with an average daily temperature of 26.6 ºC. June was the coldest month with an average daily temperature of 11.7 ºC.

Table 13
Rainfall Summary 2018

Month	Rainfall (mm)	Cumulative Rainfall (mm)
January	14.2	14.2
February	46.8	61
March	46.6	107.6
April	5.0	112.6
May	7.4	120
June	35.8	155.8
July	1.8	157.6
August	29.9	187.5
September	20.6	208.1
October	38.4	246.5
November	63.8	310.3
December	70.8	381.1

Table 14
Monthly Temperature Summary 2018

Month	Min Temperature (°C)	Avg Temperature (°C)	Max Temperature (°C)
January	12.2	26.6	42.1
February	13.7	24.4	39.4
March	10.2	22.9	38.4
April	9.2	20.6	34.3
May	3.2	14.6	27.5
June	0.3	11.7	21.1
July	-1.2	11.9	24.7
August	0.6	12.6	23.9
September	3.1	16.0	31.9
October	6.0	19.1	33.4
November	10.2	21.8	38.0
December	12.1	25.0	39.4
Average	**6.6**	**18.9**	**32.8**

Wind Speed & Direction

In 2018, prevailing winds were generally from the south to south-east during the summer months and from the north to north-east and north-west during the winter months, consistent with long term observations.

Table 15 provides a summary of the data captured at Dartbrook Mine in 2018. Monthly wind roses compiled from Met-02 are provided in **Appendix B**.

6.2.3 Next Reporting Period

Dartbrook will continue to monitor meteorological conditions on site and will report results in the 2019 Annual Review.

No upgrades to the existing meteorological monitoring infrastructure are planned.

6.3 AIR QUALITY

6.3.1 Environmental Management

Potential impacts to air quality at Dartbrook include airborne dust and odour. These impacts are managed in accordance with the onsite EMS, DA 231-07-2000 conditions and relevant environmental management plans, including the Dust Management Plan (DMP). The DMP is the primary tool used to minimise and control dust impacts onsite.

As discussed in **Section 4.6**, revisions to site management plans, including the DMP, will take place following the determination of MOD7. Dust gauges however, were fitted with bird rings during 2018 to prevent contamination. Coal stockpile areas and the REA have been previously cleared of coal material and revegetated (see **Figure 4**) in order to minimise potential dust emissions during Care and Maintenance. Dartbrook Mine is generally not undertaking activities that generate dust during Care and Maintenance.

Table 15
Wind Summary 2018

Month	% Period with Wind Speed <3.0 m/s	% Period with Wind Speed >3.0 m/s	Predominant Wind Direction
January	52.0	48.0	SSE
February	47.9	52.1	SSE
March	51.0	49.0	SSE
April	60.2	39.8	SE
May	70.9	29.1	N/NE
June	72.2	27.8	NNE/SE
July	61.8	38.2	NNW
August	57.3	42.7	N
September	55.8	44.2	SSE
October	57.3	42.7	SSE
November	49.1	50.9	SSE
December	54.4	45.6	SSE

Dust Monitoring Criteria

The dust standards and goals specified in Condition 6.1(a1) and Condition 6.1(axvii) of DA 231-07-2000 are presented in **Table 16** and **Table 17**, respectively.

Dartbrook Mine maintains an air quality monitoring network consisting of 17 dust deposition gauges and 5 High Volume Air Samplers (HVAS), the locations of which are shown in **Figure 6**. However, not all of these monitoring locations are included as compliance monitoring locations in the approved DMP.

The compliance monitoring network in the approved the DMP includes:

- Five depositional dust gauges:
  - Three dust deposition gauges at locations representative of the closest private residences to the East Site (including Aberdeen);
  - Two dust deposition gauges at locations representative of the closest private residences to the south and west of the West Site surface facilities; and
- Two PM_{10} monitoring locations, one located to the south of the CHPP and one south of the West Site workshop, which are representative of the closest private residences; and
- Meteorological stations at the East and West Sites (see **Section 6.2**).

Table 16
Dartbrook Mine Air Quality Standards & Goals

Health Based Standards/Goals		
Dust Type	Standard/Goal	Agency
Total Suspended Particulate Matter (TSP)	90 μg/m^3 (annual average)	National Health and Medical Research Council
NSW EPA Amenity Based Standards/Goals for Dust Fallout		
Existing Dust Fallout Level (g/m^2/month)	Maximum Acceptable Increase Over Existing Deposition Levels (g/m^2/month)	
	Residential	Other
2	2	2
3	1	2
4	0	1

Table 17
Dartbrook Mine PM_{10} Air Quality Goals

PM_{10} Goal	**Agency**
50 μg/m^3 (24-hour average)	NEPC
25 μg/m^3 (Annual average)	EPA

6.3.2 Environmental Performance

Dust Deposition

During the reporting period, dust monitoring continued at 17 dust deposition monitoring sites located throughout the area. Dust deposition gauges have been established on a grid network that covers the major areas in relation to all surface activities. Results from dust deposition gauges are expressed as insoluble solids, comprised of combustible matter (or organic matter) and ash residue.

Ash residue is considered to be more representative of the dust component (from soils and weathered rock) while the remainder, typically organic matter, includes bird droppings, leaf or grass litter, insects and coal.

Standard units are reported in g/m^2/month. Most insoluble solid results that are above 4 g/m^2/month undergo an XRD scan (microscopic examination) of the combustible matter to determine whether the material is carbonaceous, organic matter or sandy clay matter.

Appendix C presents results of air quality monitoring undertaken throughout the year.

Table 18 and **Figure 7** summarise the annual average deposition rate of insoluble solids and the ash component.

'Contaminated samples' as listed in **Appendix C** were excluded from calculations of annual average dust deposition rates. Contaminated samples collected during the reporting period generally contained varying levels of bird droppings, vegetation and insects.

Results where the monthly Insoluble Solids recorded are greater than 4 g/m^2/month are displayed in **Appendix C**. As Dartbrook Mine is not operating, the majority of elevated dust results can be attributed to elevated background levels generated by farming, grazing activities and other industries on adjacent lands.

The annual average dust deposition for insoluble solids during 2018 ranged from 0.81 g/m^2/month (at Site 870, Kayuga Village) to 12.06 g/m^2/month (at Site 897, Eastern Site North).

In 2018, annual average dust deposition rates were below the limit of 4 g/m^2/month at all sites except Site 897, which recorded annual averages of 12.1 g/m2/month (insoluble matter) and 7.7 g/m2/month (ash content) in 2018. While this is an exceedance of DA 231-07-2000 criteria for depositional dust, Dartbrook Care and Maintenance activities during the year were not a significant contribution to this elevated result.

High Volume Air Samplers

Dartbrook Mine has five HVAS that monitor PM_{10} (particulate matter less than 10 microns) dust concentration.

Dust is monitored for a 24-hour period on a 6-day cycle. Where samples are not captured due to programming or other technical issues, a program re-run is undertaken to capture missing data. Sample analyses are carried out in accordance with the relevant Australian Standards. The locations of the HVAS are illustrated in **Figure 6** and described in **Table 19**.

The data recovery rate was 100% for all HVAS sites in 2018. There were no program re-run's undertaken during the reporting period. All sites were compliant with the NEPC standard for data capture, which requires recovery of data to be greater than 75%.

The 24-hour annual average PM_{10} results for the HVAS show a slight increase across the summer period as presented in **Figure 8**. Elevated PM_{10} HVAS results were recorded at all five monitors on 20 March 2018. These elevated results were not related to Dartbrook Care and Maintenance activities, and a review of these results found that they were likely associated with a regional dust event.

Table 20 presents the Annual Average PM_{10} concentrations at the five HVAS during 2018 and compares these with the predictions in the EIS and subsequent modifications.

PM_{10} concentrations recorded in the Dartbrook Mine HVAS sites were greater than the levels predicted in the EIS, however the annual averages were below the EPA criteria of 25 $\mu g/m^3$ at all sites during the reporting period.

2018 results were also slightly higher than the previous reporting period, with the increase attributed to the ongoing dry conditions and contributions from other sources that were not considered in the EIS assessments.

Annual average TSP concentrations for the five HVAS sites were calculated based on measured PM_{10} values and are presented in **Figure 9**. These results show that the monitored annual average for the reporting period did not exceed the relevant air quality goals from DA 231-07-2000.

6.3.3 Next Reporting Period

Dust mitigation and control activities will continue to be employed as required. Air quality monitoring will continue in accordance with the DMP.

Table 18
Annual Average Dust Deposition for 2018

Site	Location Description	Insoluble Solids (g/m^2/month)	Ash Component (g/m^2/month)	Number of Samples
852	Dorset Road	1.03	0.70	12
860	No. 1 Vent Shaft	0.93	0.61	12
870	Kayuga Village	0.81	0.54	12*
880	Hunter River / Dart Brook Junction	1.45	0.91	12
885	Frazer Farm paddock near Hunter River	3.18	2.18	12

Site	Location Description	Insoluble Solids (g/m²/month)	Ash Component (g/m²/month)	Number of Samples
897	Eastern Site North	12.06	7.68	12
898	Eastern Site West	1.36	0.78	12
900	Eastern Site South	0.98	0.65	12
902	Aberdeen Tree Screen	0.96	0.64	12
911	Browns Mountain	1.18	0.66	12
890a	Garoka Dairy	1.40	0.85	12
Aberdeen East	South east of Aberdeen	0.84	0.53	12
D13	Residence northwest of CHPP	1.47	1.03	12
D14	Southwest of CHPP	1.87	0.88	12
JLON West	Residence south of West Site	2.04	1.10	11*
Macairstrip	Northwest of West site	1.90	1.20	11*
Wattus	Between Dart Brook and Hunter River	1.70	1.05	11*

** Dust gauges damaged during October 2018; results not available*

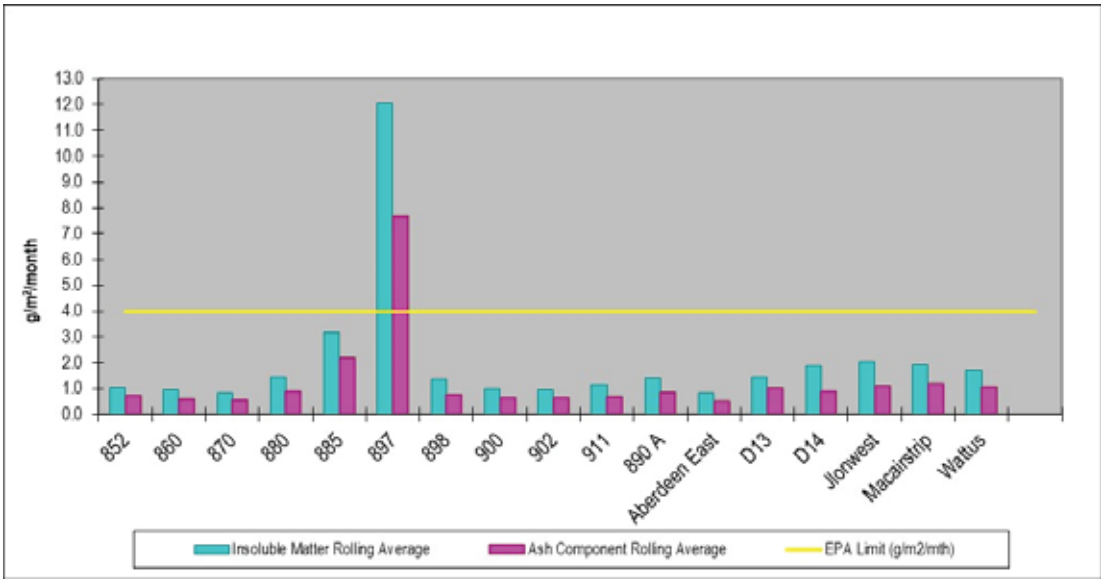


Figure 7
2018 Depositional Dust Annual Average

Table 19
HVAS Monitoring Sites for PM_{10} and TSP

HVAS Site	Location
East Site Meteorological Station (ESMS)^	East Site, north of the CHPP
Fan Site Number 1 ^	West Site, adjacent to the ventilation fan
Hulbert*	East Site, south-south-west of the CHPP
Standings*	West Site, south of the surface infrastructure
Macairstrip^	West Site, centre of the Mining Leases

** Representative of Private Receiver*
^ Internal Management Site

Table 20
Comparison of Measured PM_{10} Concentrations with EIS Predictions

Location	Units	EIS Predicted Annual Average PM_{10}	Annual Average PM_{10} Results 2018
ESMS	µg/m^3	20.1	20.6
Fan site 1	µg/m^3	18.7	19.0
Hulbert	µg/m^3	17.4	20.7
Standings	µg/m^3	17.3	18.9
Macairstrip	µg/m^3	17.0	20.4

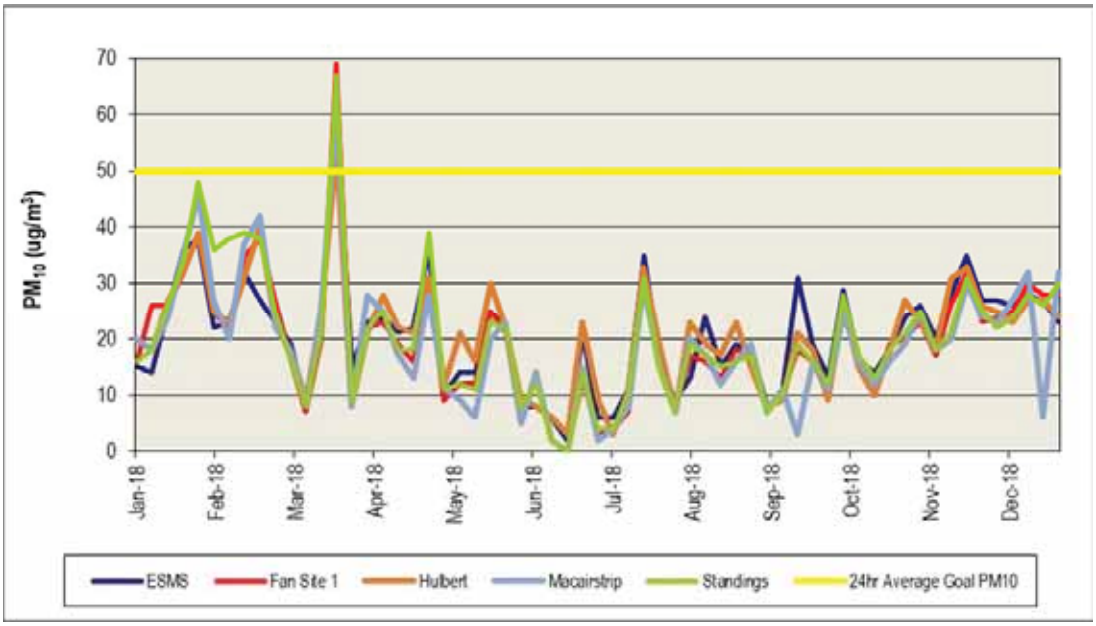


Figure 8
HVAS 24-hr Average PM_{10} Results

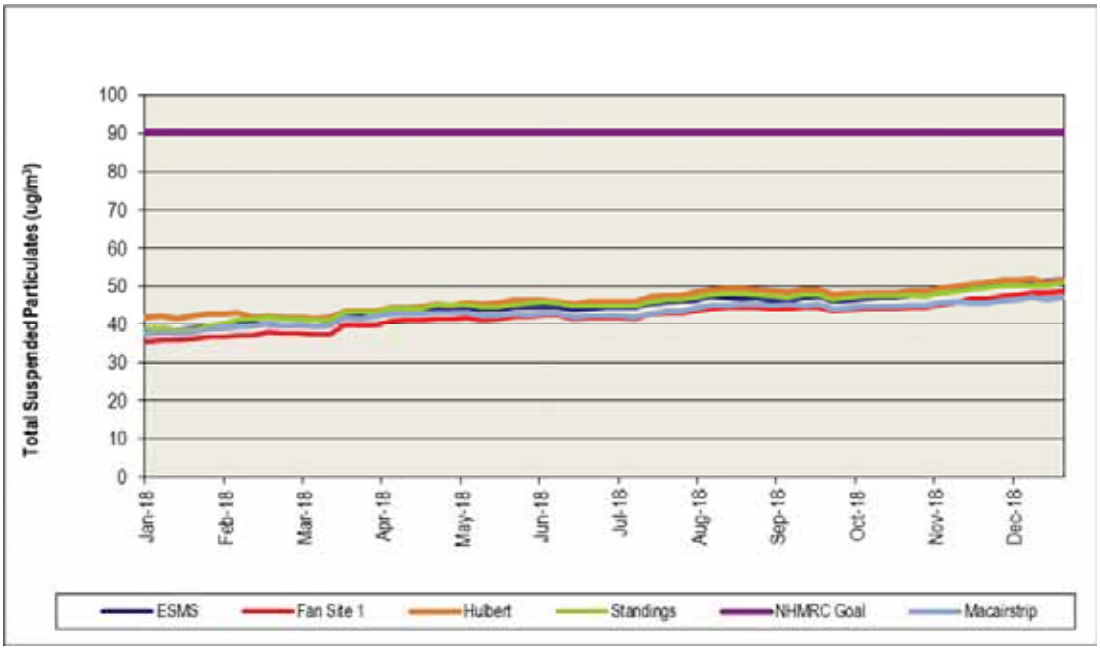


Figure 9
Calculated Rolling Annual Average TSP Concentrations

6.4 THREATENED FLORA AND FAUNA

6.4.1 Environmental Management and Performance

In terms of threatened flora and fauna species and habitat values, the Dartbrook Mine environment is a highly modified and fragmented environment of low ecological significance

Ecological studies previously undertaken at Dartbrook Mine in 2011 (the study) identified two communities listed as Endangered under the *Threatened Species Conservation Act 1995* (now replaced by the *Biodiversity Conservation Act 2016* (BC Act)) within the mining authorisations. This included approximately:

- 2,252 ha of Upper Hunter White Box Grassy Woodland (Box Gum Woodland); and
- 54 ha of Hunter Floodplain Red Gum Woodland.

Two threatened plant species were also identified in this study, including:

- Austral Toadflax (*Thesium australe*); and
- Black Orchid (*Cymbidium canaliculatum*).

The study also found six fauna species that are listed as either threatened under the BC Act or migratory under the Commonwealth *Environmental Protection and Biodiversity Act 1999* (EPBC Act).

These species included:

- Eastern Bentwing Bat (*Miniopterus schreibersii oceanensis*), listed as vulnerable under the BC Act;
- Large-footed Myotis (*Myotis macropus*), listed as vulnerable under the BC Act;
- Speckled Warbler (*Chthonicola sagittata*), listed as vulnerable under the BC Act;
- Little Eagle (*Hieraaetus morphnoides*), listed as vulnerable under the BC Act;
- Rufous Fantail (*Rhipidura rufifrons*), listed as marine and migratory under the EPBC Act; and
- White-throated Needletail (*Hirundapus caudacutus*), listed as marine and migratory under the EPBC Act.

Flora and fauna impacts, including all identified threatened and endangered species, are managed in accordance with the approved Flora and Fauna Management Plan.

Care and Maintenance operations at Dartbrook Mine generally do not require the clearing of vegetation. Where minor disturbance is required during Care and Maintenance, as described in **Section 4.1**, activities are undertaken to minimise disturbance to vegetation. A Permit to Disturb system is also used prior to any disturbance to check areas for any significant flora or fauna issues.

6.4.2 Next Reporting Period

Fauna and flora communities on site will continue to be managed in accordance with the approved Flora and Fauna Management Plan. In circumstances where clearing is required, a Permit to Disturb will be processed and appropriate pre-clearing surveys will continue to be undertaken by qualified ecologists.

The native forest tree screen along the New England Highway and the area north of the CHPP, which is planted with native forest will be surveyed and maintained. Maintenance of the River Restoration and Forestry Plantation Project areas will continue.

6.5 NOXIOUS WEEDS AND FERAL ANIMALS

6.5.1 Environmental Management and Performance

The management of noxious weeds and feral animals forms an integral part of the ongoing land management practices adopted for the site as described in the approved Land Management Plan.

Weed Management

Noxious weeds such as African Boxthorn, St John's Wort, Galenia, Bathurst Burr and Green Cestrum have been located on Dartbrook Mine owned land in the past. Their control continued to be a key land management objective during the reporting period.

The control of weeds on the alluvial river flats and riverbank areas on AQC owned land also provides management challenges and AQC seeks to work with leaseholders to manage weed outbreaks in these areas.

Dartbrook Mine maintains a Weed Management Register, which outlines the location of the weeds identified, method for control of the weeds and the control works undertaken across the site. Throughout 2018, small areas disturbed for Care and Maintenance activities were rehabilitated as soon as possible to reduce the potential for weed invasion.

Weed management activities undertaken in 2018 included targeted spraying of African Boxthorn, Prickly Pear and Green Cestrum. In addition, Dartbrook Mine's licensees sprayed weeds, slashed and grazed approximately 120 ha of agricultural land in 2018.

Feral Animal Management

Feral animal control at Dartbrook Mine during 2018 was largely focused on kangaroos, feral dogs and pigs.

In 2018, a professional kangaroo shooter holding appropriate licences was engaged to cull kangaroos on site. A total of 187 kangaroos were culled during the reporting period.

Dog baiting continued to be undertaken in conjunction with Hunter Local Land Services (LLS) around the Kayuga, 100% bait take was reported from the program in May 2018.

6.5.2 Next Reporting Period

Site personnel will continue to undertake weed and feral animal inspections and management across the Dartbrook Mine lands in the next reporting period.

6.6 OPERATIONAL NOISE

6.6.1 Environmental Management

In 2012, the DPE granted approval for Dartbrook Mine to suspend noise monitoring while under Care and Maintenance. The Care and Maintenance strategy involves low level noise equipment and machinery operation for maintenance activities only. Since coal is not mined at site, there currently is no need to operate production equipment or the CHPP.

6.6.2 Environmental Performance

Noise monitoring would re-commence should Dartbrook Mine recommence active operations.

6.7 VISUAL AND LIGHTING

6.7.1 Environmental Management and Performance

Dartbrook Mine facilities may still have the potential to generate visual and stray light impacts for sensitive receivers located in the surrounding environment during care and maintenance. With the use of tree screens, earthen bunds, fencing and shielding, the impacts of visual and stray light are minimised.

The approved Landscape and Lighting Management Plan (LLMP) includes a description of the extent of bunding and screening implemented across the mining authorisation.

A 75-ha forestry plantation was established north of the CHPP in 2003 and is detailed further in **Section 8.4**. This plantation was surveyed in 2018 and was found to be progressing well, with Spotted Gum dominating. As the trees continue to mature, they will provide additional screening of the township of Aberdeen from views of the CHPP.

In 2010, a Tree Screen was developed along the Western Side of the New England Highway in the vicinity of the CHPP to provide a visual buffer for motorists (see **Plate 2**). The tree screen is surveyed on an annual basis and has been undertaken in October 2015, November 2016, December 2017 and December 2018. During 2018, the western tree screen continued using drip irrigation during dry periods to ensure survival and optimum growth.

6.7.2 Next Reporting Period

Maintenance of the tree screening areas will continue as required subject to the prevailing weather conditions. A review of the screens will be undertaken during the next reporting period and replacement trees established if significant mortality of plantings occurs.

Plate 2
Tree Screening adjacent to New England Highway 2018

6.8 ABORIGINAL HERITAGE

6.8.1 Environmental Management and Performance

There are over 100 known Aboriginal heritage sites identified within the mining authorisations. Sites that are located within the vicinity of the approved surface facilities are fenced and signposted to ensure their protection.

As described in **Section 4.2**, AQC has a Permit to Disturb system in place for planned disturbance on site. Part of the permit includes a pre-disturbance requirement to check the location of planned disturbance against a database of the known Aboriginal site locations to ensure that potential impacts are avoided. A due diligence inspection for Aboriginal heritage items was undertaken in 2018 for the proposed groundwater drilling and exploration rehabilitation programs prior to disturbance taking place.

All post subsidence monitoring of Aboriginal sites located above previous mining areas has been completed. No incidences of harm or damage to Aboriginal sites have been identified.

6.8.2 Next Reporting Period

The existing Permit to Disturb system will continue to be used prior to any surface disturbance to minimise the potential for disturbance to Aboriginal heritage, including exploration and rehabilitation if required.

6.9 EUROPEAN HERITAGE

6.9.1 Environmental Management and Performance

Management of European heritage is undertaken in accordance with Dartbrook Mine's Archaeology and Cultural Heritage Management Plan.

General property maintenance works, such as mowing, slashing and fence repairs were carried out in 2018 to protect the heritage items under the control of AQC. Such areas include continued work around the Riverview Homestead and the Dartbrook and Kayuga Cemeteries.

The renovations of the Kayuga Homestead that began in the previous reporting period were completed in 2018.

6.9.2 Next Reporting Period

AQC will continue existing efforts to minimise the impact of the operation on European heritage sites and to continue the upkeep of the various sites, in consultation with regulatory agencies

6.10 SPONTANEOUS COMBUSTION

6.10.1 Environmental Management

The REA remained stable during the reporting period. The risks posed by potential spontaneous combustion at the REA continue to be classified as minimal.

Dartbrook Mine has an approved REA Spontaneous Combustion Management Plan (REA Plan), which outlines measures for monitoring and mitigating potential spontaneous combustion issues.

6.10.2 Environmental Performance

The REA underground temperature is monitored using 13 thermocouples installed in boreholes to measure the temperature of the reject's material. **Figure 10** provides the results of REA thermocouple monitoring in 2018.

The risk of spontaneous combustion continues to be considered 'low' as the REA has been fully rehabilitated and all coal material has been removed from the coal stockpiles (as discussed in **Section 8**).

There were no incidents of spontaneous combustion during the reporting period. All temperature monitoring probes read satisfactorily. Temperatures remained generally stable and below the site TARP value of 50 ºC (as provided in the approved REA Plan).

Appendix D shows the REA temperature monitoring summary from 2001 to the end of the reporting period. The REA is also monitored for sub-surface water level movements, which have remained relatively stable during the reporting period (as presented in **Appendix D**).

6.10.3 Next Reporting Period

REA thermocouple temperatures and piezometric water levels will continue to be monitored and reported in the next reporting period.

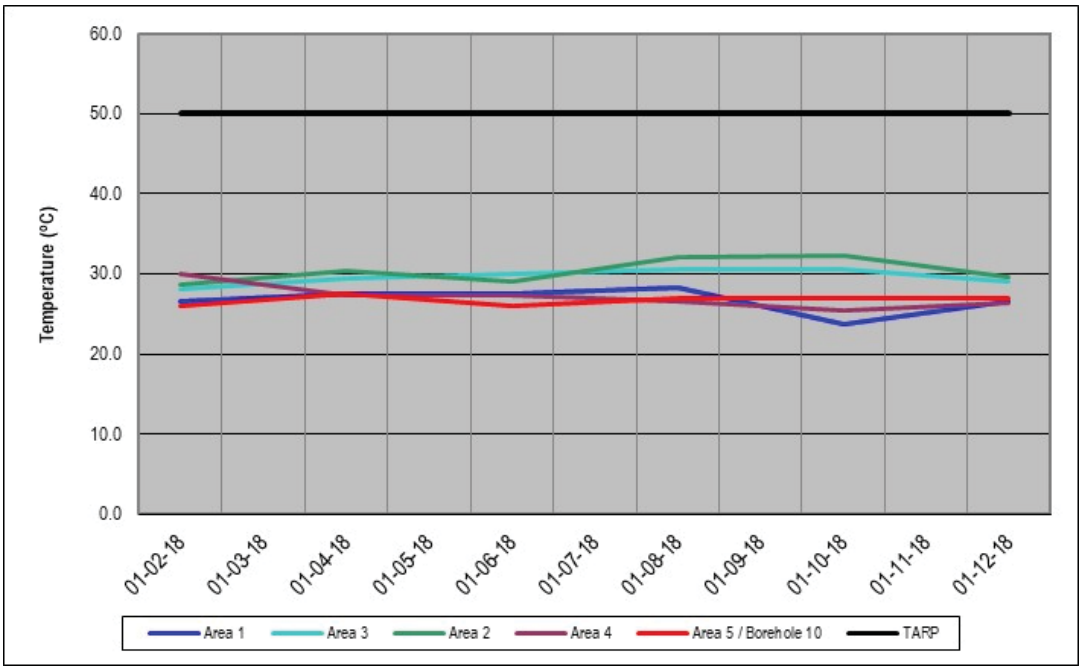


Figure 10
REA Thermocouple Temperature Monitoring Results

6.11 BUSHFIRE

6.11.1 Environmental Management and Performance

As outlined in the Bushfire Management Plan, fire prevention is the primary management objective at Dartbrook Mine.

All surface facilities with the potential to create a fire hazard, such as electrical substations, are kept clear of combustible materials to minimise the risk of a fire within these areas.

Roadsides are slashed on a regular basis and most surface areas managed by AQC are also grazed by cattle, which assists in the control of fuel build up.

Dartbrook Mine has a fire trailer equipped with a 1,000 L water tank and pump, which can be utilised to control any fire outbreaks if required.

6.11.2 Next Reporting Period

Bushfire fuel loads across the site will continue to be monitored and reduced (as required).

6.12 MINE SUBSIDENCE

6.12.1 Environmental Management

The management of the effects of subsidence is undertaken as detailed in the originally approved Property Subsidence Management Plans and the Longwall Subsidence Management Plan.

The current management generally involves an annual inspection to determine if there are any ongoing impacts from subsidence, with remediation works being undertaken as required.

6.12.2 Environmental Performance

A total of 817.8 ha of land has subsided as a result of historic underground mining operations at Dartbrook Mine. No new active subsidence was identified in the reporting period.

There has been negligible impact to land as a result of subsidence to date, with generally only minor surface cracks (<50 mm) occurring. Surface cracking generally appeared around the beginning and end of longwall blocks. In most instances, earthworks were not required to repair subsidence cracks as the minor cracks naturally sealed themselves.

There have not been any changes to agricultural land suitability classes resulting from previous longwall mining.

The annual subsidence survey included inspection of areas affected by mining of the Kayuga Seam longwall panels KA101 - KA103. This was to check for any redevelopment of surface cracking and to assess the condition of previous remediation works. The inspection found that the previously treated areas have remained stable.

Subsidence resulting from mining the Kayuga Seam has affected three 2nd and 3rd order tributaries of Sandy Creek. There has been only minor cracking and grade changes have been subtle and localised with little impact on stream hydrology. There has been no change to agricultural land capability resulting from mining the Kayuga Seam.

6.12.3 Next Reporting Period

Annual inspections of previous subsidence areas will continue to be undertaken. Should any new areas be identified as requiring surface repair, remedial actions will be undertaken as soon as practicable. As part of the inspection process, previously remediated sites will be re-inspected to determine if additional repairs are required.

6.13 HYDROCARBON CONTAMINATION

6.13.1 Environmental Management and Performance

There are only minimal quantities of hydrocarbon-based products (such as oils or diesel fuels) stored or used at Dartbrook Mine during Care and Maintenance. This has greatly reduced the potential risk of contamination from such products.

Any oils or fuels that are required to be stored at Dartbrook Mine are appropriately bunded and maintained to prevent spillages to land or water.

The facilities have been constructed so that all drainage from the workshop and service areas flows by gravity into an oil separator for clarification before return to the Western Holding Dam (WHD). The separator and existing sump continued to be serviced and cleaned out regularly during the reporting period to ensure the system remains effective. Inspections of the workplace are ongoing to ensure good housekeeping standards are maintained.

Environmental training, which included spill response, water management and hydrocarbon management continued to be offered to new staff and contractors at the site.

Spill kits containing absorbent materials are strategically located on site to assist in containing and immediately cleaning up any spills should they occur. The hardstand area also has controlled drainage, eventually reaching the WHD through the oil separation system.

During the reporting period, no new indications of contamination by petroleum hydrocarbons, polycyclic aromatic hydrocarbons, or heavy metals were identified.

Removal of the 93 longwall roof supports stored on the West Site hardstand commenced in 2017. All remaining supports were removed from site by September 2018.

6.13.2 Next Reporting Period

Environmental spill response training will continue to be provided to new staff and contractors. Maintenance of the oil separation system will also continue.

6.14 GAS DRAINAGE & VENTILATION

6.14.1 Environmental Management and Performance

The majority of gas from the underground mine is managed by mine ventilation and released through an upcast shaft. During Care and Maintenance, methane (CH_4) and carbon dioxide (CO_2) were vented to the atmosphere via Ventilation Shaft No. 1.

Scope 1 emissions are from underground fugitives (split into methane and carbon dioxide); or use of diesel, petrol, LPG, oils and greases. Scope 2 emissions are those from the use of electricity on site.

The total emissions are calculated from both Scope 1 and Scope 2 emissions. Tube bundles are installed to measure the gas mix, which has been extrapolated to establish monthly quantities, as shown in **Table 21**.

All gas drainage boreholes and plants previously used to extract gas from the mine goaf have been closed. These sites continued to be regularly inspected during the reporting period.

As shown in **Table 21**, a total of 94,343 tonnes of CO_2 equivalent gas (CO_2-e) was emitted during the 2017/18 National Greenhouse and Energy Reporting (NGER) period. The main contributor to total emissions was CH_4 gas emitted from the underground mine (77,822 tonnes CO_2-e).

The total greenhouse gas emissions value for the 2017/18 NGER period is higher than the 66,943 tonnes CO_2-e reported in the 2017 Annual Review. This is largely the result of a change to an updated emissions monitoring calculation method implemented in 2018.

During the 2017/18 NGER reporting year, the equipment used for the continuous monitoring of fugitive methane emissions from the underground workings at Dartbrook Mine was replaced. This new more sophisticated monitoring sensor has allowed for the content of the total gas emissions from the site to be more accurately recorded, particularly when greenhouse gas levels are in the very low range of less than one percent of total gas emissions.

6.14.2 Next Reporting Period

Gas emissions, electricity use and fuel use will continue to be calculated and reported in accordance with relevant legislative requirements.

6.15 PUBLIC SAFETY

6.15.1 Environmental Management and Performance

AQC seeks to ensure that the safety of visitors, neighbours and the general public is maintained at all times. Signage, restricted access, fencing and inspections by security personnel are established means of warning the public and preventing access to operational areas of the mine.

To account for the Care and Maintenance status and the reduced number of personnel on site, a number of additional security measures have been implemented, including:

- Installation of security fences around the box cut mine entrance and the Hunter Tunnel entrance;
- Establishment of secure gates on all mine portals to prevent unauthorised access; and
- Employment of a security firm to patrol the site nightly from Monday – Friday and on weekends.

There were no significant security breaches in 2018. Regular security patrols are undertaken along the boundary fence between the CHPP and the 'Aberdeen Common' (a public access area). In addition, remote motion activated cameras have been strategically placed around the site to monitor any areas that are vulnerable to trespassers.

In 2018, Dartbrook Mine's private access road to the New England Highway continued to be strategically closed at night to reduce the risk of unauthorised access.

6.15.2 Next Reporting Period

Regular patrols by site personnel will continue. Full-time onsite caretakers will remain on-site, fences will be maintained and gates will remain locked and secured.

Roadside vegetation slashing will continue, as required.

Table 21
Greenhouse Gas Emissions during 2017/18 NGER period

Month	Scope 1 Emissions			Scope 2 Emissions	Total Emissions (t CO_2-e)
	Carbon Dioxide (t CO_2-e)	Methane (t CO_2-e)	Nitrous Oxide (t CO_2-e)	Carbon Dioxide (t CO_2-e)	
Jul-17	1,005	4,313	0.010	379	5,697
Aug-17	936	4,281	0.011	393	5,610
Sep-17	995	9,684	0.013	353	11,032
Oct-17	961	8,553	0.016	404	9,917
Nov-17	839	5,899	0.016	413	7,152
Dec-17	1,079	6,241	0.012	447	7,767
Jan-18	1,101	6,746	0.019	478	8,325
Feb-18	944	5,712	0.013	418	7,074
Mar-18	1,034	6,994	0.012	420	8,448
Apr-18	961	5,575	0.012	407	6,943
May-18	903	6,948	0.016	395	8,246
Jun-18	872	6,875	0.190	384	8,132
FY 18 Total	**11,630**	**77,822**	**0.339**	**4,891**	**94,343**

7 WATER MANAGEMENT

This section describes the objectives for water management and performance at Dartbrook Mine during the reporting period.

7.1 OVERVIEW

Dartbrook Mine has a water management system whereby all water accumulated on-site has generally been retained in storages (such as mine water dams or the Wynn Seam Goaf). The main inflows to the site water balance occur via rainfall runoff and groundwater seepage into the goaf. Water can be transferred from these storages via pipelines to the CHPP and the underground mine or between the East and West Sites.

AQC holds a licence to discharge excess water under the Hunter River Salinity Trading Scheme (HRSTS) and presently has an entitlement of 12 credits.

The site water management system is generally shown on **Figure 3** and **Figure 4**, with a schematic included as **Appendix G**.

Approval was granted from the Natural Resources Access Regulator (NRAR) on 12 June 2018 to construct 13 new groundwater monitoring sites on AQC owned land. These additional monitoring bores were installed during the reporting period (see **Plate 3** and **Plate 4**), with the locations of each shown on **Figure 11**.

During the reporting period, AQC continued to manage the water level in the Wynn Seam Goaf by pumping water to surface dams to encourage evaporation. Water accumulating in the goaf is reclaimed by the Wynn Seam Goaf Dewatering Plant, with a pipeline able to transfer water to the Evaporation Ponds, the Staged Discharge Dam (SDD) and the WHD.

7.1.1 Fresh Water Use

Approximately 3.2 megalitres (ML) of potable water was sourced from the Aberdeen town water supply. Approximately 7.4 ML of groundwater was extracted from two bores (Blairemore bores) adjacent to the mine West Site during the reporting period.

7.1.2 Water Take

Water take under the Dartbrook Mine water licences during the reporting period is provided in **Table 22**.

The passive take of 128 ML from the Hunter Regulated River Alluvial Water Source in 2018 accounts for the seepage of groundwater flowing into the Hunter Tunnel. The remaining volumes are related to active pumping under licence for the support of agricultural activities by leaseholders on AQC owned land in 2018.

Table 22
Dartbrook Mine Water Take

Water Licence	Water Sharing plan, source and management zone (as applicable)	Entitlement	Passive Take/inflows	2018 Active Pumping (ML)**	Total Entitlement
WSP for Hunter Unregulated and Alluvial Water Sources 2009					
WAL 17739	Dartbrook Alluvial Water Source	30	-	6.3	950
WAL 17762		254			
WAL 17781		278			
WAL 17863		5			
WAL 23875		50			
WAL 17790		228			
WAL 30213		105			
WAL 17889	Dartbrook Unregulated River Source	17	-	0	85
WAL 17797		68			
WAL 18134	Hunter Alluvial Water Source	297	128	0	1,249
WAL 18174		37			
WAL 18210		235			
WAL 18225		121			
WAL 18228		90			
WAL 18239		371			
WAL 18126		98			
WSP for Hunter Regulated River Water Source 2016					
WAL 506	General Security	261	-	2,194.8	2,811
WAL 759		24			
WAL 838		8			
WAL 956		176			
WAL 996		120			
WAL 1005		171			
WAL 1021		480			
WAL 1022		264			
WAL 1024		228			
WAL 1025		3			
WAL 1026		5			
WAL 1027		63			
WAL 1235		270			
WAL 13386		270			
WAL 14607		328			
WAL 14609		5			
WAL 9048		135			
WAL 955	High Security	3	-	0	6
WAL 1023		3			
WAL 1267	Supplementary Water	6	-	0	254.8
WAL 1313		30.2			
WAL 1316		10			

Water Licence	Water Sharing plan, source and management zone (as applicable)	Entitlement	Passive Take/inflows	2018 Active Pumping (ML)**	Total Entitlement
WAL 1317		42.			
WAL 1318		23.8			
WAL 13336		18.7			
WAL 14605		89			
WAL 9055		35			
WSP for Sydney Basin North Coast Groundwater Source					
WAL 41523	Sydney Basin North Coast Groundwater Source*	30	-	0	180
WAL 41524		150			

** Updated to correct Water Source by DoI-Water in 2018*
*** Calculated from NSW Water Accounting System Reporting*

Plate 3
Drilling of new groundwater monitoring sites

Plate 4
Completed groundwater monitoring bore site PB01

7.1.3 Sewage

There was no irrigation of land using treated sewage effluent during the reporting period.

7.1.4 Surface Water Dams

During the reporting period, water levels in the Eastern Holding Dam (EHD) and WHD were maintained as low as practicable to ensure that there was adequate capacity to capture and contain storm water run-off from site.

This was further assisted by below average rainfall experienced in 2018 which resulted in reduced surface water storage volumes being maintained. Despite the reduced levels of rainfall, the Evaporation Ponds and SDD were maintained at higher levels to maximise water losses to evaporation. Due to the generally dry conditions onsite, levels recorded at EHD were below 50% capacity as at the end of the reporting period.

Dam storage volumes during the reporting period are shown in **Table 23**.

Table 23
Dartbrook Mine Stored Water Summary

Storage	Location	Volume Held (m^3)		
		Start of Period 1/01/2018	End of Period 31/12/18	Storage Capacity
Clean Water				
Clean Water Dam 1	East Site	0	0	10,000
Clean Water Dam 2	East Site	3,500	500	10,000
Clean Water Dam 3	East Site	0	0	10,000
Southern Clean Water Dam	East Site	0	0	53,000
Dirty Water (runoff)				
Sediment Dam 1	West Site	450	50	1,000
Sediment Dam 2	West Site	0	0	400
Northern Dam REA	East Site	1,035	0	2,300
Southern Dam REA	East Site	4,400	1600	8,000
Stage 4 REA Dam	East Site	0	0	7,900
Controlled Discharge Water				
SDD	West Site	256,000	254,000	400,000
Contaminated Water				
Western Holding Dam *	West Site	3,542	3,542	15,400
Eastern Holding Dam *	East Site	30,080	35,200	88,000
Evaporation Ponds	West Site	79,200	66,000	132,000
Wynn Seam Goaf	Underground	~3,090,000	~3,003,000	~3,547,000

*Note: * Maintained at <50-70% as standard practice to ensure sufficient capacity for storm events.*

Hunter River Salinity Trading Scheme

In order to maximise evaporation and readiness for the gravity-fed HRSTS discharge system, the SDD was maintained at approximately 65% capacity during the reporting period.

AQC did not discharge under the HRSTS during the reporting period.

Groundwater

There was an estimated 128 ML of groundwater inflow into the Hunter Tunnel during the reporting period (see **Table 24**). This water was pumped directly into the Wynn Seam Goaf for storage. Groundwater seepage, mainly from the Wynn Seam into the goaf, was estimated at 106 ML for the reporting period. These volumes equate to total modelled inflows of 234 ML during the reporting period (see **Table 24**).

The management of the accumulation of water in the Wynn Seam goaf was the main groundwater management task during the reporting period. The management strategy is to dewater the Wynn Seam Goaf so that the rate of outgoing water is the same as the rate of incoming water.

The management strategy utilised for water levels in the Wynn Seam goaf follows a TARP framework. This strategy seeks to maintain a target depth of 275 m (groundwater depth below surface) at the Pleuger pump monitoring site. When levels show large fluctuations from 275m (groundwater depth below surface), an onsite investigation is undertaken and additional actions are taken to manage levels, consistent with those identified in the SWMP. The revised TARP depth of 275m will be reflected in future revisions of the SWMP.

Site Inventory

Measured site inventory based on monthly dam observations decreased from 3.535 ML to 3,364 ML during 2018. This represents a net loss of 171 ML when compared to the net loss of 68 ML in 2017 and gain of 95 ML in 2016.

Table 24
Estimated Dartbrook Mine Water Balance Components

Water Stream	2018 Volumes (ML)
Inputs	
Fresh Water (Blairemore bore)	7.4
Groundwater Seepage In (including Hunter Tunnel)	234
Rainfall Runoff	117
Recycled to CHPP from Tails & Storage (not included in total)	0
Imported Potable (Aberdeen)	3.2
Total Inputs	**362**
Outputs	
Groundwater Seepage Out	50
Dust Suppression	0
Evaporation – Mine Water	401
Entrained in Process Waste	0
Discharged (HRSTS)	0
Potable Usage	10.6
Total Outputs	**462**
Estimated Change in Total Storage (decreased)	**100**

7.2 GROUNDWATER

7.2.1 Environmental Management

There are two main aquifer systems within the Dartbrook area:

- Alluvial aquifer systems associated with the Hunter River, Dart Brook and Sandy Creek; and
- The Permian coal measures (Burnamwood Formation).

The alluvial aquifers are the most important with respect to groundwater dependent ecosystems and human use. The Hunter River alluvial aquifer is a major aquifer providing high yields and good water quality. It is used for irrigation, stock and domestic purposes, whereas the alluvial aquifers associated with Dart Brook and Sandy Creek are primarily used for stock and domestic purposes.

The Permian aquifers are generally deep, low yielding and contain poor quality (brackish to saline) groundwater. They are less productive aquifers and as such, the impact of the mine on these aquifers has less significance.

AQC undertakes an extensive monitoring program at Dartbrook Mine to fulfil the Groundwater monitoring commitments in the SMWP, required under DA 231-07-2000.

The primary objective of the groundwater monitoring program, as prescribed by Condition 4.2 (a) (ii) of DA 231-07-2000 is to collect sufficient data to adequately assess:

- The impact on groundwater levels at neighbouring properties and in the locality, and to identify any water quality impacts;
- The impact of the development on groundwaters associated with the alluvial aquifer of the Hunter River including the ongoing monitoring of the volume and quality of inflows into the Hunter Tunnel;
- Regional groundwater levels and water quality including the extension of the regional groundwater monitoring network to include bores RDH508-511; and
- Any concerns or complaints from surrounding landholders regarding groundwater matters, and any ensuing actions, which shall be recorded and be available to DoI-Water (formerly DLWC).

In particular, the monitoring program is designed to detect impacts on alluvial groundwater levels or quality that may have been induced by mining. The potential impacts of mining include seepage from the:

- Hunter River alluvium to the Hunter Tunnel; and
- REA and Wynn Seam Goaf Tailings water storage area to the Wynn Seam.

Details of the groundwater bores included in the groundwater monitoring program are provided in **Table 25**. The scope of the groundwater monitoring program has been reduced due to the mine being under Care and Maintenance.

As noted in **Table 25**, monitoring of groundwater bores is undertaken on a six-monthly basis during Care and Maintenance. As can be seen in **Appendix E,** a small number of bores were monitored annually in 2018.

Figure 11 shows the locations of all groundwater monitoring bores sampled during the reporting period.

Groundwater monitoring results for the reporting period and hydrographs showing long term trends are included in **Appendix E**. **Appendix E** also includes graphs of groundwater levels and water quality parameters for the aquifers that were monitored and monitoring results for pH and EC.

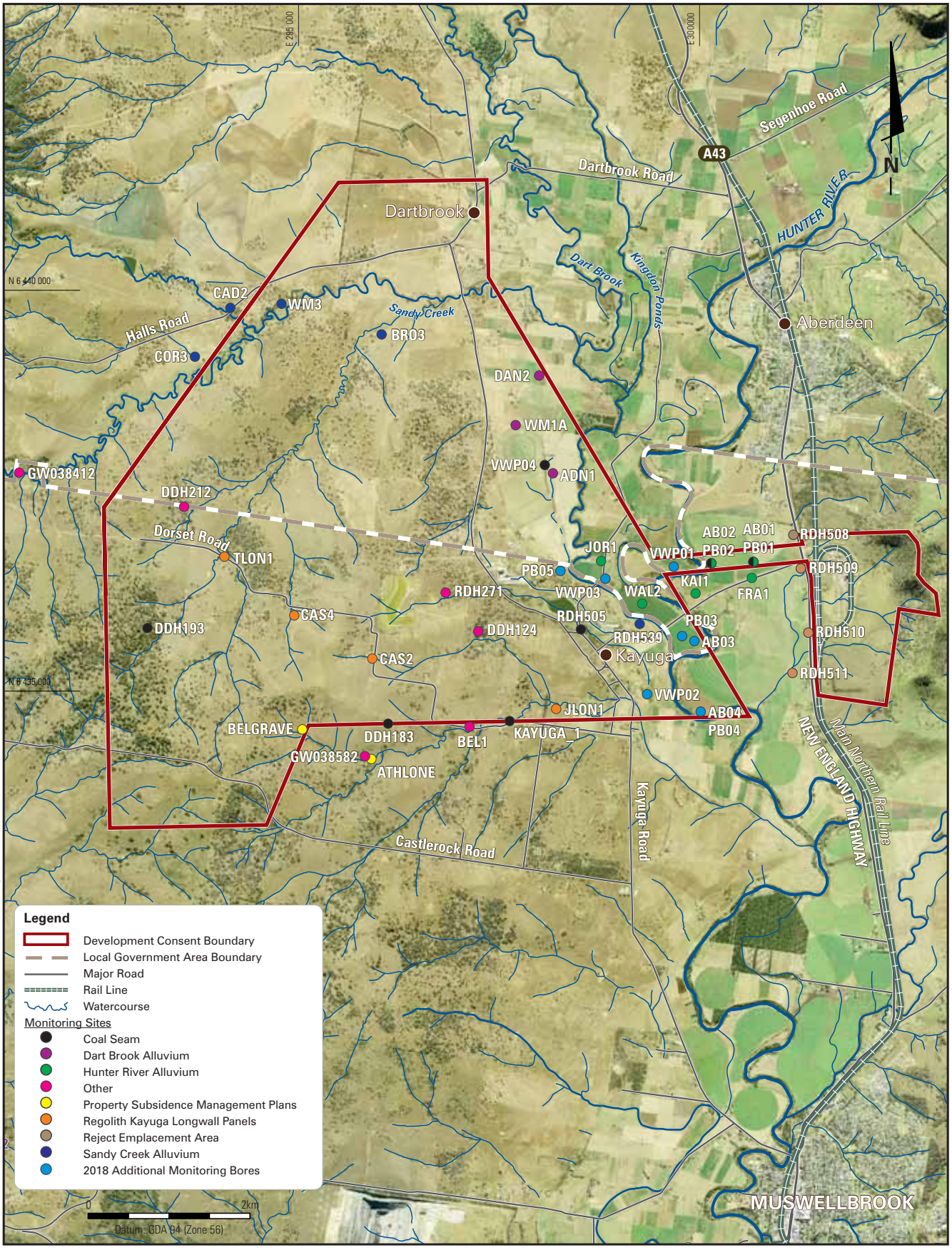
Table 25
Groundwater Monitoring Bores

Bore	Bore Type	Aquifer Monitored	Details	Parameter / Frequency
Hunter River Alluvium Monitoring Bores				
FRA1	Well	Hunter River Alluvium	Monitor any interaction between the alluvial aquifer to the Hunter Tunnel. Located in a west to east direction across the alluvial plain, along the alignment of the Hunter Tunnel.	Monitored on a six-monthly basis for water depth, pH, EC & additional suite parameters.
JOR1	Well			
KAI1	Well			
WAL2	Well			
Dart Brook Alluvium Monitoring Bores				
ADN1	Well	Dart Brook Alluvium	Monitor water levels and quality within the Dart Brook alluvium. These bores are located between the underground mining area and the Hunter River alluvium.	Monitored on a six-monthly basis for water depth, pH, EC & additional suite parameters.
DAN2	Well			
WM1A	Bore			
Sandy Creek Alluvium Monitoring Bores				
BRO3	Bore	Sandy Creek Alluvium	Located in the Sandy Creek alluvium.	Monitored on a six-monthly basis for water depth, pH, EC & additional suite parameters.
COR3	Bore			
WM3	Bore			
CAD2	Bore			
GW038412	Well			
Coal Seam Monitoring Bores				
Kayuga 1	Bore	Kayuga Seam		

Bore	Bore Type	Aquifer Monitored	Details	Parameter / Frequency
DDH183	Bore		Monitor the Kayuga and Wynn Seam aquifers.	Monitored on a six-monthly basis for water depth, pH, EC & additional suite parameters.
DDH193	Bore			
DDH212a	Bore	Wynn Seam		
Regolith Monitoring Bores				
CAS2	Bore	Regolith – shallow overburden	Monitor the regolith overlying and in the vicinity of the Wynn and Kayuga longwall panels.	Monitored on a six-monthly basis for water depth, pH, EC & additional suite parameters.
CAS4	Windmill			
TLON1	Windmill			
BEL1	Well			
Athlone	Bore			
JLON1	Windmill			
GW038582	Bore			
Belgrave	Bore			
REA Monitoring Bores				
RDH508	Bore	Hunter River Alluvium	These bores are located west of the REA. Monitoring bores RDH508 and RDH509, located on the eastern side of the Hunter River alluvium to detect any seepage from the REA.	Monitored on a six-monthly basis for water depth, pH, EC & additional suite parameters.
RDH509	Bore			
RDH510	Bore			
RDH511	Bore			

Note: Bore = Monitoring bore and not a current water supply.

See SWMP for additional suite of parameters.



HB DARTBROOK Underground 2019 Annual Review HB1849 F11 Groundwater Monitoring Network 28 03 2019 Rev A

DARTBROOK MINE

Groundwater Monitoring Network

FIGURE 11

Hansen Bailey
ENVIRONMENTAL CONSULTANTS

Australian Pacific Coal

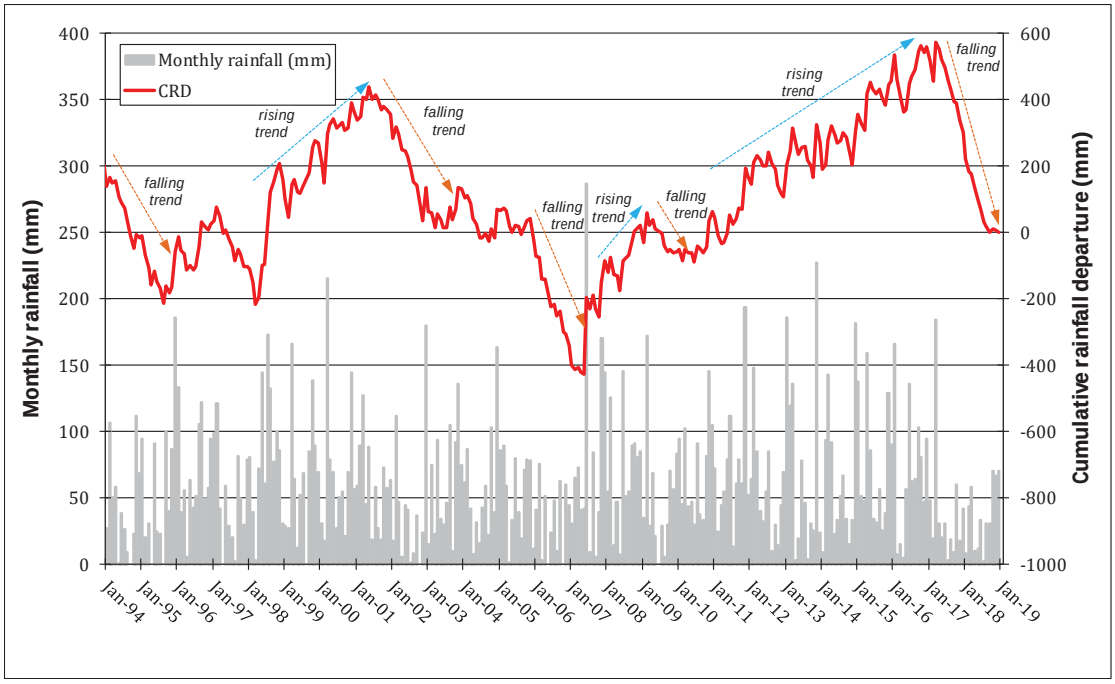
7.2.2 Cumulative Rainfall Departure

Groundwater levels in relatively shallow wells or bores constructed in alluvium are generally highly dependent on rainfall recharge and can rise or decline quite rapidly in response to rainfall events.

CRD is a technique for assessing groundwater level trends in unconfined alluvial aquifers and provides a summary of the monthly departure of rainfall from the long-term average. A rising trend in the CRD plot indicates periods of above long-term average rainfall, whilst a falling trend indicates periods when rainfall is below the long-term average.

Average monthly rainfall for the period 1926 to 2018 from the BoM Aberdeen Rossgole Station (ID: 61065) located approximately 9 km from the mine area was used to produce the CRD shown on **Figure 12**.

As reported in **Section 6.2**, Dartbrook experienced below average rainfall in 2018 and this corresponded with the sharp decline in the CRD as shown in **Figure 12**.



Source: AGE (2019)

Figure 12
Cumulative Rainfall Departure

7.2.3 Hunter River Alluvium

Water Levels

Graph E-1 in **Appendix E** shows groundwater levels from Hunter Alluvium monitoring bores JOR1, FRA1, KAI1, KAI2 and WAL2.

During the reporting period, groundwater levels in FRA1 and KAI1 decreased by 2.02 m, and 0.01 m respectively. These observations were within historical levels and did not exceed the SWMP trigger levels. Monitoring of KAI2 recommenced during 2018, with observed groundwater levels similar to those previously recorded at this bore (see Graph E-1 of **Appendix E**).

The depth to groundwater levels measured within JOR1 during April and October 2018 were 11.93 m and 11.06 m respectively, exceeding the SWMP trigger level of 10 m. These lower groundwater levels correspond to the sharp decline in average rainfall since early 2017, shown by the falling CRD trend on **Figure 12**.

Despite a falling CRD trend, the groundwater levels measured within WAL2 recovered slightly in 2018 to be within SWMP target values.

Water Quality

Graphs E-2 and E-3 in **Appendix E** show water quality measurements from Hunter River Alluvium monitoring bores JOR1, FRA1, KAI1, KAI2 and WAL2.

pH measured at JOR1, FRA1, KAI1, KAI2 and WAL2 generally ranged between 6.9 to 7.3 during the reporting period. These measurements were within the historical ranges and did not exceed the SWMP trigger levels.

Electrical Conductivity (EC) recorded at JOR1, FRA1, KAI1, KAI2 and WAL2 were measured between 477 and 4,990 µS/cm. EC levels recorded at JOR1, KAI1 and KAI2 remained within historical ranges and did not exceed the SWMP trigger levels.

EC measured at WAL2 during October 2018 monitoring was 1,936 µS/cm, with measurements exceeding the SWMP trigger level of 1,917 µS/cm.

EC measured at FRA1 during the April and October 2018 monitoring were 4,990 µS/cm and 4,760 µS/cm, respectively. Both measurements exceeded the SWMP trigger level of 659 µS/cm.

7.2.4 Dart Brook Alluvium

Water Levels

Graph E-4 in **Appendix E** shows groundwater levels from Dart Brook Alluvium monitoring bores ADN1, DAN2 and WM1A in 2018.

During the reporting period, groundwater levels at ADN1 and DAN2 were within the historical levels and did not exceed the SWMP trigger levels. Only one groundwater level was measured for WM1A in 2018 (6 April 2018), with the measurement within SWMP trigger levels.

Water Quality

Graphs E-5 and E-6 in **Appendix E** show water quality measurements from Dart Brook Alluvium monitoring bores ADN1, DAN2 and WMA1. pH measurements at these bores generally ranged between 7.0 and 7.5 during the reporting period. These measurements are within the historical ranges and did not exceed the SWMP trigger levels.

EC recorded at these monitoring bores ranged between 1,787 to 2,960 µS/cm and were generally consistent with measurements from previous years. These results were consistent with historical levels and did not exceed the SWMP trigger levels.

7.2.5 Sandy Creek Alluvium

Water Levels

Graph E-7 in **Appendix E** shows groundwater levels from Sandy Creek Alluvium monitoring bores COR3, WM3, BRO3 and GW038412.

During the reporting period groundwater levels in WM3 and GW038412 decreased by 0.88 m, and 0.44 m respectively.

The groundwater levels measured within GW038412 during the April and November 2018 monitoring rounds were 5.31 m and 5.90 m, respectively. Both of these measurements exceeded the SWMP trigger level.4.8 m. GW038412 is the closest Sandy Creek alluvium monitoring location in relation to the Kayuga underground workings (~ 2 km). Given that GW038412 is a well and coupled with the declining trend in rainfall during this time period, it is possible that more water was being pumped from this site at the times of monitoring during 2018.

The groundwater levels measured within bore WM3 also continued to decline slightly during the reporting period. April and November 2018 groundwater levels were 7.63 m and 7.98 m (respectively), with both measurements exceeding the SWMP trigger level of 7.6m.

The groundwater level measured within COR3 continued to reduce during the reporting period, recording a level of 7.11 m during November 2018. This recording exceeded the SWMP trigger level of 5.3 m.

Measurements at BRO3 were within historical ranges and did not exceed the SWMP trigger level.

Water Quality

Graphs E-8 and E-9 in **Appendix E** shows water quality measurements from Sandy Creek Alluvium monitoring bores COR3, WM3, BRO3 and GW038412.

pH measurements generally ranged between 6.7 and 8.8 during the reporting period. Measurements at all sites were within historical ranges and did not exceed the SWMP trigger levels.

EC levels recorded at all sites ranged from 1,315 – 3,600 µS/cm and results did not exceed their respective SWMP trigger levels at bores BRO3, COR3 and WM3.

EC measured within GWO38412 during the April and November monitoring rounds was 3,170 µS/cm and 3,600 µS/cm (respectively) with both measurements exceeding the SWMP trigger level of 1,917 µS/cm.

7.2.6 Staged Discharge Dam

Water Levels

Graph E-10 in **Appendix E** shows groundwater levels from the Staged Discharge Dam bore RDH505. 2018 depth to groundwater levels were found to be similar to those recorded in previous years.

Water Quality

Graph E-11 in **Appendix E** shows the water quality measurements from the Staged Discharge Dam bore RDH505.

pH levels recorded in RDH505 increased slightly during the reporting period up to 7.4, which is within the upper SWMP trigger value of 7.5. Measured EC declines slightly during the year, with an upper result of 10,530 µS/cm recorded in April 2018, which is within the SWMP trigger value.

7.2.7 Coal Seams

Water Levels

Graph E -12 in **Appendix E** shows groundwater levels from Kayuga Seam monitoring bores, Kayuga-1, DDH183, DDH193 and DDH212a.

Bores Kayuga-1, DDH183 and DDH193 were affected by depressurisation associated with mining of Kayuga longwall panels prior to 2007. Groundwater levels recorded in Kayuga-1, DDH183 and DDH193 have remained relatively steady since the cessation of mining in 2006, a trend which continued during the reporting period.

Monitoring bore DDH212a measures water levels in the Wynn Seam. Depressurisation of the Wynn Seam occurred during active mining operations prior to 2007. Groundwater levels in DDH212a have continued to remain steady from 2011 to 2016. The groundwater level measured within DDH212a during November 2018 monitoring was 27.53 m, exceeding the SWMP trigger level of 27.5 m.

Water Quality

Graphs E-13 and E-14 in **Appendix E** shows water quality measurements from Kayuga Seam monitoring bores Kayuga-1, DDH212a, DDH183 and DDH193.

pH measurements for bores Kayuga-1, DDH183 and DDH193 remained within historical ranges and did not exceed SWMP trigger levels in the reporting period.

Bore DDH212a is screened in the Wynn Seam. In April and November 2018, pH measurements of 8.17 and 8.07 (respectively) were recorded. These measurements were within historical ranges and did not exceed the SWMP trigger levels.

EC levels have remained relatively stable for all coal seam bores since 2009. During the reporting period, monitoring results for DDH183, DDH193 and Kayuga1 remained within historical ranges and did not exceed the SWMP trigger level.

The EC level measured within DDH212a in April 2018 was 4,040 µS/cm which exceeded the SWMP trigger level of 3,861 µS/cm.

7.2.8 Regolith

Water Levels

Graph E-15 in **Appendix E** shows the groundwater levels in bores CAS2, CAS4, JLON1 and TLON1.

Monitored groundwater levels in TLON1 have remained relatively stable since the commencement of Care and Maintenance operations. The groundwater level measured within TLON1 during April and November 2018 were 11.42 m and 11.52 m respectively, exceeding the SWMP trigger level of 11.3 m.

Groundwater levels in CAS2 have steadily declined since 2002. The groundwater level measured within CAS2 during April and November 2018 was 41.56 m and 42.43 m respectively, exceeding the SWMP trigger level of 36.5 m.

CAS4 levels remained within the historical range and did not exceed the SWMP trigger level during the reporting period.

Water Quality

Graphs E-16 and E-17 in **Appendix E** shows water quality measurements in bores CAS2, CAS4, JLON1 and TLON1. Monitoring at JLON1 recommenced during the reporting period; however, prior to this, the last sample recovered from this monitoring location was in 2011.

pH measurements between the range of 6.8 and 7.1 were recorded for CAS2, CAS4 and TLON1 during the reporting period. These measurements were within historical ranges and did not exceed SWMP trigger levels.

EC levels recorded at CAS2, CAS4 and TLON1 ranged from 4,240 – 13,170 µS/cm and results did not exceed the respective SWMP trigger levels.

7.2.9 Rejects Emplacement Area

Water Levels

Graph E-18 in **Appendix E** shows water level measurements in REA monitoring bores, RDH508, RDH509, RDH510 and RDH511.

Levels measured in bores RDH 508, RDH509 and RDH511 were generally consistent with previous years, while depth to groundwater increased slightly in bore RDH510 during the reporting period.

Water Quality

Graph E-19 and E-20 in **Appendix E** show water quality measurements in REA monitoring bores, RDH508, RDH509, RDH510 and RDH511.

pH measurements between the range of 7.1 and 8.0 were recorded for the four REA bores in 2018. All REA monitoring bores remained within the respective SWMP trigger levels for pH, with the exception of bore RDH511. RDH511 recorded relatively high pH values in 2018 of 8.04 (April) and 7.99 (October) which exceed the SWMP trigger value of 7.4.

EC levels recorded at REA bores RDH508 and RDH511 remained relatively stable during 2018, with exceedances of SWMP EC trigger values at bores RDH509 and RDH510. The groundwater sample for RDH509 October 2018 was 5,910µS/cm, exceeding the SWMP trigger level of 5,874µS/cm. The EC levels recorded in bore RDH510 were 9,200 µS/cm (April 2018) and 8,950 µS/cm (October 2018). These values exceeded the SWMP trigger level of 8,744 µS/cm.

7.2.10 Landowner Bores

Water Levels

Graph E-21 in **Appendix E** shows water levels at Landowner monitoring bores, GW038582, Belgrave, CAS2 and RDH76.

Groundwater level at Belgrave was measured once in April 2018. The October 2018 measurement could not be taken due to the site being inaccessible. The recorded groundwater level in April decreased by 0.5 m compared to those recorded in 2017, but did not exceed the SWMP trigger level.

The groundwater levels measured within GWO38582 during April and October 2018 were 6.63 m and 7.4 m respectively, exceeding the SWMP trigger level of 5 m.

Monitoring results for CAS2 during the reporting period have previously been discussed in **Section 7.2.8**

Water Quality

Graph E-22 and E-23 in **Appendix E** shows water quality at landowner monitoring bores GW038582, Belgrave, CAS2 and RDH76.

pH measurements between the range of 7.4 and 8.0 were recorded for Belgrave, RDH76 and GW038582. These measurements were within historical ranges and did not exceed SWMP trigger levels.

Belgrave has recorded a gradual decline in EC from 12,500 µS/cm in 2007 to 8,250 µS/cm during the reporting period, which did not exceed the SWMP trigger levels.

Bore RDH76 recorded a slight decline in EC during 2018, to 5,600 µS/cm, which is consistent with the historic trend in EC results at the site.

In 2018, GW038582 continued to show fluctuations in measured EC levels, a trend which has continued since 2009. However, the EC measurement of 6,310 µS/cm recorded in October 2018 did not exceed the SWMP trigger levels.

Monitoring results for CAS2 during the reporting period have previously been discussed in **Section 7.2.8**.

7.2.11 Annual Groundwater Assessment

Condition 4.1(b) of DA 231-07-2000 requires the proponent to conduct an annual assessment of the accuracy of the groundwater model predictions contained in the Dartbrook EIS. The assessment involves comparing the results of actual monitoring with predictions under the model. In 2018, this assessment was carried out by Australasian Groundwater and Environmental Consultants Pty Ltd (AGE).

In regards to the comparison of water levels against the predictions made in the EIS, AGE came to the following conclusions:

- Monitoring results for the alluvium monitoring bores confirmed the statement in the Dartbrook EIS that "*existing bores and wells in the alluvial lands will remain unaffected by depressurisation within the coal measures"* (MER, 2000).
- Variances in groundwater levels are largely attributed to below average rainfall from mid-2001 to mid-2007. This is confirmed by a rise in groundwater levels as a result of above average rainfall from mid-2007 to mid-2009, 2010 to 2012 and a general decline in groundwater levels in 2018 which is comparative to a decline in annual rainfall;
- Monitoring bores in the regolith to the south-east of the completed longwall panels have shown a decline in groundwater levels in response to mining between 2004 and 2006. Monitoring data suggests these bores showed a rapid recovery to pre-mining conditions following the commencement of Care and Maintenance. Current trends in groundwater continue to generally correspond with rainfall patterns and are consistent with the predictions made in the EIS and MER (2000);
- Monitoring bores in the regolith directly overlying the Kayuga longwall panels have shown a decline in groundwater levels in response to mining between 2004 and 2006. Unlike the bores to the south-east of the longwall panels, water levels have not recovered in the overburden directly above the Kayuga longwall panels. These groundwater levels

have stabilised in bores CAS4 and TLON1 but at a lower level than pre-mining conditions;

- These trends are likely to be associated with mine subsidence and surface cracking. The level of decline is well within the predictions in MER (2000). The water level at CAS2 has continued to decline following the cessation of mining. This is likely to be related to the position of the bore between the Kayuga Seam and Wynn Seam longwall panels and the predicted connective cracking that occurred as a result of mining; and
- Groundwater levels in the coal seams have declined due to mining related depressurisation. However, the magnitude of the decline had been less than the predictions in the Dartbrook EIS. This is due to the mining being suspended in 2006 rather than progressing for the 20-year period that was modelled by MER (2000). Since the cessation of mining, groundwater levels in the coal seam monitoring bores have recovered to varying degrees. However, by the end of 2018, groundwater level recovery within these bores has stabilised to a level which corresponds with the water level in the flooded Wynn Seam goaf.

In regards to water quality, AGE noted that:

- Overall, groundwater quality trends were within the historical ranges and are remaining generally consistent over time. The exceptions to this as noted by AGE are for bores RDH510, CAD2, Athlone, GWO038412 and FRA1, which showed an upward trend in EC values in 2018; and
- Exceedances of the SWMP trigger values recorded during 2018 should be investigated to determine the cause of these elevated results.

7.2.12 Next Reporting Period

It is noted that there has been no underground mining activity at Dartbrook Mine during the reporting period and that drought conditions have prevailed in the region throughout 2018. It is also recognised that the SWMP will require review following the determination of MOD7. At this time, an investigation of groundwater monitoring at the site will occur to confirm the appropriateness of the SWMP trigger levels.

7.3 SURFACE WATER

7.3.1 Environmental Management

Dartbrook Mine's SWMP includes strategies for the mitigation of impacts to surface water and groundwater resources during the Care and Maintenance period. Multiple control strategies have been implemented across Dartbrook to minimise the risks associated with water pollution. These strategies include:

- Separation of clean and mine water sources;
- Use of sedimentation dams and traps to collect sediment;
- Diversion of clean water around the site;

- Containment of runoff from disturbed areas;
- Usage and re-use of potentially contaminated runoff and process water from the mine;
- Pumping and pipeline systems to transfer water between the surface and underground and also between the East and West Sites;
- Maximise water evaporation through the Evaporation Ponds;
- Employee and contractor awareness and training in relation to spill response and pollution control;
- Licensed discharge facilities to discharge excess water from the SDD into the Hunter River in accordance with the requirements of the HRSTS; and
- Regular sampling and inspections of surface waters.

Surface water samples are collected and analysed on a regular basis from storage dams and streams in and around the mining authorities to examine water quality. Specifically, samples are collected from an upstream and downstream site in the Hunter River and the Dart Brook. This sampling regime is used to confirm that Dartbrook Mine is not having an adverse impact on the surrounding surface water catchment and streams.

The water analyses include measurement of pH, EC, Alkalinity, Calcium, Chloride, Magnesium, Potassium, Sodium, Sulphates, Total Dissolved Solids (TDS) and Total Suspended Solids (TSS). Selected mine water dams are also tested for reactive phosphorus, Methylene Blue Active Substances (foaming agents), oil and grease, and algae.

The surface water monitoring sites at Dartbrook Mine are illustrated in **Figure 13**.

All runoff from the West Site workshop and hardstand area eventually flows through the oil separator and into the WHD. Water from the WHD can be pumped to the SDD or to the EHD, as required, to ensure that the WHD is maintained at <50 - 70 % capacity.

All runoff from the East Site CHPP and disturbed surrounds eventually flows into the EHD. Water from the EHD is pumped onto the coal stockpile areas for evaporation, to the Wynn Seam Goaf or to the WHD, as required, to ensure the EHD is maintained at approximately 50% capacity.

The general levels of the major dams are inspected weekly and the water level of the SDD, WHD and EHD are continuously monitored via the Dartbrook Mine CITECT system. The SDD is also registered under the *Dams Safety Act 1978* and as such, is subject to regular inspections. Inspections during the reporting period did not identify any non-compliances.

A five-yearly review of the SDD was carried out in 2016, as required by the DSC. Both the latest Surveillance Report and the Environmental Management Plan were submitted to the DSC in 2016 and made available to DPE.

In accordance with Schedule 2, Condition 9.2 (a)(xii), the five-yearly Dam Safety Committee Surveillance Report will be appended to relevant future Annual Review reports.

As a result of CCC discussions in 2017, an additional eight monitoring locations were established in consultation with DoI-Water to provide further information on regional water quality and aquatic ecology in the vicinity of Dartbrook Mine. This program involved installation of an additional eight surface water monitoring sites (shown in **Figure 13**) both upstream and downstream of the site in the Hunter River and the Dart Brook.

7.3.2 Environmental Performance

The water quality results in **Appendix F** show that most of the on-site dams and storages recorded EC and TDS levels (and the associated anions and cations) that exceeded the relevant trigger levels in the SWMP. An investigation of these exceedances in accordance with the SWMP contingency measures found that the water quality recorded during 2018 generally reflects the water quality of the dewatered groundwater or of surface runoff that has concentrated due to evaporation and low surface runoff. Given the very dry conditions in 2018, there was very little surface runoff to dilute the water stored in these dams. These storages were operated to maximise the evaporation potential whilst maintaining a 50% to 70% freeboard to prevent spills in accordance with the SWMP.

As noted in **Section 7.1**, Dartbrook Mine did not discharge under the HRSTS during the reporting period. As a result, no monitoring at the discharge point was undertaken. All relevant monitors continue to be calibrated annually as required by the HRSTS to maintain compliance with Dartbrook Mine's EPL requirements.

A summary of results from the additional surface water and aquatic ecology monitoring sites (see **Section 7.3.1**) will be included in the next Annual Review.

Table 26 presents a summary of the water quality results for the Hunter River and Dart Brook for the reporting period.

Graph F1 and F3 in **Appendix F** shows that surface water monitoring results for EC, TDS (and their associated anions and cations) in the Hunter River were generally similar at both upstream and downstream sites and within historical levels. The pH levels recorded at the Hunter Upstream site were lower than historical levels throughout the period particularly in March 2018 at pH 6.3. The pH levels at the Hunter Downstream site were similar to historical levels for all measurements. There is no apparent reason for the low recording at the upstream site, given there would have been no surface runoff between the two stations at the time of the recording. It is expected that the March 2018 reading may be a recording error.

For the Dart Brook, all upstream and two downstream recordings of EC and TDS (and their associated anions and cations) exceeded the SWMP trigger levels. It is likely that the upstream recordings taken in 2018 occurred when there was very low to no flow in the Dart Brook. The downstream monitoring site is located within the vicinity of the Hunter River confluence, meaning that this site's recordings can be influenced by backflow from the Hunter River, hence the lower EC and TDS results than upstream. All of the corresponding recorded concentrations of EC and TDS were lower at the Dart Brook downstream location.

The pH levels for the Dart Brook upstream monitoring location were slightly higher than the downstream readings, but both stations recorded values consistent with historical levels.

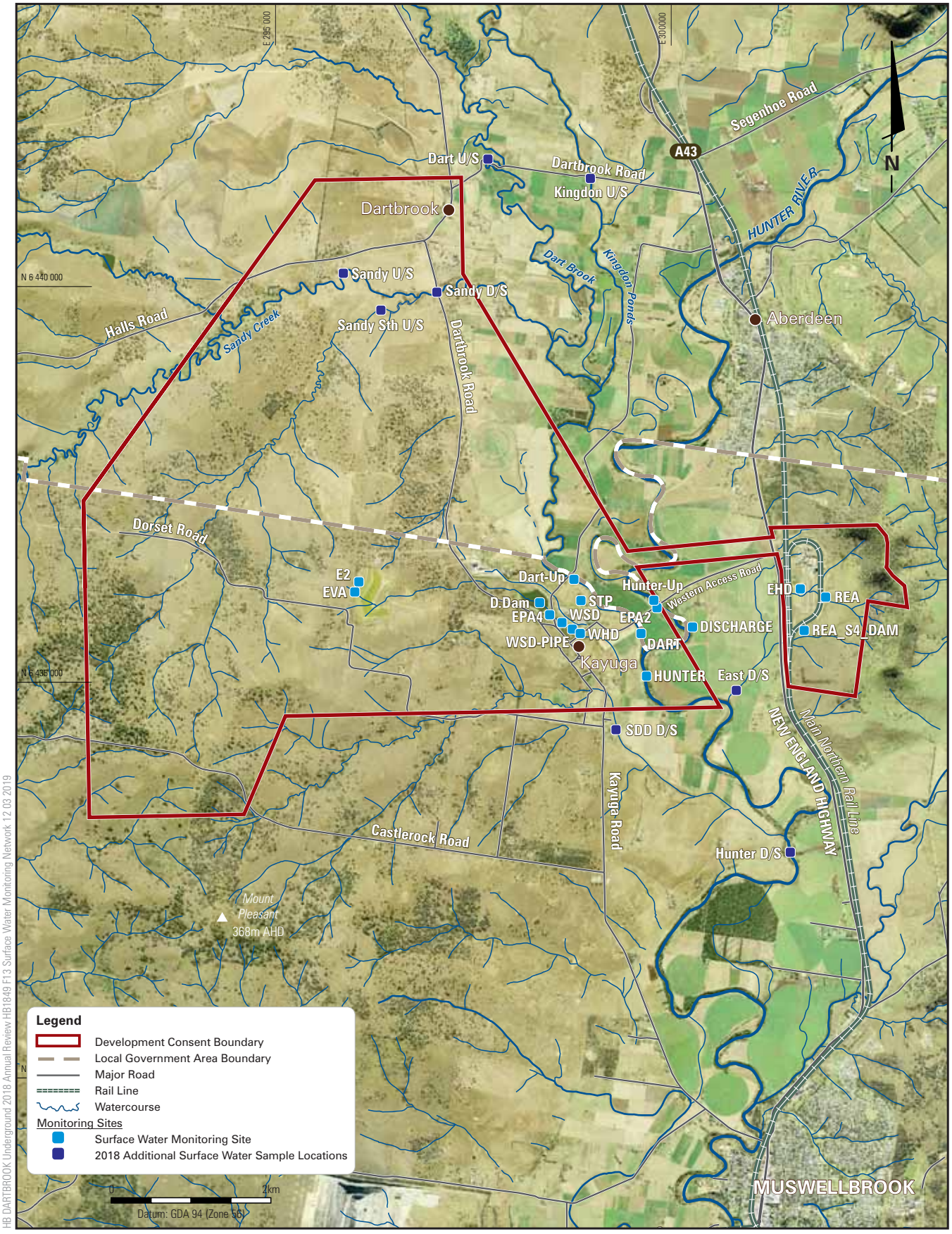
7.3.3 Next Reporting Period

It is noted that there has been no underground mining activity at Dartbrook Mine during the reporting period and that drought conditions have prevailed in the region throughout 2018. It is also recognised that the SWMP will require review following the determination of MOD7. At this time, an investigation of surface water monitoring at the site will occur to confirm the appropriateness of the SWMP trigger levels.

The HRSTS discharge system will remain in readiness so that discharges can be undertaken as required.

Table 26
Summary of Water Quality Results for the Hunter River and Dart Brook

Site	EC Range (µS/cm)	TDS Range (mg/L)	pH Range
Hunter River Upstream	291 - 475	200 - 320	6.3 - 8.6
Hunter River Downstream	293 - 389	200 - 260	7.9 - 8.7
Dart Brook Upstream	4,710 - 5,770	3,160 - 3,870	8.2 - 8.5
Dart Brook Downstream	2,360 - 3,110	270 - 2,150	7.9 - 8.2



HB DARTBROOK Underground 2018 Annual Review HB1849 F13 Surface Water Monitoring Network 12 03 2019

DARTBROOK MINE

Surface Water Monitoring Network

FIGURE 13

Hansen Bailey
ENVIRONMENTAL CONSULTANTS

Australian Pacific Coal

7.4 EROSION & SEDIMENT

7.4.1 Environmental Management

Erosion and sediment control across the site remains a priority, despite the relatively small amount of surface disturbance. Strategies to prevent erosion and control sediment include:

- The installation of diversion drains and contour banks to redirect overland flow from disturbed areas into dams and sediment structures;
- The use and maintenance of silt traps to slow water flow and capture water borne sediments;
- Design of rehabilitation areas to reduce slope length and minimise the potential for erosion;
- The re-establishment of vegetation on disturbed areas to minimise exposure of bare ground with erosion risk; and
- Monitoring and inspection of rehabilitation areas and disturbed areas to identify risks of erosion.

Erosion and sediment controls are managed as described in Dartbrook Mine's Erosion and Sediment Control Plan.

7.4.2 Environmental Performance

Dartbrook Mine continues to undertake maintenance on drains, sediment traps and sumps, as identified during routine inspections undertaken in 2018.

Any drains, sumps or traps that contain greater than 30% sediment are generally required to be cleaned out to prevent and minimise unnecessary risks associated with water storage onsite.

Contour banks, drains and sediment traps were constructed as part of the final landform of the REA to ensure that runoff is directed into appropriate sediment and water control structures.

During 2018, only minor repairs were made to key contour drains to ensure the effective flow of runoff waters, while rehabilitation continues to gradually build up surface vegetation and litter. The pipe drainage system servicing the REA continued to function satisfactorily during 2018, with only minor maintenance required.

7.4.3 Next Reporting Period

Sediment structures will continue to be maintained during 2019, and inspections carried out in accordance with an ongoing monitoring and desilting program. Water runoff from any disturbed areas will continue to be directed into sediment dams until areas are adequately revegetated with grass cover.

8 REHABILITATION

This section provides a summary of the rehabilitation activities and performance at Dartbrook Mine during the reporting period.

8.1 BUILDINGS

Under the Care and Maintenance program, no mine related buildings at the West or East Sites were constructed or rehabilitated in the reporting period.

8.2 REHABILITATION OF DISTURBED LAND

The rehabilitation that has been completed to date is outlined in **Table 27**. No additional rehabilitation was undertaken during the reporting period. The rehabilitation maintenance activities undertaken during the reporting period are outlined in **Table 28**.

The REA was covered, topsoiled and seeded in 2007. The REA continued to be maintained during the reporting period. Since establishment, the REA rehabilitation area has developed land capability characteristics similar to open grassland, suitable for cattle grazing.

During the reporting period, no surface rehabilitation works were required above previously mined longwalls and no subsidence issues were identified (see **Section 6.12**).

8.2.1 Topsoil Audit

As noted in **Section 5**, DRG requested a topsoil audit be completed in 2018 and described in this Annual Review. The aim of the audit was to confirm the amount of topsoil stockpiled on site and review these volumes against the predicted requirements for the future rehabilitation of any remaining Dartbrook infrastructure.

Topsoil Volumes

Approximately 14,780 tonnes of topsoil (see **Table 8**) is stored at two locations on site, which equates to approximately 5,620 m3 of material.

The disturbed areas on site which were identified for rehabilitation in the Care and Maintenance MOP cover an area of approximately 74.7 ha. Based on this area, and an assumption of minimum topsoil cover depth of 100 mm, approximately 74,700 m3 of topsoil would be required to fully top dress the site. Assuming the above, there is currently a deficit of approximately 69,080 m3 of topsoil required for the rehabilitation of Dartbrook.

Alternate options for top dressing parts of the mine site will be explored as part of the preparation of the Dartbrook Mine Closure Plan.

Topsoil Health & Suitability

A review of the topsoil stockpiles on site has found that they are composed of A-horizon soil stripped from areas of site disturbed from between 15 to 25 years ago. The health and suitability of the stockpiled material was assessed by the excavation of six test pits (three within each stockpile) and the analysis at depths of up to 200 cm for the following parameters:

- pH;
- Electrical conductivity (EC);
- ECe;
- Emerson Aggregate Test;
- Texture;
- Exchangeable Calcium (Ca) (meq/100g);
- Exchangeable Magnesium (Mg) (meq/100g);
- Exchangeable Potassium (K) meq/100g;
- Exchangeable sodium (Na) meq/100g;
- Exchangeable sodium (%);
- Cation Exchange capacity (ECE) (meq/100g);
- Colwell K mg/kg;
- Nitrate -N mg/kg;
- Total N mg/kg; and
- Phosphorous (Bray method).

The assessment of material excavated from the test pits found that the topsoil stockpiled on site was generally suitable to support the development of rehabilitated pasture. It was recommended that additional fertiliser, gypsum or organic solids should be incorporated with the topsoil prior to spreading and seeding. These treatments were recommended to further increase the suitability of the topsoil for use in site rehabilitation.

A copy of the topsoil assessment report is included as **Appendix H**.

8.3 OTHER INFRASTRUCTURE

No structural exploration work was undertaken in 2018. AQC completed the program to seal and rehabilitate the available open exploration boreholes on site during the reporting period as described in **Section 4.1**.

8.4 REHABILITATION TRIALS AND RESEARCH

8.4.1 River Restoration Project

The River Restoration Project was undertaken in conjunction with the HCRCMA from 2005 to 2010. Two Fish-Hotels and about 20 log jams remained in place over a 6.5km stretch of the Hunter River that interfaces with Dartbrook Mine owned land. These structures create pool and riffle sequences as well as assisting in bank stabilisation.

Monitoring and maintenance activities of the River Restoration Project area continued during the reporting period. The main maintenance activities included:

- Maintenance of native trees planted along the banks of the Russell Island Channel and Hunter River upstream of the bridge (northern site); and
- Weed spraying within the River Restoration Project areas.

Monitoring and maintenance of the River Restoration Project area will continue in the next reporting period.

8.4.2 Riparian Vegetation Management

Approximately 5,000 tree seedlings have been planted to date in riparian zones within the Dartbrook Mine mining authorities. The seedling stock was comprised mostly of River Red Gum but also river oak, yellow and white box, and apple.

The trees have since established themselves to the point where "crash grazing" by cattle can be undertaken in riparian areas without damaging the trees. "Crash grazing" is undertaken on an ad hoc basis to prevent weeds seeding, which allows native and naturalised grasses to dominate. Limited grazing was undertaken in these areas in 2018, however this method has proven to be an effective land management tool available to reduce the presence of noxious weeds onsite.

8.4.3 River Red Gum Restoration

An experimental study was established in 2007 by the Hunter Central Rivers Catchment Management Authority (HCRCMA) and Dartbrook Mine on a remnant patch of River Red Gum woodland present on the floodplain of the Hunter River.

The purpose of this project is to enhance and protect a population of River Red Gums (listed as being endangered in the Hunter Valley). The project area is remote from any mine related infrastructure, has been fenced to exclude stock, and contains over 2,500 River Red Gums that have been planted amongst the mature population. The River Red Gums that had naturally regenerated as a result of artificial flooding in 2007 continue to thrive within the constructed bunds.

Cumberland Ecology completed follow-up monitoring of the River Red Gum Restoration area in November 2018. An assessment of adult tree health and seedling health found that the slight improving trend in overall health of mature trees since the baseline surveys in 2007 has continued. The overall good health of seedlings is considered to be a positive sign for the recovery and re-establishment of this remnant population.

Weed management and general maintenance actions for the River Red Gum Restoration area that were identified in the 2018 monitoring program will be implemented in the next reporting period.

Table 27
Rehabilitation Status

Mine Area Type	Area Affected/ Rehabilitated (ha)		
	Prev Reporting Period (End 2017)	This Reporting Period (End 2018)	Next Reporting Period (End 2019)
A: MINE LEASE AREA			
A1 Mine Lease(s) Area CL386, ML1381, ML1497, ML1456	3,258	3,258	3,258
B: DISTURBED AREAS			
B1 Infrastructure area (other disturbed areas to be rehabilitated at closure including facilities, roads)	117	117	117
B2 Active Mining Area (excluding items B3 - B5 below)	-	-	-
B3 Waste emplacements (active/unshaped/in or out-of-pit)	0	0	0
B4 Tailings emplacements (active/unshaped/uncapped)	0	1	0
B5 Shaped waste emplacement (awaits final vegetation)	Nil	Nil	Nil
ALL DISTURBED AREAS	118	118	118
C: REHABILITATION PROGRESS			
Overburden Dump	3.7	3.7	3.7
Wattus Ponds	14.7	14.7	14.7
Rejects Emplacement Area	29.2	29.2	29.2
Infrastructure Area	4	4	4
C1 Total Rehabilitated area (except for maintenance)	51.6	51.6	51.6
D: REHABILITATION ON SLOPES			
D1 10 to 18 degrees	32.9	32.9	32.9
D2 Greater than 18 degrees	-	-	-
E: SURFACE OF REHABILITATED LAND			
E1 Pasture and grasses	51.6	51.6	51.6
E2 Native forest/ecosystems	-	-	-
E3 Plantations and crops	-	-	-
E4 Other (includes non-vegetative outcomes)	-	-	-

Table 28
Maintenance Activities on Rehabilitated Land

Nature of Treatment	Area Treated (ha)		Comment / control strategies / treatment detail
	Report period (2018)	Next period (2019)	
Additional erosion control works (drains re-contouring, rock protection)	<1-20		Maintenance works may be required if settlement has occurred.
Re-covering (detail - further topsoil, subsoil sealing etc.)	0		No re-covering of the REA erosion control contour banks was required during the reporting period.
Soil treatment (detail - fertiliser, lime, gypsum etc.)	0		No additional gypsum and fertilizer to the REA erosion control contour banks during the reporting period.
Treatment/management (detail - grazing, cropping, slashing etc.)	0		Continued controlled grazing of Wattus Ponds area. Some areas of the REA rehabilitation were treated for the management of weeds. Grazing recommenced on the REA in late 2017 and ceased mid-2018.
Re-seeding/replanting (detail - species density, season etc.)	<1		No maintenance of disturbed REA erosion control contour banks areas was required during the reporting period.
Adversely affected by weeds (detail - type and treatment)	~20		The following weeds were controlled by spraying or slashing during reporting period: African Boxthorn, Liverseed Grass, Prickly Pear and Green Cestrum. The weed control program will continue in the next reporting period.
Feral animal control (detail - fencing, trapping, baiting etc.)	10		Pig trapping and dog / fox poisoning was conducted in conjunction with the LLS where appropriate. Kangaroo culling was undertaken (with the approval of the National Parks and Wildlife Service) in 2018 and will continue in the next reporting period.

8.4.4 Forestry Plantation

In 2003, Dartbrook Mine commenced the establishment of a 75ha forestry plantation in conjunction with Forests NSW. The plantation was located on undulating grazing land north of the CHPP, and south of the town of Aberdeen. Approximately 75,000 seedlings, comprised mainly of Spotted Gum (*Corymbia maculata*) were planted in 2004 and 2005.

The plantation was part of a regional plan to create a sustainable forestry resource on land that was previously grazed

To date, the project has also been successful at achieving the additional objectives of establishing a biodiversity corridor, providing fauna habitat and stabilising the soil however, long term trends cannot be determined at this point.

Monitoring of the plantation will continue to be undertaken in 2019.

8.4.5 Sustainable Cattle Grazing Trial

Dartbrook Mine commenced a grazing trial in 2015 to demonstrate that rehabilitated land, in this case the REA, could sustain grazing by livestock, be productive and blend with the adjacent land uses. This trial proved to be successful as evidenced by the weight gains observed in the cattle and results have been previously provided in 2015, 2016 and 2017 Annual Review.

Grazing of the REA was discontinued in 2018 due to the ongoing dry conditions. AQC will review opportunities to recommence grazing in this area once pasture conditions improve.

8.5 NEXT REPORTING PERIOD

Dartbrook Mine will continue to undertake rehabilitation maintenance activities as required. Additional maintenance activities may include weed control, feral animal control and drainage works.

Dartbrook Mine will also continue regular inspections of the areas associated with the River Restoration Project, River Red Gum Restoration Project and Forestry Plantation.

9 COMMUNITY RELATIONS

9.1 ENVIRONMENTAL COMPLAINTS

9.1.1 Protocol

AQC operates Dartbrook Mine under a Complaints Handling Protocol, which details the process for receiving and responding to complaints. The process involves:

1. Recording details of the complaint (including date, time, method of complaint, nature and other general details);
2. Seeking immediate identification and addressing the cause of the complaint (where possible);
3. Telephone contact with the complainant within 24 hours (where possible); and
4. Formal follow up with a letter of response.

Complaints can be received via a dedicated complaints telephone line, 1300 131 058, general telephone number, facsimile, email, letter or in person.

All complaints received are recorded in a Complaints Register. The community complaints procedure was further updated in 2017 following the transfer of ownership to AQC. The Dartbrook Mine contact number continues to be advertised within local papers, on the AQC website and provided to CCC members during meetings.

9.1.2 Complaints

No formal complaints were received during the reporting period. Dartbrook Mine has not received any formal complaints since 2007.

9.2 COMMUNITY LIAISON

9.2.1 Dartbrook Community Consultative Committee

Since 2006, three CCC meetings per year have been held. Due to the transfer of ownership and requirement to draft a new MOP in 2017, four CCC meetings were held throughout 2017.

There were four CCC meetings held during the reporting period.

CCC members comprise of community representatives from MSC and UHSC, council staff and community representatives.

The council representatives for 2018 were Cnr Martin Rush (MSC representative) and Cnr Kiwa Fisher (UHSC representative). Paul Smith (UHSC), Scott Brooks (MSC) and Sharon Pope (MSC) were the relevant council staff representatives.

The 2018 community representatives on the CCC were Arthur Mitchell, Annette Rahn, Tony Lonergan, Jennifer Lecky and Noel Downs (also representing the Wanaruah Local Aboriginal Land Council).

Table 29 lists the dates of meetings held during 2018 and the topics discussed at each meeting. Minutes of these meetings are posted on the Dartbrook Mine website. Updates of AQC activities and general environment performance at Dartbrook Mine were also distributed to the CCC.

Table 29
Summary of Topics Discussed During CCC Meetings 2018

Date	Topics Discussed
21/03/2018	• Proposed Underground Modification (MOD7), including: o Scope and proposed timing of MOD7 Environmental Assessment o Proposed Stakeholder Engagement Strategy o Employment and economic benefits o Proposed mining and transport arrangements • Progression of Low Impact Surface Mining Studies and proposed environmental monitoring program, exploration activities
18/04/2018	• Regulatory document update including Mining Operations Plan (approved December 2017) and submission of the 2018 Annual Review • Proposed Hunter River Monitoring Program (as requested by the CCC) • Update on MOD7 Environmental Assessment process • Update on open cut project studies, scope, timeline and planned stakeholder consultation program • Update on additional environmental studies, including: o Groundwater monitoring program o Proposed development of new exploration holes and rehabilitation of historic exploration holes o Additional monitoring sites and riparian assessments proposed for the Hunter River and Dart Brook • Summary environmental monitoring results and land management activities • AQC sponsorships and donations
11/07/2018	• Update on MOD7 Environmental Assessment process • Update on open cut project studies including completion of PFS, progress of background studies • Commencement of additional Hunter River and Dart Brook Monitoring Program • Exploration drilling program • Summary environmental monitoring results • Transition of care and maintenance mine operators from UGM to Terrequip
24/10/2018	• Update on the strategic partnership between AQC and Stella Natural Resources • Background summary of SNR including experience and management structure • Update on MOD7 Environmental Assessment process • AQC sponsorships and donations

9.2.2 Community Participation

During the reporting period, AQC continued to support and sponsor community-based programs and events, including the Muswellbrook Preschool Kindergarten, Young Endeavour Scheme, Aberdeen Care Package Cadets and the Scone Neighbourhood Community Centre.

AQC continued to advertise its support and sponsorship of community-based programs and events on its website, at CCC meetings and in its quarterly newsletters.

9.2.3 Workforce Characteristics

Dartbrook Mine currently maintains a contract workforce of 18 persons residing in the following areas (also see **Figure 14**):

- Muswellbrook (6);
- Upper Hunter (1)
- Singleton (3);
- Cessnock (2);
- Newcastle and Port Stephens (2);
- Lake Macquarie (3); and
- Central Coast (1).

Where practicable, AQC will continue to utilise a locally-sourced workforce for activities on site. AQC continues to lease properties surrounding the site to a number of local families and farmers (see **Section 9.2.4**).

No significant changes to workforce characteristics are expected for the continuation of Care and Maintenance in 2019.

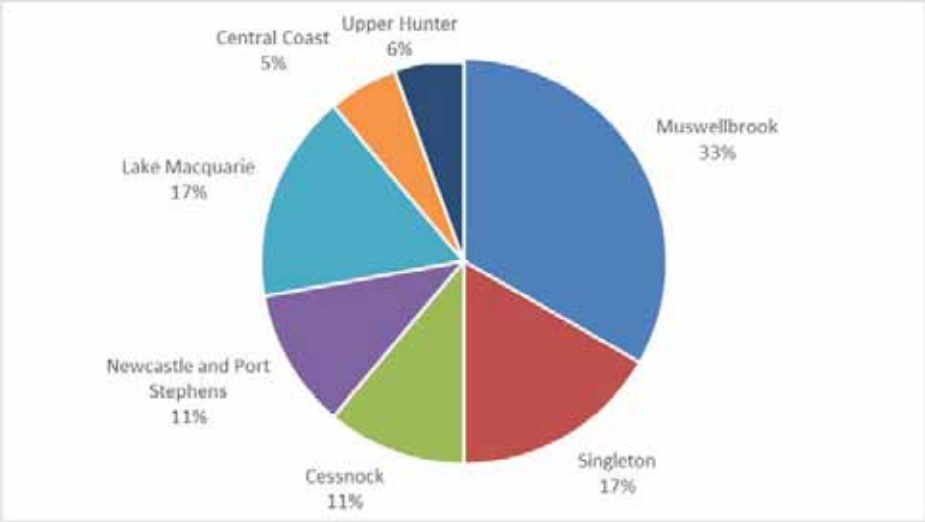


Figure 14
Breakdown of Current Workforce by Place of Residence

9.2.4 Leaseholders and Dairy Farm

AQC has seven major leaseholders and agistees that occupy the Dartbrook Mine owned land surrounding the mining authorisations. There are also 18 tenants who occupy the AQC residences.

The Garoka Dairy has been operating in the vicinity of Dartbrook Mine since 1992 and is generally located on the alluvial lands between the Dartbrook CHPP and the workshop and portal entry. The dairy currently supports 600 to 700 head of cattle.

The Garoka Dairy is an amalgamation of the four farms that were originally established to the east of the Hunter River and Dartbrook Mine's administration office, and one farm at the confluence of the Hunter River and Dart Brook.

Construction of a new 50 cow rotary platform and milking shed at Garoka Dairy was completed in mid-2018 (see **Plate 4**). The upgrade to facilities, jointly funded by AQC, allows for greater efficiency in milking, improved wellbeing of cows and better OH&S standards for dairy operators.

Plate 5
First milking at upgraded Garoka Dairy

10 INDEPENDENT ENVIRONMENTAL AUDIT

In accordance with DA 231-07-2000 conditions, the next IEA is scheduled to be undertaken in 2019. An update on the next audit will be provided in the next Annual Review.

11 ENVIRONMENTAL INCIDENTS & NON-COMPLIANCES

This section describes any environmental incidents or non-compliances that occurred during the reporting period.

11.1 ENVIRONMENTAL INCIDENTS

There were no reportable environmental incidents during the reporting period.

11.2 ENVIRONMENTAL NON-COMPLIANCES

As part of the EMS, internal and external audits are undertaken to assess compliance with regulatory requirements including the conditions of Development Consent, EPL 4885 and Dartbrook Mine mining authorities.

Dartbrook Mine did not identify any operational non-conformances in the reporting period.

12 ACTIVITIES PROPOSED IN THE NEXT REPORTING PERIOD

The activities proposed to be undertaken in 2019 are summarised in **Table 30**. Further details on the proposed activities are provided in **Section 6** and **Section 7**.

Table 30
Dartbrook Mine Environmental Management Activities Proposed for 2019

Area	Proposed Activity
Operational	• AQC will continue to consult with NSW regulatory agencies over the assessment of MOD7; and • AQC will review and update the Dartbrook EMS as required following any determination of MOD7.
Air Quality	• Dust mitigation and control activities will be employed onsite, where required; • Air Quality Monitoring will continue onsite in accordance with the DMP.
Erosion and Sediment	• Sediment structures will continue to be inspected and maintained; • Water runoff from previously disturbed areas will continue to be directed into sediment dams.
Surface Water Management	• Monitoring will continue in accordance with the SWMP; • Review of the SWMP following the determination of MOD7.
Ground Water Management	• Groundwater monitoring will continue in accordance with the frequencies and parameters listed in the SWMP; • Review of the SWMP following the determination of MOD7.
Rehabilitation	• Ongoing monitoring of rehabilitation areas on site, with maintenance work as required.
Threatened Flora and Fauna	• Fauna and flora communities will be managed in accordance with the approved Flora and Fauna Management Plan; • In circumstances where clearing is required, the Permit to Disturb system will continue to be implemented; • Maintenance of the River Restoration, River Red Gum and Forestry Plantation areas will continue in 2019.
Noxious Weeds and Feral Animals	• Weed control will continue to be conducted within the mining authorisations and the Weed Control Register will be maintained; • Feral animals will continue to be controlled as necessary.
Visual / Stray Light	• Maintenance of the tree screens will continue (as required).
Aboriginal Heritage	• The existing Permit to Disturb system will continue to be implemented prior to commencing ground disturbance activities such as exploration and rehabilitation.
European Heritage	• Ongoing maintenance of European heritage items as required, in consultation with regulatory agencies.

Area	Proposed Activity
Spontaneous Combustion	• REA thermocouple temperatures will continue to be monitored.
Bushfire	• Fuel loads across the site will continue to be monitored and reduced as required.
Mine Subsidence	• Treated areas will be re-inspected to determine if further surface subsidence remediation is required.
Hydrocarbon Management	• Appropriate storage and management of hydrocarbon storages and materials will continue; • Areas identified as contaminated will continue to be recorded on the site contamination register.
Waste Management	• Ongoing management and monitoring of waste generated on site.
Gas drainage / Ventilation	• Monitoring of gas emissions from the mine will continue.
Public Safety	• Full-time onsite caretakers will remain on site; • Fences will be maintained and gates will remain locked and secured, as required; • Roadside vegetation slashing will continue, as required.
REA	• Reintroduction of cattle grazing on Rehabilitated REA, weather conditions permitting.

APPENDIX A

Summary of Minor Amendments to Development Consent Conditions during Care and Maintenance

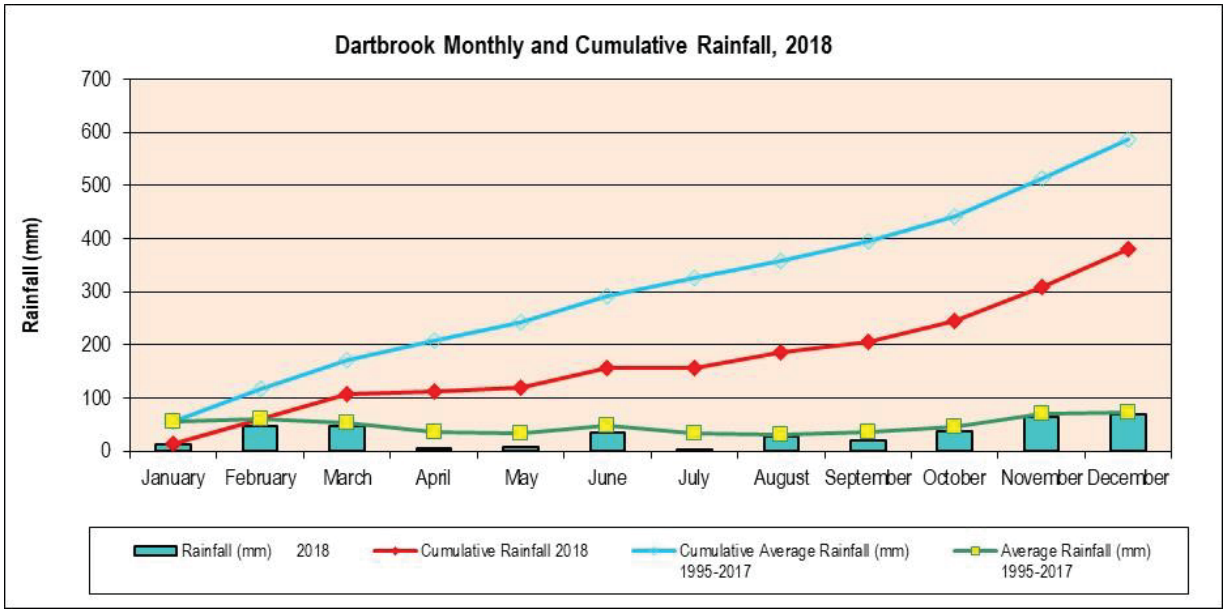
Table 1
Summary of minor amendments to Development Consent conditions during Care and Maintenance

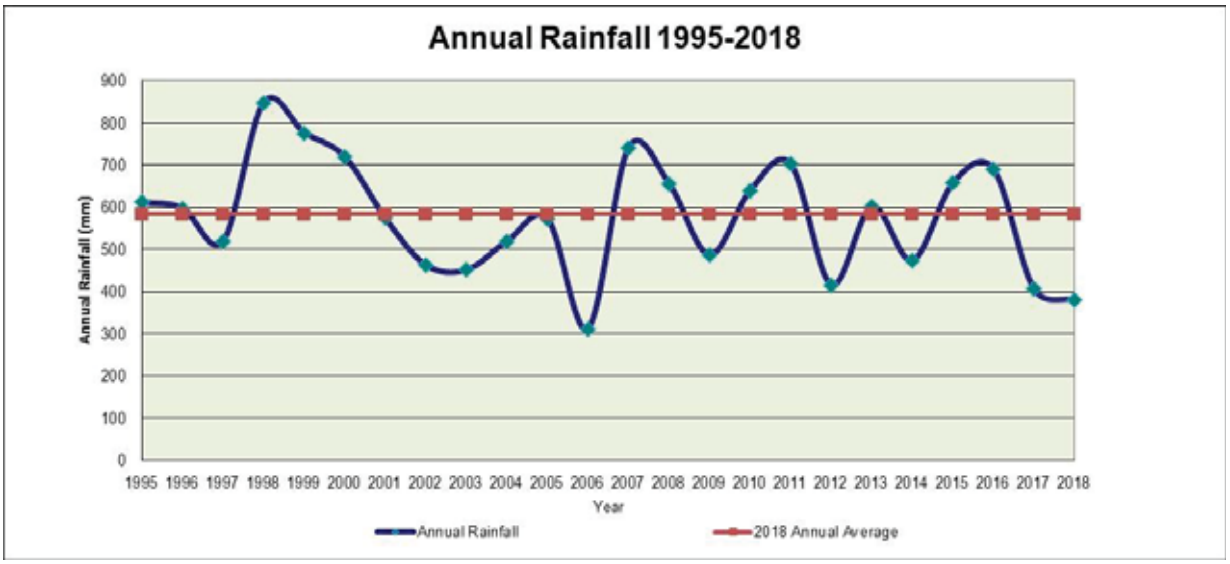
Approval Document Reference	Development Consent No. Reference	Existing Requirement	Requirement During Care & Maintenance
Complaints protocol & Environmental Management Strategy	10.2a (ii)	6 monthly complaints report to DoP (now DPE), MSC, UHSC, EPA, DPI-MR (now DRG) and Dartbrook Community Consultative Committee (DCCC).	Complaints to be included in Annual Environmental Management Report and DCCC Meetings only.
Community Consultation	10.1 (i)	The DCCC meet 6 times per year (every two months).	Three DCCC meetings per annum.
Community Consultation	10.1 (ii)1	Two company representatives required on the DCCC.	One company representative on the DCCC.
Development Consent	10.2b	Required to have two company persons available as EPA contact 24hrs day.	One person as the EPA person contact. This person will be available via a pager system.
Development Consent & Environmental Management Strategy	32.f	Review of Environmental Mgt Plans is required every 5 years (2007 due).	Continue to operate under existing Mgt plans without reviewing. Propose to modify these Mgt Plans should any activities recommence.
Development Consent	3.3 (l)	Surface subsidence monitoring is required up to 3 years following mining.	Reduce this period due to limited impacts observed on the surface from subsidence to-date.
Development Consent	8.1a	An Independent compliance audit is required every 3 years (due 2007).	Audit to occur, scope to be re-defined (e.g. cannot audit against EIS predictions etc).
Development Consent	3.2d	Preparation of the Water Mgt Plan and Soil Stripping Mgt Plan is required prior to construction of the REA.	As the REA is not being constructed and there are no further construction activities proposed, a Soil Stripping Management Plan is not necessary. The Water Management Plan will be prepared prior to Care & Maintenance.

Approval Document Reference	Development Consent No. Reference	Existing Requirement	Requirement During Care & Maintenance
Development Consent	2.1 (e)	A Mine Closure Plan is required to be prepared 2 years prior to completion of mining, in consult with DoP, DPI-MR, DNR, MSC, UHSC & approved by DoP and DPI-MR.	Decision and process to be managed through MOP.
Environmental Management Strategy & Dust Management Plan	6.1b (iii)	Required to report on a quarterly basis the results of air quality monitoring data to DoP and MSC.	Report on annual basis via the AEMR.
Lighting and Landscape Management Plan		Monitoring of tree screens is required 2 - 3 times per year.	Monitor once per year.
Waste Management Plan		A Waste audit is required to be undertaken annually.	Waste to be reported via the AEMR.
Noise Management Plan	6.4.1b	Attended noise surveys are to be undertaken on a quarterly basis.	DP&I advised that noise monitoring could be suspended as from 10/05/12.
REA Surveillance Program		Extensive monitoring requirements for the current REA (e.g. weekly thermocouples).	To be managed through the MOP process with DRG.

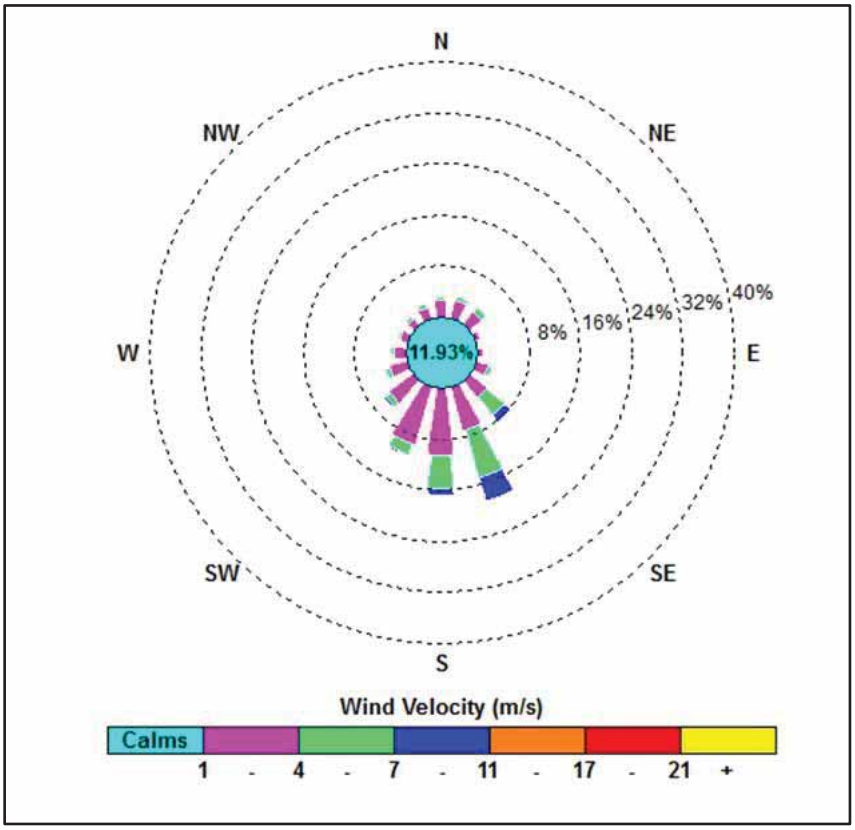
APPENDIX B

Meteorological Summary

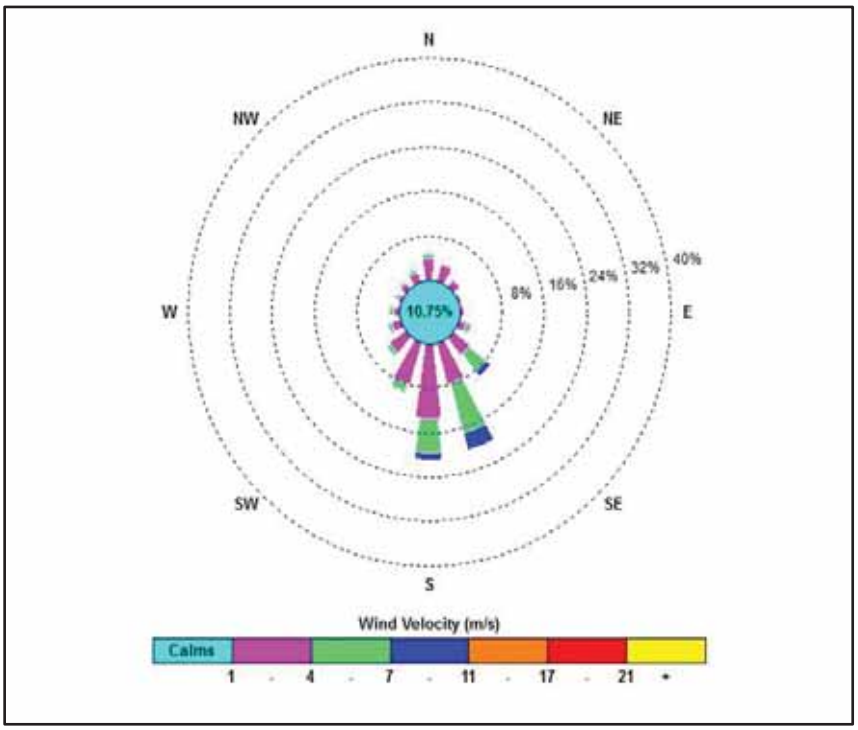

Dartbrook Monthly and Cumulative Rainfall, 2018
Rainfall (mm)
700
600
500
400
300
200
100
0
January
February
March
April
May
June
July
August
September
October
November
December
Rainfall (mm) 2018
Cumulative Rainfall 2018
Cumulative Average Rainfall (mm) 1995-2017
Average Rainfall (mm) 1995-2017


Annual Rainfall 1995-2018
Annual Rainfall (mm)
900
800
700
600
500
400
300
200
100
0
1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
Year
Annual Rainfall
2018 Annual Average

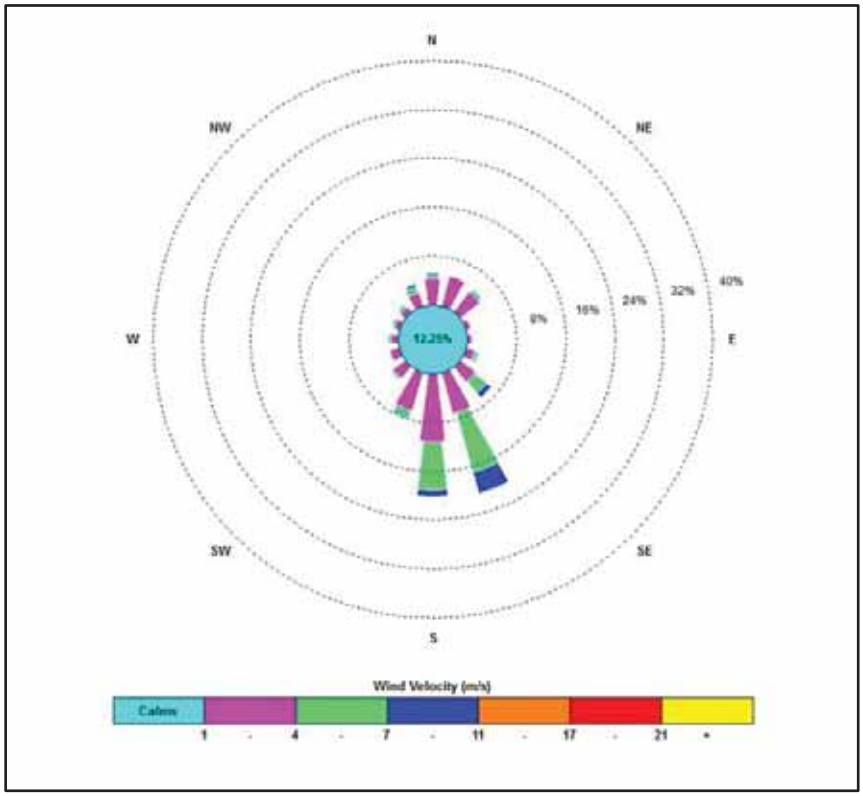
January 2018



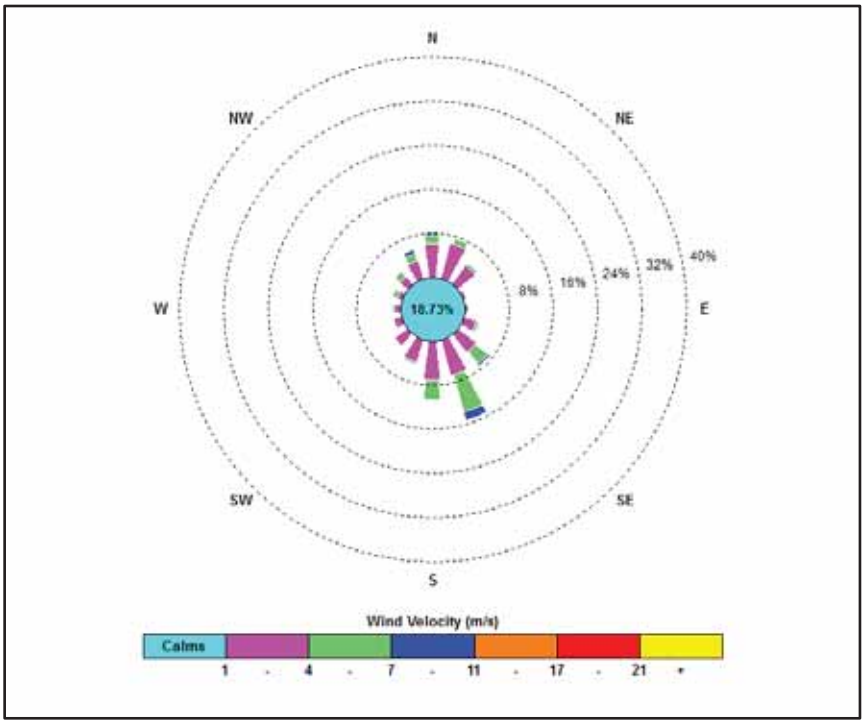
February 2018



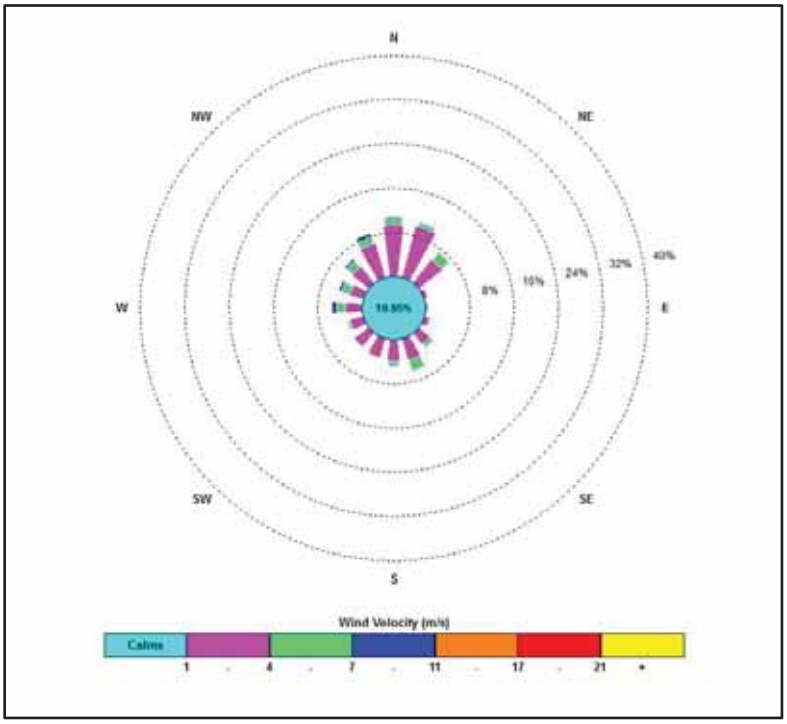
March 2018



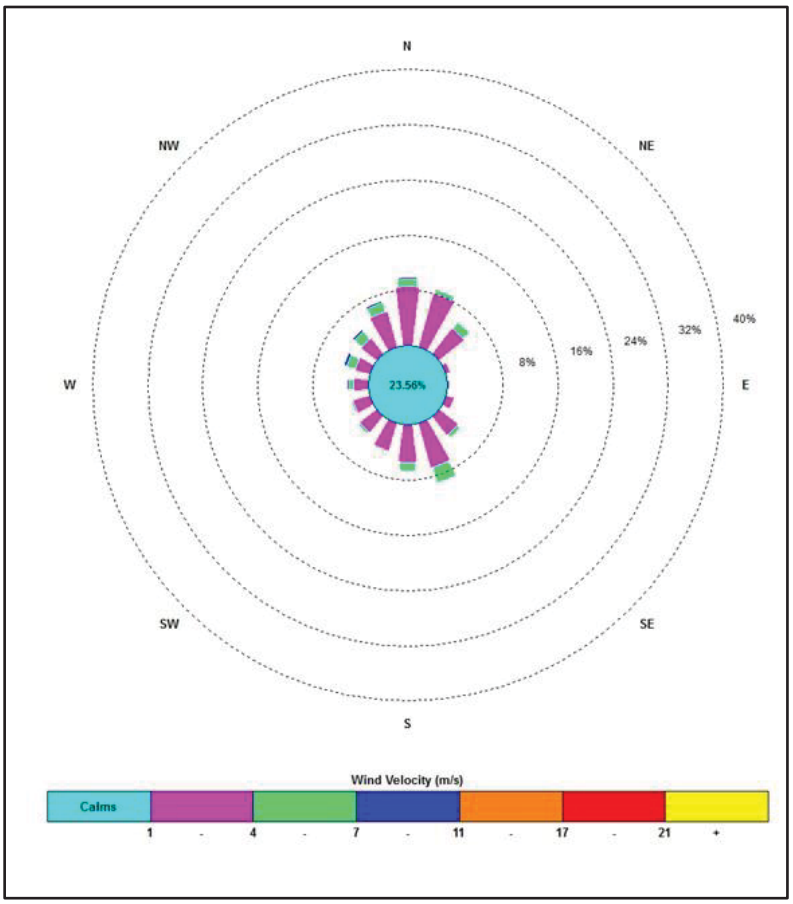
April 2018



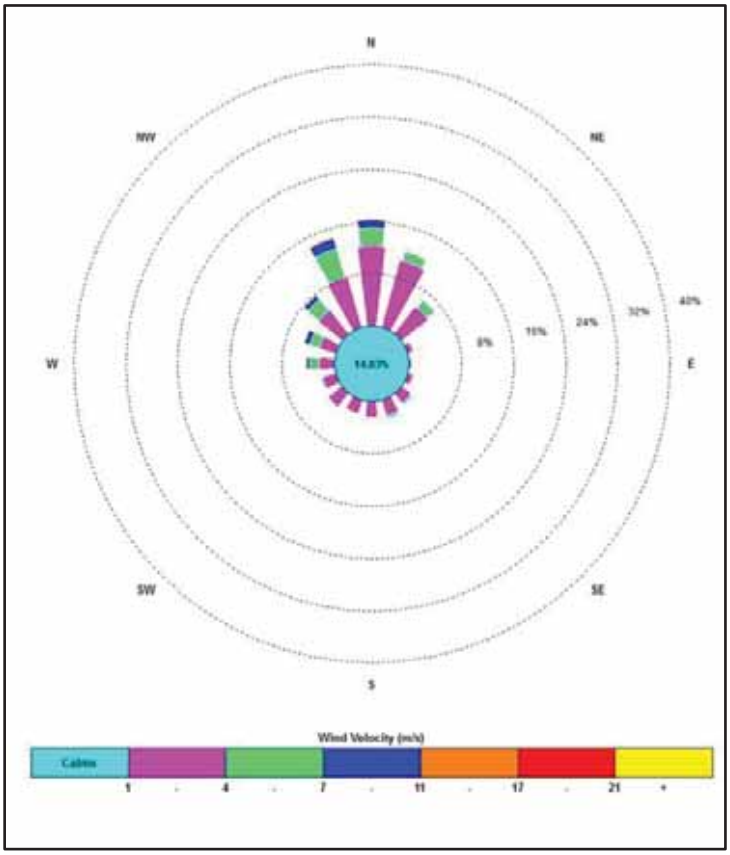
May 2018



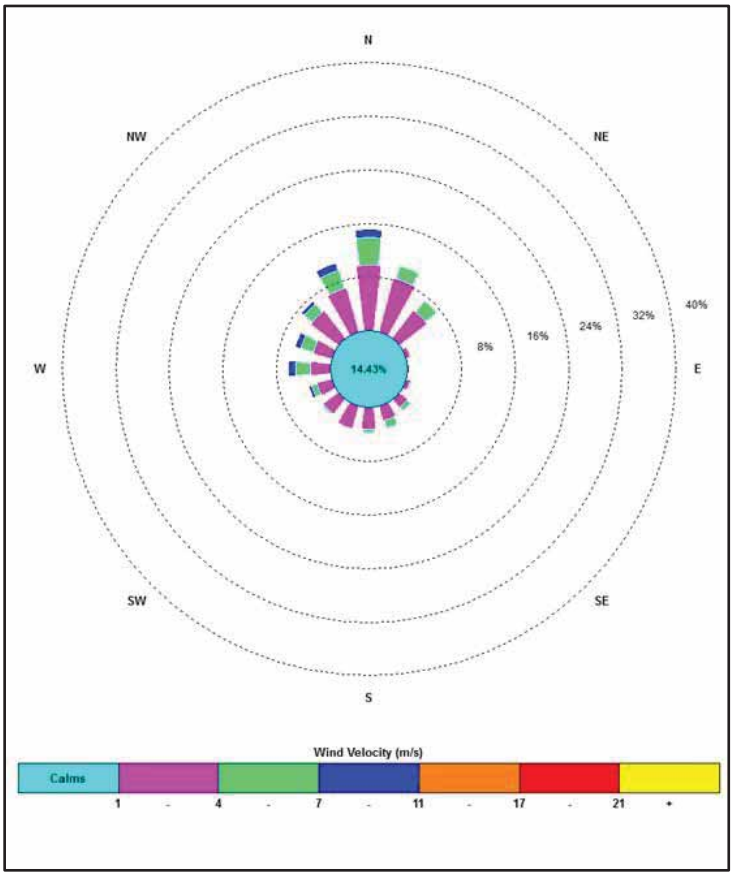
June 2018



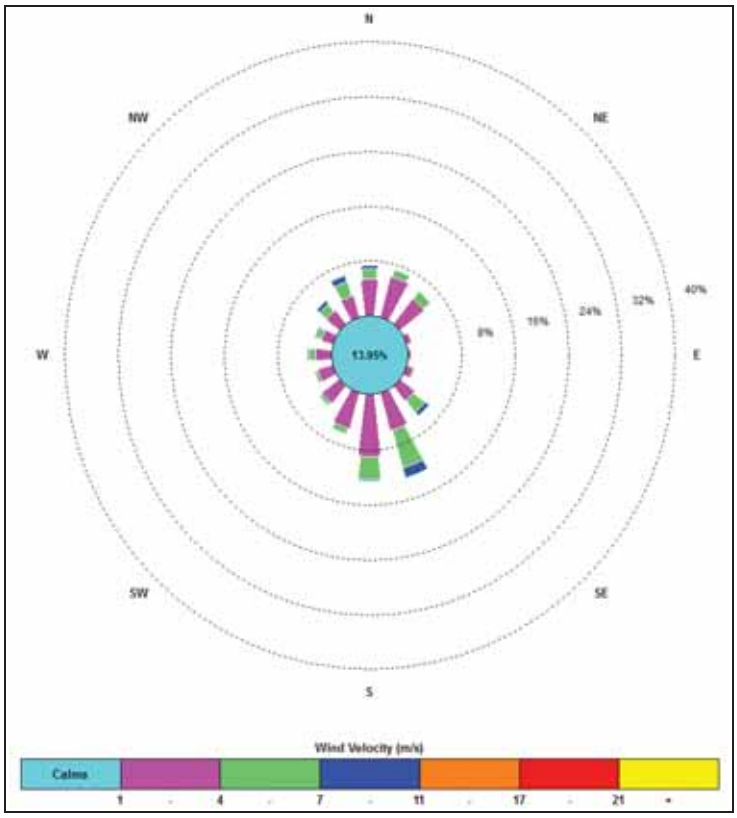
July 2018



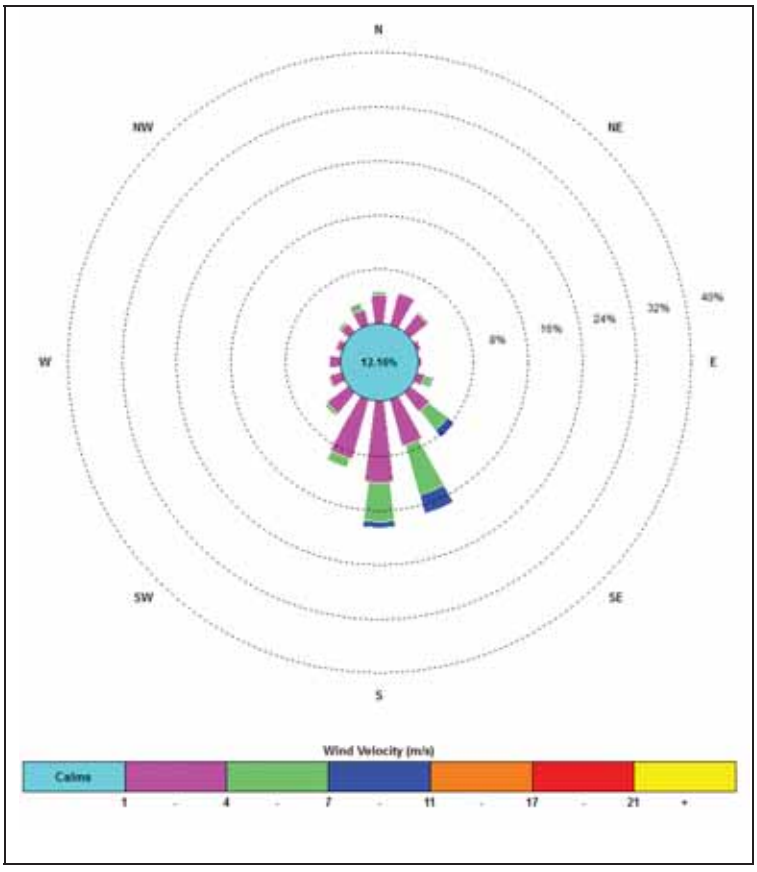
August 2018



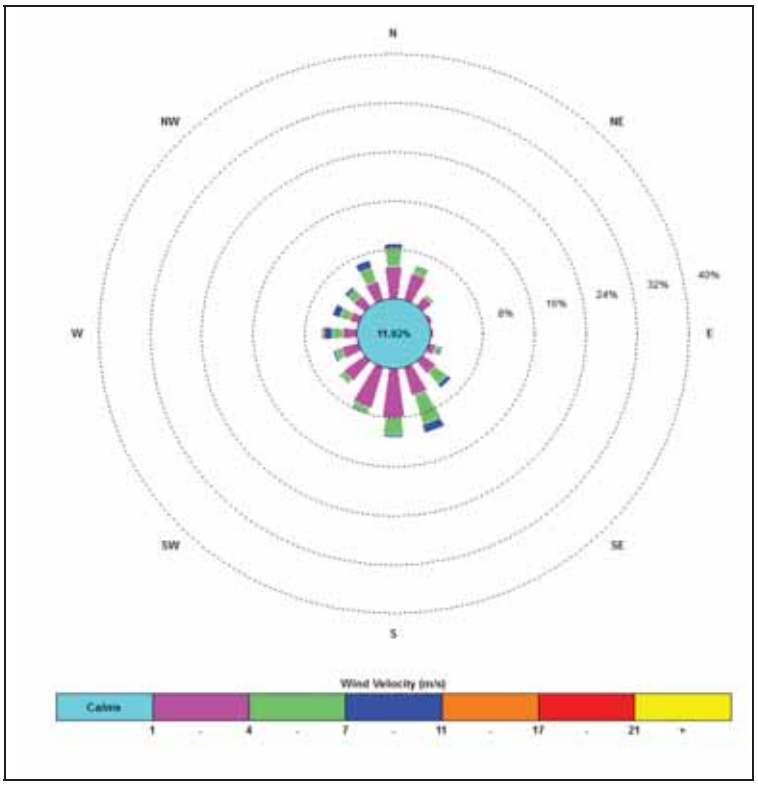
September 2018



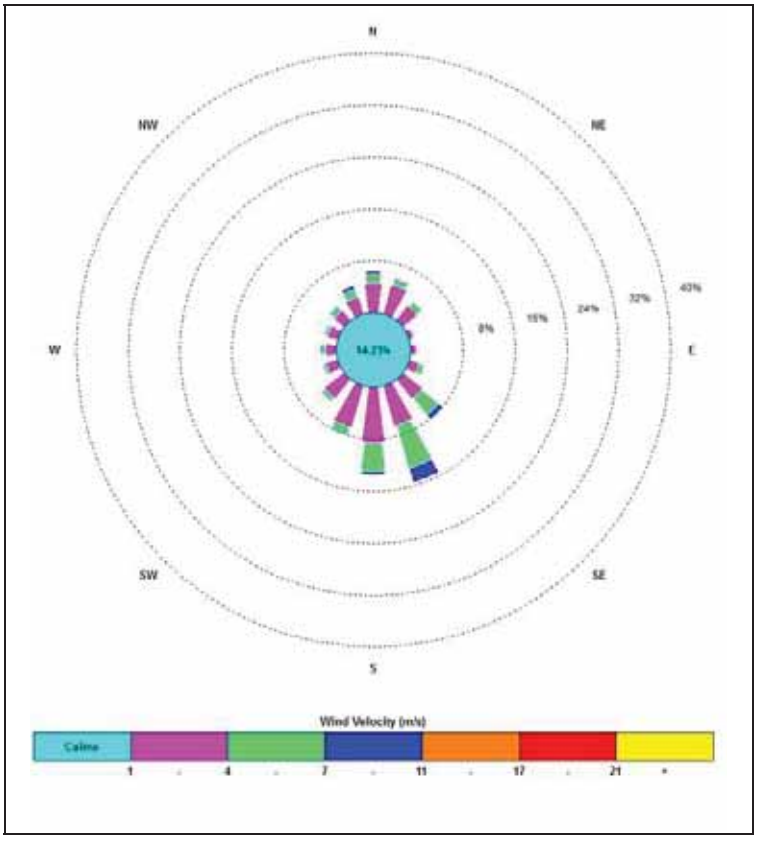
October 2018



November 2018

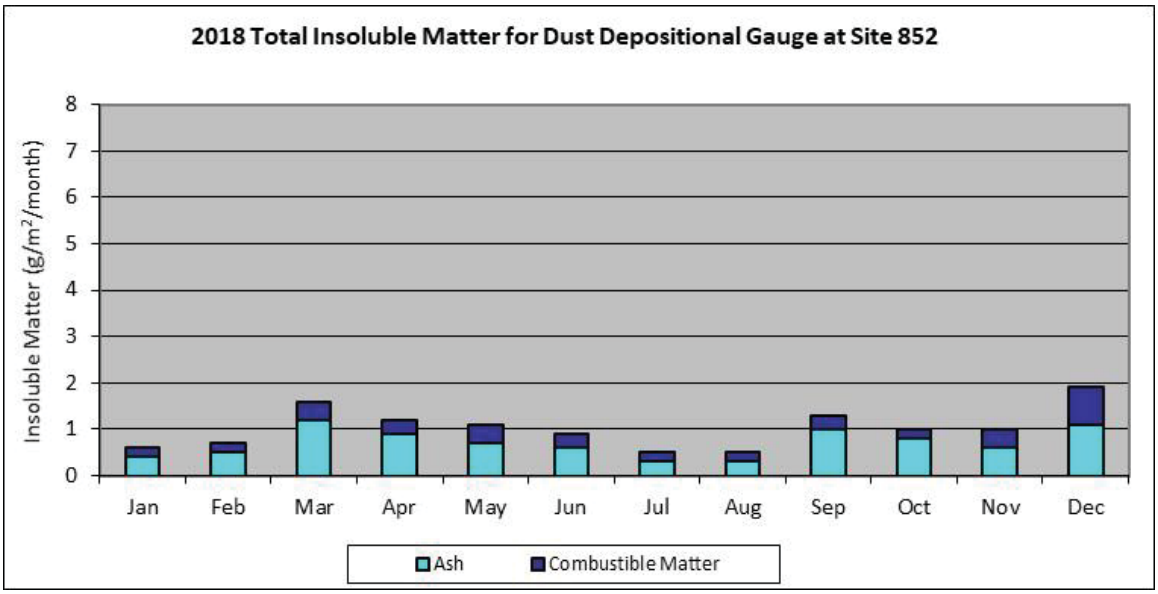


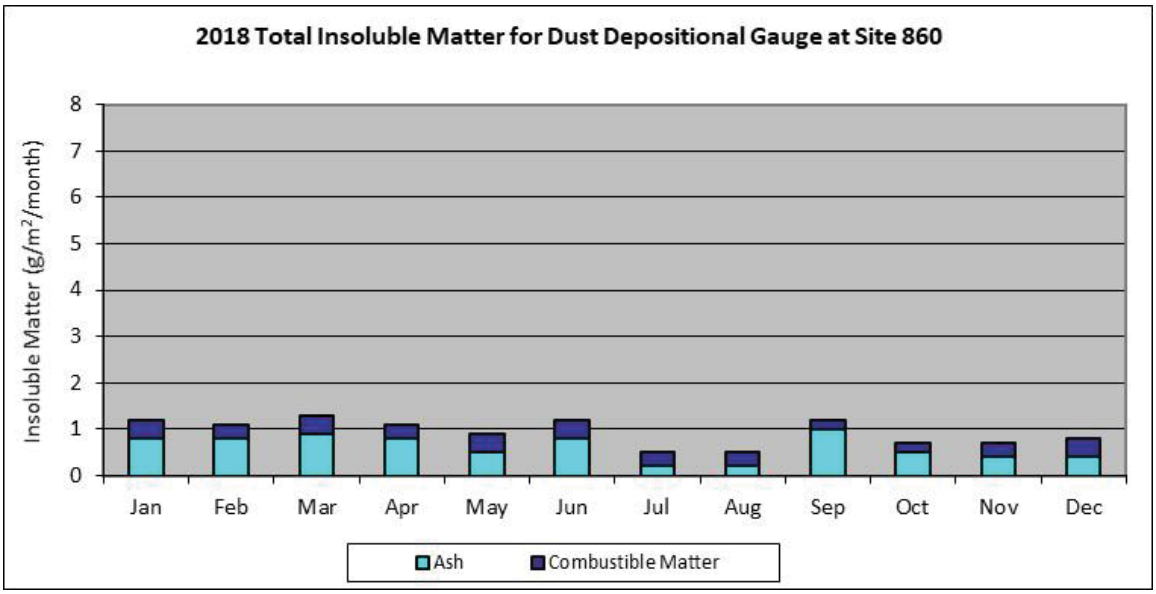
December 2018

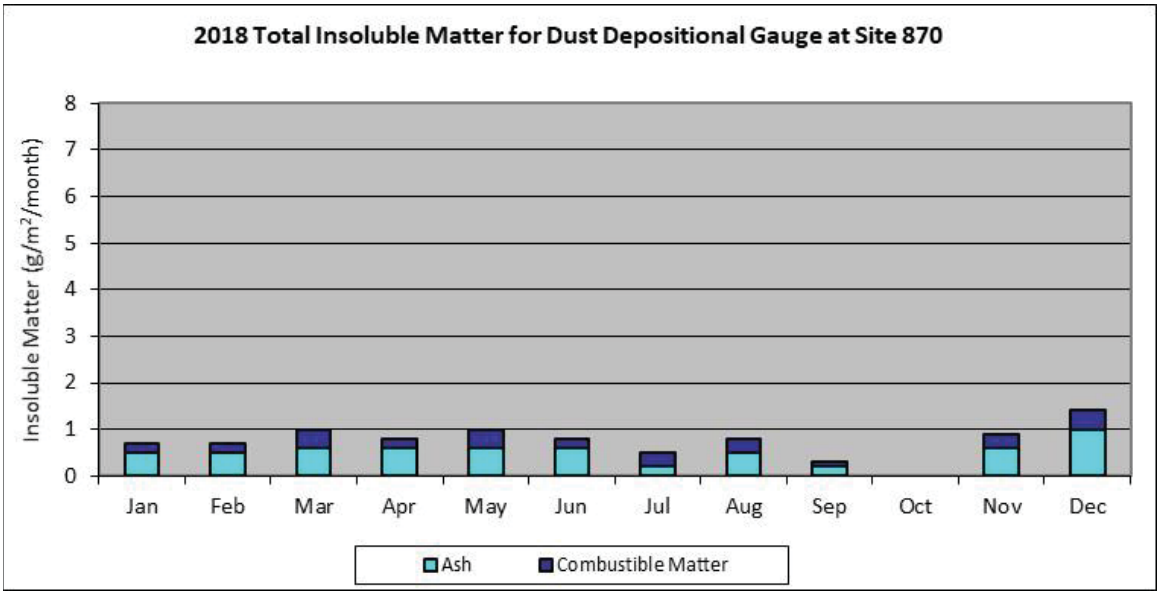


APPENDIX C

Air Quality Monitoring Summary







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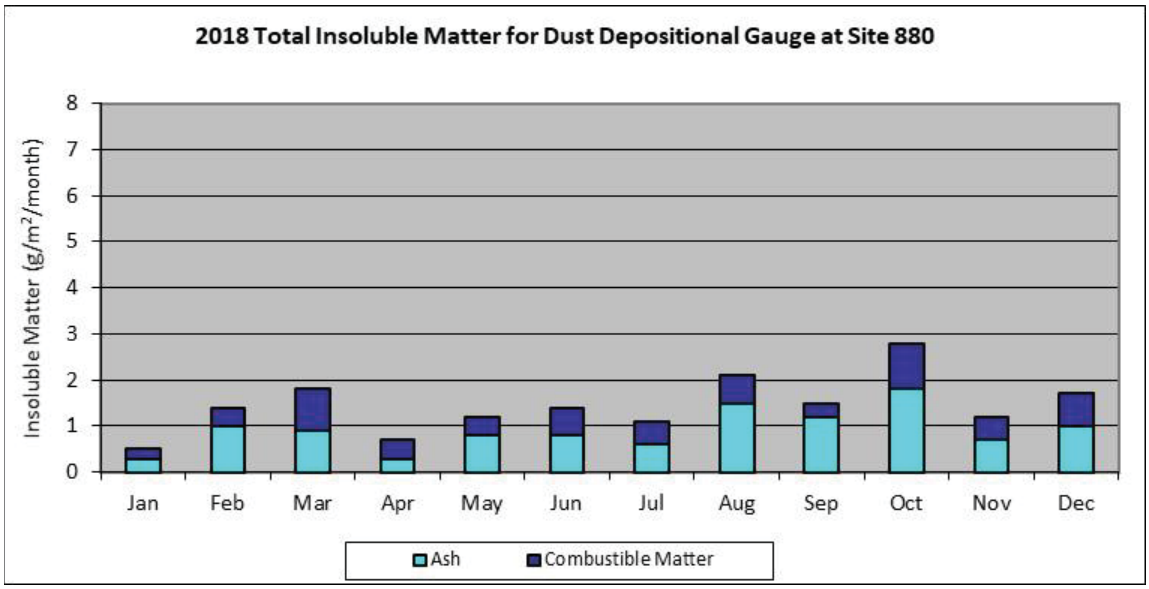
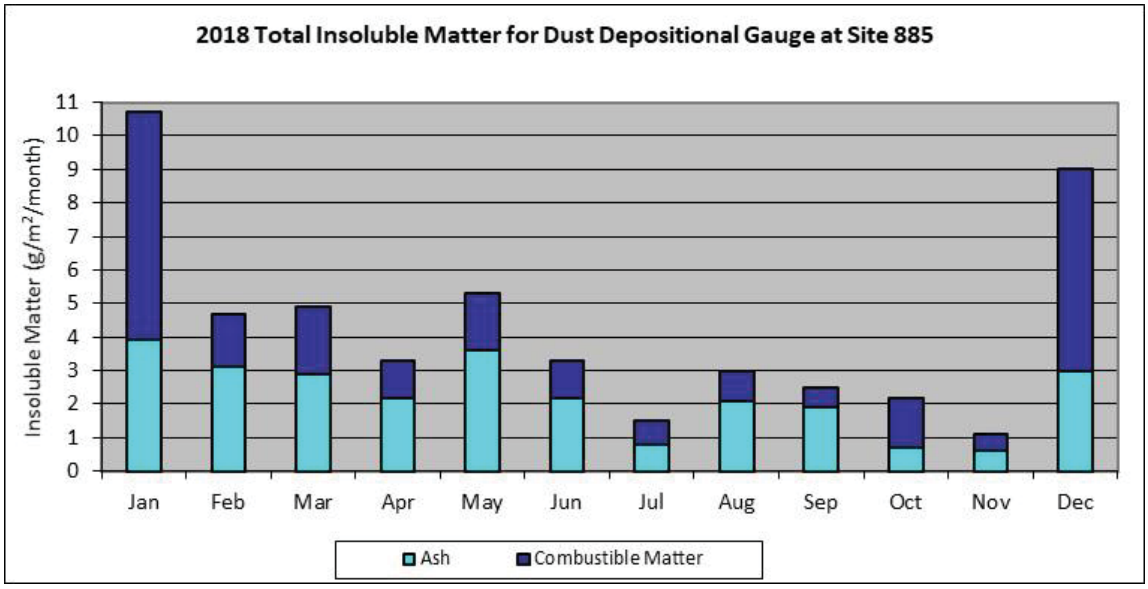
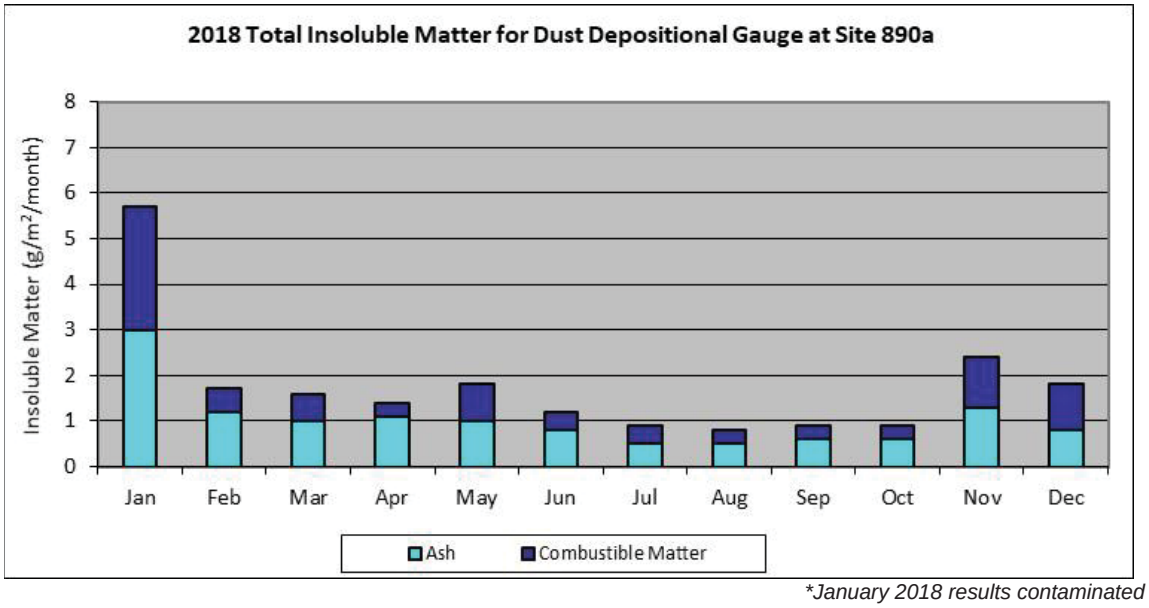




**January & December 2018 results contaminated*



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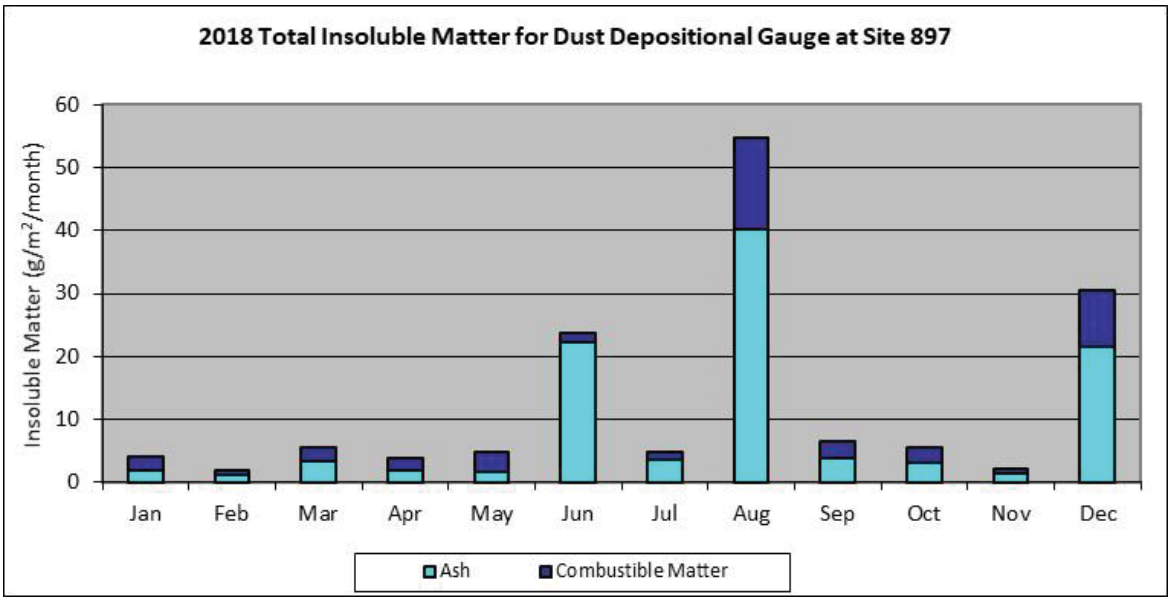

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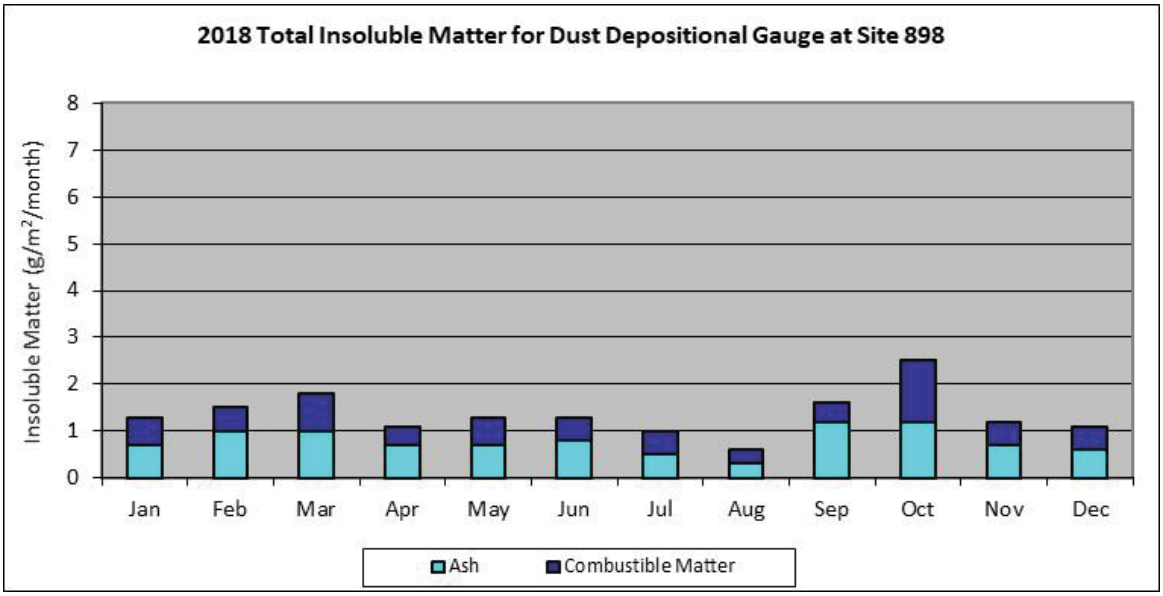

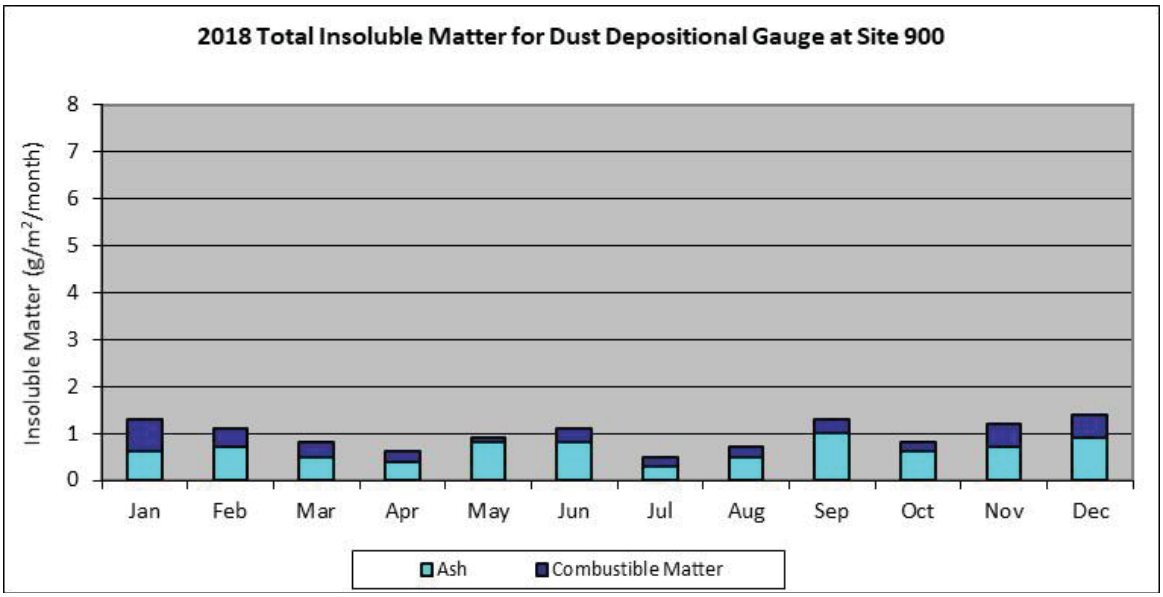

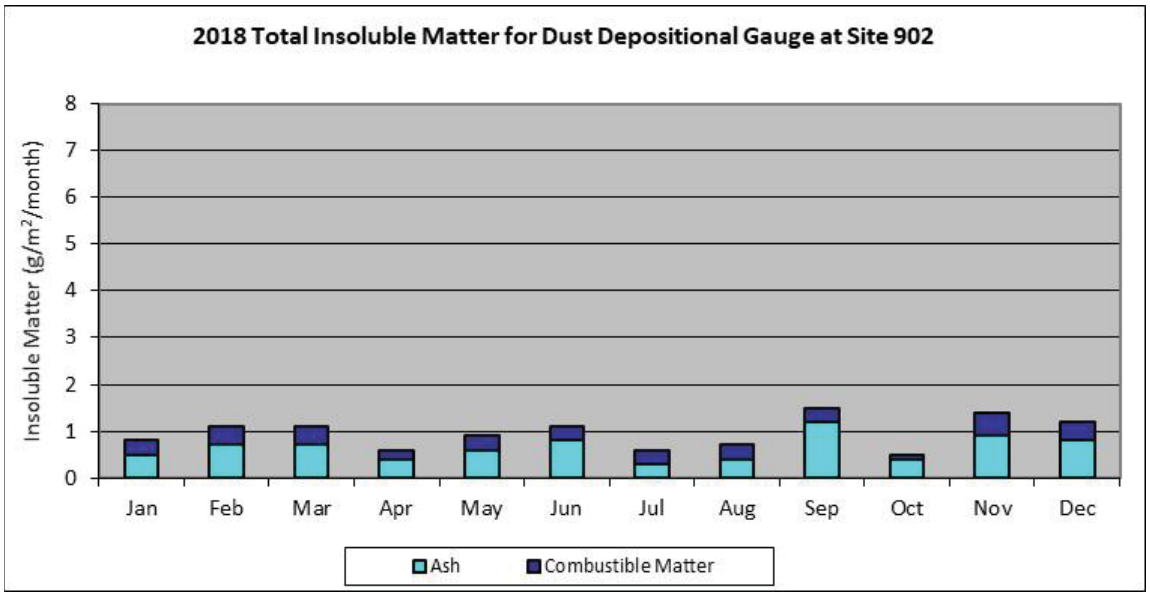

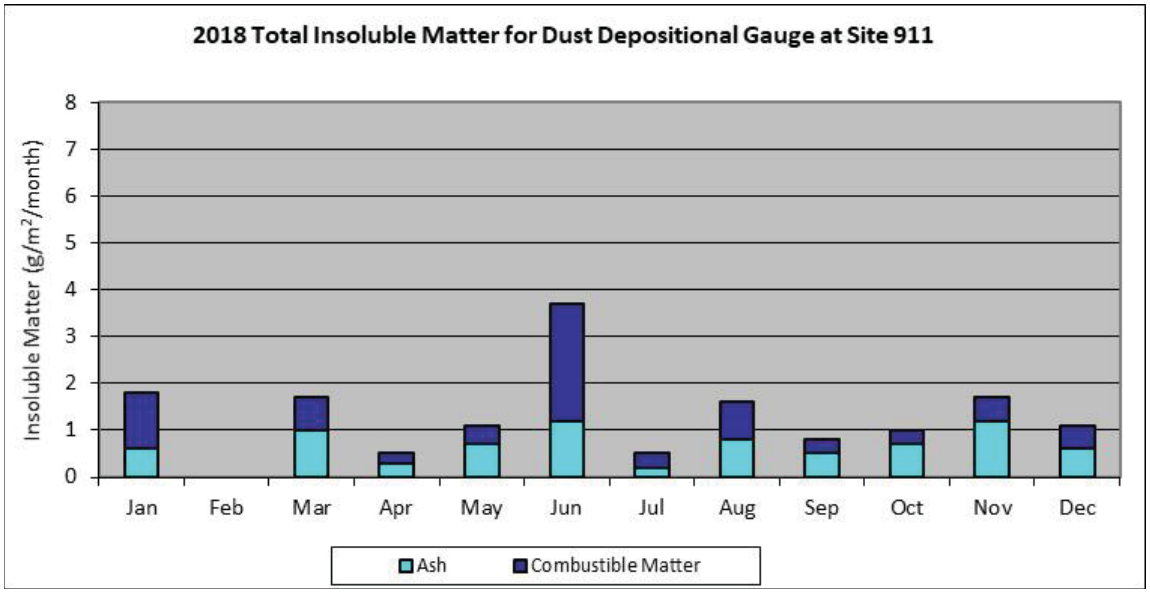

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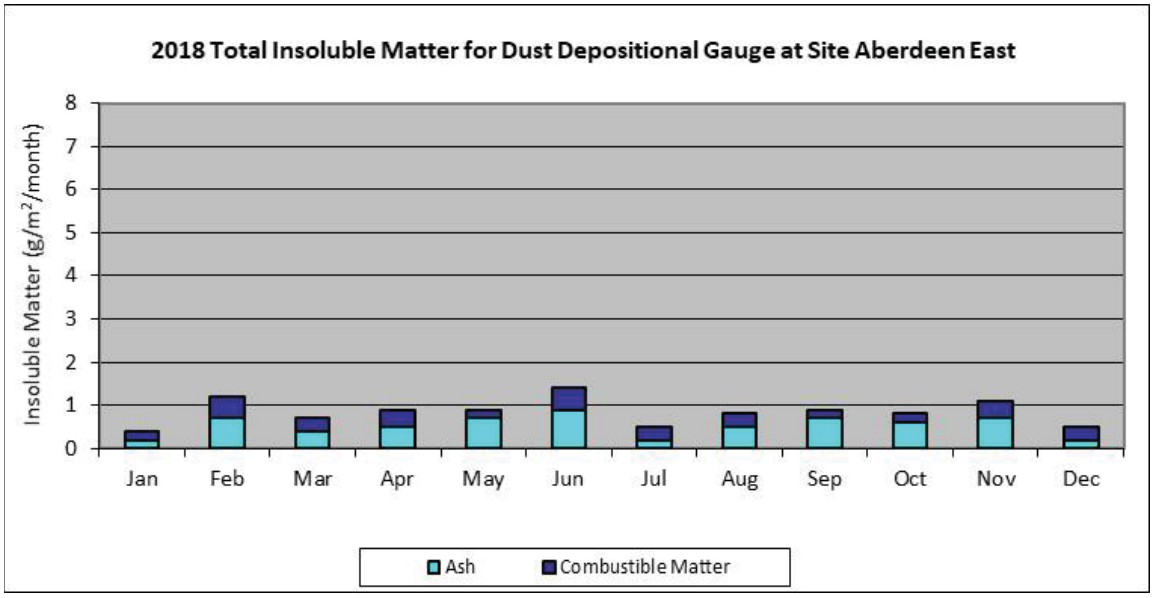

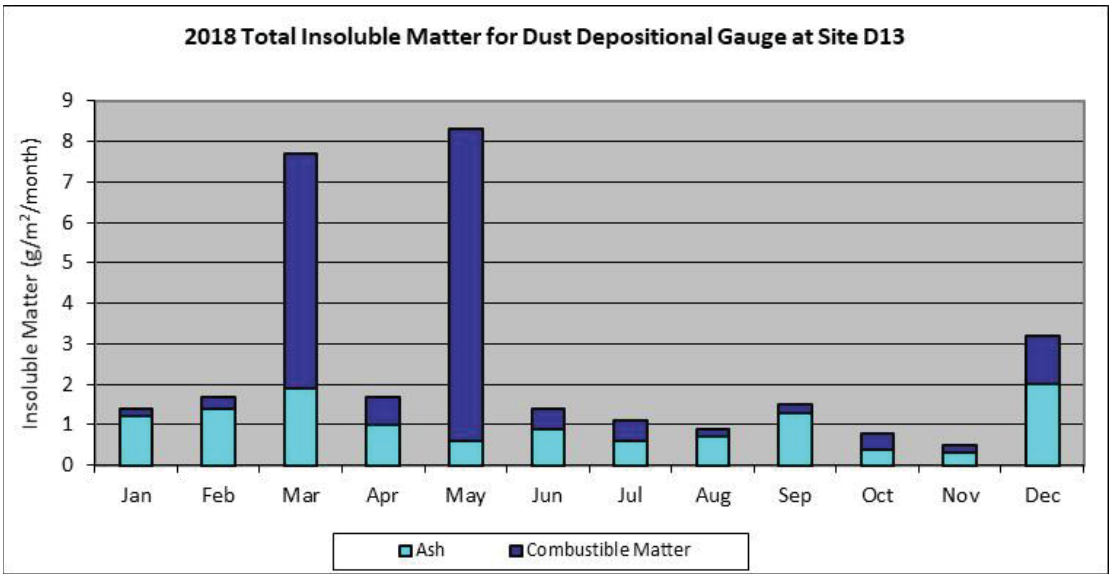

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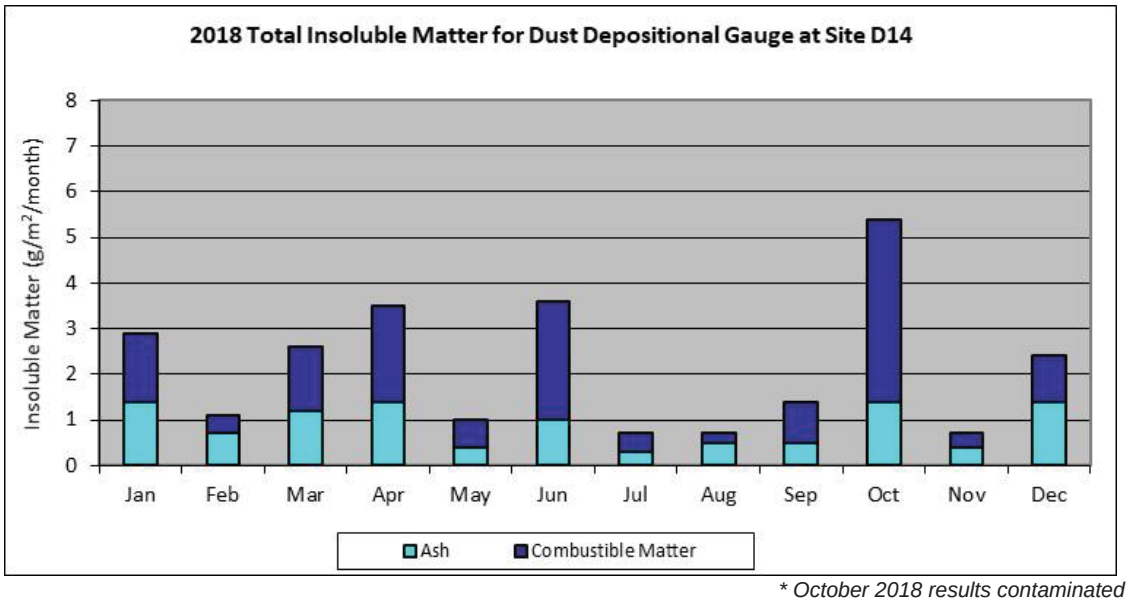

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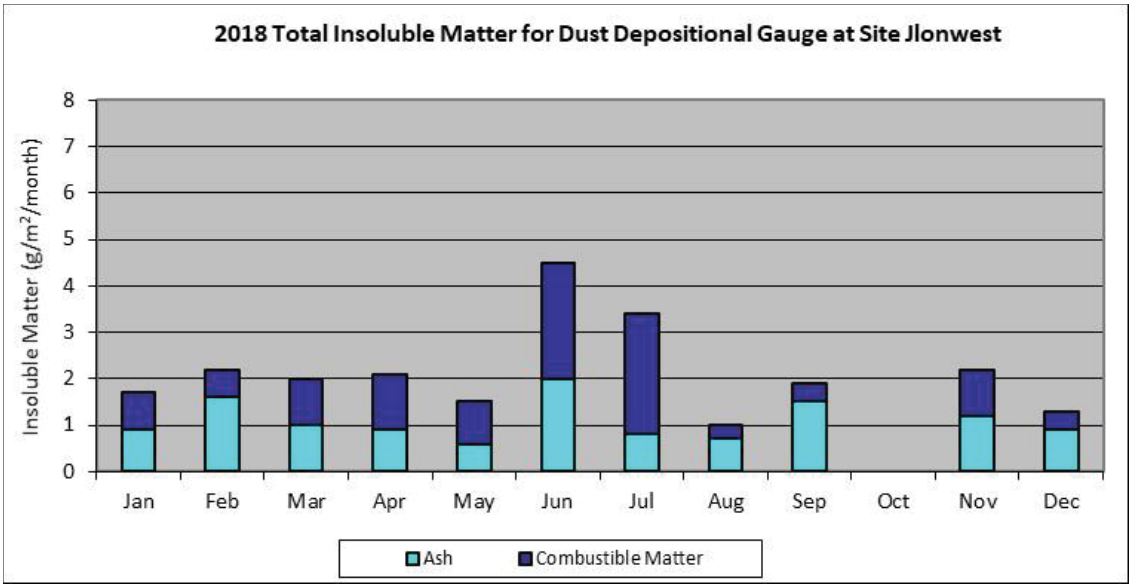
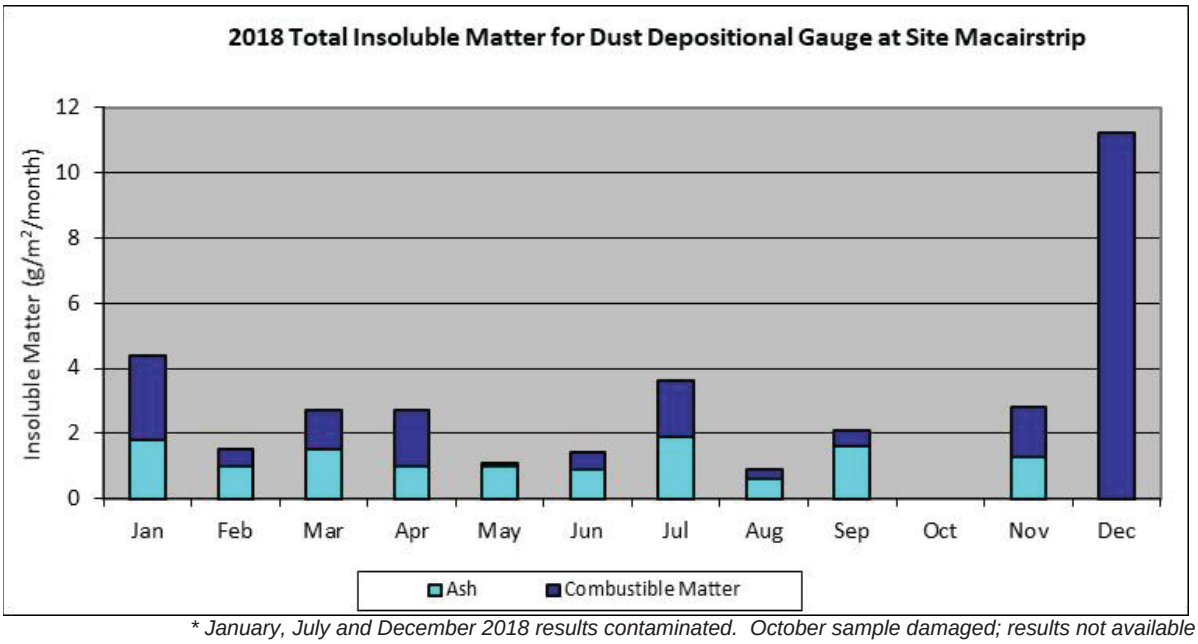
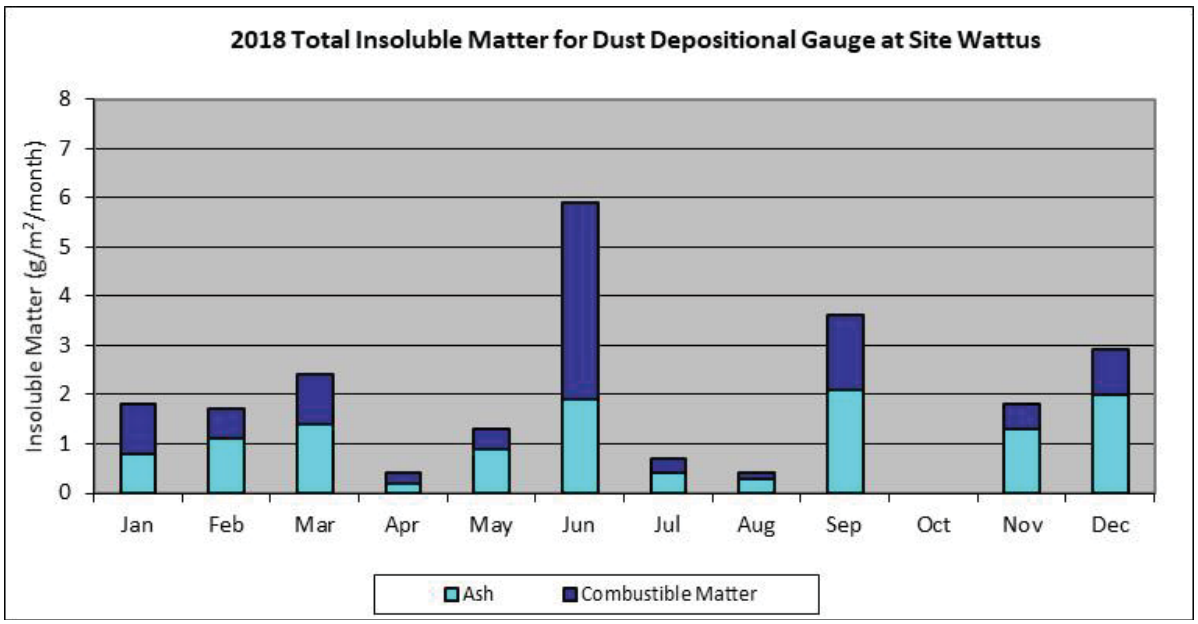


** July 2018 results contaminated. October sample damaged; results not available*



** January, July and December 2018 results contaminated. October sample damaged; results not available*



** June 2018 results contaminated. October sample damaged; results not available*

Table 1C
Elevated & Contaminated Monthly Depositional Dust Results in 2018

Site	Date	Insoluble Solids (g/m2/month)	Combustible Matter (g/m2/month)	Ash Component (g/m2/month)	Reason for high reading
870	11/10/18	-	-	-	Monitoring jar damaged, October results not available
885	10/01/18	10.7c	6.8	3.9	Insects, bird droppings
885	08/02/18	4.7	1.6	3.1	Insects, bird droppings and vegetation
885	09/03/18	4.9	2	2.9	Insects and vegetation
885	11/05/18	5.3	1.7	3.6	Insects, bird droppings and vegetation
885	12/12/18	9c	6	3c	Insects
897	10/01/18	4.1c	2.1	2	Insects, bird droppings and vegetation
897	09/03/18	5.4	2.1	3.3	Insects, bird droppings and vegetation
897	11/05/18	4.8c	3.2	1.6	Insects, bird droppings and vegetation
897	12/06/18	23.7	1.4	22.3	Insects, bird droppings and vegetation
897	10/07/18	4.9	1.4	3.5	Insects, bird droppings and vegetation
897	10/08/18	54.8	14.6	40.2	Insects, bird droppings and vegetation
897	11/09/18	6.4	2.5	3.9	Insects and vegetation
897	11/10/18	5.5	2.4	3.1	Insects and vegetation
897	12/12/18	30.6c	9.1	21.5c	Insects and vegetation
890a	10/01/18	5.7c	2.7	3c	Insects and vegetation
911	12/06/18	3.7c	2.5	1.2c	Insects, bird droppings and vegetation
D13	09/03/18	7.7c	5.8	1.9	Insects
D13	11/05/18	8.3c	7.7	0.6	Insects, bird droppings and veg
D14	11/10/18	5.4c	4	1.4	Insects and bird droppings
JLON West	12/06/18	4.5	2.5	2	Insects and vegetation
JLON West	10/07/18	3.4c	2.6	0.8	Insects, bird droppings and vegetation
JLON West	11/10/18	-	-	-	Monitoring jar damaged, October results not available
Macair strip	10/01/18	4.4c	2.6	1.8c	Insects, bird droppings and vegetation
Macair strip	10/07/18	3.6c	1.7	1.9	Insects and bird droppings

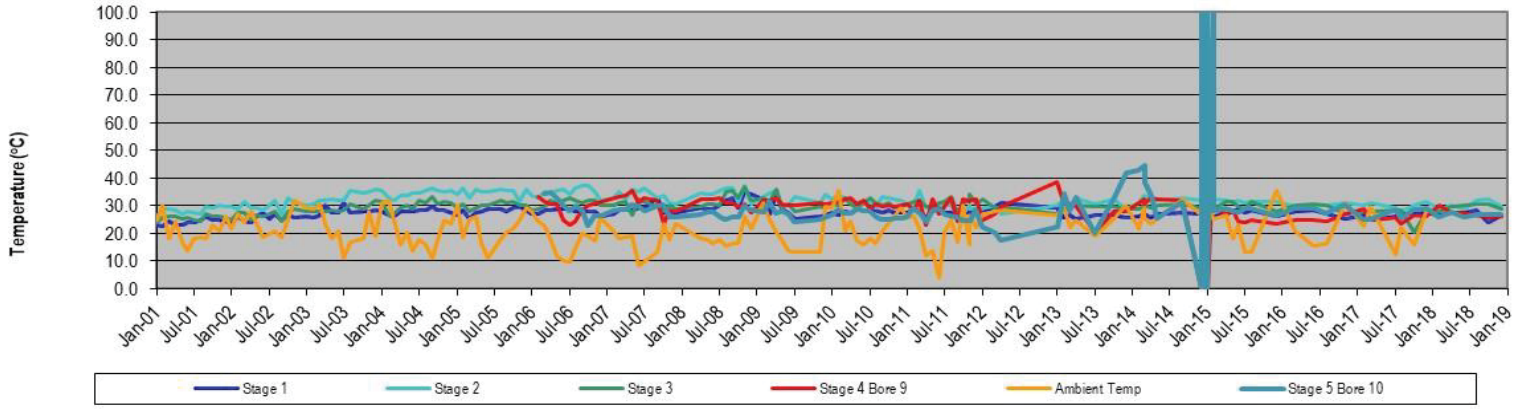
Site	Date	Insoluble Solids (g/m2/month)	Combustible Matter (g/m2/month)	Ash Component (g/m2/month)	Reason for high reading
Macair strip	11/10/18	-	-	-	Monitoring jar damaged, October results not available
Macair strip	12/12/18	17c	11.2	5.8c	Insects and bird droppings
Wattus	12/06/18	5.9c	4	1.9c	Insects, bird droppings and vegetation
Wattus	11/10/18	-	-	-	Monitoring jar damaged, October results not available

Note: c = contaminated sample

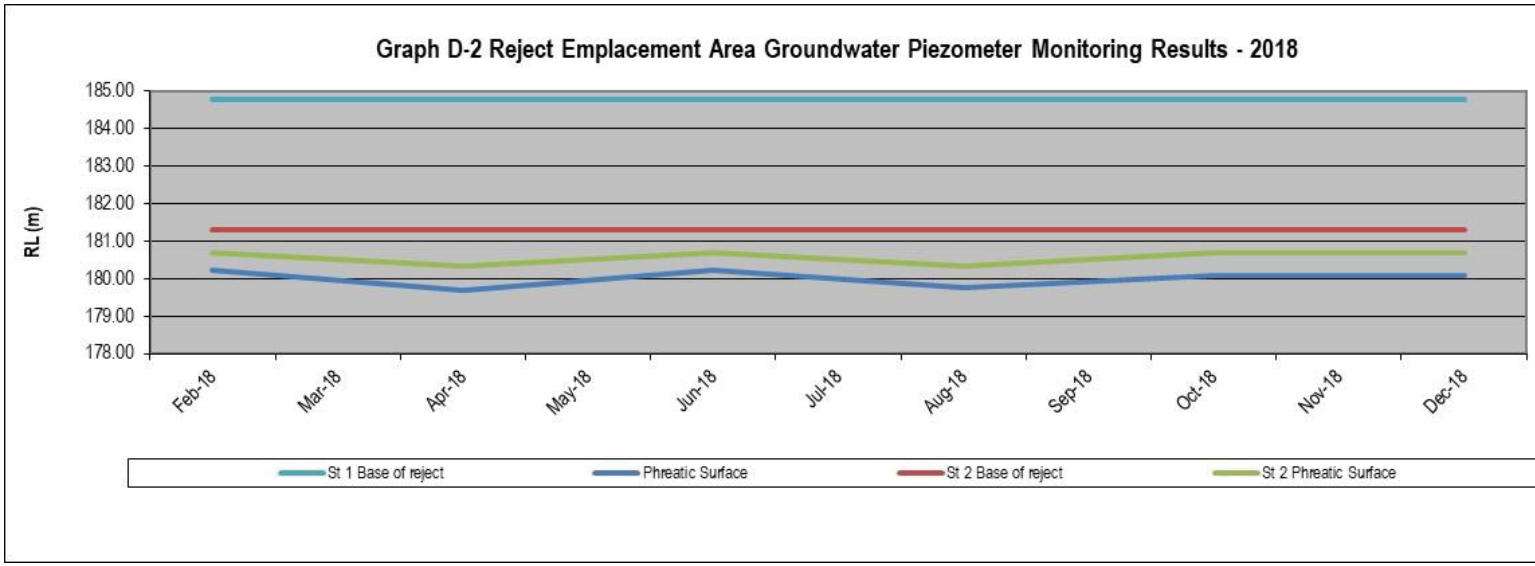
APPENDIX D

REA Monitoring Summary

Graph D-1 Reject Emplacement Area Average Temperature Monitoring Results (2001 - 2018)

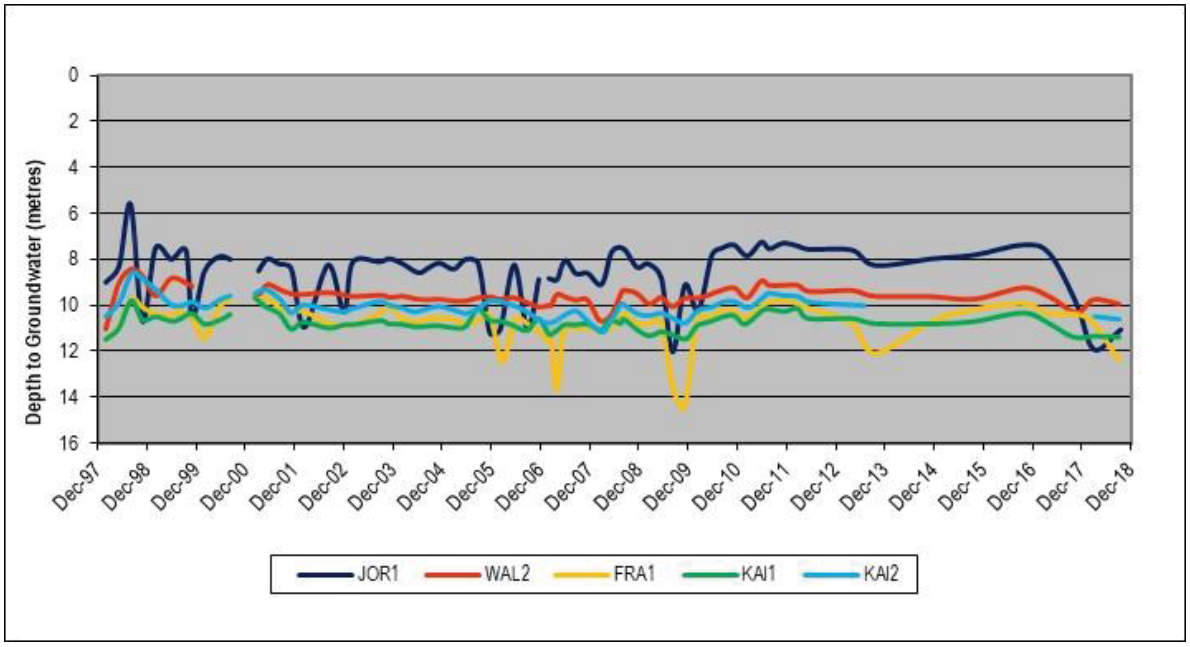


Graph D-2 Reject Emplacement Area Groundwater Piezometer Monitoring Results - 2018

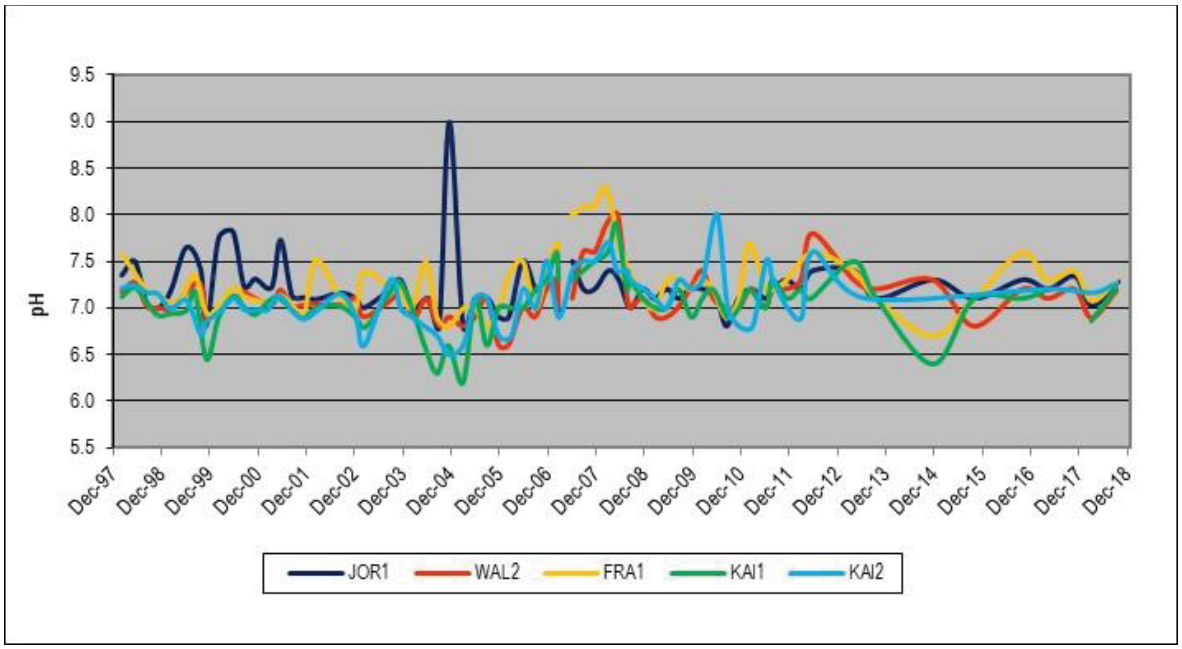


APPENDIX E

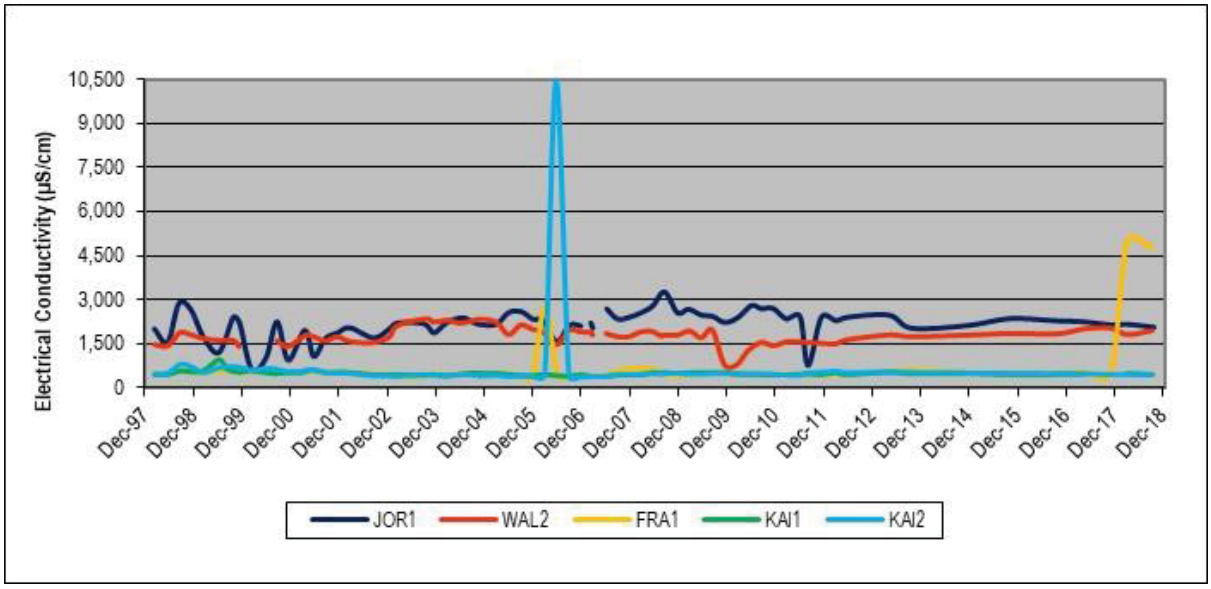
Groundwater Monitoring Summary



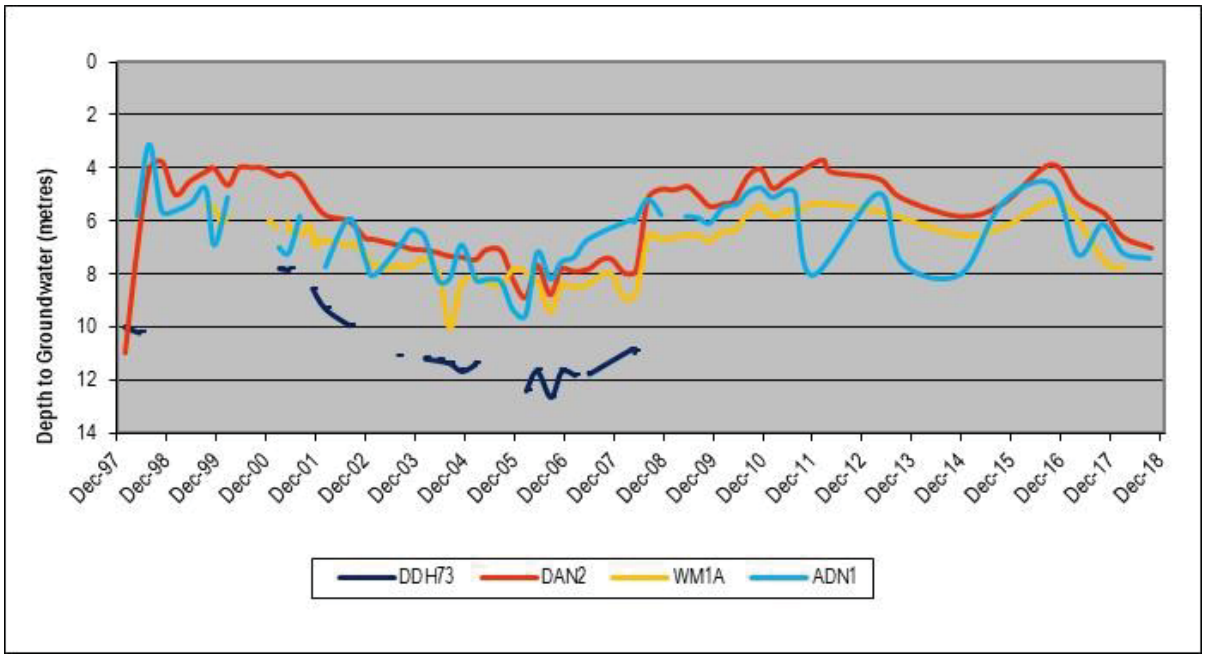
Graph E-1
Groundwater Level for Hunter River Alluvium Bores (1998-2018)



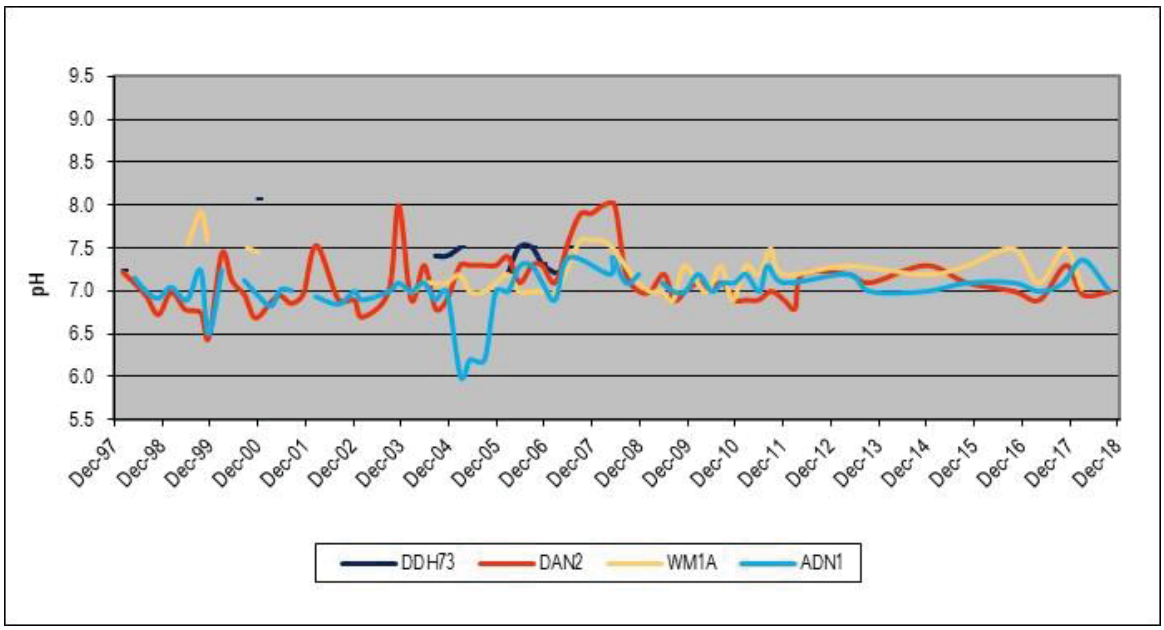
Graph E-2
pH for Hunter River Alluvium Bores (1998-2018)



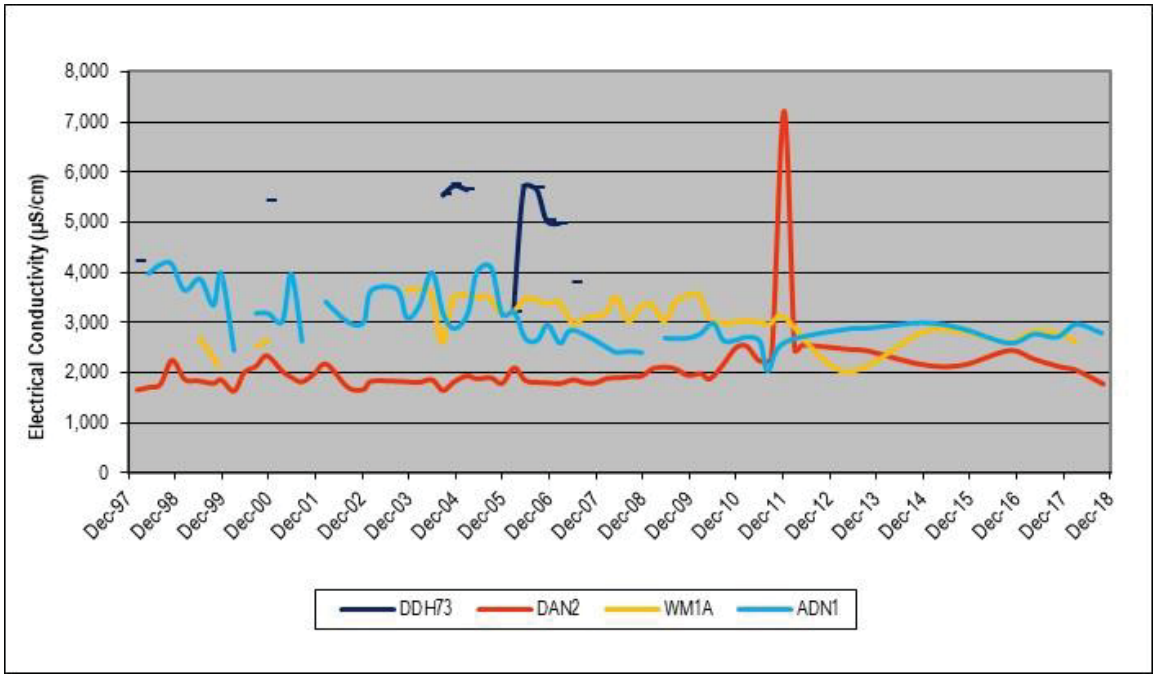
Graph E-3
Electrical Conductivity for Hunter River Alluvium Bores (1998-2018)



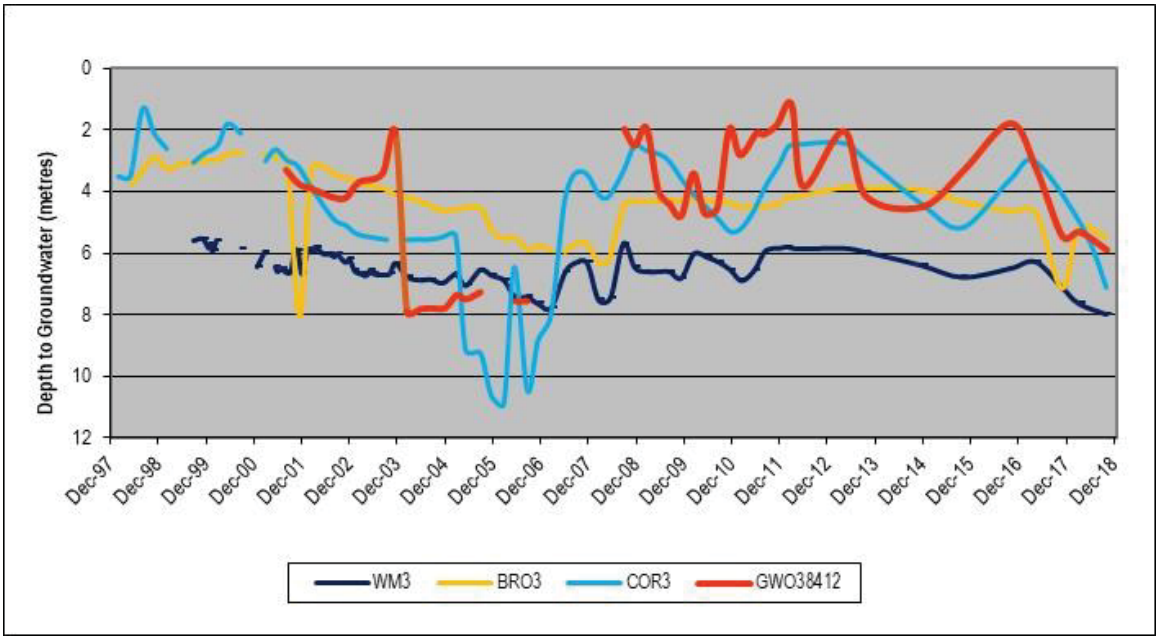
Graph E-4
Groundwater Level for Dart Brook Alluvium Bores (1998-2018)



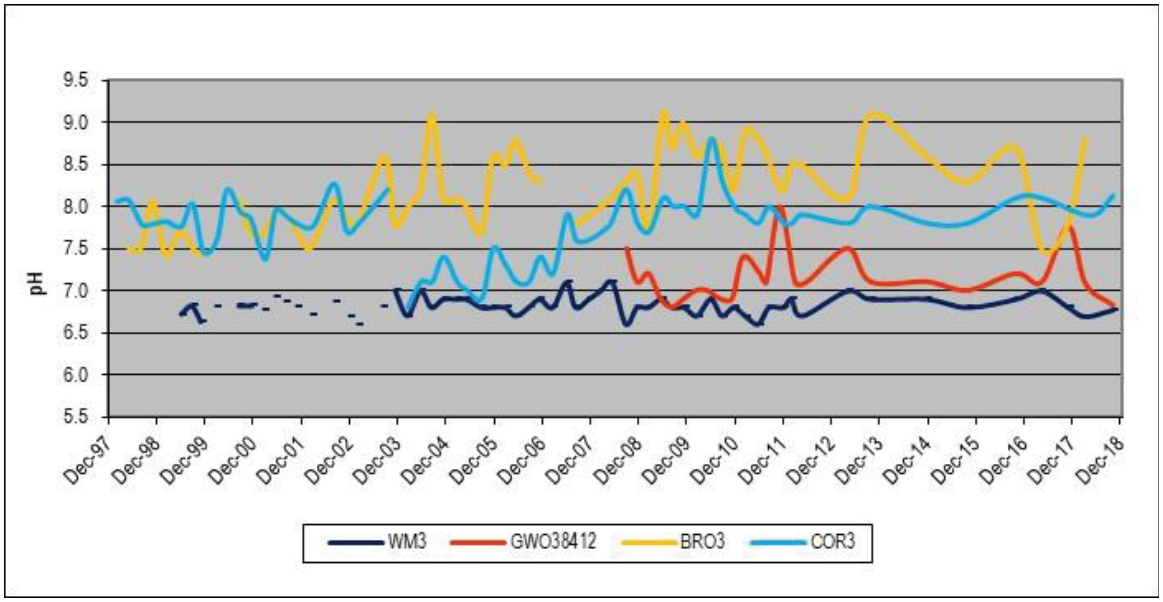
Graph E-5
pH for Dart Brook Alluvium Bores (1998-2018)



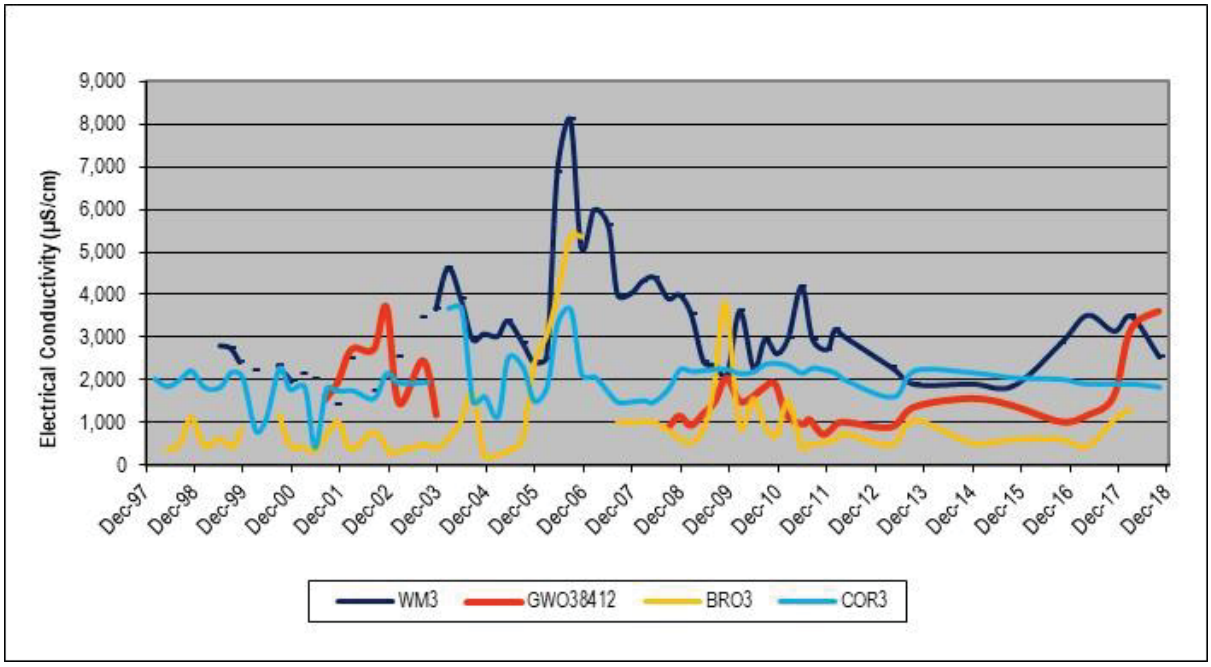
Graph E-6
Electrical Conductivity for Dart Brook Alluvium Bores (1998-2018)



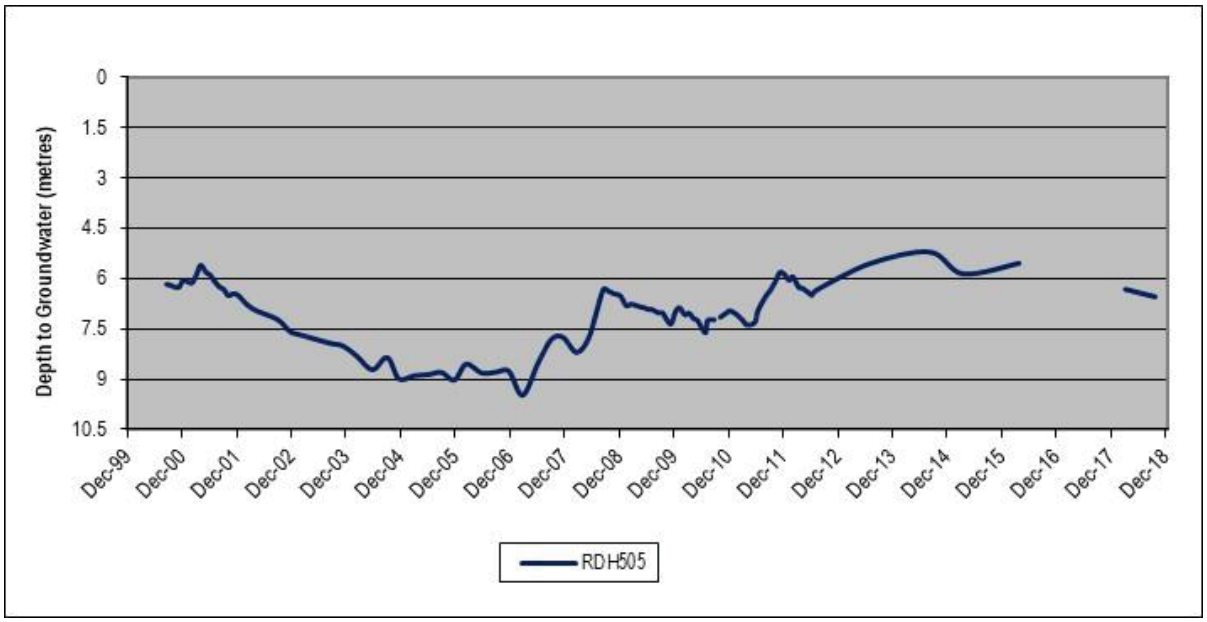
Graph E-7
Groundwater Level for Sandy Creek Alluvium Bores (1998-2018)



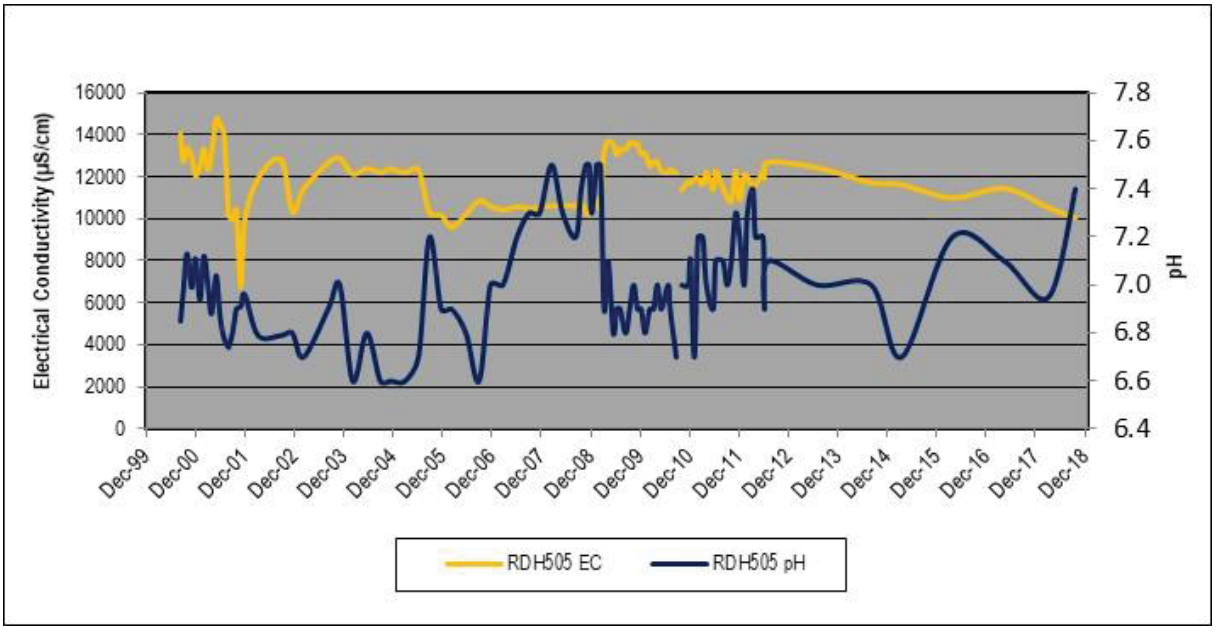
Graph E-8
pH for Sandy Creek Alluvium Bores (1998-2018)



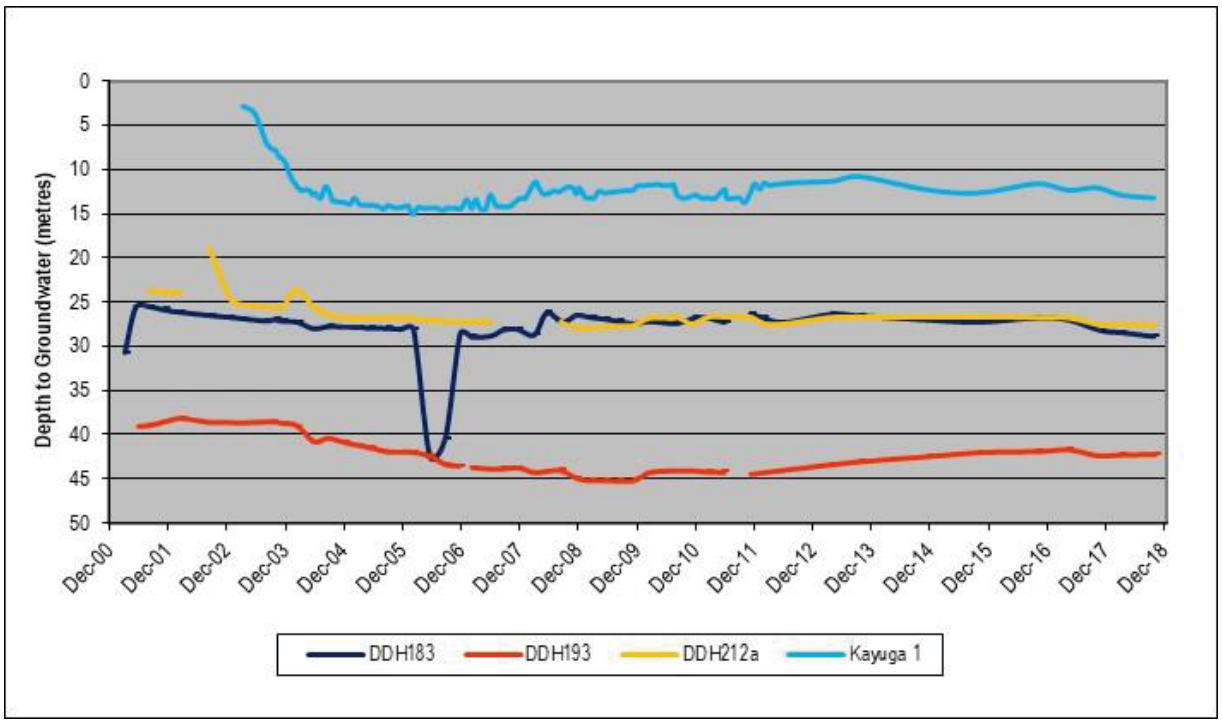
Graph E-9
Electrical Conductivity for Sandy Creek Alluvium Bores (1998-2018)



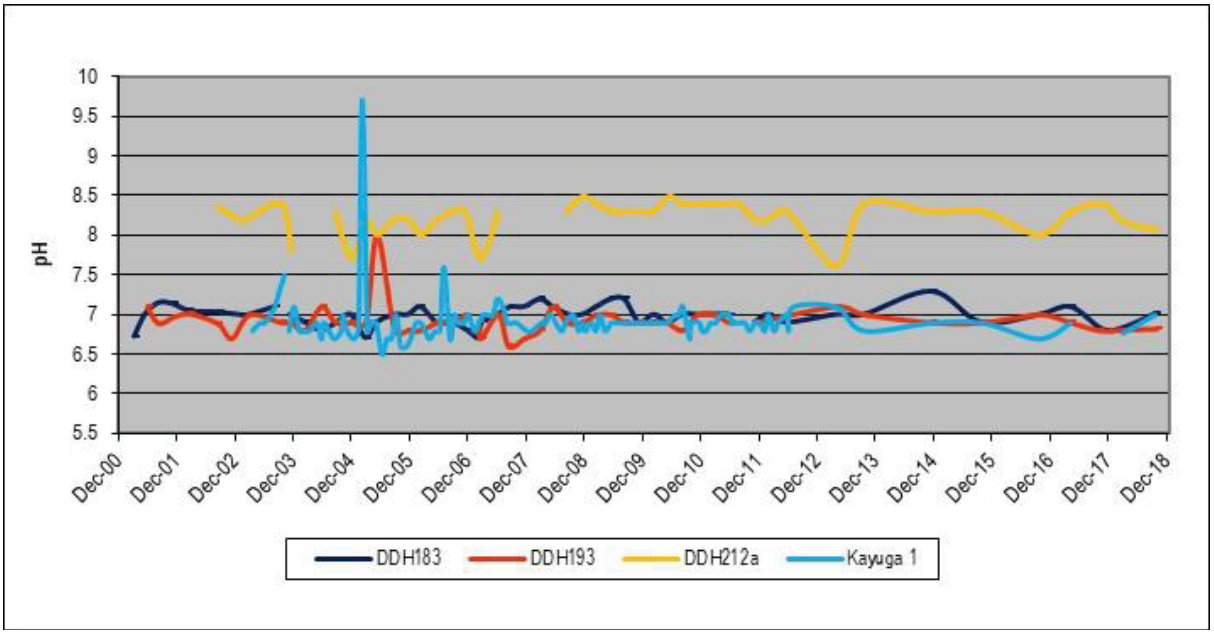
Graph E-10
Groundwater Level for Staged Discharge Dam Bore (2000-2018)



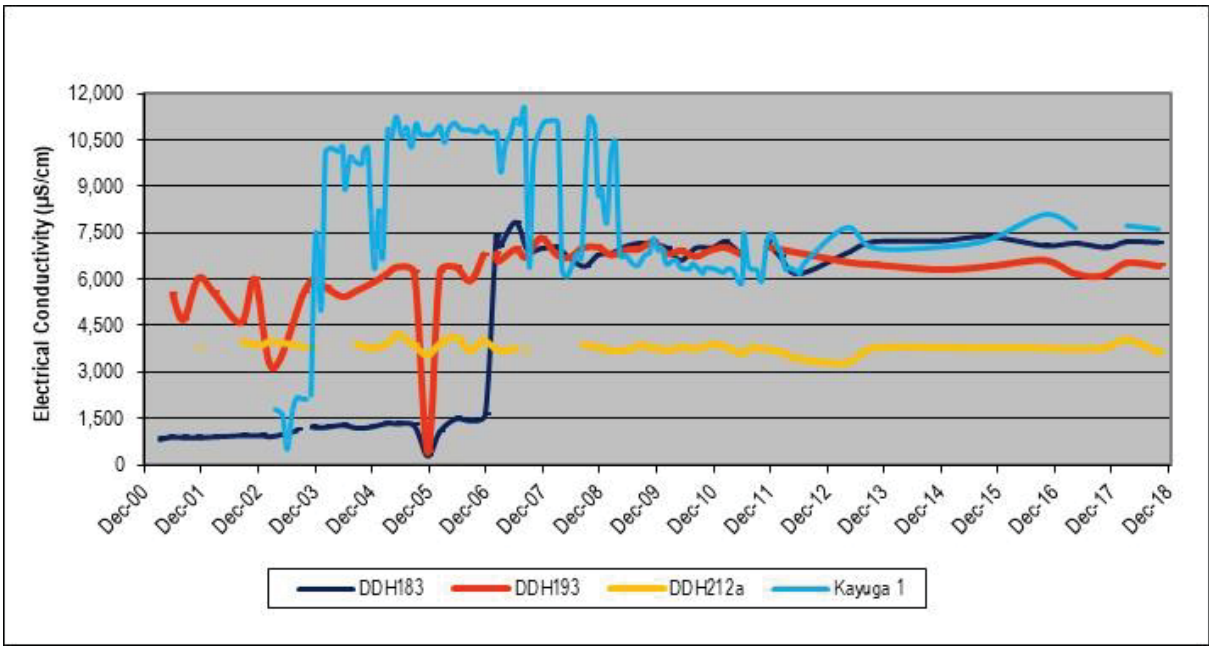
Graph E-11
pH and Electrical Conductivity for Staged Discharge Dam Bore (2000-2018)



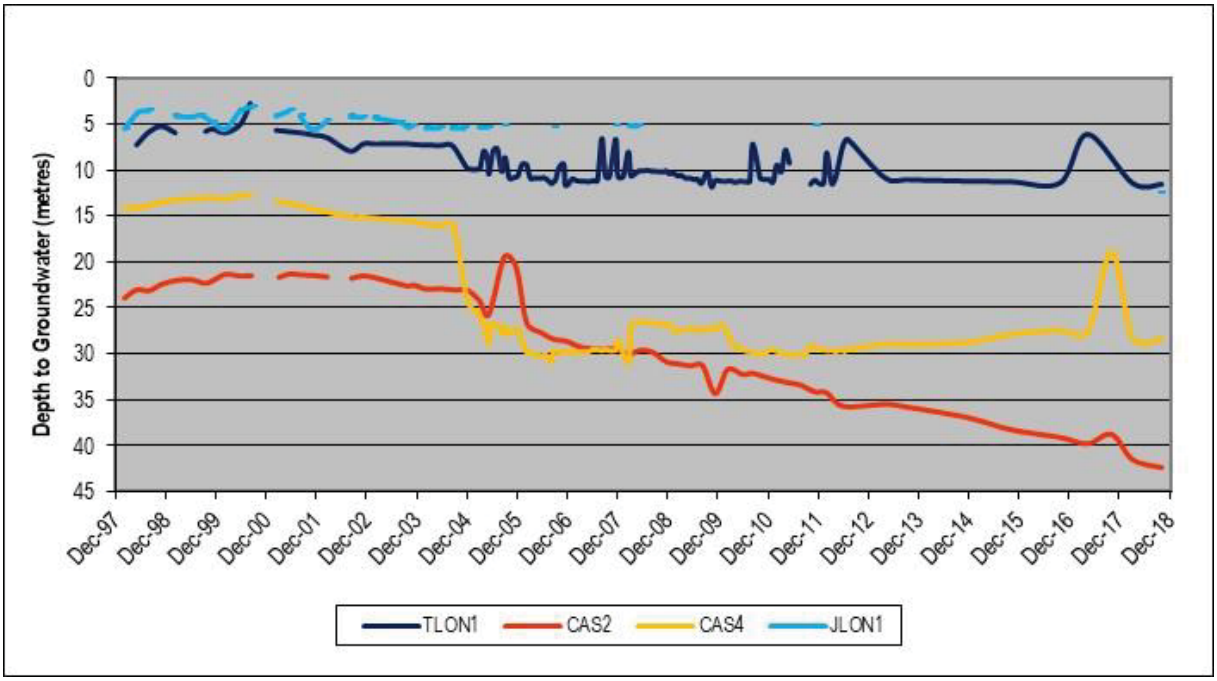
Graph E-12
Groundwater Level for Coal Seam Bores (2001-2018)



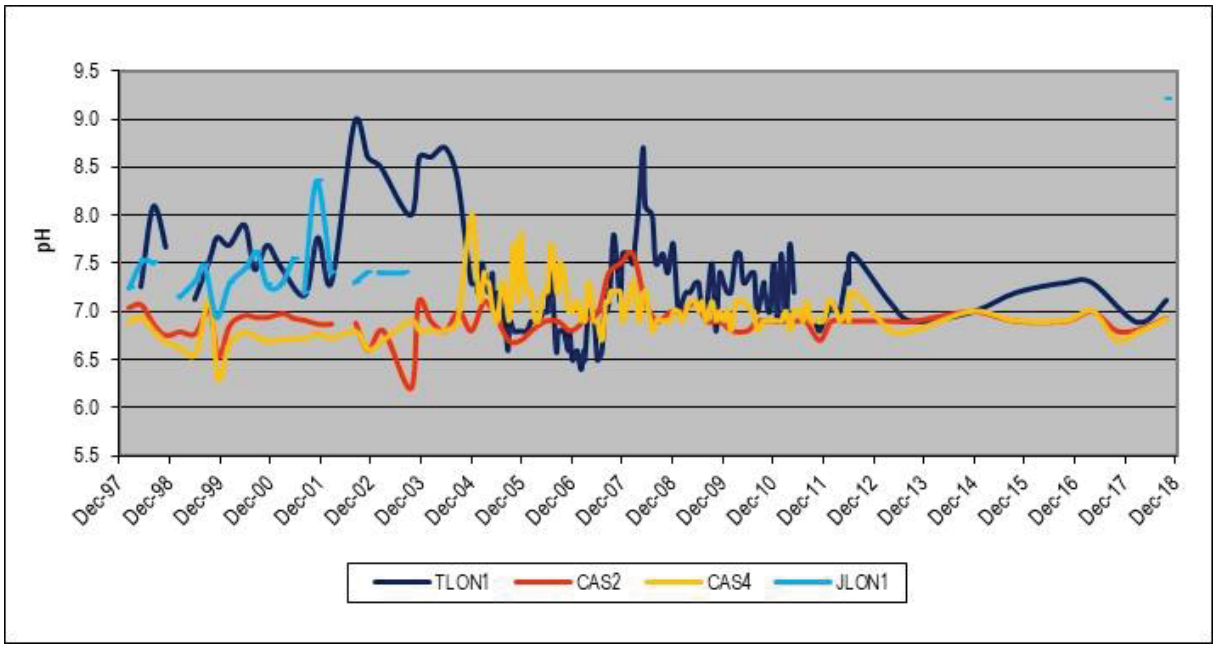
Graph E-13
pH for Coal Seam Bores (2001-2018)



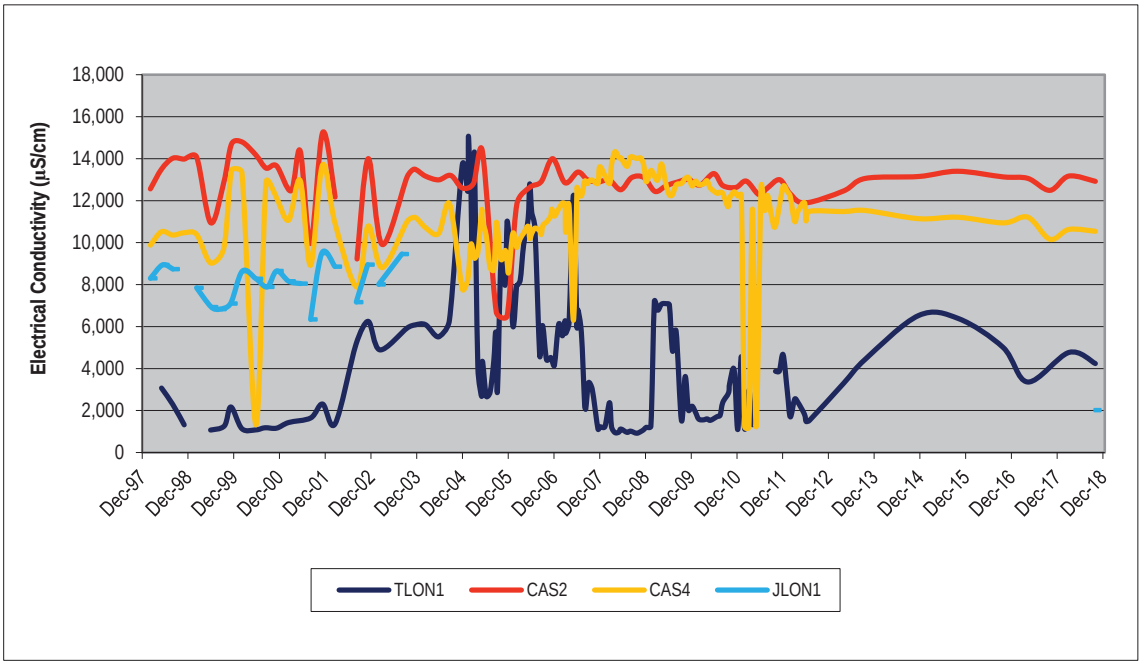
Graph E-14
Electrical Conductivity for Coal Seam Bores (2001-2018)



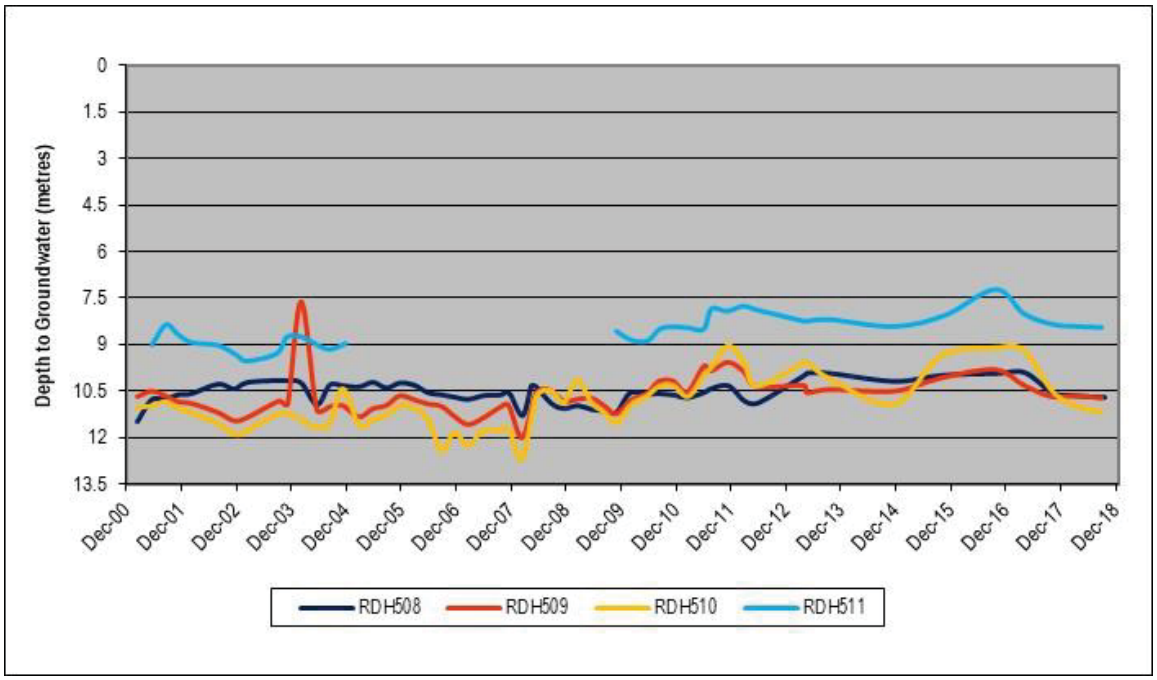
Graph E-15
Groundwater Levels for Regolith Bores (1998-2018)



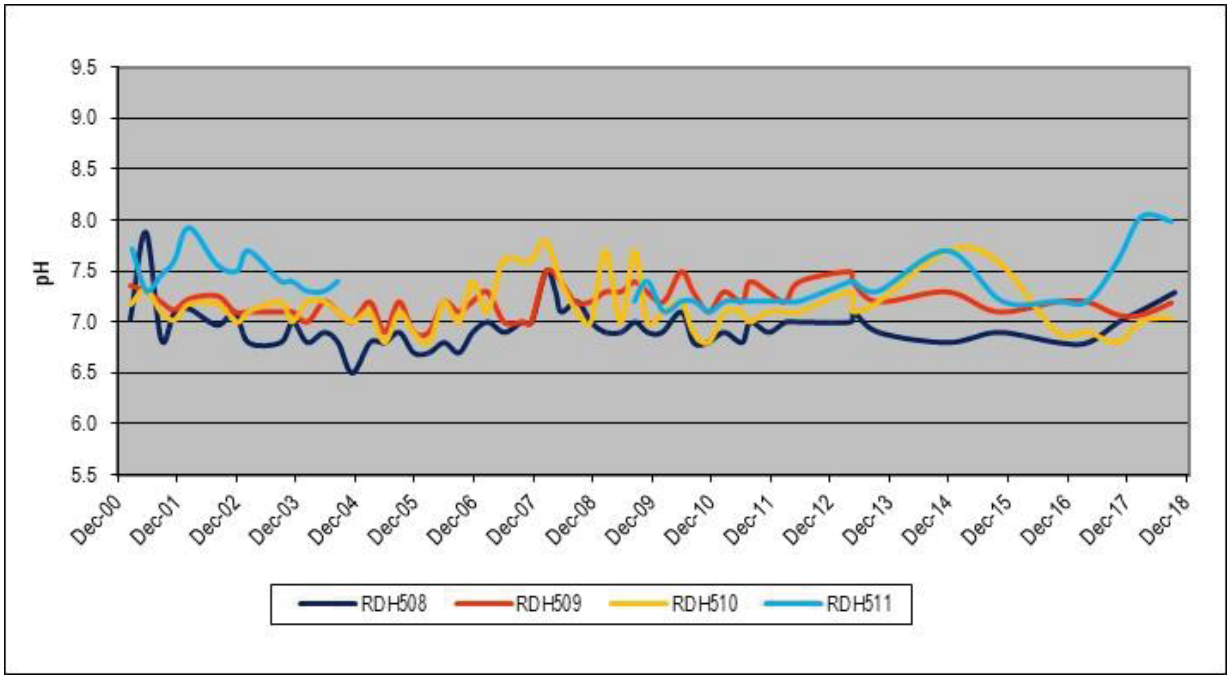
Graph E-16
pH for Regolith Bores (1998-2018)



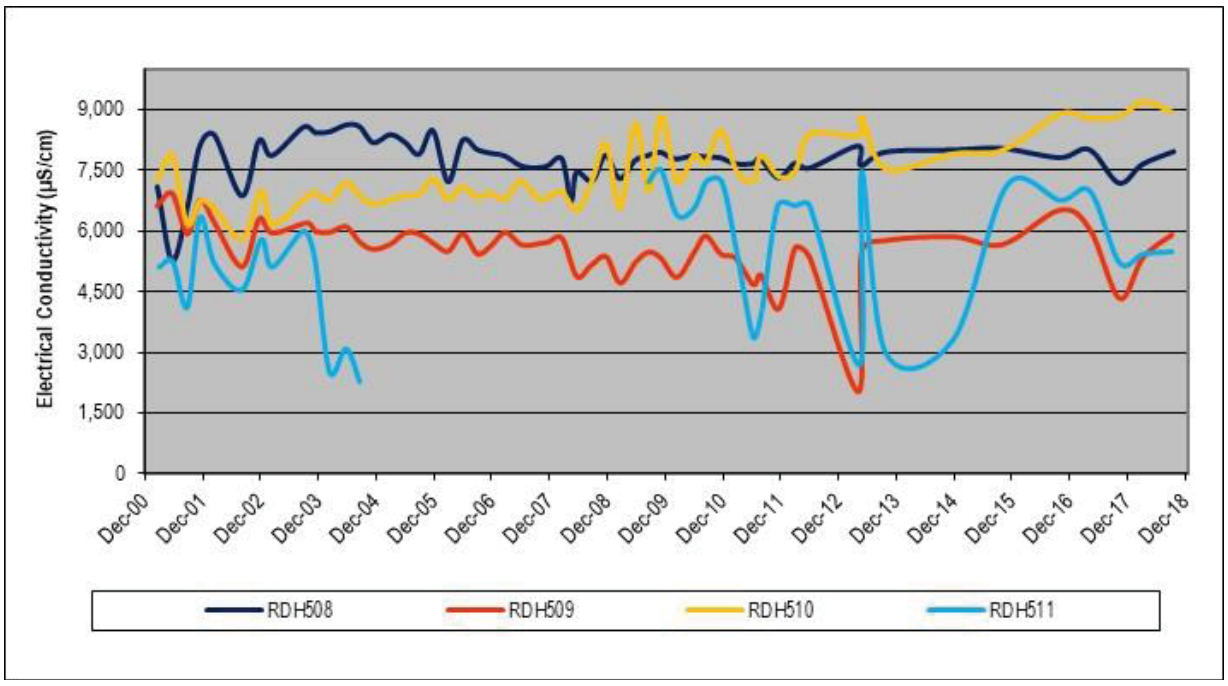
Graph E-17
Electrical Conductivity for Regolith Bores (1998-2018)



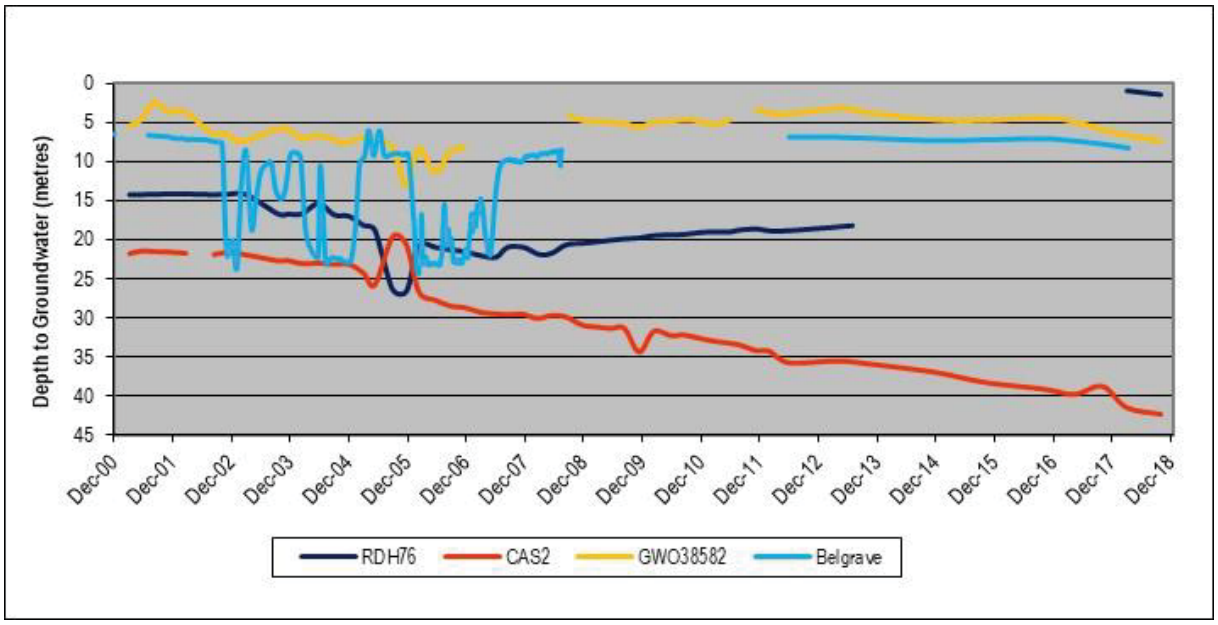
Graph E-18
Groundwater Level for Rejects Emplacement Area Bores (2001-2018)



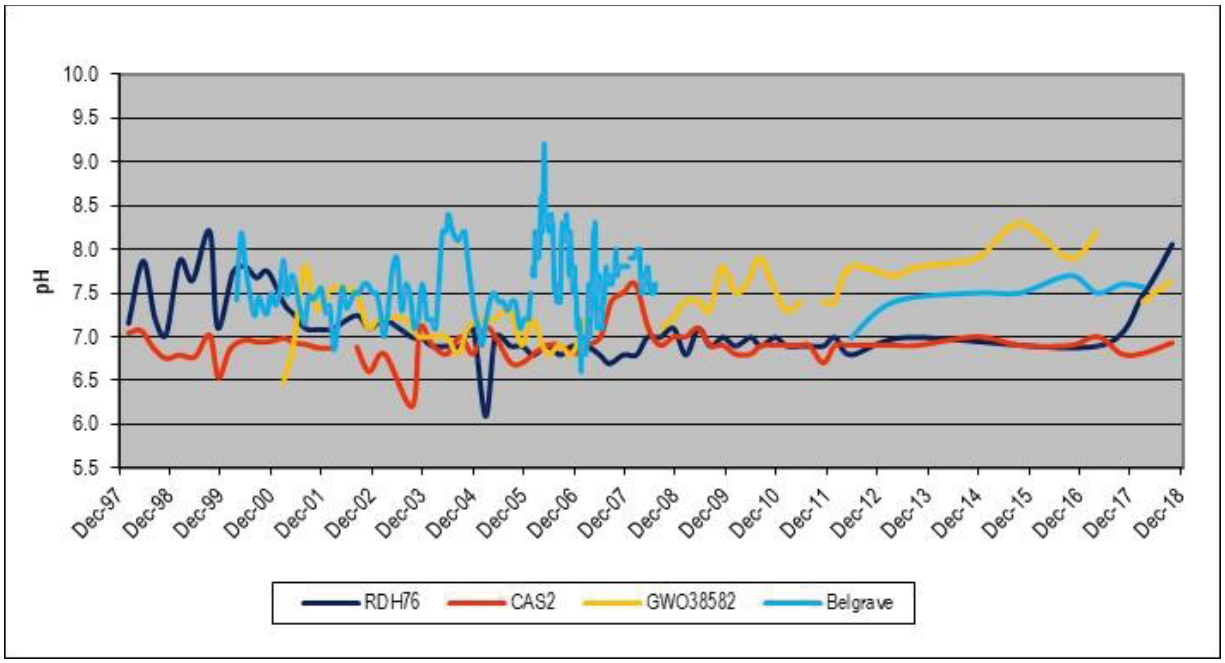
Graph E-19
pH for Rejects Emplacement Area Bores (2001-2018)



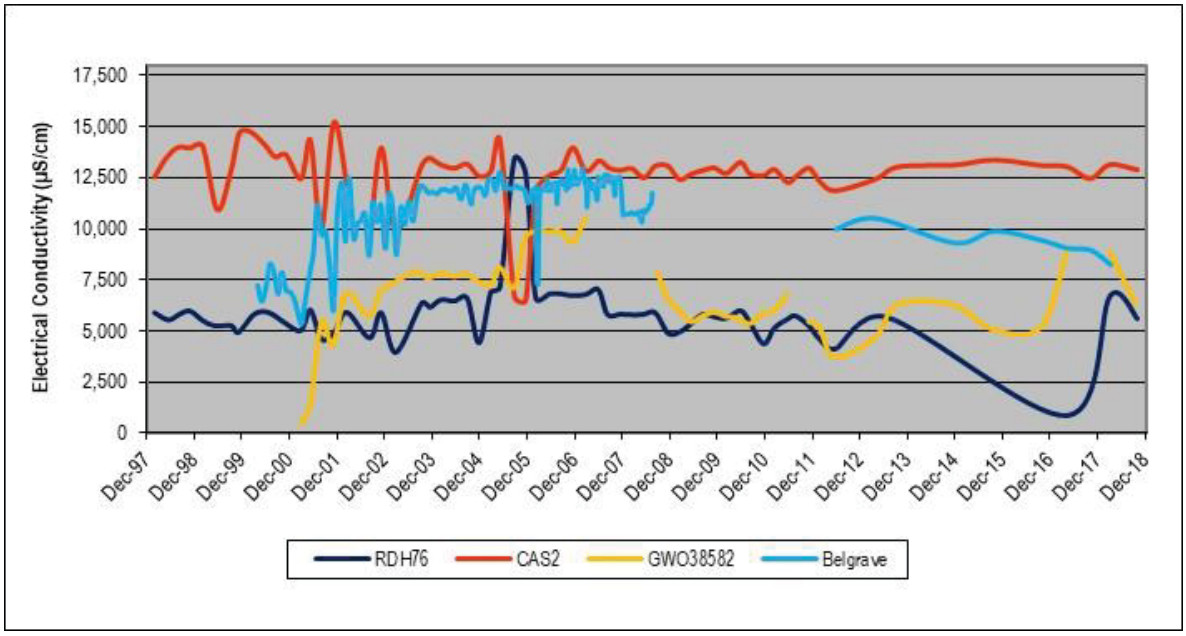
Graph E-20
Electrical Conductivity for Rejects Emplacement Area Bores (2001-2018)



Graph E-21
Groundwater Level for Landowner Propoerty Bores (2001-2018)



Graph E-22
pH for Landowner Propoerty Bores (1998-2018)



Graph E-23
Electrical Conductivity for Landowner Propoerty Bores (1998-2018)

Table E-1 – Groundwater Monitoring Summary

Sample Location	Sample Date	Field EC (µS/cm)	Field pH	Depth to Ground (m)	Depth to Standpipe (m)
Hunter River Alluvium					
FRA1	03-Apr-18	4990	7.1	10.76	11.10
FRA1	09-Oct-18	4760	7.3	12.37	12.72
JOR1	03-Apr-18	2175	7.0	11.93	12.37
JOR1	19-Oct-18	2077	7.3	11.06	11.56
KAI1	03-Apr-18	507	6.9	11.36	11.87
KAI1	10-Oct-18	477	7.2	11.41	11.91
WAL2	05-Apr-18	1799	6.9	9.72	9.72
WAL2	10-Oct-18	1936	7.2	9.92	10.02
Dart Brook Alluvium					
ADN1	06-Apr-18	2960	7.4	7.2	7.82
ADN1	19-Oct-18	2780	7.0	7.4	8.00
DAN2	05-Apr-18	2059	7.0	6.61	6.61
DAN2	02-Nov-18	1787	7.0	7.03	7.03
WM1A	06-Apr-18	2620	7.0	7.73	8.18
Sandy Creek Alluvium					
BRO3	05-Apr-18	1315	8.8	5.23	5.24
BRO3	02-Nov-18	*	*	5.5	5.50
COR3	15-May-18	1892	7.9	5.24	5.61
COR3	01-Nov-18	1830	8.1	7.11	7.45
GWO38412	05-Apr-18	3170	7.1	5.31	6.31
GWO38412	01-Nov-18	3600	6.8	5.9	6.75
WM3	05-Apr-18	3480	6.7	7.63	833.00
WM3	01-Nov-18	2520	6.8	7.98	8.75
Coal Seams					
DDH183	06-Apr-18	7210	6.8	28.45	29.00
DDH183	25-Oct-18	7180	7.0	28.88	29.33
DDH193	06-Apr-18	6530	6.8	42.33	43.28
DDH193	01-Nov-18	6430	6.8	42.25	43.20
DDH212a	05-Apr-18	4040	8.2	27.46	28.26
DDH212a	01-Nov-18	3630	8.1	27.53	28.33
Kayuga 1	05-Apr-18	7750	6.8	12.84	13.27
Kayuga 1	25-Oct-18	7630	7.0	13.15	13.47
Regolith over Kayuga LW					
CAS2	03-Apr-18	13170	6.8	41.56	42.10
CAS2	01-Nov-18	12920	6.9	42.43	42.97
CAS4	05-Apr-18	10630	6.8	23.88	28.74
CAS4	01-Nov-18	10540	6.9	28.33	28.76
JLON1	03-Apr-18	*	*	*	*
JLON1	25-Oct-18	2021	9.2	12.6	13.40
TLON1	05-Apr-18	4770	6.9	11.42	11.42
TLON1	01-Nov-18	4240	7.1	11.52	11.62

Sample Location	Sample Date	Field EC (µS/cm)	Field pH	Depth to Ground (m)	Depth to Standpipe (m)
Rejects Emplacement Area					
RDH508	03-Apr-18	7660	7.1	10.65	11.15
RDH508	19-Oct-18	7980	7.3	10.71	11.31
RDH508a	03-Apr-18	7640	7.0	18.1	18.57
RDH508a	19-Oct-18	7780	7.1	18.08	18.58
RDH509	03-Apr-18	5350	7.1	10.66	10.95
RDH509	03-Oct-18	5910	7.2	10.73	0.30
RDH509a	03-Apr-18	*	*	15.02	15.28
RDH509a	03-Oct-18	*	*	15.08	15.36
RDH510	03-Apr-18	9200	7.0	10.96	11.56
RDH510	03-Oct-18	8950	7.0	11.19	11.69
RDH510a	03-Apr-18	9440	6.9	10.86	11.31
RDH510a	03-Oct-18	9600	7.1	11.09	11.49
RDH511	03-Apr-18	5440	8.0	8.44	8.44
RDH511	03-Oct-18	5500	8.0	8.47	8.47
RDH511a	03-Apr-18	6810	7.4	8.45	8.45
RDH511a	03-Oct-18	6910	7.4	8.48	8.48
Property Subsidence Management Plans					
Belgrave	06-Apr-18	8250	7.6	8.36	8.36
Belgrave	25-Oct-18	*	*	*	*
GWO38582	06-Apr-18	8870	7.4	6.63	6.93
GWO38582	25-Oct-18	6310	7.6	7.4	8.12
Other Monitoring Bores					
Athlone	06-Apr-18	11280	6.8	7.52	7.52
Athlone	25-Oct-18	11020	7.0	7.92	8.22
Bel1	07-Apr-18	9530	7.3	3.91	3.91
Bel1	25-Oct-18	9650	7.9	4.62	4.62
CAD2	05-Apr-18	*	*	12.42	12.70
CAD2	01-Nov-18	5900	6.1	12.84	13.04
DDH124	05-Apr-18	*	*	14.64	15.26
DDH124	24-Oct-18	*	*	14.7	15.28
DDH212b	05-Apr-18	3980	8.1	27.36	28.06
DDH212b	01-Nov-18	3610	8.2	27.44	28.14
DDH212c	05-Apr-18	3970	8.1	27.24	27.84
DDH212c	01-Nov-18	3700	8.2	27.34	27.94

** Dry or unable to be monitored*

Table E-2 – Statistical Analysis of Groundwater Quality Monitoring Data

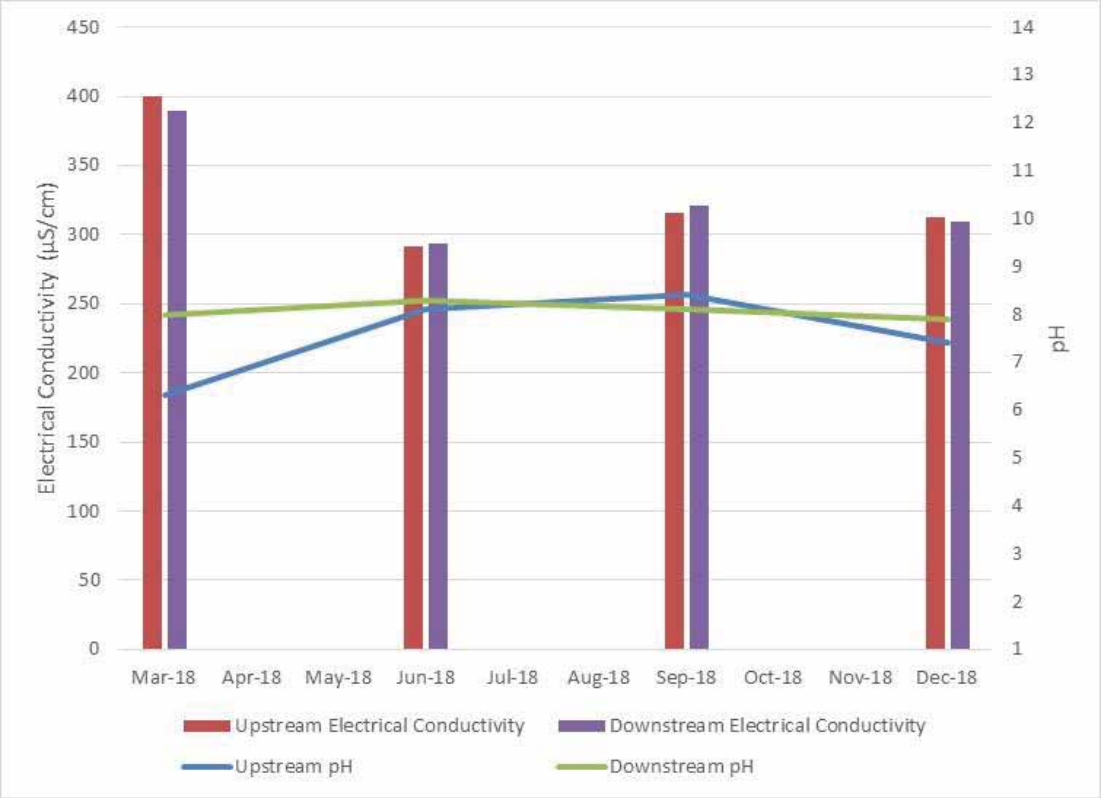
Sample Location	Parameter	Minimum	Mean	Maximum	Variance
Hunter River Alluvium					
JOR1	**pH**	7.0	7.2	7.3	0.3
JOR1	**EC**	2077.0	2126.0	2175.0	98.0
WAL2	**pH**	6.9	7.0	7.2	0.3
WAL2	**EC**	1799.0	1867.5	1936.0	137.0
KAI1	**pH**	6.9	7.0	7.2	0.4
KAI1	**EC**	477.0	492.0	507.0	30.0
FRA1	**pH**	7.1	7.2	7.3	0.2
FRA1	**EC**	4760.0	4875.0	4990.0	230.0
Dart Brook Alluvium					
DAN2	**pH**	7.0	7.0	7.0	0.0
DAN2	**EC**	1787.0	1923.0	2059.0	272.0
WM1A**	**pH**	7.0	7.0	7.0	0.0
WM1A**	**EC**	2620.0	2620.0	2620.0	0.0
ADN1	**pH**	7.0	7.2	7.4	0.4
ADN1	**EC**	2780.0	2870.0	2960.0	180.0
Sandy Creek					
GWO38412	**pH**	6.8	7.0	7.1	0.3
GWO38412	**EC**	3170.0	3385.0	3600.0	430.0
BRO3**	**pH**	8.8	8.8	8.8	0.0
BRO3**	**EC**	1315.0	1315.0	1315.0	0.0
COR3	**pH**	7.9	8.0	8.1	0.2
COR3	**EC**	1830.0	1861.0	1892.0	62.0
WM3	**pH**	6.7	6.7	6.8	0.1
WM3	**EC**	2520.0	3000.0	3480.0	960.0
Coal Seams					
DDH183	**pH**	6.8	6.9	7.0	0.2
DDH183	**EC**	7180.0	7195.0	7210.0	30.0
DDH193	**pH**	6.8	6.8	6.8	0.0
DDH193	**EC**	6430.0	6480.0	6530.0	100.0
Kayuga 1	**pH**	6.8	6.9	7.0	0.2
Kayuga 1	**EC**	7630.0	7690.0	7750.0	120.0
DDH212(a)	**pH**	8.1	8.1	8.2	0.1
DDH212(a)	**EC**	3630.0	3835.0	4040.0	410.0
Regolith					
CAS2	**pH**	6.8	6.9	6.9	0.1
CAS2	**EC**	12920.0	13045.0	13170.0	250.0
CAS4	**pH**	6.8	6.9	6.9	0.1
CAS4	**EC**	10540.0	10585.0	10630.0	90.0
TLON1	**pH**	6.9	7.0	7.1	0.2
TLON1	**EC**	4240.0	4505.0	4770.0	530.0

Sample Location	Parameter	Minimum	Mean	Maximum	Variance
Rejects Emplacement Area					
RDH508	**pH**	7.1	7.2	7.3	0.2
RDH508	**EC**	7660.0	7820.0	7980.0	320.0
RDH508(a)	**pH**	7.0	7.0	7.1	0.0
RDH508(a)	**EC**	7640.0	7710.0	7780.0	140.0
RDH509	**pH**	7.1	7.1	7.2	0.1
RDH509	**EC**	5350.0	5630.0	5910.0	560.0
RDH510	**pH**	7.0	7.0	7.0	0.0
RDH510	**EC**	8950.0	9075.0	9200.0	250.0
RDH510a	**pH**	6.9	7.0	7.1	0.2
RDH510a	**EC**	9440.0	9520.0	9600.0	160.0
RDH511	**pH**	8.0	8.0	8.0	0.0
RDH511	**EC**	5440.0	5470.0	5500.0	60.0
RDH511a	**pH**	7.4	7.4	7.4	0.0
RDH511a	**EC**	6810.0	6860.0	6910.0	100.0
Property Subsidence Management Plans					
GWO38582	**pH**	7.4	7.5	7.6	0.2
GWO38582	**EC**	6310.0	7590.0	8870.0	2560.0
Belgrave**	**pH**	7.6	7.6	7.6	0.0
Belgrave**	**EC**	8250.0	8250.0	8250.0	0.0
Other Bore Holes					
Athlone	**pH**	6.8	6.9	7.0	0.2
Athlone	**EC**	11020.0	11150.0	11280.0	260.0
Bel 1	**pH**	7.3	7.6	7.9	0.6
Bel 1	**EC**	9530.0	9590.0	9650.0	120.0
CAD2**	**pH**	6.1	6.1	6.1	0.0
CAD2**	**EC**	5900.0	5900.0	5900.0	0.0
DDH124	**pH**	*	*	*	*
DDH124	**EC**	*	*	*	*
DDH212b	**pH**	8.1	8.1	8.2	0.1
DDH212b	**EC**	3610.0	3795.0	3980.0	370.0
DDH212c	**ph**	8.1	8.1	8.2	0.1
DDH212c	**EC**	3700.0	3835.0	3970.0	270.0

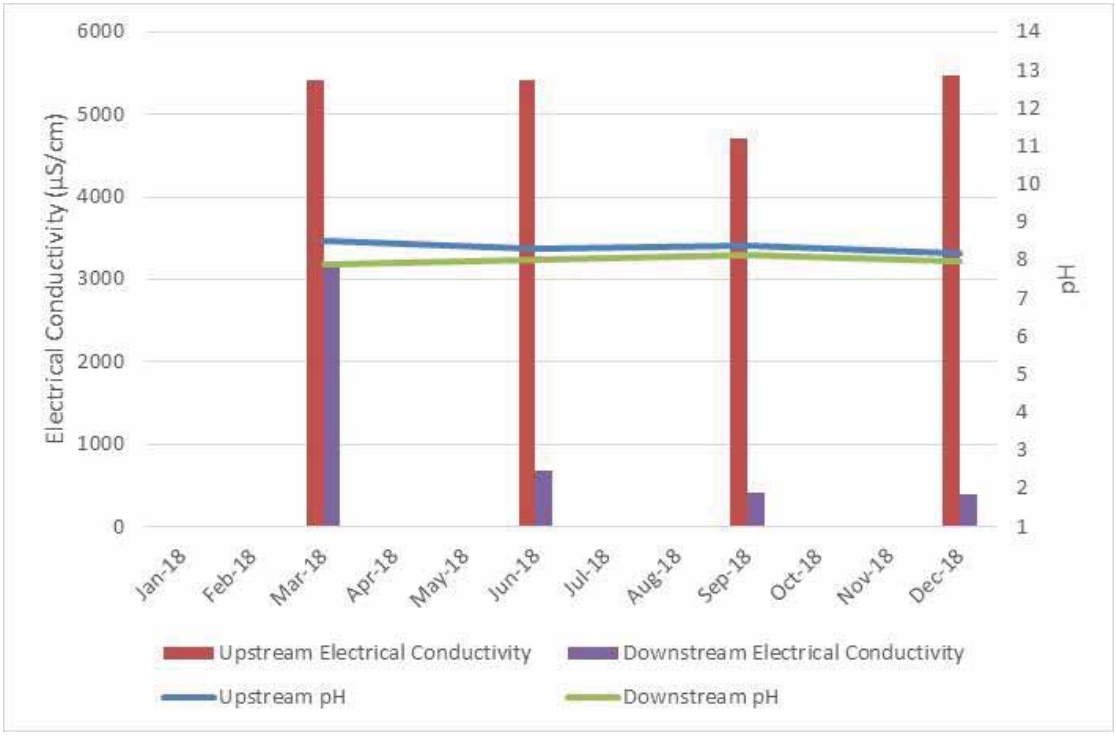
** Dry or unable to be monitored in 2018*
*** One record available*
Note: Standard Deviation Calculations not undertaken due to reduced number of samples collected during the reporting period.

APPENDIX F

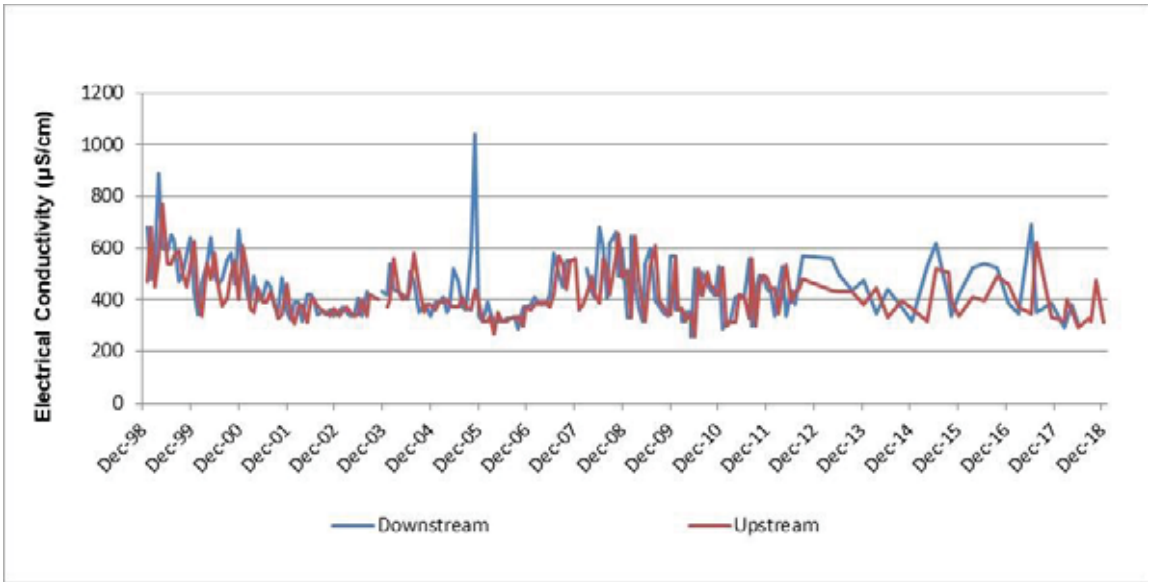
Surface Water Monitoring Summary



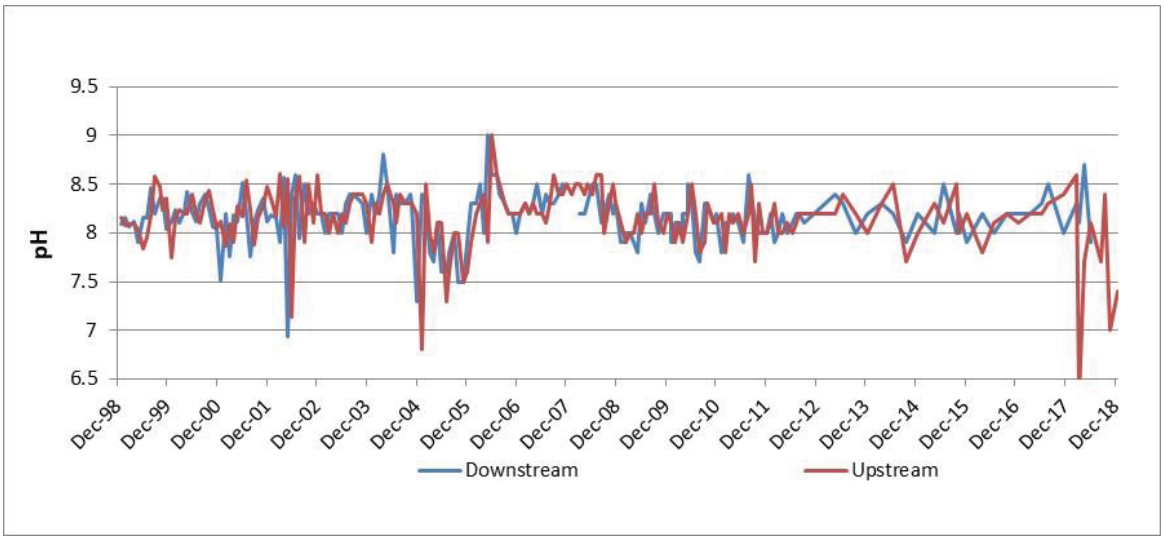
Graph F-1
Quarterly Hunter River EC and pH Results



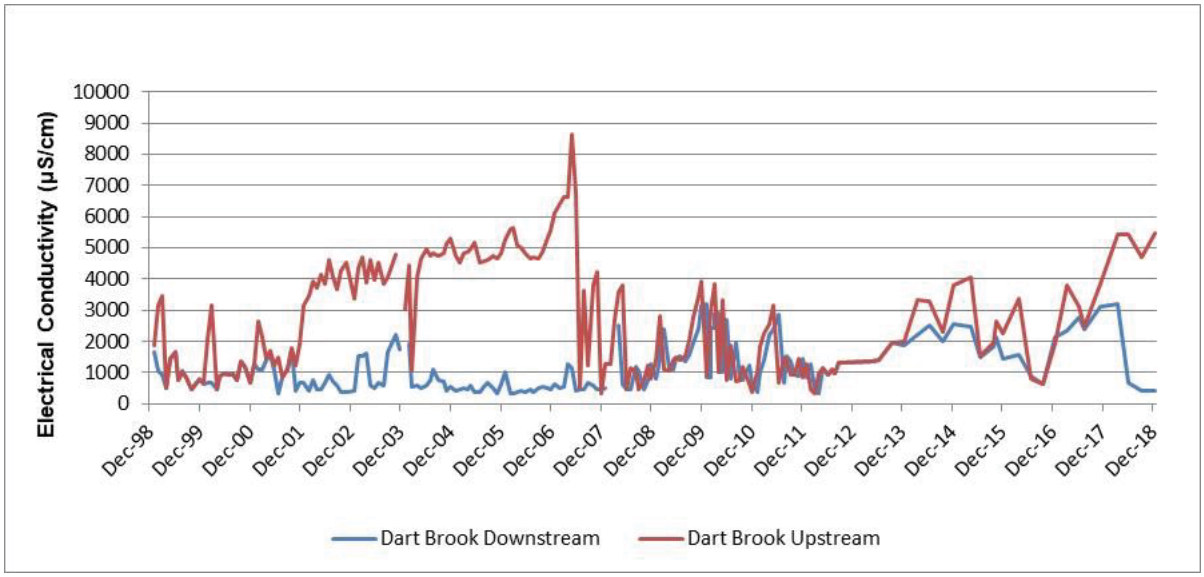
Graph F-2
Quarterly Dart Brook EC and pH Results



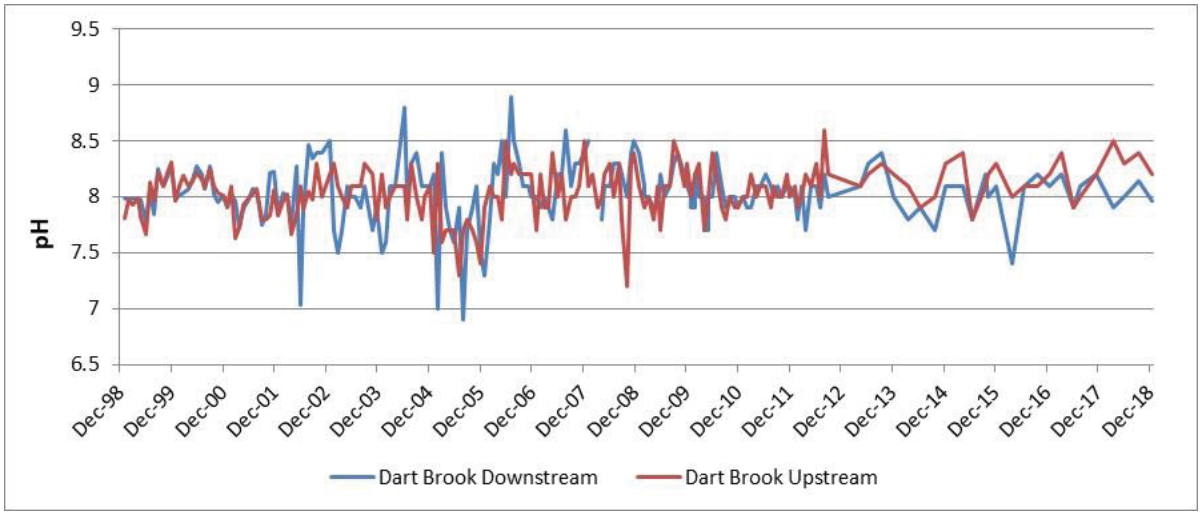
Graph F-3
Hunter River Long Term EC (1999-2018)



Graph F-4
Hunter River Long Term pH (1999-2018)



Graph F-5
Dart Brook Long Term EC (1999-2018)



Graph F-6
Dart Brook Long Term pH (1999-2018)

Table F-1 Annual Surface Water Monitoring Results (18 September 2018)

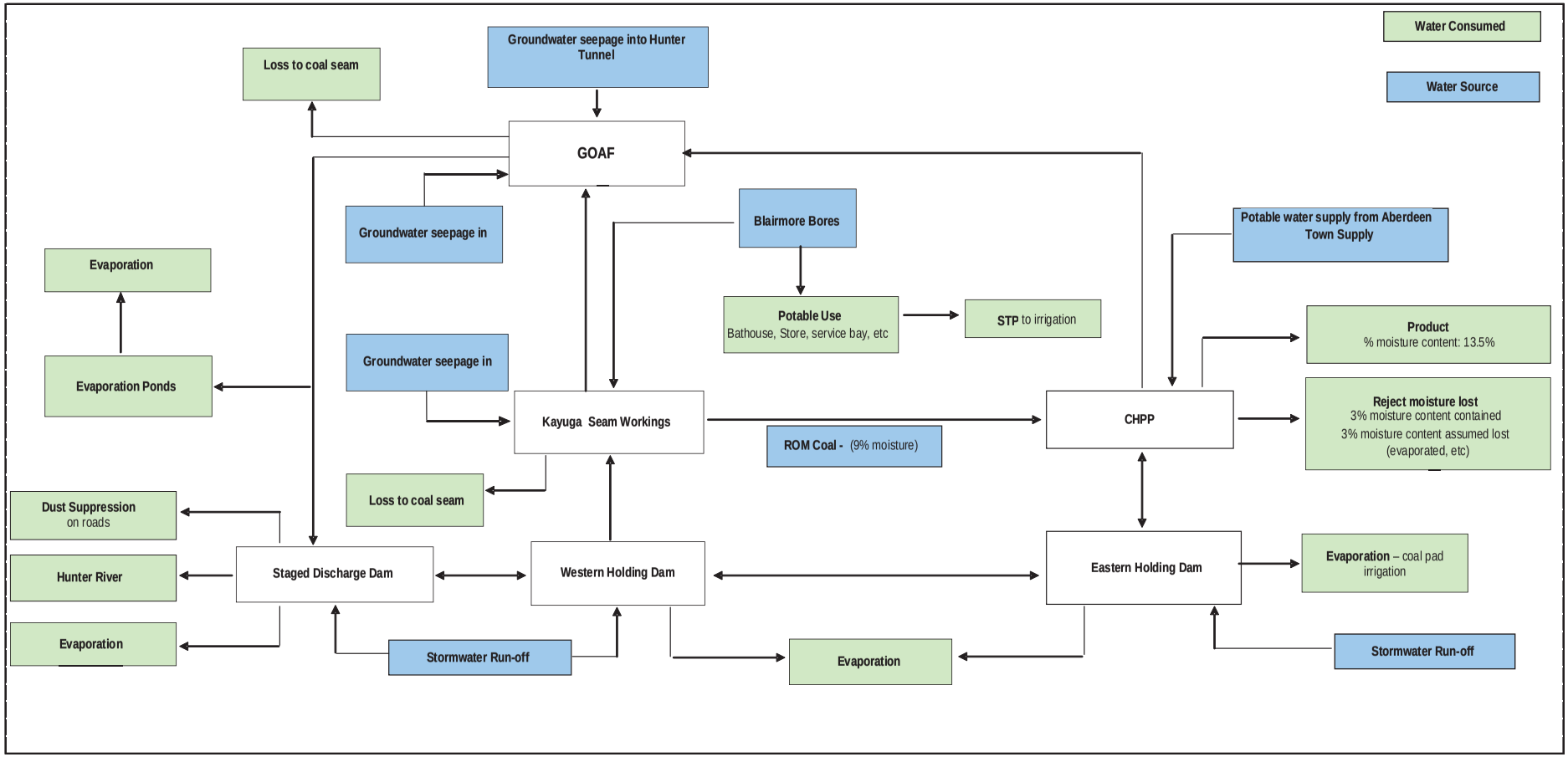
	Bicarbonate mg CaCO3/L	Carbonate mg CaCO3/L	Hydroxide mg CaCO3/L	Biochemical Oxygen Demand mg/O2/L	Calcium - total mg/L	Chloride mg/L	Electrical Conductivity µS/cm - field	Faecal Coliforms cols/100mL	Magnesium total mg/L	MBAS mg/L	Nitrates mg N/L	pH - field	Phosphorus - Reactive mg/L	Potassium - total mg/L	Sodium - total mg/L	Sulphates mg/L	Total Dissolved Solids - calculation mg/L	Total Suspended Solids @105C mg/L
Dartbrook Downstream	152	<1	<1	N/A	N/A	33	402	150	N/A	N/A	<0.01	8.14	0.01	1	29	15	270	5
Dartbrook Upstream	644	17	<1	N/A	N/A	**1210**	**4710**	18 est.	N/A	N/A	<0.01	**8.4**	<0.01	**3**	**679**	**154**	**3160**	47
E2	**6260**	3610	N/A	N/A	**7**	1200	17600	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Eastern Holding Dam	**2170**	**3310**	N/A	N/A	7	776	**10120**	N/A	**11**	<0.1	N/A	**9.7**	<0.01	**16**	**2570**	10	**6780**	**110**
Evaporation Tailing Dam	Dry	Dry	N/A	N/A	Dry	Dry	Dry	N/A	Dry	N/A	N/A	Dry	N/A	Dry	Dry	Dry	Dry	Dry
Hunter Downstream	153	<1	<1	N/A	N/A	16	321	280	N/A	N/A	<0.01	8.1	<0.01	2	31	14	220	<5
Hunter Upstream	138	<1	<1	N/A	N/A	18	316	190	N/A	N/A	<0.01	8.4	<0.01	1	19	14	210	<5
REA	Dry	Dry	N/A	N/A	Dry	Dry	Dry	N/A	Dry	N/A	N/A	Dry	N/A	Dry	Dry	Dry	Dry	Dry
REA Stg 4 Dam	Dry	Dry	N/A	N/A	Dry	Dry	Dry	N/A	Dry	N/A	N/A	Dry	N/A	Dry	Dry	Dry	Dry	Dry
Sewage Treatment Plant	*	*	N/A	**68**	*	*	**6910**	N/A	N/A	N/A	N/A	9.6	N/A	N/A	N/A	N/A	**4630**	N/A
SDD	4160	**4700**	N/A	*	5	**1070**	**14330**	N/A	**10**	<0.1	N/A	9.4	**0.13**	**30**	**4200**	<10	**9600**	30
WHD	**2860**	**3940**	N/A	N/A	4	**870**	**12060**	N/A	**29**	<0.1	N/A	9.6	<0.01	**27**	**3380**	32	**8080**	48
WSD	Dry	Dry	N/A	N/A	Dry	Dry	Dry	N/A	Dry	N/A	N/A	Dry	N/A	Dry	Dry	Dry	Dry	Dry

N/A - Monitoring parameter not required
** Monitoring for parameter not undertaken in 2018*
Bold: Monitoring result exceeded SWMP Trigger Level

APPENDIX G

Water Balance Schematic

Water Balance Schematic



APPENDIX H

Dartbrook Topsoil Assessment

ASSESSMENT OF SOILS

Dartbrook Underground Coal Mine Topsoil Stockpiles

RJ Connolly Environment Management Consulting Pty Ltd
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Contents

Introduction

AQC Dartbrook Management Pty Limited (AQC) is the proprietor of the Dartbrook Mine, located in the Upper Hunter Valley of New South Wales (NSW). Dartbrook Mine is located approximately 10 km north-west of the township of Muswellbrook and approximately 4.5 km south-west of the village of Aberdeen. AQC is a wholly owned subsidiary of Australian Pacific Coal Limited.

Dartbrook Underground Coal Mine was approved in December 1991 for longwall mining in the Wynn and Upper Seams. This approval authorised the development of the East Site and West Site, as well as an access road linking the two sites. The East Site and West Site are also linked by the Hunter Tunnel, which facilitates the conveying of coal from the underground mine to the East Site.

The East Site is located east of the New England Highway and adjacent to the Main Northern Railway Line. Infrastructure at the East Site consists of a Coal Handling and Preparation Plant (CHPP) and a Rail Loadout Facility. Construction commenced in 1993 with the removal of topsoil from the CHPP and coal stockpile areas. This material was largely placed to the west of the CHPP and adjacent to the then Eastern Holding Dam site.

West Site Infrastructure originally consisted of the Wynn Seam Drift, Pit Top Infrastructure, Workshop, Store and Office as part of the original development of the mine. However, in 2002 the Kayuga Boxcut was constructed west of the existing Infrastructure to allow access to the Kayuga Coal Seam. Topsoil was removed from footprint of the Kayuga Boxcut and stockpiled west of the boxcut. Some was used in landscaping and stabilising the areas of surface disturbance and some was stockpiled to comprise the West Site topsoil stockpile.

Scope

The purpose of this report is to address one of the conditions of the Department of Planning and Environment (Resources and Geoscience) (DRG) approval for the Dartbrook Mining Operations Plan (MOP) (Hansen Bailey, 2017). In their letter of approval, DRG required AQC to complete a topsoil audit for the site in 2018 and noted that *"…commentary on the health and suitability of the available soil is also required."* This report seeks to fulfil that requirement.

Method

Volumes of topsoil in the East Site Topsoil Stockpiles and The West Site Topsoil Stockpile have been determined by survey and are shown in plans within the Dartbrook MOP (Hansen Bailey, 2017).

Test pits were dug in the topsoil stockpiles on the East Site and the West Site at locations as indicated in **Figure 1** and **Figure 2**, including:

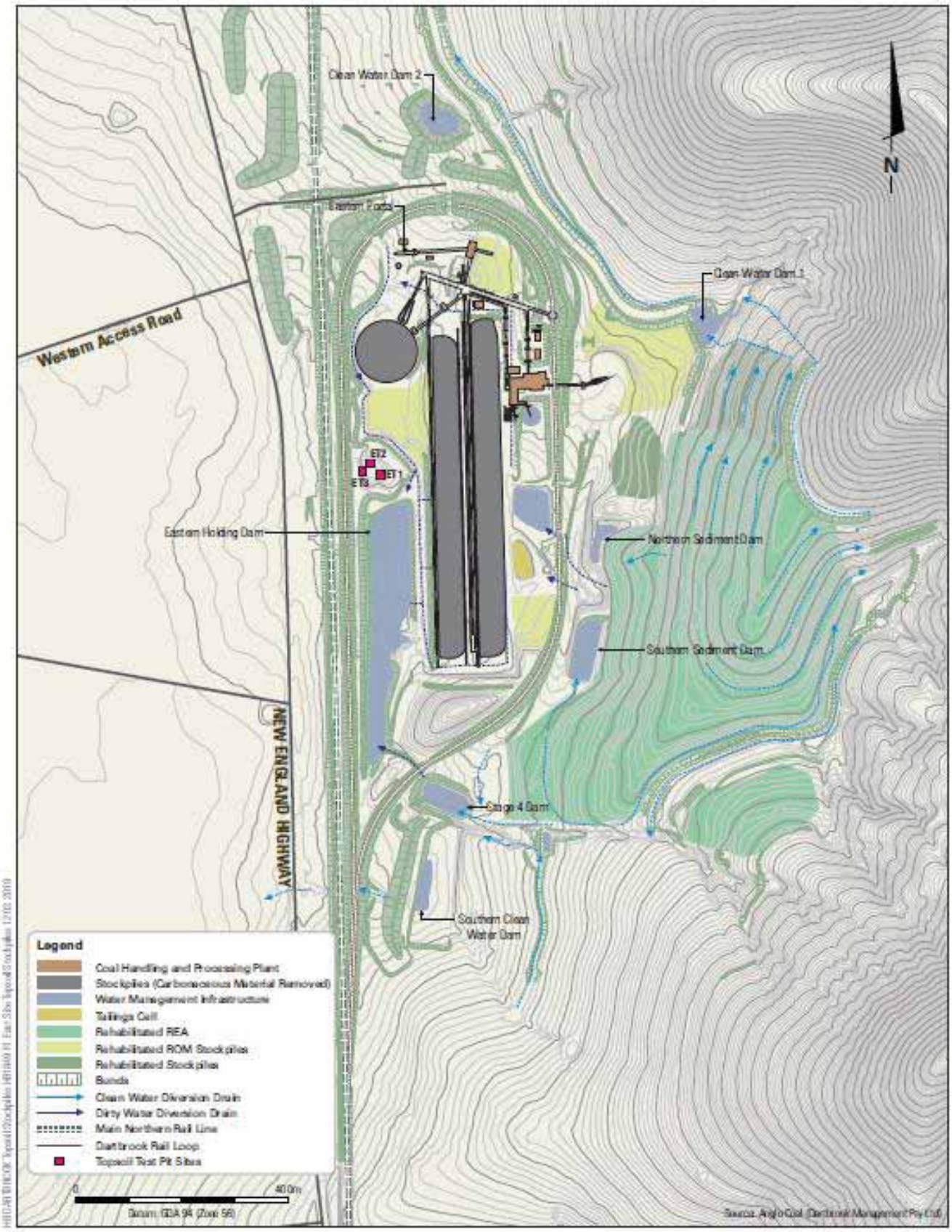
- ET1, ET2 and ET3 (East Site); and
- WT1, WT2 and WT3 (West Site).

The test pits were dug with a backhoe to a depth of approximately 2 metres (the maximum safe working excavation depth of the machine). Samples of the soil were collected from near the surface to 30cm depth to reflect the aerated zone, at about 50cm to include soil likely to be subject to wet/ dry sequences and at depth of maximum dig to include material likely to have had anaerobic conditions. The continuity within each test pit was confirmed in all cases, with no foreign material or rock layer encountered.

Photos were taken of each soil stockpile excavation to indicate the nature and distribution of the stockpiled material. Sampled soil material was field tested for colour and texture. Approximately 1kg samples were also taken from each test pit to fill sample bottles, that were labelled and forwarded to ALS Laboratory for testing of a range of parameters including:

- pH;
- Electrical conductivity (EC);
- ECe;
- Emerson Aggregate Test;
- Texture;
- Exchangeable Calcium (Ca) (meq/100g);
- Exchangeable Magnesium (Mg) (meq/100g);
- Exchangeable Potassium (K) meq/100g;
- Exchangeable sodium (Na) meq/100g;
- Exchangeable sodium (%);
- Cation Exchange capacity (ECE) (meq/100g);
- Colwell K mg/kg;
- Nitrate -N mg/kg;
- Total N mg/kg; and
- Phosphorous (Bray method).

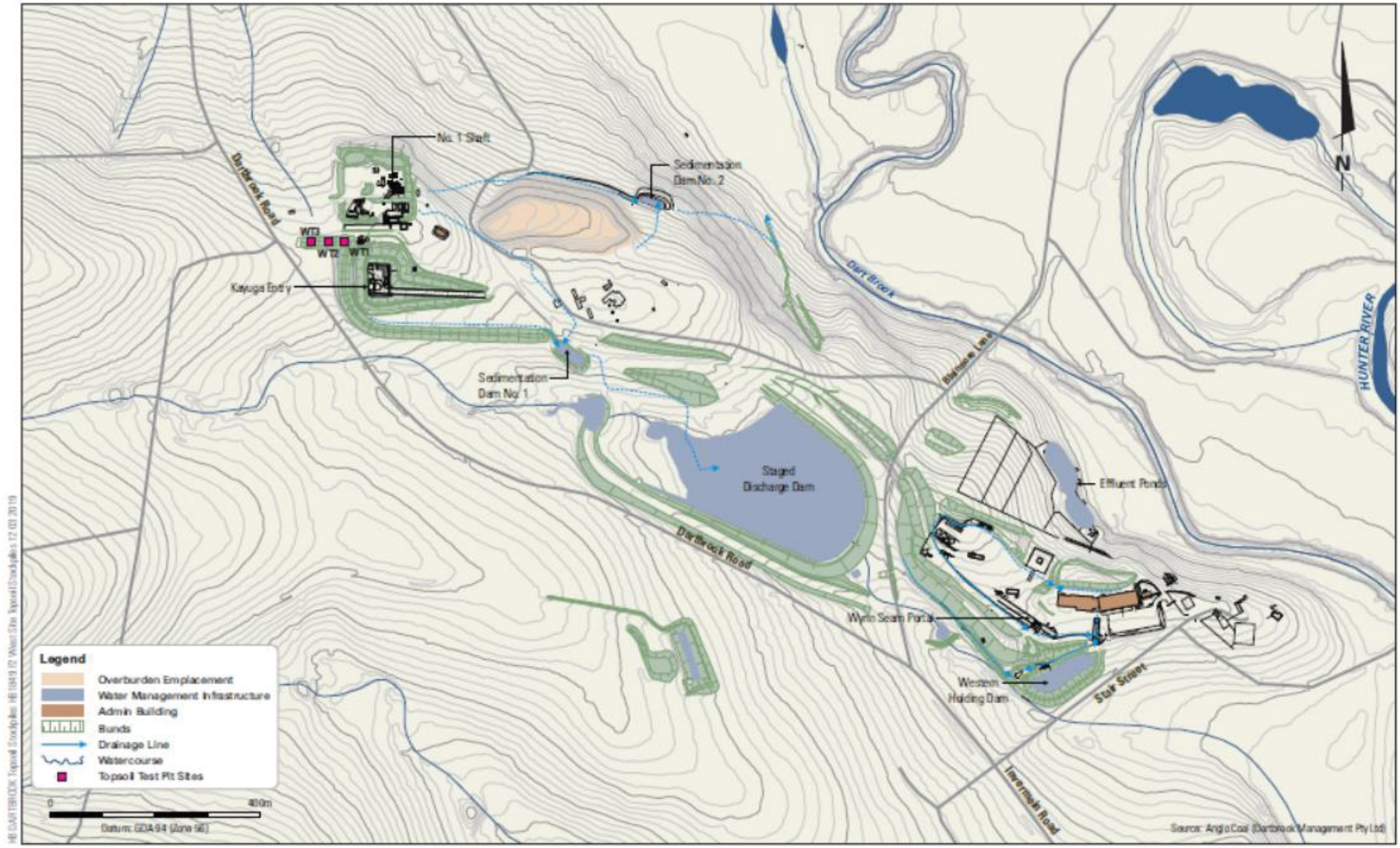
Appropriate attention was paid to chain of custody for each sample.



DARTBROOK MINE

East Site Topsoil Stockpiles

FIGURE 1



DARTBROOK MINE

West Site Topsoil Stockpiles

FIGURE 2

HansenBailey

Australian Pacific Coal

Results

Results from field testing of the soil samples are indicated in **Table 1**.

In the field the stockpiled soil was generally a dark brown colour, mostly well structured and in the clayey texture groups. One sample only (WT1.2) was classified in the clay loam texture group.

Table 1. -Field Testing

Sample No	Depth (cm)	Colour (Munsell)	Structure*	Texture#	Presence of roots
ET1.1	5-10	7.5YR3.2	Strong	MC	Present
ET1.2	40-50	7.5YR3.2	Strong	MC	Present
ET1.3	170-180	7.5YR3.2	Moderate	MC	Not observed
ET2.1	5-10	7.5YR3.2	Strong	LMC	Present
ET2.2	50-60	7.5YR3.2	Strong	LMC	Present
ET2.3	170-180	7.5YR3.3	Weak	SC	Not observed
ET3.1	5-10	7.5YR3.2	Strong	SiC	Present
ET3.2	40-50	7.5YR3.2	Moderate	SC	Present
ET3.3	170-180	7.5YR3.2	Weak	SC	Not observed
WT1.1	5-10	7.5YR3.3	Strong	SC	Present
WT1.2	50-60	7.5YR3.3	Moderate	FSCL	Present
WT1.3	190-200	7.5YR3.3	Strong	LC	Present
WT2.1	40-50	7.5YR4.3	Strong	LC	Present
WT2.2	50-60	7.5YR4.3	Moderate	LMC	Present
WT2.3	190-200	7.5YR3.3	Strong	LMC	Present
WT3.1	10-20	7.5YR3.3	Strong	LC	Present
WT3.2	40-50	7.5YR3.3	Strong	LMC	Present
WT3.3	170-180	7.5YR3.4	Strong	LMC	Not observed

*Following Northcote (1979) classification

Where:

Structureless is no observable aggregation of particles; and

Weak is where less than 1/3 material present as peds, moderate has 1/3rd-2/3rd material present as peds, Strong structure indicated more than 2/3rd peds present.

Texture Classes follow Northcote (1979) where:

FSCL is fine sandy clay loam;

SC is sandy clay;

SiC is silty clay;

LC is light clay;

LMC is light medium clay; and

MC is medium clay, thus representing an increasing clay content.

Results from the laboratory testing of the soil samples is indicated in **Table 2** and **Table 3**.

Table 2 East Site Soil Stockpile Test Results

Sample	**ET1.1**	**ET1.2**	**ET1.3**	**ET2.1**	**ET2.2**	**ET2.3**	**ET3.1**	**ET3.2**	**ET3.3**
pH	8.0	8.6	8.0	8.3	8.8	8.1	8.4	8.5	7.9
EC	333	176	454	361	172	484	255	155	484
ECe	2.99	1.58	4.09	3.25	1.55	4.36	2.29	1.39	4.36
EAT	4	4	4	4	4	4	4	4	4
Texture	CL	SCL	CL	CL	CL	CL	CL	CL	CL
Exchangeable Ca meq/100g	6.9	13.6	6.8	8.2	14.1	7.6	19.5	7.4	8.1
Exchangeable Mg meq/100g	2.7	8.2	3.1	2.8	10.4	3.5	5.7	4.2	3.6
Exchangeable K meq/100g	1.8	0.6	0.6	1.9	0.4	0.7	<0.2	<0.2	<0.2
Exchangeable Na meq/100g	0.8	19.2	2.3	<0.2	0.8	7.0	<0.2	<0.2	<0.2
Exchangeable sodium%	6.6	46.1	17.9	<0.2	3.2	37.3	<0.2	<0.2	<0.2
CEC meq/100g	12.2	41.7	12.9	12.9	25.8	18.7	29.1	11.7	12.6
Colwell K mg/kg	2210	<200	695	2180	<200	609	1800	<200	783
Nitrate -N mg/kg	118	17.5	197	109	12.8	229	73.5	20.5	249
Total N mg/kg	2420	2320	1840	1810	1510	1270	2570	1820	1640
P (Bray)	<1	<1	1.7	<1	1.2	<1	1.2	<1	5.0

Where:

EC is electrical conductivity, units µS/cm;

EAT is Emerson Aggregate Test, measuring aggregate stability in water, classes 1-8;

Texture Classes, CL being clay loam and SCL being sandy clay loam;

Exchangeable Cations expressed as milliequivalents per 100g;

CEC is cation exchange capacity, being the sum of the major cations present;

Colwell K measures the amount of potassium available for plant uptake;

Nitrate nitrogen measures the amount of nitrogen immediately available to plants;

Total N is the amount of nitrogen present in the soil and includes non-available N; and

P (Bray) is a measure of the amount of phosphorus available to plants.

Table 3 West Site Topsoil Stockpile Test Results

Sample	WT1.1	WT1.2	WT1.3	WT2.1	WT2.2	WT2.3	WT3.1	WT3.2	WT3.3
pH	6.9	6.5	7.7	6.3	6.4	6.5	6.7	7.7	8.1
EC	116	189	384	181	277	506	164	93	518
EAT	3	3	3	3	3	3	3	3	3
ECe	1.16	1.89	3.46	1.81	2.77	4.55	1.64	0.93	4.66
Texture	SCL	SCL	CL	SCL	SCL	CL	SCL	SCL	CL
Exchangeable Ca meq/100g	9.1	10.1	5.9	9.7	9.0	9.4	9.9	3.1	5.1
Exchangeable Mg meq/100g	3.0	4.0	4.2	3.7	4.1	3,5	5.1	4.4	4.1
Exchangeable K meq/100g	2.6	o.8	1.6	3.2	0.7	0.9	2.8	0.5	1.0
Exchangeable Na meq/100g	0.2	0.4	6.2	<0.1	0.4	<0.1	0.2	<0.2	0.3
Exchangeable sodium%	1.3	2.3	34.6	0.5	3.1	0.5	1.4	<0.2	2.7
CEC meq/100g	14.9	15.3	17.8	16.6	14.3	13.8	18.1	8.0	10.5
Colwell K mg/kg	1950	471	976	2180	514	655	2030	355	2670
Nitrate -N mg/kg	20.9	68.4	190	65.2	139	382	61.1	16.7	276
Total N mg/kg	2490	1880	1620	2460	1800	910	2840	1340	920
P (Bray)	<1.0	<1.0	<1.0	<1,0	2.2	<1.0	1.8	<1.0	<1.0

Where:

EC is electrical conductivity, units µS/cm;

EAT is Emerson Aggregate Test, measuring aggregate stability in water, classes 1-8;

Texture Classes, CL being clay loam and SCL being sandy clay loam;

Exchangeable Cations expressed as milliequivalents per 100g;

CEC is cation exchange capacity, being the sum of the major cations present;

Colwell K measures the amount of potassium available for plant uptake;

Nitrate nitrogen measures the amount of nitrogen immediately available to plants;

Total N is the amount of nitrogen present in the soil and includes non-available N; and

P (Bray) is a measure of the amount of phosphorus available to plants.

Conclusions

Soils in the Dartbrook area have been mapped by the Soil Conservation Service (Kovac and Lawrie, (1991)). The footslopes of Browns Mountain, the location of the East Site infrastructure, was mapped as the Brays Hill Soil Landscape. The major soil types present are Red clays and Black Earths with the possibility for some Yellow Solodic Soil along drainage lines (likely minor). Soil was stripped from this soil landscape area in the initial phase of construction for the East Site, likely in 1993/94. The East Site topsoil stockpiles and test pits ET1, ET2 and ET3 comprise some of this material. Other topsoil originally stripped was used for existing stabilisation and rehabilitation purposes. The remaining stockpiles may therefore have been in place for about 25 years (see **Figure 1**).

On the Western Site (western side of the Hunter River) the Kayuga Boxcut was constructed to provide access to the Kayuga Seam. This area is within the Dartbrook Soil Landscape where Brown Clays are predominant. Non-calcic brown clay soils also occur in mid-slope positions. The Kayuga Box Cut Topsoil Stockpile is likely to have been in place for approximately 15 years (see **Figure 2**).

Topsoil Properties

pH

The East Site topsoil stockpiles had a mean pH of 8.3, range 7.9-8.8, this indicates a moderately alkaline soil. There appears no trend with depth of material within the stockpile.

The West Site topsoil stockpile has on average neutral pH 7.0, range 6.3 to 8.1. At the three sites WT1, WT2 and WT3, the deepest samples had the highest pH.

The pH range is satisfactory at all test pits for growth of grasses and legumes. There is unlikely to be problems with nutrient availability or legume inoculation.

Electrical Conductivity

Electrical Conductivities have been reported as EC(1:5) in S/cm. These values are converted to saturation extract values by a multiplier factor depending on soil texture. Saturation extract values ECe (dS/m) allow reference to established standards as displayed below in **Table 4**.

Table 4 Saline Soils Rating

Rating	ECe (dS/m)	Effect on Plants
Non-saline	<2	Salinity effects negligible
Slightly saline	2-4	Yield reduction sensitive plants
Moderately saline	4-8	Yield reductions in many crops
Highly saline	8-16	Tolerant crops only yield satisfactorily
Extremely saline	>16	Very tolerant crops only yield satisfactorily

Based on the EC values from **Table 2**, East Site topsoil stockpiles ranged 1.39-4.36 dS/m, with the mean being 2.87 dS/m. These soils are thus slightly saline on average, where three samples were over 4 dS/m and therefore moderately saline. These samples were from the greatest excavation depths in the stockpiles at 1.7-1.8m depth below stockpile surface level. It may be that leaching of salt from surface materials has occurred with accumulation at depth, or seepage from upslope has occurred, or the stockpile may have been located on a naturally saline area.

West Site Topsoil Stockpiles range 0.93-4.66 dS/m, with mean salinity being 2.54 dS/m, or slightly saline. Two samples exceeded 4 dS/m and were moderately saline. These were at depth in the stockpile. Similar to the Eastern Stockpiles, downward leaching of salts may have occurred since the stockpiles were established.

Salinity levels of 'slightly saline' are quite suitable for use in rehabilitation activities at mine sites. While some sensitive plants such as broad leaf vegetable and flowers may not grow well, pasture plants are generally reasonably salt tolerant, with some grasses like Kikuyu and Rhodes Grass being very salt tolerant. The stockpiled topsoil will be suitable for rehabilitation programs. The base of the stockpiles appears to contain the saltier layers of soil. Shape and layering of the stockpiles indicates the stockpiles were built using scrapers. If the material was reclaimed from the stockpile for rehabilitation using a frontend loader and trucks, it would be effectively mixed by working the full face of the stockpiled soil prior to soil material being respread in rehabilitation areas.

Emerson Aggregate Test

Emerson Aggregate Testing of the materials indicates the stability of soil aggregates. It determines if slaking (surface sealing) will occur. Low Emerson Aggregate Classes (1-3) may have dispersion of clay materials and be susceptible to tunnelling.

The East Site stockpile materials were assessed as Emerson Class 4. Soil aggregates of this class generally remain stable in water without slaking or dispersion. The soil is thus well structured and likely to support the establishment of common pasture species. Existing rehabilitated areas at the Dartbrook Reject Emplacement Area have been capped with similar material and have supported such pasture species for over ten years.

The West Site stockpile materials are ranked as Emerson Class 3. This material slakes on wetting, indicating particles may have a tendency to surface seal, particularly following heavy rain. The material is generally suitable for soil conservation earthworks and where slight dispersion occurs can form contour banks and dams that will hold water. This material should be satisfactory for rehabilitation purposes and would likely be improved by the addition of gypsum to counter the tendency for surface sealing.

Exchangeable Cations

Mean calcium cations in East Site Soils was 10.2 meq/100g being a high Ca level. Ca/Mg ratio is 2 which is satisfactory. Exchangeable sodium percentage was 22%. This is a high sodium percentage that was skewed by two very high levels recorded at test pits ET1.2 and ET2.3. The addition of gypsum during the rehabilitation preparation process will likely also benefit these materials. Mean cation exchange capacity (CEC) was 19.7 meq/100g which is in moderate rating for soils. That indicates this material should have a reasonable capacity to retain nutrients if fertilisers are applied.

Calcium levels in the West Site stockpiles was 7.9 mg/kg, rating as moderate. The Ca/MG ratio was 1.9, rating as low. Mean exchangeable sodium percentage was 5.8 that is high but skewed by a high level at WT1.3. This soil would also be improved by incorporating gypsum during the rehabilitation preparation process. Cation exchange capacity mean was 14.4 meq/100g, rating as a moderate capacity to retain added nutrients.

Colwell Potassium

Mean Colwell K for the East Site stockpiles was 1,380 mg/kg, ranging <200 – 2,200 mg/kg. The lowest Colwell K levels were at intermediate depth of about 50cm. The level of Colwell K is high but as these are relatively clayey soils, availability may be restricted. Distribution was higher at the surface, lower in intermediate layers and raised at the base of the stockpiles. This may reflect long term downward leaching of K, with current surface level accumulation due to two years of drought conditions.

At the West Site stockpile the mean Colwell K was 1,311 mg/kg, with range 355 to 2,670 mg/kg. The West Site stockpile results showed a more even K distribution than the East Site. These soils are also lighter textured than the East Site Stockpiles, with K more easily leached.

Nitrate Nitrogen

Nitrate N is a measure of how much nitrogen is available to plants. At the East Site mean Nitrate N was 114 mg/kg, with a range of 12.8 – 249 mg/kg. West Site Stockpiles had mean Nitrate N levels of 135 mg/kg, with a range 16.7 – 276 mg/kg. These are adequate levels and may have built up during the prolonged dry period. Rehabilitation programs could use a legume component to pastures (clovers and Lucerne) to assist continued maintenance of adequate nitrogen levels.

High nitrogen level following drought periods can result in prolific weed growth. Stockpiles should be regularly slashed to encourage thicker grass growth and stop weeds setting seed. Where weed growth persists, appropriate herbicide should be applied to control infestation. Control of the weed Galenia is particularly important in the Hunter Valley.

Total Nitrogen

The East Site Stockpiles had mean Total N of 1,911 mg/kg with a range 1,270 – 2,570 mg/kg. West Site samples indicted mean Total N of 1,806 mg/kg, ranging from 910 – 2,840 mg/kg. Soils are rated by Hazelton & Murphy, et al (2007) as medium in organic matter if 0.15%-0.25% of the total volume, or 1,500 – 2,500 mg/kg Total N. The stockpiles have reasonable levels of Total N because they generally consist of surface soils containing plant matter consisting of roots and leaves. The surface soil of the stockpile has likewise supported plant growth and accumulation of leaf and root material during the stockpile life. Due to drought conditions surface cover was restricted, but plant roots were present down to 2m depth.

Available Phosphorus

P (Bray) measures the phosphorus component of soils which is available to plants. Mean P (Bray) for East Site Stockpiles was 2.3 mg/kg ranging from <1 to 5 mg/kg. Five samples were less than 1 (limit of measurement). The West Site had 7 samples <1 mg/kg, with mean of two other samples being 2.3 mg/kg. All samples are low in available phosphorus and would respond to the addition of fertiliser during the rehabilitation process.

Recommendations

The East Site Topsoil Stockpiles and the West Site Topsoil Stockpile are composed of A-horizon soil stripped from the surface of previously disturbed areas and placed in the stockpiles for between 15 and 25 years. Layering of the material indicated stockpiles were constructed using scrapers. Material has been placed above ground level at these locations, so it is unlikely to be affected by groundwater or any other seepage but rather some downward leaching of soluble salts to the base of stockpiles.

The material is generally suitable for supporting pasture growth. The pH is generally slightly alkaline but not at a level which would limit pasture development. Salinity is generally at slightly saline levels only, so quite suitable for common ground stabilising grass cover species. The West Site Stockpiles contain slightly lighter textured soil that was rated Emerson Aggregate Test Class 3, indicating slight dispersion could occur with surface sealing and higher runoff. Addition of natural gypsum to the soil at the rate of approximately 10t/ha is recommended at the time of its use. This would also benefit soil structure where a high sodium percentage was indicted (such as for test pit WT1.3).

The soils are generally fairly clayey soils, with moderate CEC's. The soils thus have a fair capacity to retain added nutrients in the form of fertilisers. Soil phosphorus levels were low. Nitrate nitrogen levels appeared high at the time of sampling which may be because of the prevailing prolonged dry period (resulted in a high level of mineralisation of the organic matter present but little plant uptake or leaching). Similarly, potassium levels appeared adequate, but clayey soils are known to increase difficulty for plants to extract potassium (due to osmotic pressure). Hence, when reusing this soil, the application of a broad spectrum NPK fertiliser at least initially prior to sowing rehabilitated areas with pasture species is recommended.

The stockpiles had medium organic matter present as indicted by Total N. Because of long term storage, microorganism activity has likely been restricted at depth. Application of organic solids such as mulched cow manure would be beneficial when reusing this soil.

Recommendation for use of Stockpiled Topsoil in Site Rehabilitation

1. Reclaim material using frontend loader and truck.
2. Spread evenly on slope to depth of at least 10cm.
3. Use tyned implement to lightly cultivate on the contour to tie to subsurface material.
4. Incorporate fertiliser and gypsum and organic solids (weed free) prior to sowing:
    i. Fertiliser Complete such as 11:17:9 at 400kg/ha or equivalent;
    ii. Mulched cow manure at 10t/ha; and
    iii. Gypsum at 10 t/ha.
5. Seed Mixture: All or some of the following species could be used as they have been found to be successful in grazing trials on the Dartbrook REA rehabilitation. Sowing depends on season and long-term rehabilitation targets for each.

Species	**Rate sowing (kg/ha)**
Kikuyu	5
Rye Grass	10
Phalaris	5
Green Panic	5
Couch	5
Rhodes Grass	5
White Clover	5
Lucerne	5
Medic	5

Photographs of Topsoil Stockpile Soil Test Pits

Photo No1. East Site Stockpile Site ET1

Photo No.2. East Site excavation shows layering of stockpiled material (test pit ET1)

Photo No.3. East Site ET1 Profile

Photo No.4. East Site Test Pit ET2

Photo No.5. East Site Test Pit ET3

Photo No.6. West Site Test Pit WT 1

Photo No.7. West Site Soil Test Pit WT2

Photo No.8. West Site Test Pit WT3 Profile

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