RAVENSWORTH
OPEN CUT

GLENCORE

Ravensworth Operations

Annual Review 2020

Name of Operation	Ravensworth Complex
Name of Operator	Ravensworth Operations Pty Limited
Development Consent/ Project Approval #	PA 09_0176 and DA 104/96
Holder of Development Consent/ Project Approval	Ravensworth Operations Pty Limited and Resource Pacific Limited Pty Limited
ROC Titles/ Mining Leases	ML1325, ML 1357, ML1393, ML1502, ML 1576, ML 1669, ML 1683, MLA 322, CL 380, CL 378, CL 580, CCL 723, CCL 739
RUM Titles/ Mining Leases	ML 1348, ML 1349, ML 1398, ML 1416, ML 1477, ML 1484, ML 1485, ML 1495, ML 1506, ML 1564, ML 1580, ML 1581, ML 1591, ML 1595, ML 1625, ML 1667, ML 1668
Name of holder of Mining Lease	Ravensworth Operations Pty Limited
Water Licence #	20AL210980 (replaces 20SL037759), WAL10771 (replaces 20SL045564), 20BL170797, 20BL170749, 20BL170462, 20BL171344, 20WA200463, 20BL171784, 20BL171785, 20BL171786, 20BL171787, 20BL171788, 20BL171789, 20BL171790, 20BL171996, 20BL172050, 20BL172051, 20BL172052, 20BL172710, 20BL172711, 20BL173560, 20BL173561, 20BL173562, 20BL173563, 20BL173566, 20BL173574, 20BL168240, 20WA200745, 20AL200744 (WAL9050), 20BL171346, 20BL171394, 20BL170776, 20BL171459, 20BL171476, 20BL172413, 20AL217052 (replaces 20BL172442), 20BL172735, 20BL173096, WAL13102, 20BL171422, 20BL168023, WAL1046, WAL8964, WAL1325, 20AL200462, 20AL200744, 20AL200890 (replaces 20SL608030), 20CA200975, 20WA210981, 20AL200743
Name of holder of Water Licence #	Ravensworth Operations Pty Limited/ Cumnock
MOP/ RMP start date	1 January 2021
MOP/ RMP end date	31 December 2023
Annual Review start date	1 January 2020
Annual Review end date	31 December 2020

I, Klay Marchant, certify that this audit report is a true and accurate record of the compliance status of Ravensworth Complex for the period 1 January 2020 to 31 December 2020 and that I am authorised to make this statement on behalf of Ravensworth Complex.

Note.

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.

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 authorise reporting officer	Klay Marchant
Title of authorise reporting officer	Environment and Community Manager
Signature of authorised reporting officer	
Date	31 March 2021

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1. Statement of Compliance

A summary of compliance at Ravensworth Complex is provided in ***Table 1-1.***

Approvals	Compliant
Project Approval 09_0176	NO
DA 104/96	YES
EPBC 2010_5839	YES
EPL 2652	NO
ML# 1348	YES
ML# 1357	YES
ML# 1416	YES
ML# 1495	YES
ML# 1398	YES
ML# 1506	YES
ML# 1564	YES
ML# 1580	YES
ML# 1581	YES
ML# 1591	YES
ML# 1595	YES
ML# 1625	YES
ML# 1667	YES
ML# 1668	YES
ML# 1669	YES
ML# 1683	YES
CL# 380	YES
CL# 378	YES
CL# 580	YES
CCL# 723	YES

Approvals	Compliant
CCL# 739	YES
20AL210980	YES
WAL 10771	YES
20BL170797	YES
20BL170749	YES
20BL170462	YES
20BL171344	YES
20WA200463	YES
20BL171784	YES
20BL171785	YES
20BL171786	YES
20BL171787	YES
20BL171788	YES
20BL171789	YES
20BL171790	YES
20BL171996	YES
20BL172050	YES
20BL172051	YES
20BL172052	YES
20BL172710	YES
20BL172711	YES
20BL173560	YES
20BL173561	YES
20BL173562	YES
20BL173563	YES
20BL173566	YES

Approvals	Compliant
20BL173574	YES
20BL168240	YES
20WA200745	YES
20AL200744 (WAL 9050)	YES
20BL171346	YES
20BL171394	YES
20BL170776	YES
20BL171459	YES
20BL171476	YES
20BL172413	YES
20AL217052	YES
20BL172735	YES
20BL173096	YES
WAL 13102	YES
20BL171422	YES
20BL168023	YES
WAL 1046	YES
WAL 8964	YES
WAL 1325	YES
20AL200462	YES
20AL200744	YES
20AL200890	YES
20CA200975	YES
20WA210981	YES
20AL200743	YES

Table 1-1 - Statement of Compliance

The non-compliances during the 2020 reporting period are discussed further in ***Section 11***. The non-compliances categories are described in **Table 1-2**. A summary of the non-compliances with Project Approval 09_0176, DA 104/96, EPL 2652 and relevant Mining Leases during the reporting period have been summarised in **Table 1-3**.

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

Table 1-2 - Statement of Compliance Key

Relevant approval	Condition #	Condition description	Compliance Status	Comment	Where addressed in the Annual Review
PA09_0176	Schedule 3, Condition 20	All reasonable and feasible avoidance and mitigation measures are undertaken so that particulate matter emissions generated by the Ravensworth mine complex do not exceed the criteria listed in Table 10 (short term PM_{10} criterion) at any residence on privately-owned land or on more than 25 percent of any privately-owned land.	Non-compliant	22 exceedances of the PM_{10} short term criteria occurred in 2020.	**Section 6.4.2.2** and **Section 11**
PA09_0176	Schedule 3, Condition 32	The proponent shall implement the biodiversity offset strategy as outlined in Table 16 and as generally	Non-compliant	Detailed ground surveys were completed for the four offset areas for the Ravensworth Operations Project	**Section 6.5.4** and **Section 11**

Relevant approval	Condition #	Condition description	Compliance Status	Comment	Where addressed in the Annual Review
		described in the EA (and shown conceptually in Appendix 7), to the satisfaction of the Secretary.		by a qualified surveyor, in accordance with survey guidelines stipulated by BCD (formerly OEH) for CAs. During a review of the survey results, Ravensworth has become aware that three of the offset areas are smaller than the areas described in Table 16 within Condition 32 of the Project Approval.	
PA09_0176	Schedule 3, Condition 51	Manage on-site sewage treatment and disposal in accordance with the requirements of Council	Non-compliant	Sewage treatment plant water quality results for August were outside of the acceptable limits imposed by Singleton Council.	**Section 11**
EPL 2652	M2.2	Continuously monitor PM_{10} at Point 9 and 10 (TEOM G1 and G2)	Non-compliant	Continuous PM_{10} data was not acquired.	**Section 6.4.2.2** and **Section 11**
EPL 2652	M11.1	Noise Monitoring at Point 16.	Non-compliant	In July 2020 the Ravensworth Operations EPL 2652 was varied. At the request of the EPA, the monitoring location was varied from Site 2 (monitored January 2020 – June 2020) to EPL Point 16. At the time of licence being issued, agreement between the landholder and Ravensworth had not been reached.	**Section 6.3.3-6.3.4** and **Section 11**

Table 1-3 - Summary of Non-Compliances

2. Introduction

The Ravensworth Complex comprises the following operations:

- Ravensworth Open Cut (ROC), which includes Narama, Narama West and Ravensworth North (this reporting period mining in Ravensworth North only);
- Ravensworth Underground Mine (RUM); and
- Ravensworth Coal Handling and Preparation Plant (RCHPP).

Figure 2.1 shows the layout of the Ravensworth Complex and **Figure 2.2** shows the regional context.

This Annual Review is for the reporting period 1 January 2020 to 31 December 2020. It includes PA 09_0176 (ROC), DA104/96 (RUM), various mining leases, and associated environmental management plans for the Ravensworth Complex. The project approval and mining lease boundaries are shown on **Figure 2.3**.

Copies of this Annual Review will be made available to the Department of Planning, Industry and Environment (DPIE), the Resources Regulator (RR), the Biodiversity and Conservation Division (BCD), Natural Resource Access Regulator (NRAR), Singleton Shire Council and the Environment Protection Authority (EPA). Copies and/or a link to the company website will also be provided to the members of the Ravensworth Complex Community Consultative Committee (CCC). A copy will also be made available on the Ravensworth Open Cut and Ravensworth Underground Mine website in accordance with PA 09_0176 and DA 10496 for any public person to access.

2.1 The Ravensworth Complex

2.1.1 Ravensworth Open Cut (ROC)

ROC is owned and operated by Ravensworth Operations Pty Limited, which is managed by Glencore. An Environmental Assessment (EA) was submitted for the Ravensworth Operations Project in February 2010. The EA was approved by the Department of Planning, Infrastructure and Environment (DPIE) on 11 February 2011 (PA 09_0176). The approval granted the expansion of existing approved mining operations at ROC and enabled the consolidation of existing approvals for open cut mining and infrastructure within the Ravensworth area. The single project approval has enabled the amalgamation of operational aspects of the mining operations, which has facilitated a consistent and integrated approach to environmental management and mine planning. Details of modifications to PA 09_0176 are included in ***Section 3.1***.

2.1.2 Ravensworth Underground Mine (RUM)

RUM has been managed by Glencore since February 2008. RUM is a joint venture operation between Resource Pacific Pty Limited (owned by Glencore) and Posco.

The area of land within the approved RUM development consent boundaries is owned by RUM, AGL Macquarie, Daracon, Ravensworth Operations Pty Limited, Glendell, and I. Bowman Pty Ltd. Where necessary, RUM undertakes consultation with these relevant parties.

RUM operates under development consent DA 104/96 dated 20 November 1996 (File No. N95/00395/001). A ninth modification (MOD 9) was submitted during 2012, primarily relating to changes in the longwall (LW) layout of the Liddell Seam (Liddell Seam Project). MOD 9 was approved by the DPIE on 20 June 2013.

The original 1996 development application was supported by an EA for the construction and operation of an underground coal mine. Through subsequent EA modifications, RUM has an approved maximum production of 7 Mtpa of ROM coal.

RUM's existing approved surface facilities include workshops, stores, employee amenities, access roads, offices, car parks, open air storage areas, sewage treatment facilities, water management infrastructure, ventilation infrastructure, and diesel and oil storage. ROM coal is transferred to the RCHPP for processing. Export coal is loaded into trains at this facility and transported to the Port of Newcastle along the Newdell Branch Line and Main Northern Railway.

RUM was placed in Care and Maintenance in October 2014.

In accordance with provisions of Schedule 1B Clause 14 of the Mining Act 1992, the Minister suspended the labour and expenditure conditions of RUM, effective from 14 July 2017, until 12 July 2018. An application to extend the suspension until 2021 was approved on the 15 March 2019. The suspension takes effect from 7 March 2019 for a period until 12 July 2021.

2.1.1 Ravensworth Coal Handling and Preparation Plant (RCHPP)

The RCHPP is located adjacent to the RUM pit top. Once the coal from ROC or RUM reaches the ROM stockpile it is required to be managed by RCHPP. The RCHPP is managed under PA 09_0176.

The RCHPP also receives product coal from Muswellbrook Coal Company. Coal is either fed directly into one of the three modules (20 Mt/year) at a rate of up to 3,600 tph prior to being loaded onto trains, or bypassed directly to domestic customers.

Figure 2-1 – Ravensworth Complex Layout

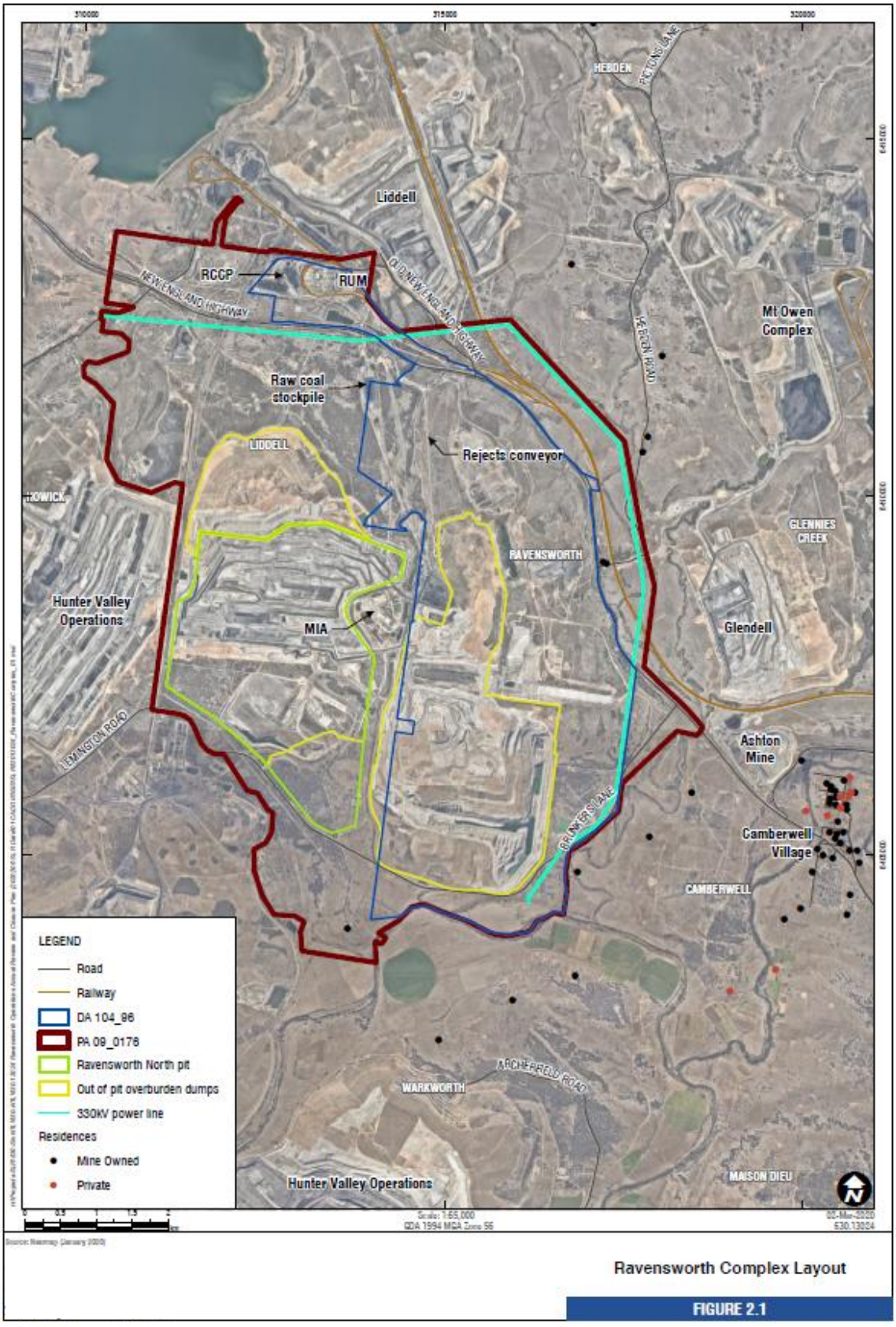


Figure 2-2 – Regional Context

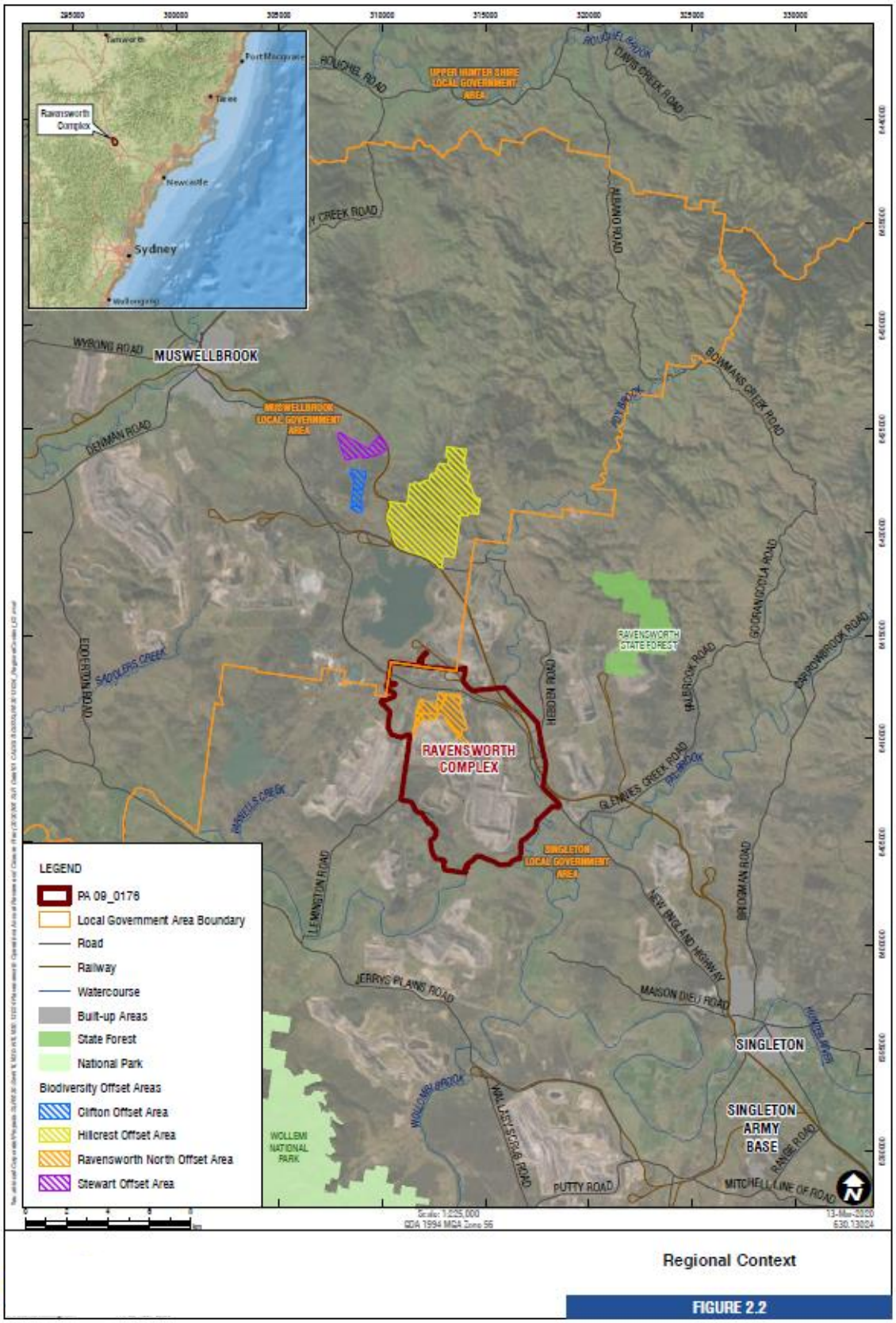
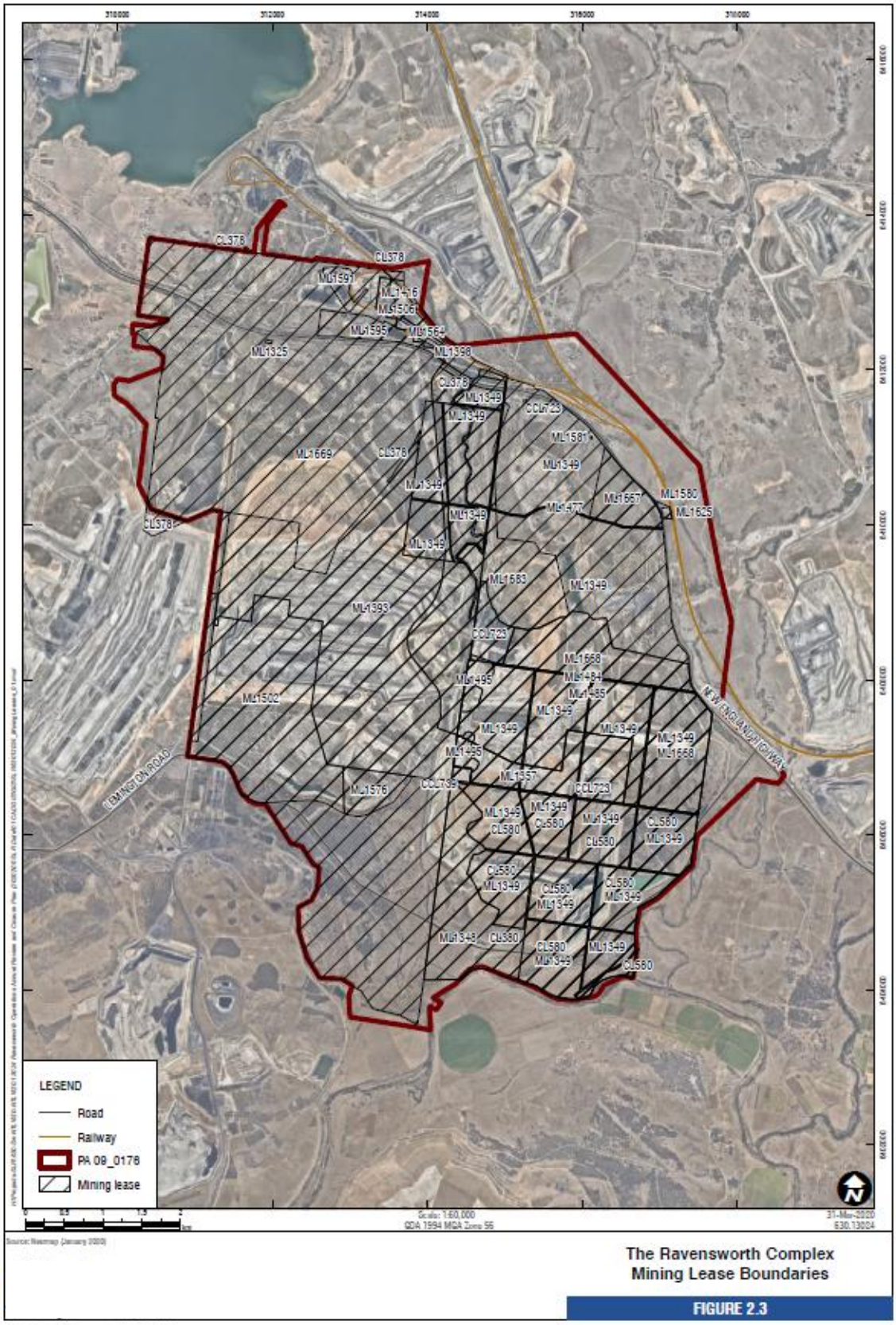


Figure 2-3 – Mining Lease Boundaries



2.2 Mine Contacts

The relevant contact details for ROC, RUM and the RCHPP are shown in ***Table 2-1***.

Name	Title	Contact Details
ROC	General Enquiries	Phone: 1800 620 553 Phone: (02) 6570 0700 Fax: (02) 6570 0747 Address: Lemington Road, Off New England Highway Ravensworth, via Singleton, NSW 2330 Postal: PO Box 294, Muswellbrook, NSW 2333 *https://www.glencore.com.au/operations-and-projects/coal/current-operations/ravensworth-operations*
RUM / RCHPP	General Enquiries	Phone: 1800 620 553 Fax: (02) 65700 747 Address: Liddell Station Rd, Ravensworth NSW 2330 Postal: P.O Box 528 Singleton 2330 *https://www.glencore.com.au/operations-and-projects/coal/past-operations/ravensworth-underground*
Tony Israel	Operations Manager	Phone: (02) 6570 0700 Fax: (02) 6570 0747 E-mail: *Tony.Israel@glencore.com.au*
Klay Marchant	Environment & Community Manager (Ravensworth Complex)	Phone: (02) 6570 0700 Fax: (02) 6570 0747 Email: *Klay.Marchant@glencore.com.au*

Table 2-1 - Mine Contacts

3. Approvals

Operations at Ravensworth Complex are regulated by a range of leases, licences and approvals which are summarised below.

3.1 Project Approval

Ravensworth Operations operate under Project Approval PA 09_0176 (granted on 11 February 2011), in accordance with the Ravensworth Operations Project Environmental Assessment dated February 2010 (2010 EA) and subsequent EA modifications. PA 09_0176 allows for an annual production of up to 16 Mtpa until 2039. This project approval has been modified three times (see ***Table 3-1***).

A separate approval applies to RUM; Development Consent (DA 104/96).

This Annual Review has been completed to fulfil the requirements of Schedule 5, Condition 3 of PA 09_0176 and Schedule 4, Condition 2 of DA 104/96.

Approval	Title	Date Granted
09_0176	Original Approval	11 February 2011
09_0176 Mod 1	Extraction of approximately 2.7 million tonnes of coal in the Narama West mining area.	16 August 2013
09_0176 Mod 2	Allow for an increase in final landform heights to accommodate a more stable free flowing natural landform.	19 December 2014
09_0176 Mod 3	Construction and operation of a tailings pipeline from the RCHPP at Ravensworth Operations to the Mount Owen West Pit Void.	16 February 2016

Table 3-1- Ravensworth Complex PA 09_0176 Modifications

3.2 Licences

3.2.1 Environment Protection Licence

Ravensworth operate under Environment Protection Licence (EPL) 2652, with an anniversary date of 12 January. Monitoring results are reported to the EPA as part of the Ravensworth Operations Pty Ltd Annual Return and monitoring data is available on the Ravensworth website.

During the reporting period Ravensworth Complex EPL was varied once on 2 July 2020. The s.58 Licence Variation 1587017 made the following variations to EPL 2652:

Administrative Conditions

- A1.1 - added activity scale note; and
- A2.1 - (existing) updated premises plan description.

Monitoring and Discharge Conditions

- P1.1 - (existing) updated reference to plan;
- P1.3 - (existing) updated reference to plan, added Sewage Treatment Plant monitoring and discharge conditions, added mine water and tailings transfer discharges and ambient water quality monitoring conditions;
- P1.4 - (existing) updated reference to premises plan, added meteorological monitoring point and noise monitoring points, added datum note; and
- P1.5 - added reference table plan condition.

Limit Conditions

- L4.1 - added waste table;
- L4.2 - added authorisation to receive mine water;
- L4.3 - added waste limit;
- L4.5 - added heavy plant tyre waste disposal limit;
- L5.1 to L5.5 - (existing) amended conditions; and
- L6.1 - (existing) removed approval requirements for blasting out of hours as this is not consistent with consent.

Operating Conditions

- O2.1-O2.6 - added STP maintenance conditions;
- O4 - added PIRMP note;
- O5.1 - added heavy plant tyre disposal operating condition; and
- O6.2 - added bunding condition.

Monitoring Conditions

- M2.3 - added turbidity monitoring;
- M5.1 - (existing) updated weather monitoring; and
- M11 - (existing) updated noise monitoring requirements.

The environmental reporting and monitoring activities undertaken at the Ravensworth Complex as required under EPL 2652, are discussed in **Section 6**.

3.2.2 Surface and Groundwater Licences

Ravensworth holds several surface and groundwater licences, which allow for surface and groundwater extraction and monitoring. Further details regarding these licences are provided in ***Section 7.4*** and ***7.5.***

3.2.3 Radiation Licences

Radiation licences held by the site include Licence 5078362 with an expiry of 5 February 2022.This licence is held for fixed radiation gauges installed at the coal handling and preparation plants. There are 11 gauges in total which are inspected every two years to ensure they comply with EPA compliance requirements. The 11 gauges were inspected on 13 January 2020.

3.3 Other Approvals

3.3.1 Management Plans

The status of site Management Plans as of 31 December 2020 are summarised in ***Table 3-2***. In accordance with Schedule 5, Condition 4 of PA 09_0176, Ravensworth will review, and if necessary, revise, the strategies, plans and programs required under the consent within three months of this Annual Review, to the satisfaction of the Secretary of the DPIE.

Document	Reference	Approved
RAVENSWORTH COMPLEX		
Ravensworth Complex Environmental Management Strategy (EMS)	PA 09_0176 Schedule 5, Condition 1	10 September 2018
Pollution Incident Response Management Plan (PIRMP)	Pollution Incident Response Management Plan	2 November 2020
Ravensworth Complex Noise Management Plan (NMP)	PA 09_0176 Schedule 3 Condition 9	10 September 2018
Ravensworth Complex Blast Management Plan (BMP)	PA 09_0176 Schedule 3 Condition 17	5 February 2020
Ravensworth Complex Air Quality and Greenhouse Gas Management Plan (AQGGMP)	PA 09_0176 Schedule 3 Condition 24	10 September 2018
Ravensworth Complex Water Management Plan (WMP)	PA 09_0176 Schedule 3 Condition 31	30 March 2020
Ravensworth Complex Biodiversity Management Plan (BioMP)	PA 09_0176 Schedule 3 Condition 31	10 September 2018 Updated plan awaiting DPIE approval.
Ravensworth Complex Rehabilitation Management Plan (MOP/RMP)	PA 09_0176 Schedule 3 Condition 41	1 January 2021 – 31 December 2023
Ravensworth Complex Heritage Management Plan (HMP)	PA 09_0176 Schedule 3 Condition 42	10 September 2018
Aboriginal Cultural Heritage Management Plan (ACHMP)	PA 09_0176 Schedule 3 Condition 42	10 September 2018 Updated plan awaiting DPIE approval.
RUM		

Document	Reference	Approved
Ravensworth Underground Air Quality and Greenhouse Gas Management Plan	DA 104/96, Schedule 2, Condition 14	December 2014
Biodiversity, Rehabilitation and Land Management Plan	DA 104/96, Schedule 2, Conditions 4, 7. Mining leases	Approved by the DP&I in 2012.
Lighting Management Plan	DA 104/96, Schedule 2, Condition 5.	Approved by the DP&I in 2012.
Bushfire Risk Hazard Reduction Management Plan	DA 104/96, Schedule 2, Condition 6.	Approved by the DP&I in 2012.
RUM Mining Operations Plan – Care and Maintenance	DA 104/96	1 January 2021 – 31 December 2022

Table 3-2 - Environmental Management Plans Status at 31 December 2020

3.3.2 Mining Operations Plan (MOP)

During the reporting period a new Mining Operations Plan (MOP) was written for both Ravensworth Operations (consisting of ROC and RCHPP) and RUM.

The Ravensworth Operations MOP relates to proposed mining operations and associated activities at Ravensworth Operations for the period 1 January 2021 to 31 December 2023. It was prepared in accordance with the ESG3: Mining Operations Plan (MOP) Guidelines (DRE, 2013) and was approved on 4 November 2020 by the Resources Regulator.

The RUM MOP outlines the operational and environmental management activities proposed for the period 1 January 2021 – 31 December 2022 during care and maintenance at RUM. This MOP was prepared in accordance with the ESG3: Mining Operations Plan (MOP) Guidelines (DRE, 2013) and was approved on 15 December 2020 by the Resources Regulator.

4. Operations During the Reporting Period

4.1 Mining Operations

During the reporting period, mining and coal preparation occurred at the Complex at Ravensworth North and RCHPP. RUM has remained in care and maintenance from October 2014.

During the reporting period, a total of 61,779 million bank cubic metres (Mbcm) of overburden was mined in Ravensworth North Pit to allow the extraction of 13.3 million tonnes (Mt) of Run of Mine (ROM) coal. No mining was undertaken at Narama, Narama West pit and RUM during the reporting period.

A summary for the Ravensworth Complex is outlined (***Table 4-1***). Schedule 2, Condition 6 of PA 09_0176 stipulates that no more than 16 Mt of ROM coal will be produced through open cut mining in a calendar year and no more than 21 Mt of ROM coal will be produced by the combined Ravensworth Complex per calendar year. Ravensworth Operations produced 13.3 Mt of ROM coal during 2020 which is within the annual limits.

Material	Cumulative Production and Waste			
	Start of Reporting Period (Cumulative)	End of Reporting Period (Cumulative)	Next Reporting Period (Actual)	2020 Total (Actual)
Ravensworth North				
Prime Overburden (Mbcm)	415,511	477,290	57,836	61,779
ROM mined (kt)	77,605	90,930	12,554	13,324
Saleable Product (kt)	50,331	59,319	8,497	8,988
RUM				
ROM Coal (kt)	0	0	0	0
Product Coal (kt)	0	0	0	0
RCHPP				
Coarse Waste Reject (t)	19,934,753	22,904,560	2,9596,472	2,969,807
Fine Waste Reject (t)	12,444,409	14,114,925	1,460,516	1,670,516

Table 4-1 - Complex Production and Waste Summary

4.2 Exploration

No exploration was carried out in 2020.

4.3 Construction

No construction was carried out in 2020.

4.4 Land Preparation

Land clearing is undertaken in accordance with the Ravensworth Complex Environmental Management System (EMS). Areas are assessed prior to clearing to minimise potential ecological, water management, sediment and erosion and cultural heritage impacts in accordance with the pre-clearing requirements.

During 2020, 26.5 ha at the Ravensworth Complex was disturbed due to progression of mining.

Land disturbed in preparation for rehabilitation is discussed in ***Section 8***.

4.5 Mineral Processing

4.5.1 Rejects Emplacement and Tailings

4.5.1.1 Coarse Rejects

Rejects are conveyed from the RCHPP to a reject bin, where they are collected by haul trucks. The haul trucks transport rejects via internal haul roads for co-disposing in the overburden emplacement areas in accordance with regulatory approvals.

4.5.1.2 Tailings

During 2020, tailings were emplaced in the Mount Owen West Pit Void through the Greater Ravensworth Area Water and Tailings Strategy (GRAWTS).

At Ravensworth, the coarse and fine rejects are disposed together. The sub 120 µm reject material is disposed of as tailings through the thickeners.

A total of 2,969,807 coarse rejects and 1,670,516 of fine tailings reject produced by the RCHPP were disposed of into approved storage areas.

4.5.2 Train and Conveyor Movements

Product coal is transported to the port of Newcastle by rail only. RCHPP train movements are summarised in ***Table 4-2***. All levels are compliant with the conditions set out in Schedule 2, Condition 7 of PA 09_0176, which specify that no more than 18 train movements (average) will occur each day, and no more than 20 million tonnes of product coal will be transported to/ from the RCHPP/RCT. Records of all train movements are provided in ***Appendix A***.

Train Movements	Total
Annual Average Daily Train Movements	1.7 movements per day
Max Daily Train Movements	5 max movements per day
Total Train Movements	616 total train movements
Annual Average Daily Train Tonnage	15,542 tonnes per day
Max Daily Tonnes	47,318 tonnes
Total product coal loaded from RCHPP	5,673,140 tonnes
Average train loading time	117.7 minutes
Total loading time	1,208.8 hours
Average Load Rate	5696.5 tonnes per hour

Table 4-2 - RCHPP Train Movements 2020

4.6 Waste Management

Waste is managed in accordance with the Ravensworth Complex EMS and EPL 2652. The EMS has been developed in accordance with the requirements of the Protection of the Environment Operations Act 1997 (POEO Act).

4.6.1 Waste Management and Reporting

The disposal of waste generated on the site is undertaken in accordance with existing regulatory guidelines and established site procedures. ***Table 4-3*** provides waste generation for the Ravensworth Complex since 2016. The total amount of waste that was disposed of and recycled at the Ravensworth Complex in 2020 was 721 tonnes and 3,285 tonnes respectively. The amount of waste produced at ROC and RUM in 2020 was lower than in previous years, which can be attributed to a change in how the amounts have been calculated. In previous years, the waste disposed offsite incorrectly included the amount of waste recycled, which elevated the total waste produced each year. The 2020 waste disposed offsite only includes waste send to landfill.

Ravensworth Operations reviews its waste minimisation strategies on an as needs basis.

Site	Waste Disposed offsite (t)	Waste recycled (t)	Total waste produced (t)	Waste Recycled (%)
ROC 2020	559	2,983	3,542	84.2
ROC 2019	3,481	2,932	4,065	83.8
ROC 2018	3,092	2,538	5,664	82.1
ROC 2017	2,652	2,298	4,277	53.7
ROC 2016	2,639	2,313	5,765	87.7
RUM 2020	5	39	44	89.6
RUM 2019	150.6	146.1	150.6	88.1
RUM 2018	14.7	2.1	14.7	28.6
RUM 2017	13.3	5.9	13	22.1
RUM 2016	28	16	80	56
RCHPP 2020	157.0	262.9	419.9	62.6
RCHPP 2019	177.8	117.7	397.2	63.5
RCHPP 2018	424	354	454	83.5
RCHPP 2017	252	194	313	70.3
RCHPP 2016	227	174	248	76.7

Table 4-3 - Waste Disposal and Recycling at the Ravensworth Complex

4.7 Product Coal

A total of 8.9 Mt of product coal was transported to the Port of Newcastle from the RCHPP in 2020.

4.8 Decommissioning

During the 2020 reporting period the 301 dragline was decommissioned.

4.9 Next Reporting Period

4.9.1 Mining

During 2021, coal extraction will continue in the Ravensworth North Pit. Forecast production for 2021 in accordance with the MOP is 12.5 Mt of ROM coal and 8.5 Mt of product coal. Mining in 2021 will remain the same as in 2020 with the equivalent mining equipment, personnel and mining techniques to be utilised in-pit. Ravensworth North will continue progressing in line with the mine plan (and MOP) with rehabilitation expected to reach MOP predictions.

4.9.2 Exploration

The five exploration holes proposed at ROC in 2020 were not undertaken and are now proposed for 2021. All proposed exploration holes are within the current mining footprint and are planned primarily for coal quality, water pressure and geotechnical monitoring.

4.9.3 Construction

The Orica explosives compound will be relocated in 2021 due to progression of mining.

The mine access road realignment and construction of the Emu Creek levee bank will commence in 2021 and be completed in 2022.

4.9.4 Coarse Rejects and Tailings Disposal

During 2021 coarse rejects will continue to be co-disposed of in overburden emplacement waste areas in accordance with current statutory approval.

Tailings will be pumped into approved tailings areas during the next reporting period. Capping of 7 South Tailings Storage Facility commenced in 2020, and is scheduled for completion in 2021.

5. Actions Required from Previous Annual Review

A letter was received from the DPIE dated 12 May 2020 requesting additional information on the 2019 Annual Review to satisfy the Department guidelines. The 2019 Annual Review was revised and resubmitted to the DPIE on 28 May 2020.

The actions required from the previous Annual Review and actions taken in response by Ravensworth during the reporting period are outlined in ***Table 5-1***.

No.	Action	Status
ROC and RCHPP		
1	Continuation of mining operations at Ravensworth North	Overburden was mined in Ravensworth North Pit during the reporting period to allow the extraction of ROM coal. No mining was undertaken at Narama, Narama West pit and RUM during the reporting period.
2	Continued support for key community projects	Ongoing. See Section 9.3
3	Continued participation in the CCC	Ongoing. See Section 9.4.
4	Review of site management plans (Biodiversity Management Plan, Biodiversity Management Plan, Air Quality and Greenhouse Gas Management Plan and Heritage Management Plan) in accordance with Schedule 5, Condition 4 of PA 09_0176	These Management Plans were reviewed and updated in 2020, and submitted to the DPIE for approval.
5	Completion of 70 ha of rehabilitation for ROC	Complete. See Section 8.3.1
6	Continuation of rehabilitation monitoring	Ongoing. See Section 8.3.2
7	Continuation of rehabilitation maintenance	Ongoing. See Section 8.3.3
8	Preparation of new MOP.	Complete. See Section 3.3.2
9	Review and update of the Conceptual Mine Closure Plan	Complete 26 June 2020.
10	Infrastructure relocations within existing disturbance	Access road relocation to be completed in 2021/2022.
11	Consultation with all relevant stakeholders.	Ongoing. See Section 9
RUM		
1	Undertake care and maintenance activities	Ongoing. RUM remained in care and maintenance during 2020.
2	Undertake underground dewatering activities	
3	Undertake flaring and gas management	
4	Continuation of rehabilitation monitoring	
5	Continued erosion and sediment control maintenance	
6	Continued spontaneous combustion monitoring	
7	Preparation of a new MOP	Complete. See Section 3.3.2

Table 5-1 - Actions from 2019 Annual Review undertaken in 2020

6. Environmental Management and Performance

6.1 Environmental Risk Assessment

Three separate environmental risk assessments were undertaken at the Ravensworth Complex in 2020.

- An Environment and Community Broad Brush Risk Assessment (ECBBRA) was completed in June 2020. The ECBBRA is conducted annually to inform the planning of operations (Open Cut and Underground) to avoid significant environmental issues. The ECBBRA was completed in accordance with the Glencore Coal Assets Australia Risk Management Standard (GCAA-625378177-2844). The ECBBRA completed in 2020 identified zero high risk issues, 15 medium risk issues and 19 low risk issues.

- A MOP Rehabilitation Risk Assessment was conducted in July 2020 for ROC. The Risk Assessment identified 40 risks, with 12 being classified as medium risks and 28 classified as low risks. No high risks were identified by the risk assessment.

- A MOP Rehabilitation Risk Assessment was conducted in October 2020 for RUM. This risk assessment included review of the existing RUM MOP Risk Assessment. The Risk Assessment identified 40 risks, with 11 being classified as medium risks and 29 classified as low risks. No high risks were identified by the assessment.

- A Closure Risk Assessment was undertaken in September 2020. The Closure Risk Assessment was completed in accordance with the Glencore Coal Assets Australia Closure and Residual Risk Guideline (GCAA-625378177-16367) and used the Bow Tie methodology to qualitatively assess the threats to executing closure in accordance with regulatory requirements.

6.2 Operational Noise

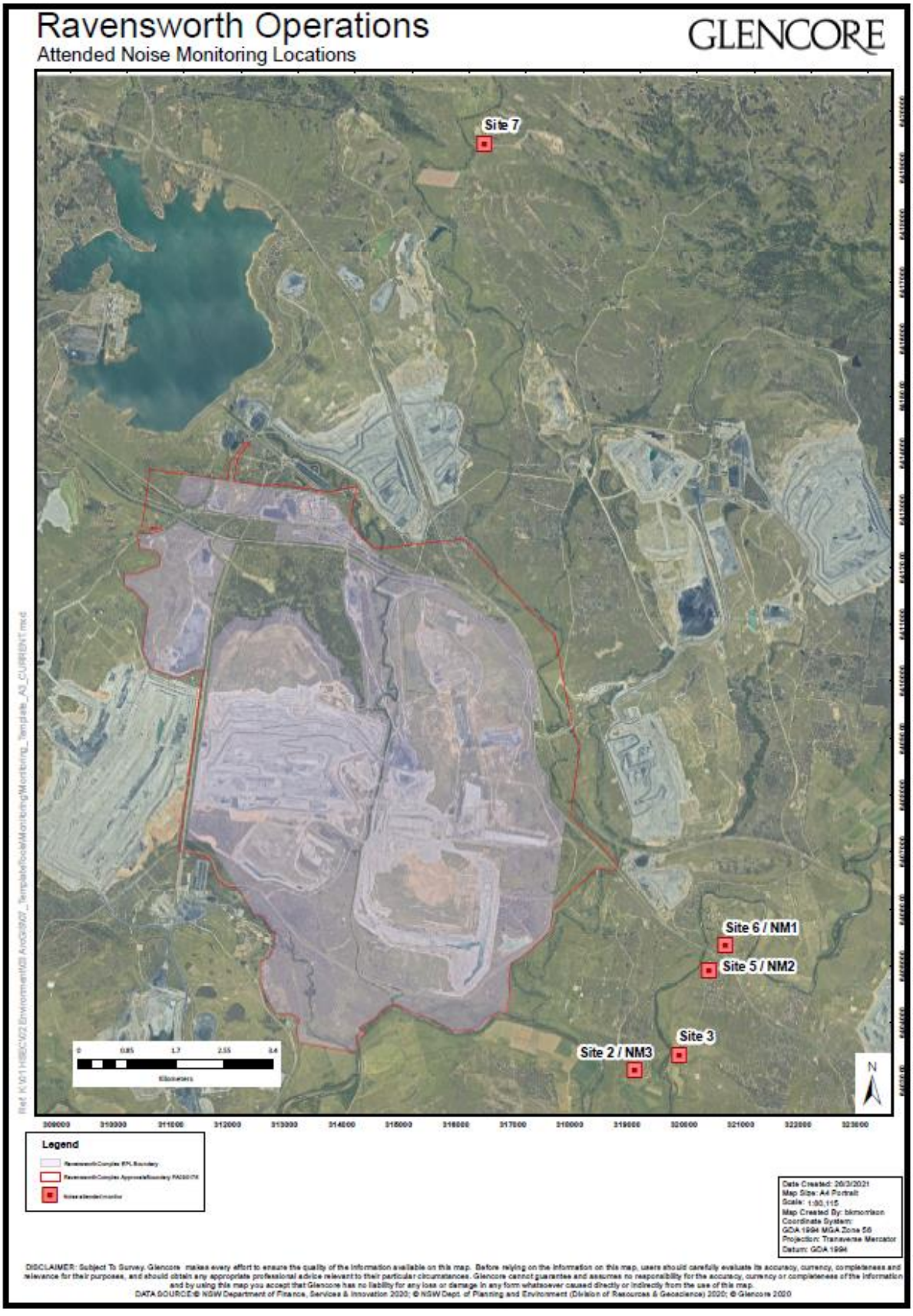
6.2.1 Environmental Management

Noise monitoring and management is outlined in the Ravensworth Complex *Noise Management Plan* which is available on the Ravensworth website.

Noise monitoring consists of both attended and unattended monitoring to meet the requirements of the PA 09_1076, DA 104/96 and EPL 2652. Noise monitoring locations, as discussed in the *Noise Management Plan* are shown on ***Figure 6.1***.

In addition to conducting noise monitoring, Ravensworth continues to implement a number of mitigation strategies with regard to the management of noise to minimise potential noise impact on nearby receivers, and to comply with the relevant conditions of the Project Approval.

Figure 6-1 – Noise Monitoring Locations



6.2.2 Environmental Monitoring Results

6.2.2.1 Results from the Reporting Period

Noise monitoring results for the reporting period are provided in ***Appendix B***. Relevant noise criteria, as outlined in PA 09_0176 Schedule 3 Conditions 2, 3 and 4, DA 104/96 Condition 12 and EPL 2652 Condition L5 are combined in ***R1** (Stapleton) has been purchased by the Ravensworth Complex

Table 6-1 and ***Table 6-2***.

Noise monitoring was conducted by Spectrum Acoustics who concluded that there were no exceedances (non-compliances) of noise approval criteria during the reporting period.

Receiver Location	Receiver	*Day* ($L_{Aeq\ (15min)}$)	*Evening* ($L_{Aeq\ (15min)}$)	*Night* ($L_{Aeq\ (15min)}$)	*Night* ($L_{A1\ (1\ min)}$)	Performance during Reporting Period (Appendix D)
R1	34 – Stapleton*	48	48	48	49	Compliant
R2	3 – A Bowman	35	35	35	45	Compliant
	13 – A Bowman	38	38	38	45	Compliant
R3	Camberwell Village Central 12 – Yates, 21 – Miller, 27 Chisholm	37	37	37	45	Compliant
	38 - Ninness	36	36	36	45	Compliant
R4	Camberwell Village North	35	35	35	45	Compliant
-	All other privately-owned land	35	35	35	45	Compliant

*R1 (Stapleton) has been purchased by the Ravensworth Complex

Table 6-1 - Noise Criteria dB(A) and performance for 2020 reporting period

In relation to cumulative noise impacts, the Ravensworth Complex implement all reasonable and feasible measures to ensure that the noise generated by the Ravensworth Complex combined with the noise generated by other mines does not exceed the criteria shown in ***Table 6-2***, at any residence on privately-owned land or on more than 25 per cent of any privately-owned land.

Receiver Location	Day	Evening	Night	Performance during Reporting Period. (Appendix D)
R3 and R4 – Camberwell Village	55	45	40	Compliant
All other privately owned land	50	45	40	Compliant

Table 6-2 - Cumulative noise criteria dB(A) LAeq (period) from PA 09_0176 and performance for 2020 reporting period

The noise conditions in EPL 2652 were modified as part of the EPL variation in July 2020 (as discussed in ***Section 3.2.1***). At the request of the EPA, one of the monitoring locations was varied from Site 2 (monitored January 2020 – June 2020) to EPL point 16. At the time of licence being issued, agreement between the landholder and Ravensworth had not been reached, therefore monitoring has unable to be undertaken at this location for the second half of the reporting period (July 2020 to December 2020). Monitoring has continued to be undertaken at the previous Site 2, which is closer to the mine than EPL point 16. No non-compliances have been recorded at Site 2 during the reporting period. Ravensworth are continuing to negotiate access to EPL point 16 and an EPL licence variation will be requested if agreement cannot be reached with the landowner.

6.2.2.2 Comparison with Predictions

As indicated by the results in ***Appendix B***, all noise monitoring results were within predicted levels for the reporting period.

6.2.2.3 Long Term Trend Analysis

The results are generally consistent with prior years (going back to three years). All results over the last five years have been within approved noise criteria.

6.2.3 Key Performance and Management Issues

There were no performance or management issues in relation to noise during the reporting period. This included no noise complaints.

6.2.4 Proposed Improvements

Ravensworth will continue to use site procedures, processes and systems to manage noise. Noise monitoring will also continue to be undertaken.

The *Noise Management Plan* will be updated in 2021 to reflect the changes to EPL 2652 noise monitoring conditions.

6.3 Blasting and Vibration

6.3.1 Environmental Management

Blasting at Ravensworth is undertaken in accordance with the Ravensworth Complex *Blast Management Plan*, which was developed in accordance with Schedule 3, Condition 17 of PA 09_0176

and is available on the website. ROC has a number of procedures in place to manage the impacts of blasting including overpressure, vibration, fume and dust.

In order to minimise the effect of meteorological conditions on blasting impacts, the following strategies are utilised:

a) Notification of all blasts to neighbouring mines, and community members prior to any blasts (note that Council requested to no longer receive these notifications in July 2020);

b) An inversion impact assessment is undertaken based on a full day predictive model for the Hunter Valley;

c) A dust and fume plume assessment is undertaken using a predictive model; and

d) Real time monitoring of onsite weather conditions is conducted to minimise dust generated from blasting when wind conditions (speed and direction) could result in impacts at community locations.

Ravensworth Complex holds EPL 2652 that includes Condition L6, which limits blasting to the following criteria at private residences only:

1. The maximum overpressure limit is 120 dB(L); with only five percent of all blasts for the year permitted to exceed 115 dB(L);

2. The maximum vibration limit is 10 mm/sec; with only five percent of all blasts for the year permitted to exceed 5 mm/sec; and

Blasting is permitted between 9:00 am and 5:00 pm, Monday to Saturday. Blasting may be carried out between 7:00 am and 9:00 am Monday to Saturday if it can be demonstrated that it is necessary to proactively manage safety and environmental issues that have been identified. Blasting must not take place on Sundays or Public Holidays without the prior approval of the Secretary of Department of Planning, Industry and Environment.

6.3.2 Environmental Monitoring Results

6.3.2.1 Results from the Reporting Period

A record of all blasting compliance during the reporting period can be found in ***Appendix C***. ***Table 6-3*** indicates performance of Ravensworth with regards to Schedule 3, Condition 10 of PA 09_0176.

During the reporting period no blasts exceeded the overpressure limit of 115dBL or vibration criteria of 5mm/s at non-mined owned residences.

There was one elevated overpressure result of 120 dBL at Chain of Ponds Hotel recorded on 29 September 2020. The overpressure limit for Chain of Ponds Hotel is 133 dBL therefore this blast is compliant.

On 14 January 2020 there was an elevated vibration result of 7.33 mm/s recorded at Chain of Ponds Hotel. However, this was under the 10 mm/s criteria for listed in the approved *Ravensworth Complex Blast Management Plan*.

Location	Approval Criteria			Environmental Performance in this Reporting Period. See Appendix C for 2020 summary results
	Airblast overpressure (dB(Lin Peak))	Ground vibration (mm/s)	Allowable exceedance	
Residence on privately owned land and Camberwell church	120	10	0%	Compliant
	115	5	5% of the total number of blasts over a period of 12 months	Compliant
Ravensworth Public School and Chain of Ponds Hotel	133	10	0%	Compliant
Ravensworth Homestead	126	10	0%	Compliant
Aboriginal axe grinding groove site (REA86)	-	[c] 175	0%	Compliant
1,000ML dam wall and proposed dam wall	-	[b] 25	0%	Compliant
Conveyors, including the Hunter Valley Operations conveyor	-	[b] 100	0%	Compliant
Main Northern Railway culverts and bridges	-	[b] 25	0%	Compliant
Transmission lines	-	[b] 50	0%	Compliant
Ashton underground mine	-	[b] 6	0%	Compliant

a Unless otherwise agreed with the relevant owner/s of the residence, and the Proponent has advised the Department in writing of the terms of this agreement.
b Unless otherwise agreed with relevant infrastructure provider, owner or the regulator (in relation to the dams), and the Proponent has advised the Department in writing of the terms of this agreement.
c Subject to meeting incremental limits under condition 10A (PA_0176).

Table 6-3 - Blasting Criteria and Performance for 2020 Reporting Period

6.3.2.2 Comparison with Predictions

The Ravensworth Operations Project Environmental Assessment (Umwelt, 2010) assessed the impacts of blasting. The assessment determined vibration and airblast (overpressure) criteria that applied to infrastructure and heritage sites that may be affected by the operations. These criteria are provided in the blast result tables, included in **Appendix C**.

During the reporting period both blast vibration and overpressure were generally consistent with EA predictions.

6.3.2.3 Long Term Trend Analysis

Since 2014, there have been no blast exceedances.

6.3.3 Key Performance and Management Issues

Two blasting complaints were received during the reporting period. Further details of these complaints are included in ***Section 9.2***.

6.3.4 Proposed Improvements

Ravensworth will continue to use site procedures, processes and systems to manage blast impacts. Blast monitoring will continue to be undertaken.

Blast monitoring locations will continue to be reviewed and updated as mining progresses.

6.4 Air Quality

6.4.1 Environmental Management

Ravensworth operates in accordance with the approved *Air Quality and Greenhouse Gas Management Plan* (AQGGMP), which is available on the Ravensworth website, and describes air quality management and monitoring requirements associated with the mine.

The objective of air quality management at the Ravensworth Complex is to reduce the generation of dust onsite and to minimise dust concentration levels at neighbouring residences. Dust deposition results are reported and reviewed internally, then made available on the website on a monthly basis. Air quality results and the effectiveness of dust mitigation procedures are also reviewed as part of the environmental audit program.

Dust monitoring is undertaken to ensure compliance with Schedule 3, Conditions 20-24 of PA 09_0176. The Ravensworth Complex operates two Tapered Element Oscillating Microbalance (TEOM) units, located to the south east of Narama on private property (TEOM G1) and to the north-west on Ravensworth owned land (TEOM G2). The location of these TEOM units is shown on ***Figure 6.10.*** TEOM G1 (EPA Point 9) and TEOM G2 (EPA Point 10) is monitored in accordance with Ravensworth's EPL 2652.

Dust monitoring is undertaken at eight depositional dust gauges (depositional dust), four of which are required for compliance and four for internal management purposed. There are four High Volume Air Samplers (HVAS) (TSP and PM_{10}), three of which are used for compliance and one for internal management purposes.

In accordance with the AQGGMP and site Environmental Trigger Action Response Plan, Ravensworth modifies operations on occasions when exceedances occur. This includes but is not limited to:

- Altering exposed dumping locations to sheltered or in pit dumping locations;
- Shutting down loading units in response to visual dust triggers;
- Postponement of blasting; and
- The application of water continually to all haul circuits.

Figure 6-10 - Air Quality Monitoring Locations

6.4.2 Environmental Monitoring Results

6.4.2.1 Results from the Reporting Period

An overview of environmental performance for air quality based on TSP and PM_{10} data (from the site's two TEOMs) and depositional dust is provided in ***Tables 6.4 - 6.6***. See ***Appendix D*** for further detail on exceedance dates and results. The air quality criteria and notes can be found in Schedule 3, Condition 20 of PA 09_0176.

Pollutant	Averaging period	Approval Criteria *Criterion	Environmental Performance this Reporting Period
Total suspended particulate (TSP) matter	Annual	90 µg/m^3	Compliant
Particulate matter < 10 µm (PM_{10})	Annual	30 µg/m^3	Compliant

Note: TSP and PM_{10} performance based on TEOM data
*Excludes extraordinary events

Table 6-4 - Long term criteria for particulate matter

Pollutant	Averaging period	Approval Criteria *Criterion	Environmental Performance this Reporting Period
Particulate matter < 10 µm (PM_{10})	24 hour	50 µg/m^3	Non-Compliant

Note: PM_{10} performance based on TEOM data
*Excludes extraordinary events

Table 6-5 - Short term criterion for particulate matter

The TEOM G1 PM_{10} rolling annual average was below the 30 µg/m^3 PA09_0176 criteria throughout 2020, with an annual average of 19.14 µg/m^3 [(1)].

The TEOM G2 PM_{10} annual average was below the 30 µg/m^3 PA09_0176 criteria throughout 2020 with an annual average of 17.40 µg/m^3 [(1)].

The PM_{10} 24 hour criterion of 50 µg/m^3 was exceeded 13 times at TEOM G1 and nine times at TEOM G2 during 2020. Relevant authorities were notified of these exceedances throughout the year. However, the majority of these exceedances were related to bushfires in the vicinity of the Ravensworth Complex in quarter 1 of 2020. As listed in **Appendix D**, the DPIE classified most days where these exceedances occurred as 'extraordinary event' days. As a result, the Ravensworth Complex only exceeded the PM_{10} 24 hour criteria of 50 µg/m^3 on three[1] occasions at TEOM G1 and one[1] occasion at TEOM G2 during the 2020 reporting period.

The G1 and G2 24 hour average PM_{10} data for 2020 is provided in ***Appendix D***. Data gaps during 2020 were attributed to storms, power outages and repairs, resulting in invalid data.

([1]) Excludes extraordinary event days by the DPIE

Approval Criteria				Environmental Performance this reporting period
Pollutant	**Averaging period**	**Maximum increase in deposited dust level**	**Maximum total deposited dust level**	
Deposited dust	Annual	2 g/m^2/month	4 g/m^2/month	Compliant

Note: Deposited dust results are used for internal management purposes only.

Table 6-6 - Long term criteria for deposited dust

Annual average depositional dust results were below 4 g/m^2/month in at every monitoring location during 2020. The annual average at D9 (3.5 g/m^2/month) was lower than the 2019 annual average (4.3 g/m^2/month) as was annual average at D12 (2.5 g/m^2/month in 2020 compared to 3.9 g/m^2/month in 2019). The annual average at D13 and D27 remained 3.1 g/m^2/month, which was consistent with 2019 results.

6.4.2.2 Comparison to EA Predictions

Air quality predictions against the 2010 EA are outlined in ***Table 6.7 - 6.9***.

Dust Deposition

Comparisons of dust deposition levels (Year 10) predicted in the 2010 EA and 2020 measured averages are shown for privately owned and mine owned residences in ***Table 6-7***. All 2020 annual results are greater than the EA predicted values for dust depositional gauges. All gauges were below the project approval criteria of 4.0g/m^2/month.

Monitor	EA Residence ID	Year 10 Prediction Ravensworth Contribution	Cumulative	2020 Results
D9	40B	0.3	0.7	3.5
D12*	34	0.3	0.9	2.5
D13	3	0.4	0.8	3.1
D27	5Z / 12	0.2	0.7	3.1

* Mine owned residence.

Table 6-7 - ROC Dust Deposition EA Prediction Comparison - Privately Owned & Mine Owned Residences

HVAS TSP and PM_{10}

Comparisons of HVAS TSP and PM_{10} levels (Year 10) predicted in the 2010 EA and 2020 measured averages are shown for privately owned and mine owned residences in ***Table 6.8*** and ***Table 6.9***, respectively.

All 2020 annual results are greater than the predicted values for both PM_{10} and TSP.

Monitor	EA ID	Year 10 Prediction Ravensworth Contribution (PM_{10})	Cumulative (PM_{10})	Ravensworth Contribution (TSP)	Cumulative (TSP)	2020 Results PM_{10}	2020 Results TSP
HVAS 2 / HVAS 19	45	6	14	5	41	21.9*	66.8*

Note: * Excluding extraordinary events as determined by DPIE

Table 6-8 - ROC HVAS TSP and PM_{10} EA Prediction Comparison - Privately Owned Residences

Monitor	EA ID	Year 5 Prediction Ravensworth Contribution (TSP)	Cumulative (TSP)	2020 Results
HVAS 4	29P	27	63	70.9*
HVAS 5	34	22	56	61.6*

Note: * Excluding extraordinary events as determined by DPIE

Table 6-9 - ROC HVAS TSP EA Prediction Comparison - Mine Owned Residence

6.4.2.3 Long Term Trend Analysis

There were 22 reportable exceedances in 2020, compared with 31 exceedances in 2019 and 23 exceedances in 2018. Eighteen (18) of these 22 exceedances occurred on 'extraordinary event' days.

The TEOM G1 PM_{10} annual average of 19.14 µg/m^3 was lower than the 2019 average results of 27µg/m^3. The TEOM G2 PM_{10} annual average of 17.40 µg/m^3 was lower than the 2019 average results of 24.9 µg/m^3. 2020 experienced higher rainfall than in previous years resulting in a reduction in dust levels across the region.

6.4.3 Key Performance and Management Issues

In 2020 additional monitoring software (RAVDAT) was implemented which allows for real-time data and monitoring in the field by OCE's on mobile devices.

During the first quarter of 2020 there were a number of bushfires in the vicinity of the Ravensworth Complex which contributed to dust levels in the region. As detailed in **Appendix D**, the DPIE classified a large number of days as 'extraordinary events' (which can include bushfires, prescribed burning, dust storms, sea fog, fire incidents, illegal activities or any other activity). Air quality conditions across the region were also impacted by low rainfall during the first half of 2020, but a wetter second half of the year lead to less exceedances recorded than in previous years.

There were several power outages at the TEOMs in 2020 relating to storms and equipment malfunctions. These were rectified as soon as possible but continuous data was not available for the complete 2020 reporting period.

There were no complaints related to air quality in the 2020 reporting period.

6.4.4 Proposed Improvements

Ravensworth will continue to use site procedures, processes and systems to manage dust. Air quality monitoring will continue to be undertaken during the next reporting period. The AQGGMP will be reviewed in 2021.

6.5 Biodiversity

6.5.1 Environmental Management

Biodiversity is managed in accordance with the *Ravensworth Complex Biodiversity Management Plan* which has been developed and approved in accordance with Schedule 3, Condition 24 of PA09_0176. The *Biodiversity Management Plan* covers the management of biodiversity at the Ravensworth Complex and biodiversity offset areas (BOAs), and is available on the website.

The Ravensworth Complex aims to mitigate effects of mining activities on native vegetation communities, fauna habitat and fauna species by planning and implementing programmes to maintain and improve the biological value of land. The programs are not only for rehabilitation areas but include other potentially degraded sites across the Ravensworth Complex holdings.

A large area has been offset as part of the establishment of Ravensworth North. This has involved the establishment, protection and enhancement of Offset Areas by an Implementation Program, which was approved in 2013. This will provide for the long term conservation of a range of significant ecological features.

6.5.2 Ravensworth Complex

No threatened flora or fauna species were recorded during the field surveys undertaken as part of the RUM 1996 EA due to the high degree of disturbance at the site. The pit top area is almost entirely cleared, with open pasture on gentle slopes and no significant remnant vegetation. One large *Eucalyptus crebra* (Narrow-leaved Ironbark) and several sub-adults of this species were identified, along with a small number of *Allocasuarina leuhamnii* (Bull Oak). The shrub layer is mainly absent and the dominant species in the ground layer is *Chloris gayana* (Rhodes Grass). The overall botanical and ecological viability of this area is low.

The Ravensworth Operations Project EA (2010) identified five threatened species in the Pikes Gully LW10 to 15 SMP Application Area. These included three species of bat (Eastern Bentwing Bat, Eastern Freetail Bat, and Large Footed Myotis), one bird species (Speckled Warbler) and one plant species (*Acacia pendula*). No mining activities occurred at RUM during the reporting period.

6.5.3 Biodiversity Offset Areas – Overview

Ravensworth Operations owns and manages four BOAs required under NSW Project Approval (PA 09_0176) and the Federal EPBC Approval (2010/5389). The offset areas are managed in accordance with the Ravensworth Complex Offset Area Management Programme (OAMP). A spatial summary of these offset areas is described in ***Table 6-10*** and shown in ***Figure 6.11***.

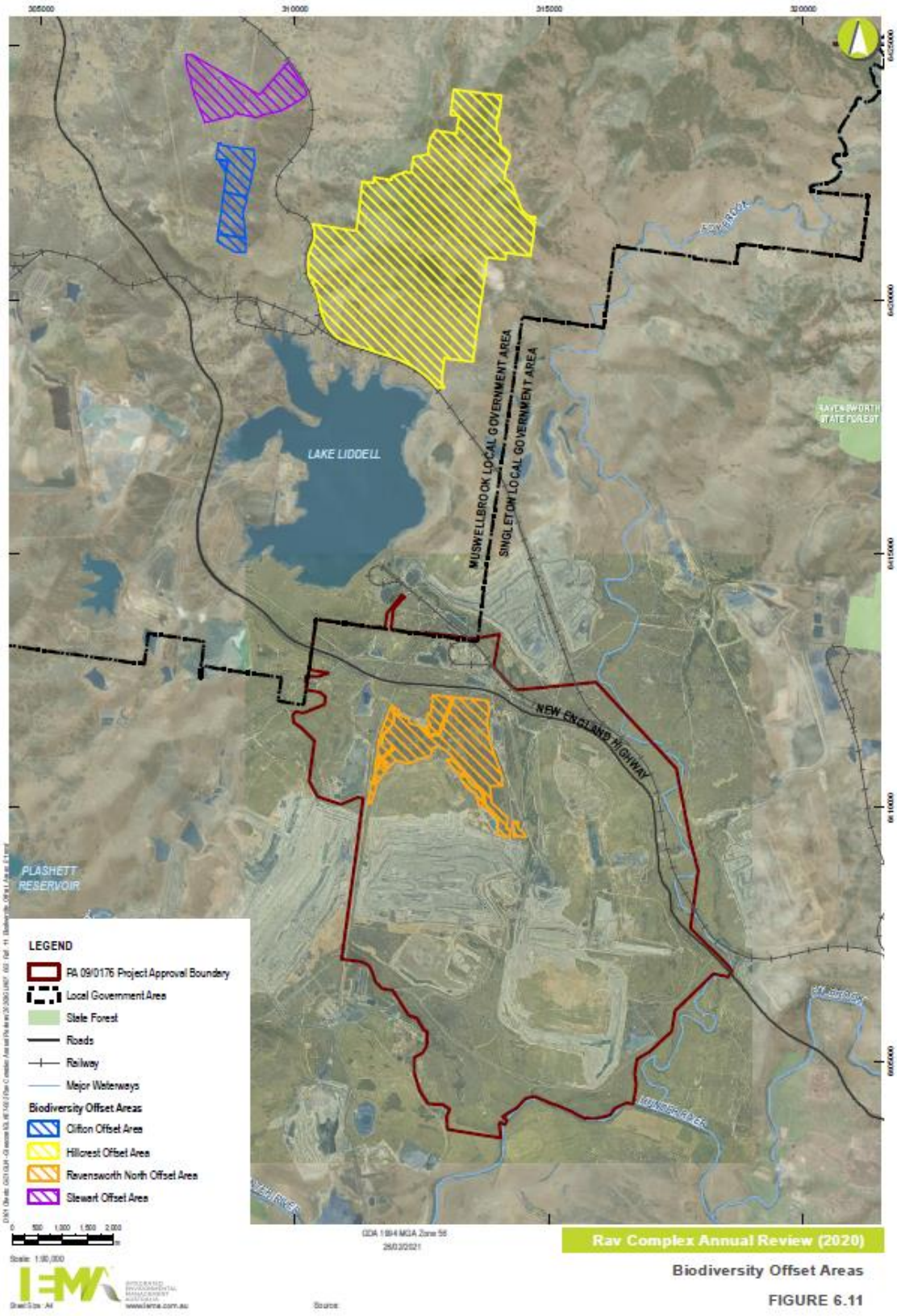
Name	Size (ha)	Location Description
Ravensworth North Offset Area (RNOA)	288	Immediately North of Ravensworth North Open Cut Disturbance Area
Hillcrest Offset Area (HOA)	1402	Approx. 6km North of Ravensworth Complex
Clifton Offset Area (COA)	106	Approx. 7.5km North of Ravensworth Complex
Stewart Offset Area	165	Approx. 10km North of Ravensworth Complex

Table 6-10 - Location and size of Ravensworth Operations Offset Areas

In accordance with the BMP (Ravensworth Open Cut, 2018), *Offset and Green and Golden Bell Frog Management Plan* (OMP) (Ravensworth Surface Operations, 2013) and the OAMP (Ravensworth Open Cut, 2019) Ravensworth Operations utilises suitably qualified and accredited ecologists to undertake an annual biodiversity monitoring program across all BOAs.

Biodiversity monitoring is undertaken at the BOAs on an annual basis. Monitoring involves vegetation condition assessments and fauna monitoring at twenty eight permanent monitoring locations across all Biodiversity Offset Areas (BOAs). The results of the 2020 monitoring program are discussed in the following section.

Figure 6-11 - Biodiversity Offset Areas



6.5.3.1 BOA Monitoring Results

The survey and assessment by Biodiversity Australia Pty Ltd was undertaken across winter, spring and summer and involved the continuation of annual vegetation condition assessments and fauna monitoring at 28 permanent monitoring locations across all BOAs.

Fauna

Bird census monitoring by Biodiversity Australia Pty Ltd in 2020 recorded a total of 79 bird species. Grassland sites continued to record fewer bird species than woodland sites however this is anticipated to be the case until a developed canopy forms within the grassland areas. A total of three threatened bird species were recorded during the 2020 monitoring surveys (Varied Sittella, Speckled Warbler, Grey-crowned Babbler) although the targeted threatened birds, the Regent Honeyeater and Swift Parrot, were not recorded in 2020.

Fauna monitoring detected three threatened fauna species during the 2020 monitoring period (Grey-headed Flying Fox, Brush-tailed Phascogale, Eastern Coastal Free-tailed Bat). One of these, the Brush-tailed Phascogale, marks the first record of this species in the BOAs since monitoring began.

Although only required every second year, fauna monitoring was conducted within in the Ravensworth North Offset Area in 2020 to utilise additional monitoring techniques. The use of ground and arboreal PIR camera surveys resulted in the detection of two fauna species which were previously unrecorded within the offset area, the Long-nosed Bandicoot and the threatened, Brush-tailed Phascogale. An additional nine fauna species, previously unrecorded within this offset area, were recorded during other monitoring activities by Biodiversity Australia Pty Ltd.

An increase in habitat suitability for the Green and Golden Bell Frog was recorded, with the increased rainfall throughout the year and evident emplacement of microhabitats. A total of eight dams across Hillcrest and RNOA were suitable to support this species at the time of survey, however targeted surveys for the Green and Golden Bell Frog did not record this species.

Feral species are evidently still present within this offset area with numerous species recorded. The majority of these were recorded in Ravensworth North Offset Area only.

Flora

The monitoring surveys by Biodiversity Australia Pty Ltd indicated a general increase in floral species richness across the BOAs since the previous monitoring event. It is expected that this is indicative of a higher annual rainfall year which followed the extreme drought conditions that were experienced in the region since 2017. Species compositions remained similar to previous monitoring surveys with grassland sites continuing to contain a higher richness of exotic species than woodland sites. The highest number exotics were observed in grassland sites, which remains a general trend across all BOAs since monitoring commenced. There is an infestation of some grassland areas by various thistles.

Canopy regeneration assessment highlighted an occurrence of tree dieback in all BOAs because of the recent drought. Despite this, most sites showed some sign of natural regeneration occurring, with only a few sites continuing to show no natural regeneration. Although not obvious at monitoring locations, the advancement of regeneration was observed in the broader offset areas and in areas where revegetation works occurred. Biodiversity Australia Pty Ltd expects the extent of regeneration to become more transparent over time.

6.5.4 Key Performance and/or Management Issues

Appendix E outlines the compliance of the 2020 monitoring results with the biodiversity objectives and target criteria outlined within the OAMP.

Ravensworth finalised its Conservation Agreements (CA) with the NSW Office of Environment and Heritage (OEH) on 31 January 2019 for four biodiversity offset areas associated with the Ravensworth Operations Project in the upper Hunter Valley NSW, being the Ravensworth North, Hillcrest, Clifton and Stewart offset areas.

The CAs were registered on the relevant land titles in accordance with Condition 35, Schedule 3 of Project Approval 09_0176 for the Ravensworth Operations Project to provide for the long term security of these four offset areas. Detailed ground surveys were completed for the four offset areas for the Ravensworth Operations Project by a qualified surveyor, in accordance with survey guidelines stipulated by OEH for CAs. During a review of the survey results, Ravensworth has become aware that three of the offset areas are smaller than the areas described in Table 16 within Condition 32 of the Project Approval. Most of the discrepancy relates to the Hillcrest Offset Area, which comprises the entire Hillcrest property. The total size of the Hillcrest Offset Area has been calculated by way of survey as being 1383.4 hectares, smaller than the area of 1,402 hectares included in Table 16, Condition 32 of the Project Approval.

Ravensworth has notified the DPIE of the discrepancy and is seeking further advice on resolving the issue.

Weeds and pests continue to be a focus of management within the BOA areas. **Section 6.10** discusses the weed and pest management undertaken during 2020 both within the mining lease boundaries and in the BOAs.

No incidents occurred in the BOAs during the reporting period.

6.5.5 Proposed Improvements

The site's biodiversity and offset areas will continue to be managed consistent with Ravensworth Complex Biodiversity Management Plan. Pest and weed management will continue to be undertaken at the BOAs during 2021, as discussed in ***Section 6.10***.

Improvement methods such as direct seeding, brush-matting, planting of fast-growing pioneer species and soil amelioration will be undertaken (where possible) to speed up the recovery of vegetation communities within the BOAs and enhance regeneration success of grassland areas.

6.6 Erosion Management

6.6.1 Environmental Management

Ravensworth Complex manages erosion and sediment control on site in accordance with the approved Erosion and Sediment Control Plan (ESCP), which is included in the Water Management Plan (WMP). The Water Management Plan was updated and approved in 2020 and is available on the Ravensworth Complex website.

Prior to land disturbance for any aspect of the mine, appropriate erosion and sediment controls are designed and constructed according the ESCP.

During the period, erosion and sediment controls have been implemented during the ongoing operation and rehabilitation phases at the Ravensworth Complex to mitigate the potential impacts of erosion and sedimentation on nearby watercourses and the surrounding environment. Standard erosion and sediment control techniques are used in accordance with the requirements of:

- Managing Urban Stormwater: Soils and Construction (the Blue Book), Volume 1;
- Volume 2A Installation of Services;
- Volume 2C Unsealed Roads;
- Volume 2D Main Road Construction; and
- Volume 2E Mines and Quarries (Landcom, 2004 and DECC, 2008).

The main operational erosion and sediment controls used by the Ravensworth Complex include:

- Training;
- Clean water diversion drains and banks;
- Catch drains;
- Sediment fences and other temporary controls;
- Completion of revegetation works;
- Sediment dams; and
- Ongoing maintenance of erosion and sediment control structures.

Erosion measures within the HOA require management in accordance with the sites ACHMP and consultation with key stakeholders.

6.6.2 Environmental Monitoring Results and Works Undertaken

During the reporting period there were minor upgrades to erosion and sediment controls at site and maintenance of existing erosion and sediment control measures (e.g. desilting of dams).

Construction of a pre-strip sediment dam was completed in 2020.

6.6.3 Key Performance and/or Management Issues

Erosion and sediment is actively managed with erosion and sediment controls in place, erosion monitoring undertaken and maintenance works undertaken on an annual basis.

6.6.4 Proposed Improvements

Erosion monitoring will continue to be undertaken during 2021, along with maintenance and upgrades to erosion and sediment controls, as required.

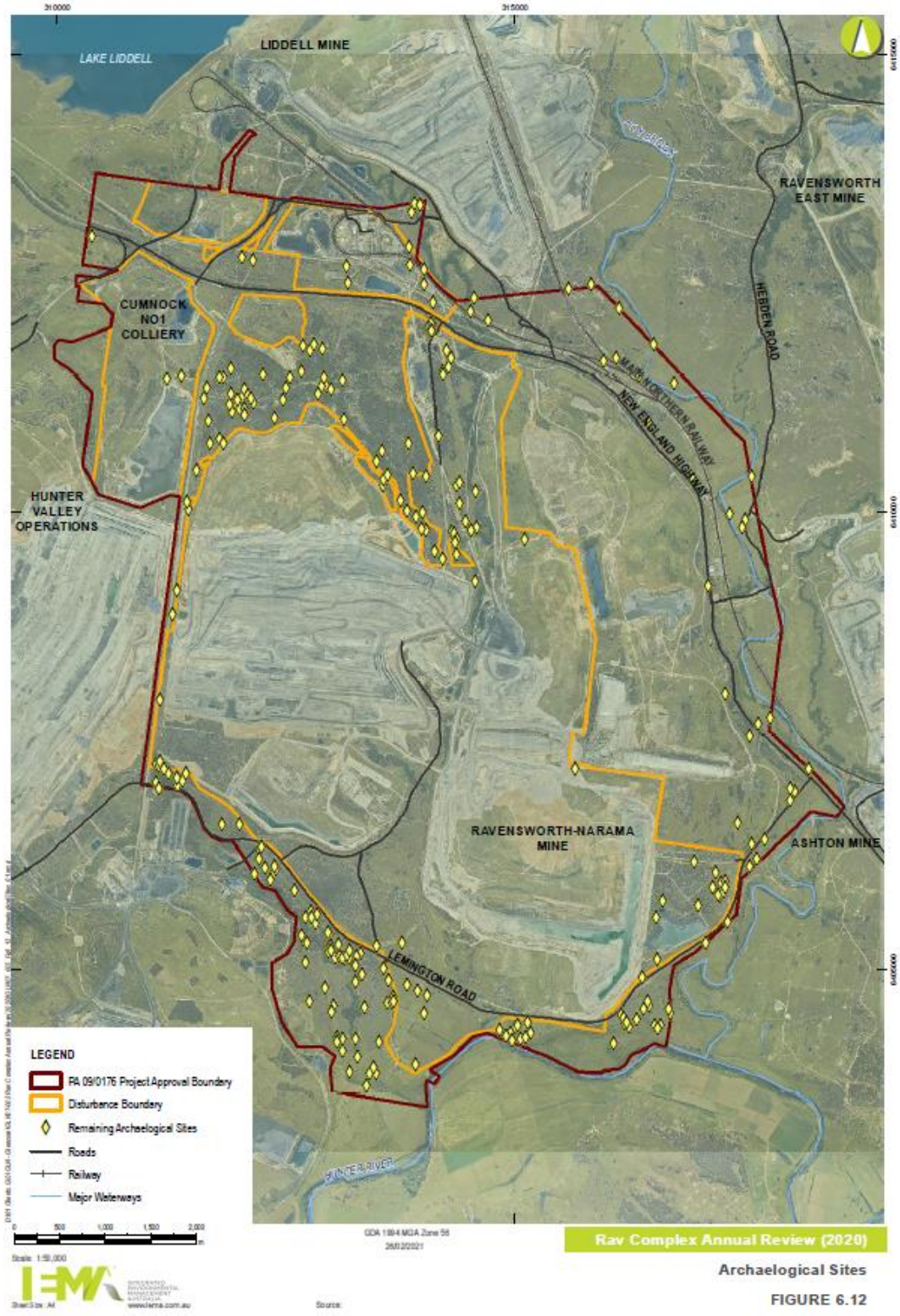
6.7 Aboriginal Heritage

6.7.1 Environmental Management

Aboriginal heritage at the Ravensworth Complex is managed in accordance with the *Aboriginal Cultural Heritage Management Plan* (ACHMP). Remaining archaeological (Aboriginal heritage) sites within the Ravensworth Complex approval boundary (PA 09_0176) are shown on ***Figure 6.12***.

A monitoring program is undertaken for Aboriginal heritage sites that are not directly impacted by approved mining activities, in accordance with the Ravensworth Complex ACHMP. Monitoring is conducted on an annual basis. Results from the monitoring program are discussed below.

Figure 6-12 - Archaeological Sites



6.7.2 Environmental Monitoring Results

The Aboriginal monitoring program for 2020 was undertaken by OzArk Environment and Heritage (OzArk) in November 2020. An archaeologist inspected a number of heritage sites within the Project Approval boundary but outside of the impact area for the purpose of ensuring site management objectives were being met. Registered Aboriginal Parties (RAPs) were unable to be present during the 2020 monitoring due to Covid 19 restrictions.

Both site condition monitoring and photographic monitoring was undertaken during 2020 as the last photographic monitoring across all sites was undertaken in 2017. In total 30 sites were monitored, as well as the grinding groove site REA86 (where photographic monitoring is undertaken annually).

OzArk state that erosion is a significant issue for several Aboriginal sites within the Ravensworth Project Area. In many cases the erosion has been severe in the past and is now beginning to stabilise, although in other cases the erosion it is on-going and sometimes extensive[2]. The result of this erosion leaves two very different archaeological contexts: the visible artefacts within eroded areas and possible archaeological deposits in non-eroded portions of a site.

The archaeological landscape surviving at ROC is generally in poor condition according to OzArk due to the long history of impacts including vegetation clearing, soil loss and the impacts of agricultural, residential, and mining activities. The sites are often located in landforms with thin soils and only rarely were surface artefacts visible at the sites. This would tend to indicate that the recorded artefacts have been obscured either by being covered (unlikely in landforms with already thin soils), or more probably, being relocated by water movement or sheet wash erosion.

Aboriginal sites at ROC are fenced and sign posted. No impacts other than natural deterioration were noted at any of the monitored sites and it is noted that the fencing program has aided the lack of inadvertent impacts to sites.

6.7.3 Key Performance and/or Management Issues

During the reporting period there was no salvage of Aboriginal heritage items. There were no complaints or incidents involving Aboriginal heritage sites.

A gap analysis was undertaken in 2020 along with a review of the Ravensworth Complex Aboriginal Heritage Information Management System (AHIMS) and the Ravensworth Complex Aboriginal Heritage Geospatial database. ***Figure 6.12*** shows the remaining sites requiring management at the site.

Following the installation of hay bales at several sites in 2019, OzArk observed a build-up of sediment on the upslope side that encourages vegetation growth. This demonstrates that the hay bales are an effective, non-invasive method to control worsening erosion. The Ravensworth Complex will continue to replace these hay bales periodically as required.

6.7.4 Proposed Improvements

Ravensworth Complex will continue to hold the monitoring program site inspections on an annual basis in accordance with the project ACHMP.

[2] Note: Erosion is due to natural processes and not directly a result of mining operations.

6.8 European Heritage

The Ravensworth Complex has committed to the following heritage management measures in the *Heritage Management Plan,* which is available on the website:

- Manage blasting practices to meet relevant blast impact assessment criteria at listed heritage sites / items within the vicinity of the Project Area; and
- Structural assessment of the Oakland's complex buildings at key stages of the mining process, this complex is to be removed from further monitoring.

6.8.1 Environmental Monitoring Results

A structural assessment inspection of the Oaklands homestead site was undertaken on the 27 November 2019. Dilapidation, weed, and pest inspections on the Oaklands homestead were undertaken in both June and November 2020. Weed spraying has been completed and rabbit control at the site is ongoing (see ***Section 6.10***).

6.8.2 Key Performance and/or Management Issues

There were no management issues related to European heritage at the Ravensworth Complex during 2020.

6.8.3 Proposed Improvements

European heritage will continue to be managed in accordance with the *Heritage Management Plan* in 2021.

6.9 Meteorological Monitoring

The Ravensworth Complex has a weather station onsite to measure atmospheric conditions, including wind speed, wind direction, sigma-theta, humidity, rainfall and temperature in accordance with EPL 2652. This allows up to date predictions to be made on the impact of weather conditions on mining operations. A summary of results is provided in ***Appendix F***.

6.9.1 Average Temperature and Windspeed

Throughout the reporting period the average mean wind speed was 2.63 m/s.

The average mean air temperature (at 2m) was 18.4 degrees Celsius. The hottest temperature recorded was 43.9 degrees Celsius, and this was experienced in February 2020.

6.9.2 Rainfall

During the reporting period a total rainfall of 848.6 mm was received. This was significantly more than the previous year when 354 mm of rain was received. February 2020 was the wettest month with 138.8 mm, followed by December with 124.8mm.

6.10 Weed and Pest Management

6.10.1 Environmental Management Activities and Monitoring Results

6.10.1.1 Weed Management Activities

Monthly environmental inspections at the Ravensworth Complex are used to identify areas of weed infestations as well as review the success of previous weed control programs.

Weeds are controlled in order to assist successful establishment of rehabilitated areas, maintain pasture quality and provide a productive post mining land use. Weed management also occurs in buffer lands to protect the existing biodiversity of these surrounding areas and remove potential seed banks for weed invasion into rehabilitated areas. The control of noxious weeds is conducted in accordance with the *Noxious Weed Act 1993*.

In February 2020 HCB Rural and Land Management (HCBRLM) compiled the Rehabilitation and Buffer Zones Weed Action Plan 2020 (WAP) based on spatial data collected in 2018 and 2019 by external sources. A summary of weed control activities undertaken by HCBRLM at the Ravensworth Complex and in BOAs is presented in ***Table 6-11***. Weed control was predominantly conducted in rehabilitation pasture areas, buffer lands and BOA's. Weed infestations were recorded in the GIS database.

Date	Location	Species	Control Method
March/April 2020	Western Emplacement	Coolatai Grass	High volume foliar spraying (Rocky 745, Roundup Ultra Max and Devour)
April 2020	Cumnock	Exotic grasses and broadleaf weeds	High volume foliar spraying (Roundup 450 and Wetter 1000)
April/May 2020	Narama	Galenia	High volume foliar spraying (Grazon Extra and Devour)
June 2020	Cumnock	Galenia and Acacia saligna	High volume foliar spraying (Grazon Extra and Devour)
June 2020	Narama	Galenia and Acacia saligna	High volume foliar spraying (Grazon Extra and Devour)
July 2020	Narama	Galenia and Acacia saligna	High volume foliar spraying (Grazon Extra and Devour)
July/August 2020	Cumnock	Rhodes grass, Coolatai, Setaria	High volume foliar spraying (Gylphosate 450, Rocky 745 and Wetter 1000)
September 2020	Buffer	Galenia	High volume foliar spraying (Grazon Extra and Devour)
August and September 2020	Buffer and Eastern Emplacement, South EEA	African Olive, African Boxthorn, Bitou Bush, Acacia saligna, Sweet Briar	High volume foliar spraying (Grazon Extra and Devour of juvenile plants Cut and Paste of mature plants (Vigilant II)
September 2020	Western Emplacement	Galenia, Mustard Weed and various thistles	High volume foliar spraying (Grazon Extra and Devour)

Date	Location	Species	Control Method
September 2020	Buffer	African Olive and African Boxthorn	High volume foliar spraying (Grazon Extra and Devour of juvenile plants Cut and Paste of mature plants (Vigilant II)
September 2020	EAA	Exotic grasses and broadleaf weeds	High volume foliar spraying (Roundup 450 and Wetter 1000)
September 2020	Cumnock	Sugar Gums and Acacia saligna	Cut stump of Sugar Gums (Garlon 600 and Diesel) Juvenile Sugar Gums and Acacia saligna high volume foliar spraying
November 2020	Narama	St Johns's Wort	High volume foliar spraying (Grazon Extra and Devour)
November and December 2020	Cumnock	Acacia saligna, Galenia, Prickly Acacia, Castor Oil, St John's Wort, Bitou Bush, Blue Heliotrope, Fennel	Manual removal of Bitou Bush High volume foliar spraying of other weeds (Grazon Extra and Devour)

Table 6-11 - Weed Control at the Ravensworth Complex and in BOAs during the Reporting Period

6.10.1.2 Feral and Pest Animal Management Activities

Wild Dogs and Foxes

The management strategy for feral animals continued with baiting program conducted during the reporting period. The program was carried out by an experienced consultant and adhered to all best practice guidelines set by NSW Environment, Energy and Science (previously known as OEH) and the Local Land Service (formerly Livestock Health and Pest Authority).

A 1080 ground baiting program was conducted during May and June 2020 within the Mining Lease boundaries and within the Clifton, Stewart and Hillcrest Offset Areas. This timing aligned with other Autumn baiting programs occurring in the Hunter area, including the autumn aerial baiting conducted by Hunter Local Land Services in the Hillcrest Offset Area.

During the 3 week program, 48 bait stations were established on site, including 16 bait stations set in Ravensworth North Offset Area. A total of 40 baits were taken, 25 by wild dogs, 5 by foxes and 10 unknown takes. Baiting efficiency for the program was 21%, relating to the target species only (wild dogs and foxes).

Rabbits

The Oaklands homestead has previously been identified as a site that required a rabbit control program. Spotlight counts were conducted on three separate nights in November 2020 before commencement of the program, resulting in an average count of 32 rabbits. The abandoned homestead, farm buildings and overgrown vegetation were being used by the rabbits as shelter, particularly under floor structures and piles of timber. The program established 16 bait stations. Initial uptake of the free feed was slow as rabbits become accustomed to the feeding hutches. 4 free feeds and 2 baited feeds were offered resulting in an uptake of 70% of the final baited feed. Actual rabbit

numbers declined, but not significantly. The average count at the end of the program, also conducted over three nights, was 24.

Spotlight counts were undertaken at the Hillcrest, Stewart and Clifton BOAs in December 2020. All areas indicated low rabbit numbers and do not require control at this stage.

6.10.2 Key Performance and/or Management Issues

No reportable incidents, performance or management issues regarding weeds and feral animal management occurred during the reporting period.

6.10.3 Proposed Improvements

Throughout 2021 weed monitoring will continue to be undertaken, as well as weed and pest management.

6.11 Visual and Lighting

6.11.1 Environmental Management

The Ravensworth Complex employs various management strategies for mitigating and minimising its impacts on the visual amenity from community locations and public roads.

The Ravensworth Complex undertakes regular community inspections. A photographic record is maintained at strategic monitoring locations around the Ravensworth Complex as evidence, and if there are issues identified during the inspection the Open Cut Examiner (OCE) is informed and actions to address any amenity issues from mining operations are completed.

6.11.2 Environmental Monitoring Results

No lighting surveys were undertaken during the reporting period. The internal lighting procedure was reviewed and updated during an internal audit in 2020.

6.11.3 Key Performance and/or Management Issues

There were no performance or management issues regarding visual mitigation or lighting during the reporting period.

6.11.4 Proposed Improvements

There are no proposed visual and lighting improvements for 2021.

6.12 Spontaneous Combustion, Methane Drainage and Ventilation

6.12.1 Environmental Management

6.12.1.1 ROC/RCHPP

ROC and the RCHPP have a comprehensive management plan in place that addresses the placement of carbonaceous materials to ensure the potential for spontaneous combustion is minimised. The procedure identifies potential sources of carbonaceous material at the mine and details methods to

be used when handling and disposing. A specific training module has been developed to communicate the requirements of this procedure to appropriate personnel.

6.12.1.2 RUM

Methane drainage and ventilation is undertaken by RUM in accordance with the approved *Monitoring Arrangements Management Plan* (RAVUG-1057118485-4445). The plan documents and the management strategies associated with mine ventilation.

6.12.2 Environmental Monitoring Results

Monitoring is conducted annually as per the requirements of the *Spontaneous Combustion Management Plan.* No significant spontaneous combustion events occurred during the reporting period.

6.12.3 Key Performance and/or Management Issues

No significant spontaneous combustion events occurred during the reporting period.

6.12.4 Proposed Improvements

Improvements to spontaneous combustion, methane drainage and ventilation are not proposed for the 2021 period. Current management activities are deemed sufficient.

6.13 Bushfire Management

6.13.1 Environmental Management

Slashing of grasses is conducted on a regular basis, such as road verges, infrastructure areas, and sensitive and high risk growth areas to reduce excessive fuels.

The Ravensworth Complex *Bushfire Management Plan* outlines the key mitigation measures for managing bushfire risk at ROC and the RCHPP.

6.13.2 Environmental Monitoring Results

There were no bushfire events onsite or in BOAs during 2020. However, in quarter 1 of 2020, there were numerous bushfires in the Hunter Region which had an impact on air quality at the Ravensworth Complex (as discussed is ***Section 6.4***).

6.13.3 Key Performance and/or Management Issues

The *Ravensworth Complex Bushfire Management Plan* is currently being reviewed and will be finalised in 2021.

6.13.4 Proposed Improvements

No improvements are proposed for the 2021 reporting period.

6.14 Mine Subsidence

6.14.1 Environmental Management

RUM have a *Subsidence Management Plan* to ensure adequate management of any subsidence impacts associated with surface cracking, erosion, slope instability, land degradation and spontaneous combustion due to longwall mining.

Visual subsidence monitoring is undertaken and subsidence repairs are completed in accordance with the SMP.

6.14.2 Environmental Monitoring Results

RUM was in care and maintenance during the reporting period and no underground mining activities occurred. Visual subsidence inspections were undertaken as part of the ongoing Environmental Monitoring Inspections in 2020. Monitoring did not identify any subsidence related issues.

6.14.3 Key Performance and/or Management Issues

No remedial repair works were required during the reporting period.

6.14.4 Proposed Improvements

There are no proposed improvements in 2021.

6.15 Hydrocarbon and Chemical Management

6.15.1 Environmental Management

Bulk fuel facilities are managed in accordance with *AS1940-2017 The Storage and Handling of Flammable and Combustible liquids.* All permanent fuel facilities are bunded, with measures in place to manage spills.

All hydrocarbon contaminated waste material within pit, hardstand and truck wash areas is bio remediated and disposed onsite in a bioremediation area. The site has been designed to prevent contamination and the storage and handling of chemicals is undertaken in accordance with Australian Standards and relevant guidelines.

Hydrocarbon contaminated material resulting from spillages in the impervious workshop areas are cleaned up using oil absorbent material. This material is then taken offsite by appropriately licensed waste contractor to a licensed facility for treatment and disposal in accordance with site procedures as part of the Ravensworth Complex EMS. Hydrocarbon contaminated water is contained and separated in the site's industrial oily water separators where treated water is recycled for reuse and separated oil is disposed of offsite by the licensed waste contractor. In the event of accidental contamination of onsite dams, contaminated water is contained and transported offsite for treatment by a licensed waste contractor.

At the Ravensworth Complex there are several procedures in place that deal with the safe handling and disposal of chemicals on the mine site. Safety Data Sheets (SDS) are made available to all

employees at the store facility or via the ChemAlert computer database, which provides computer based information on all chemicals held onsite.

6.15.2 Environmental Monitoring Results

The bioremediation area is tested once cells are full and dry or inspection deems testing necessary. Cells 1 – 20 were tested in both April and November 2020.

All facilities utilised for the storage of chemicals on-site conform to relevant Australian Standards and are regularly inspected as part of the monthly work area safety inspections and internal environmental audits.

The bioremediation area remains in good condition with ongoing maintenance to access and lay-down areas throughout the reporting period as required.

6.15.3 Key Performance and/or Management Issues

Minor spills (Category 1 and below) occurred during the reporting period. There was no Category 2 spills. Contaminated material was taken to the onsite bioremediation area.

There were no significant issues regarding the storage of chemicals throughout the reporting period.

6.15.4 Proposed Improvements

Hydrocarbon spills will continue to be managed appropriately, with any spills cleaned up and contaminated material sent to the bioremediation area.

It is proposed to relocate the bioremediation area as mining advances to the south in 2021.

6.16 Greenhouse Gas and Energy

6.16.1 Environmental Management

The Ravensworth Complex is committed to reducing GHG emissions from its operation. The National Greenhouse and Energy Reporting (Measurement) Determination 2008 (Cth) provides methods and criteria for calculating GHG emissions and energy data under the NGER Act. Each reporting year technical guidelines based on the Determination are developed, reflecting improvements in estimation methods and in response to industry feedback. The Ravensworth Complex, through Glencore, uses an online reporting tool known as AQS, which calculates energy consumption and GHG emissions for every site in accordance with the technical guidelines.

6.16.2 Environmental Monitoring Results

6.16.2.1 Results from the Reporting Period

Scope 1 and Scope 2 emissions during the 2020 reporting period are presented in ***Table 6-12***.

Emission Source	T CO_2 -e
Ravensworth Open Cut	
Scope 1 Emissions	302,224.98

Scope 2 Emissions	58,409.25
Ravensworth UG	
Scope 1 Emissions	161,526.99
Scope 2 Emissions	4,884.87
TOTAL	554,046.09

Table 6-12 - GHG Emissions Summary 2020

6.16.2.2 Comparisons with Predictions

The Scope 1 and 2 GHG emissions from the Ravensworth Complex have been estimated at the annual average of 869,681 T CO2 -e. Actual GHG emissions for 2020 were 554,046 $TC0_2$-e which is significantly less than predicted levels.

6.16.3 Key Performance and/or Management Issues

There were no significant issues regarding GHG throughout the reporting period.

6.16.4 Proposed Improvements

There are no proposed improvements for greenhouse gas in 2021, with 2020 GHG emissions falling well below predicted levels.

7. Water Management

7.1 Water Balance

The overall water balance for the Ravensworth Complex in 2020 was a surplus of 1,124 ML (3.07 ML/day) which was well above the predicted deficit of approximately -750 ML (-2.05 ML/day) for the Ravensworth Operations Project (ROP) water balance (Umwelt, 2010) in a 90th percentile rainfall year in 2020. At the time the ROP water balance was prepared, the current GRAWTS scheme was not anticipated and therefore not incorporated into the water balance model calculations. Water imports from other mining operations under the GRAWTS are significant and are likely to account for a significant portion of the discrepancy between the ROP water balance predictions and the observed 2020 site water balance.

Month	Fresh Water Import	Import from GRAWTS	Potable Water Import	Dust Suppression & Wash bays	Export to GRAWTS	HRSTS Discharge
Jan	6.7	244.6	1.2	88.8	0.0	0.0
Feb	8.3	187.4	1.3	70.2	0.0	0.0
Mar	8.8	346.0	1.4	52.6	0.0	0.0
Apr	69.2	358.7	4.7	104.2	0.0	0.0
May	106.3	353.3	2.8	102.4	0.0	0.0
June	72.8	439.3	0.6	41.6	0.0	0.0
Jul	50.8	521.6	2.2	35.8	0.0	0.0
Aug	66.0	489.2	1.1	49.6	0.0	0.0
Sep	5.3	252.8	1.9	60.7	0.0	0.0
Oct	6.3	313.6	1.3	68.8	0.0	0.0
Nov	7.1	580.9	0.5	55.7	0.0	0.0
Dec	6.2	506.3	0.5	61.7	0.0	0.0
Total	**413.8**	**4593.6**	**19.6**	**792.0**	**0.0**	**0.0**

Table 7-1 - Ravensworth Complex Water Imports, Usage and Exports 2020 (ML)

7.2 Water Take

Ravensworth Complex holds water access licences WAL 9050, WAL 10771 and WAL 18317 that allow for extraction of water from the Hunter River and Bayswater Creek. The RCHPP also holds WAL 1046, WAL 8964 and WAL 1325 which also allows extraction from the Hunter River.

In 2020, six water allocation assignments totalling 860.4 ML with entitlement transferred from WAL 8964 to the Mangoola Open Cut mine (271.4 ML) and Singleton Shire Council (589 ML) occurred. Council then transferred this 589 ML entitlement to Glencore's Bulga Open Cut mine.

Ravensworth 2020 water take is outlined in ***A*** - General security entitlement is 1,590 ML less 860.4 ML transferred to Mangoola Open Cut and Singleton Shire Council

Table 7-2.

The extraction of surface water was undertaken in compliance with the conditions of the relevant licences.

Water Licence #	Water Source / Management Zone	Category	Entitlement	Extracted Volume (ML)
WAL 18317 (20AL21098)	Hunter Unregulated and Alluvial Water Source/Jerry Water Source/Jerrys Management Zone (extraction from Bayswater Ck)	General Security	20	0
WAL 9050 (20AL200462)	Hunter River Regulated / Zone 1b (Hunter River from Goulburn River Junction to Glennies Creek Junction)	General Security	500	414
WAL10771 (20A200744)	Hunter River Regulated / Zone 1b (Hunter River from Goulburn River Junction to Glennies Creek Junction)	High Security	25	0
WAL 8964 (20AL203224)	Hunter River Regulated / Zone 1b (Hunter River from Goulburn River Junction to Glennies Creek Junction)	General Security	729.6[A]	0
WAL 1046 (20AL201444)	Hunter River Regulated / Zone 1b (Hunter River from Goulburn River Junction to Glennies Creek Junction)	High Security	3	0
WAL 1325 (20AL203042)	Hunter River Regulated / Zone 1b (Hunter River from Goulburn River Junction to Glennies Creek Junction)	Supplementary	13	0

A - General security entitlement is 1,590 ML less 860.4 ML transferred to Mangoola Open Cut and Singleton Shire Council

Table 7-2 - Surface Water Extractions 2020

ROC holds seven water licences that allow the extraction of groundwater, as listed in ***Table 7-3***. The extraction of groundwater was undertaken in accordance with the conditions of all relevant licences in 2020.

Licence #	Water Source / Management Zone	Entitlement (ML)	Extracted Volume (ML)
WAL 41496 (20AL216920)	Cumnock UG Extraction	2,520	498
WAL 41531 (20AL218933)	Narama Void Incidental Groundwater Interception	150	146
WAL 41530 (20AL218992)	Ravensworth West Pit Void Incidental Groundwater Interception	100	0
WAL 41507 (20AL217068)	Ravensworth North Pit Incidental Groundwater Interception	576	9
WAL 41529 (20AL218991)	Ravensworth Underground Mine Dewatering	400	0
WAL 41505 (20AL217052)	Cumnock Wash Plant Pit	300	0
WAL 41554 (20AL219016)	South Open Cut	576	0

Table 7-3 - Groundwater Extractions 2020

7.3 Water Supply, Use and Discharges

7.3.1 ROC

The ROC water management system comprises a range of infrastructure including water storages, pipes and pumps for water transfers (within the mine complex and between external water sources and sinks) and instrumentation for flow and level measurement.

Water sources for the ROC include:

- Rainfall / runoff within the ROC and RCHPP;
- Groundwater seepage into operating mine pits (ROC and RUM) and spoils seepage to Narama Pit;
- Moisture in ROM coal;
- Groundwater extracted from former Cumnock underground workings;
- Water imported from the Mount Owen Complex or Liddell Mine under the Greater Ravensworth Area Water and Tailings Scheme (GRAWTS);
- Fresh water pumped from the Hunter River; and

- Potable water trucked to site.

Water demands for the ROC include:

- Evaporative losses from water storages;
- Dust suppression (haul roads, stockpiles and handling) and vehicle wash bay losses;
- Moisture bound with product coal and rejects (coarse and fine);
- Discharges under the Hunter River Salinity Trading Scheme (HRSTS); and
- Transfers to the Mount Owen Complex or Liddell Mine under the GRAWTS.

Surplus surface water at ROC is transferred to the RCHPP or discharged from the Narama In-pit Storage Dam to the Hunter River via Bowmans Creek under the conditions of ROC EPL No. 2652 and the HRSTS or transferred to other Glencore mine sites under the GRAWTS. In 2020, ROC did not discharge any water from the Narama In-pit Storage Dam under the conditions of the HRSTS and EPL 2652. Furthermore, no unregulated discharges from ROC occurred during 2020. This is consistent with 2019.

7.3.2 Hunter River Salinity Trading Scheme

Surface water management across the Ravensworth Complex is undertaken in accordance with the Ravensworth Complex *Water Management Plan*. This plan has been developed in consultation with relevant agencies and approved by the DPIE in accordance with Schedule 3, Condition 31 of PA 09_0176.

Zero (0) ML of water was discharged from the Narama In-Pit Storage Dam during the 2020 reporting period.

The Greater Ravensworth Water and Tailings Scheme between other Glencore sites transfers water to the Narama In pit Storage Dam and is the primary discharge point for the Complex.

7.4 Surface Water Monitoring

7.4.1 Environmental Management

Surface water management across the Ravensworth Complex is undertaken in accordance with the Ravensworth Complex *Water Management Plan*. This plan has been developed and approved by the DPIE in accordance with Schedule 3, Condition 31 of PA 09_0176.

The Ravensworth Complex *Water Management Plan* outlines the interactions of the water management system across the sites that form part of the Ravensworth Complex.

The objective of the Ravensworth Complex water management system is to manage all surface and sub-surface water so impacts on the surrounding environment are minimised and to ensure minimal interference to mining production.

The surface water monitoring program includes observation of the following elements of the Ravensworth Complex water management system and surrounding creeks:

- Surface water quality;

- On-site water management; and
- Discharge to the Hunter River via Bowmans Creek under the HRSTS.

The Ravensworth Complex maintains a large network of surface water monitoring locations, including computer controlled mine water dams, sedimentation dams and local watercourses.

As a minimum, each of these monitoring points is tested monthly for pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS) and Total Suspended Solids (TSS). The watercourse locations are also monitored for flow.

Water quality sampling is undertaken monthly in Bowmans Creek, Bayswater Creek and Emu Creek. Water quality monitoring is undertaken in Davis Creek and Pikes Creek every second month.

Ravensworth Complex undertakes stream health and channel stability monitoring in Bayswater, Emu, Bowmans, Davis and Pikes Creeks. This monitoring involves site inspections and stability assessments, macro invertebrate sampling and water quality monitoring at seven sites across the Complex. The results are compared to reference sites located in the Stewart and Clifton Offset Areas.

7.4.2 Environmental Monitoring Results

7.4.2.1 Surface Water Quality Monitoring Results

Water quality results (pH, EC, TDS and TSS) for the Ravensworth Complex sampling program reported by Umwelt (Australia) Pty Ltd in 2020 are presented in ***Appendix G,*** along with analysis (minimum, maximum and average) and time-series charts.

Impact assessment criteria (IAC), also referred to as 'trigger values', for pH, EC, TSS and TDS have been determined for specific receiving water monitoring locations as part of the *Ravensworth Complex Water Management Plan*. All surface water quality data collected as part of the monitoring program were assessed against the IAC in order to identify deviations from the baseline water quality conditions. The results are discussed in Section 4.1 of ***Appendix G***. There were some exceedances of IAC values, which were investigated in accordance with the *Water Management Plan.* The majority were related to samples being taken from pooled water which are unrepresentative of typical water quality. No further mitigation measures were required. Stream Health Monitoring

Stream health monitoring is undertaken at Bayswater Creek, Bowmans Creek, Pikes Creek, Davis Creek and Emu Creek on a biannual basis. Monitoring is also undertaken at control sites. The results of the monitoring program; Habscores, AusRivAs [Signal2] and erosion and stability observations are provided in ***Table 7-4***. The Habscore provides a relative indicator of stream health at dry and wet sites. The AusRivAs (Signal2) provides an indication of the macroinvertebrate community's overall tolerance to pollution or disturbance.

Umwelt (2020) concluded that all sites have remained relatively stable compared to previous results, despite the prolonged drought in the three years leading up to the 2020 monitoring. Sufficient rainfall occurred before the May surveys meaning ten of the fourteen sites contained water, whereas only eight sites contained water in October.

HABSCORE assessments in autumn showed one of the six monitoring sites improved since baseline in 2013, whereas the remaining five sites decreased. However, in spring, four of the six sites showed increases since baseline. In comparison, two of the ten control sites showed a decrease in autumn and

spring with the remainder improving or remaining the same as baseline. The HABSCORE categories for these sites range from poor to optimal, as consistent with previous results.

Site		2020 Erosion / Stability Observations	HABSCORE		AusRivAs (Signal2)		HABSCORE		AusRivAs (Signal2)	
			Autumn 2019	Spring 2019	Autumn 2019	Spring 2019	Autumn 2020	Spring 2020	Autumn 2020	Spring 2020
BWC-AQ2	Bayswater Creek Mid 1	Minor bank erosion upstream. Recovering with groundcover vegetation cover improving.	70 (S)	29 (M)	Dry	Dry	36* (P)	36* (P)	Dry	Dry
BWC-AQ3	Bayswater Creek Mid 2	Significant erosion at points where ephemeral tributaries join with Bayswater Creek.	21 (P)	25 (P)	3.50	3.09	66 (M)	50* (M)	4.0	Dry
BWC-AQ4	Bayswater Creek D/S	Minor erosion adjoins rip-rap.	24 (P)	25 (P)	3.60	Dry	43* (S)	40* (S)	Dry	Dry
DAC-AQ1	Davis Creek U/S	Moderate undercutting and general erosion of banks. These are revegetating with groundcovers.	27 (M)	37 (M)	3.25	Dry	43* (M)	36* (M)	Dry	Dry
DAC-AQ2	Davis Creek D/S	Significant erosion where ephemeral tributaries meet Davis Creek.	49 (M)	27 (M)	Dry	Dry	31* (P)	31* (P)	Dry	Dry
EMC-AQ2	Emu Creek D/S	Significant erosion and undercutting of the left bank. Has not improved despite presence of stabilising groundcover vegetation.	35 (M)	19 (P)	3.33	Dry	38 (S)	35* (M)	3.75	Dry

O=optimal; S=suboptimal; M=marginal; P=poor. * denotes the site did not contain water

Table 7-4 - Stream Health at Ravensworth Complex for 2019 and 2020

7.4.2.2 Comparison to EA Predictions

Stream Health Monitoring

Water quality parameters recorded at the monitoring sites during autumn and spring 2020 sampling were compared against the Ravensworth Complex adopted impact assessment criteria (Umwelt, 2014) listed in ***Table 7-5***.

Site	pH	Oxygen % saturation	Maximum conductivity (µs/cm)
Bayswater Creek (BWC) sites	6.5 – 8.0 (all conditions)	85 – 110 (all conditions)	2100 (all conditions)
Other monitoring sites	6.5 – 8.0 (flow) 6.5 – 8.4 (no flow)	85 – 110 (all conditions)	2100 (flow) 6100 (no flow)

Table 7-5 - Adopted Impact Assessment Criteria

Ravensworth sites with water quality results outside of permissible ranges were:

- BWC-AQ3 (pH and EC beyond permissible range); and
- EMC-AQ2 (pH and DO beyond permissible range).

The remaining Ravensworth sites did not contain water.

Overall, these results were consistent with those of previous monitoring.

7.4.2.3 Long Term Trend Analysis

Despite the drought conditions occurring within the region since 2017, both monitoring and control sites have generally remained stable, albeit in low condition. The rainfall recorded in 2020 was substantially higher than that recorded in previous years and this was evident in the number of sites that contained water compared with those in 2019. Given the recent good rainfall in 2020, Umwelt (2020) believe that the overall stream health of most of the sites should continue to improve.

7.4.3 Key Performance and/or Management Issues

Stream health continues to be a focus for management at ROC. Refer to the ***Section 7.4.4*** below for proposed improvements in 2021, in relation to stream health.

7.4.4 Proposed Improvements

Stream health monitoring will continue to be undertaken during the 2021 reporting period. In accordance with Umwelt recommendations, the following will also be undertaken at the Ravensworth Complex during 2021:

- Weed control at sites with high infestations of the exotic sharp rush (*Juncus acutus*), being BWC-AQ3, by application of follicular spray (hexazinone) before plants set seed (i.e. late spring and early summer);
- Continue implementing erosion and sediment controls in accordance with the WMP with a focus at BWC-AQ2, BWC-AQ3, DAC-AQ2 and EMC-AQ2; and

- Investigate the potential causes of canopy dieback at DAC-AQ2, EMC-AQ2 and BWC-AQ2 if continued dieback is observed in 2021 that cannot be attributed to drought.

7.5 Groundwater Management

7.5.1 Environmental Management

The Ravensworth Complex *Water Management Plan* was prepared to satisfy the requirements of the Project Approval PA 09_0176 Schedule 3, Condition 31.

The groundwater management strategies and practices employed by the Ravensworth Complex include:

- Groundwater quality monitoring program and network;
- Groundwater level monitoring program and network;
- Site water balance including water usage metering to determine groundwater interception volumes;
- Established groundwater impact criteria and assessment of impacts on other users; and
- Documented Groundwater Impact Contingency Plans if other groundwater users are impacted by ROC activities.

7.5.2 Environmental Monitoring Results

7.5.2.1 Results from the Reporting Period

During the 2020 monitoring period, the groundwater management monitoring report undertaken by Umwelt (Australia) Pty Ltd included review of monthly monitoring of water levels, quarterly monitoring of pH and EC, and annual monitoring of inorganic species (speciation data). The results are provided in ***Appendix G***.

All monitoring data collected as part of this program is assessed against established IAC in order to:

- Determine whether groundwater extraction volumes are within WAL limits and are comparable with modelled predictions;
- Identify deviations from the baseline water quality conditions; and
- Identify deviations from the baseline groundwater level trends.

Groundwater Quality

A summary of groundwater quality data for pH, EC and trace elements (speciation) is provided in ***Appendix G***, along with individual results. Historical pH and EC results for all current and decommissioned monitoring bores are also presented in Charts in ***Appendix G*** with the mean and standard deviation for each bore shown on each chart.

A detailed discussion of groundwater quality results for 2020, along with comparison to historical data and IAC values from the Ravensworth Complex *Water Management Plan* can be found in Section 5.1.1 of ***Appendix G***.

The majority of groundwater quality results in 2020 were within historical ranges and the adopted IAC. Umwelt (2021) concluded that any exceedances of IAC in 2020 were minor in nature and consistent with historical trends. It is recommended that IAC trigger values be reviewed, and that bores be cleared of any sediment that may be impacting water quality results.

Groundwater Levels

In 2020, groundwater levels were measured at thirteen locations, with monitoring results shown in ***Appendix G***.

Following a period of declining groundwater levels from early 2018, believed to be a consequence of an extended period low rainfall, recorded levels at NPZ7 Small (Hunter River Alluvium) showed an increase over the 2020 monitoring period, rising from 30.08 mAHD in February to 32.52 mAHD in December. It is considered that increased rainfall over 2020 has resulted in increased surface water recharge to the alluvial aquifer.

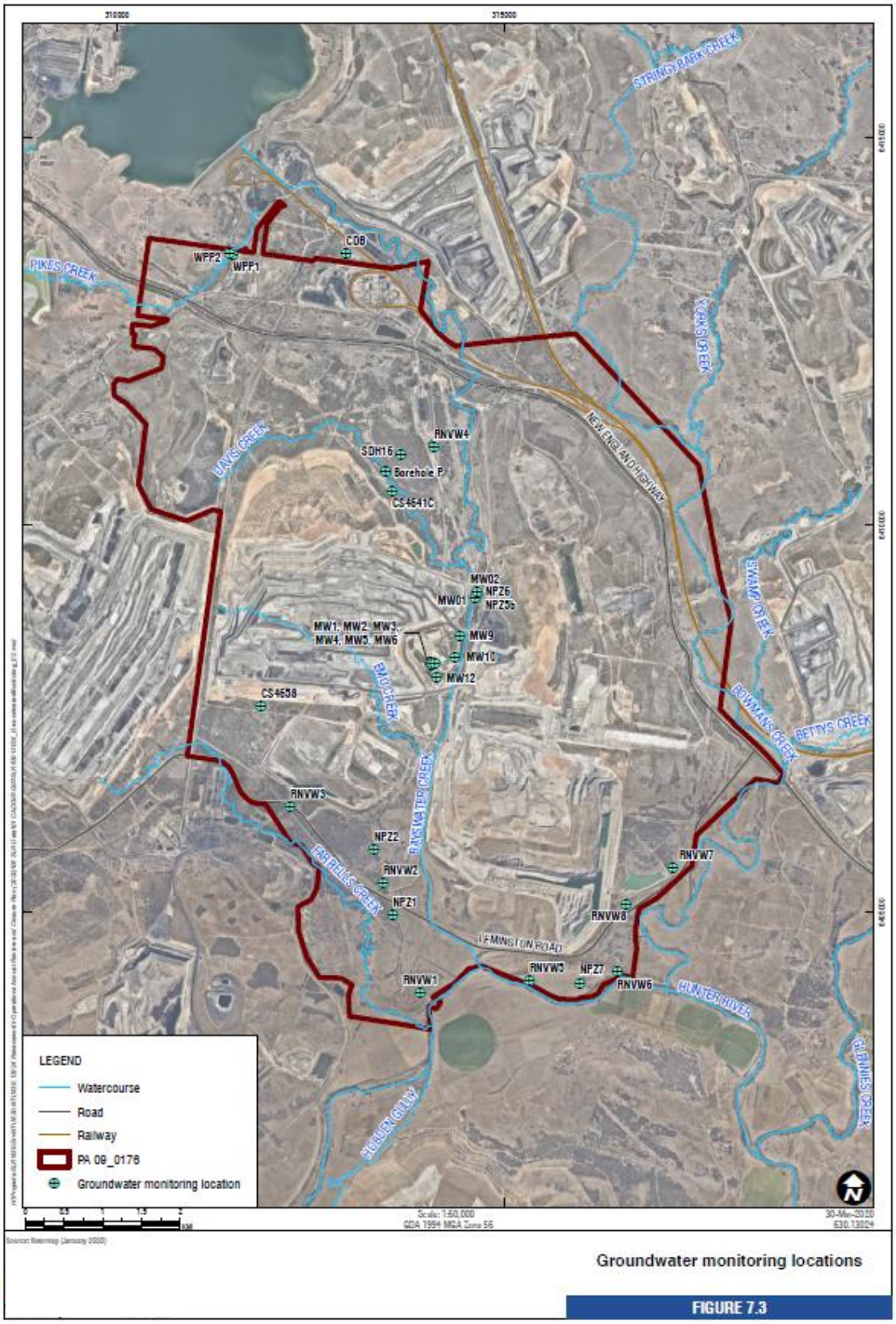
Recorded water levels at CS4641C (Pikes Gully seam) were relatively stable of the 2020 period following a steady decline in level since 2015, which followed the sharp decline observed from 2013 to 2015 as a result of and dewatering of the former Cumnock underground workings to allow mining in the Ravensworth North Pit. Water levels in SDH16 and Borehole P also stabilised over 2020 which is reflective of reduced Cumnock Underground dewatering rates from April 2020 onward. The rate of decline in the Coffey Dam Borehole (Liddell seam) water level slowed over 2020 which may also reflect reduced Cumnock Underground dewatering rates.

NPZ7 Tall (Bayswater seam) and NPZ1 Tall (Lemington seam) both exhibited rising water levels over the 2020 period with increases of 2.38 m and 1.74 m respectively. This may reflect an increase in surface water recharge to the aquifers as a result of higher rainfall in 2020.

NPZ6 Tall (Broonies Seam) exhibited a steady decline in water level over the 2020 period with a decrease of 1.3 m, however, NPZ5B P1 which also targets the Broonies seam was stable over 2020. The decrease in NPZ6 Tall water level may be a consequence of the progression of mining in the North Pit, however, it is unclear why a corresponding decrease in NPZ5B P2 did not accompany these results.

MW1, MW2, MW3, MW5, MW6, MW9, MW10 and MW12 all exhibited a decline in water levels with decreases ranging from -0.09 m (MW9) to -1.62 m (MW12). The cause of these decreases is likely to be a consequence of the progression of mining in the North Pit and appear to be consistent with the groundwater model predictions for the Ravensworth Project. MW4 showed a slight increase in water level (0.06 m), however, the cause for this increase was not apparent.

Figure 7-3 - Groundwater Monitoring Locations



8. Rehabilitation

8.1 Objectives and Final Land Use

The principal objective of rehabilitation at the Ravensworth Complex is to return the site to a condition in which its landform, soils, hydrology and biodiversity are stable, sustainable and compatible with the surrounding landscape and pre-mining land use.

Ravensworth Complex Area	Objective	Final Land Use
ROC	Establishment of native vegetation communities to be representative of the pre-mining landscape and be consistent with PA 09_0176.	Predominately woodland (Class IV) rehabilitation with an area of pasture for cattle grazing (Class V) consistent with the EA.
RUM	Disturbed land will be returned to a land capability consistent to that which existed before mining.	Minimal disturbance due to underground nature of mining. Life of mine rehabilitation include: • Subsidence crack remediation; • Areas of the surface facilities requiring revegetation after disturbance; • Key areas of the operation requiring visual screening with vegetation; • Maintenance of previously rehabilitated areas; and • Final rehabilitation.
RCHPP	Decommissioning and establishment of native vegetation communities' representative with the pre-mining landscape consistent with PA 09_0176 unless the DPIE agree otherwise.	Disturbed land will predominantly return to woodland (Class IV).

Table 8-1 - Objectives and Final Land Use for the Ravensworth Complex

8.2 Rehabilitation of Disturbed Land

8.2.1 Key Issues that may Affect Successful Rehabilitation

Key Issue	Discussion
Rainfall & Climate	The project area experiences a temperate climate with warm summers and no defined dry season. Summer daytime temperatures average around 30–32^{o} C; but on occasion exceed 38–40^{o}C. In the winter months, daytime temperatures are on average 8–9^{o}C; but have been known to drop below zero in places. The area experiences frost conditions. The region experiences an average annual rainfall of approximately 650 mm/year. Rainfall depths of 30–60 mm occur in most months of the year, with higher falls dominant in the summer months. The number of rain days per month may be used as an indicator of how often runoff may occur, and, therefore, potential for erosion. Depending on recent preceding rainfall events, storms less than 10 mm are considered to have little potential to cause erosion as much of the water will infiltrate into the soil and run-off will be minimal. In the wetter summer months, the incidence of rainfall days with rainfall depths greater than 10 mm is approximately 20 occasions per year; with rainfall depths exceeding 25 mm on 5 to 6 occasions per month (BoM, 2016).
Topsoil Management	Topsoil analysis records for Ravensworth Operations indicate materials tend to be *sandy clay* and *medium clay* textured and of relatively poor quality. Results indicate the topsoil materials are sodic and magnesic (and likely dispersive), sometimes moderate to highly saline, and have pH ranges from near neutral 7.1 to highly alkaline at 10.1. There are no known Acid Mine Drainage (AMD) issues at Ravensworth Operations. Therefore this aspect is not a major consideration in relation to rehabilitation on site during the MOP period. Testing has been conducted on exploration samples to determine propensity for AMD generation, across the site. No evidence of AMD has been found to date.
Subsoil and overburden Management	Spoil materials are overburden and inter-burden from the mine pit. Materials are reported to be moderately alkaline (pH 7.1–8.7), moderately saline, sodic, with appreciable levels of magnesium. Ravensworth revised the internal rehabilitation procedure in 2019 and has implemented the following changes to the rehabilitation methodology: • Ripping and raking of subsoil to extract large rocks; and • Applying gypsum to subsoils at a rate of ~ 8tonne/Ha
Slope Considerations	Landform design is predominantly undertaken at the environmental assessment (approval) phase of an operation and is then integrated in the MOP. This process involves the selection of emplacement locations and sizes, location of final voids and the development of a 'final landform' which must be adhered to throughout the life of the operation. Considerations such as landform profiles, dump heights, gradients and drainage flow paths are largely developed at this stage. Therefore, the main consideration relating to landform and slope design throughout the life of the operation is ensuring that the construction of emplacements etc. comply with the approved final landform. The **Design Compliance Procedure (RAVOC-258458278-14293)** details the steps to be completed at the various stages of the mining operation to ensure that final designs are achieved. Ravensworth uses a combination of geomorphic landform design and conventional landform design. The objective of the design is to mimic a natural, free draining,

Key Issue	Discussion
	stable landform with a variety of slope lengths, aspects, grades and drainage pathways.
Vegetation Cover	Ravensworth is committed to restore self-sustaining ecosystems, including establishing at least 1,767 ha of woodland vegetation in accordance with the Ravensworth Biodiversity offset strategy. Ravensworth is committed to carry out rehabilitation progressively, that is, as soon as reasonably practicable following disturbance. The Rehabilitation Strategy for the Project is integrated with the Biodiversity Management Plan for the Project through creating extensive areas of woodland within rehabilitated areas associated with the Project that target the following vegetation communities: • Central Hunter Box-Ironbark Woodland; • Central Hunter Swamp Oak Forest; • Central Hunter Bulloak Forest Regeneration; and • Grassland.
Management of the above rehabilitation issues is conducted in accordance with: • Ravensworth Complex Operational Mine Closure Plan; • Ravensworth Complex Biodiversity Management Plan; • Ravensworth Open Cut Mining Operations Plan; and • Ravensworth Underground Mining Operations Plan.	

Table 8-2 - Key Rehabilitation Issues

8.2.2 Spoil Shaping and Landform Design

ROC

The conceptual final landform for ROC has been designed to blend into the surrounding environment and will be shaped in accordance with the approved MOP. The geomorphic landform design mimics natural landforms of the Hunter Valley. The geomorphic landform has the potential to significantly reduce the need for engineered straight run drop structures reducing dependence on contour drains in the longer term. These landforms offer a diversity of habitat that can enhance the value of rehabilitated ecological systems.

RCHPP

Once the tailings storage facilities at Cumnock are capped, they will be shaped in accordance with the approved MOP for ROC/RCHPP and rehabilitated to achieve local woodland ecological communities.

RUM

Final landform management is outlined in the RUM MOP. The final landform will be a free draining surface that incorporates drainage controls to manage potentially sediment-laden water from the areas along with minimising the possibility of erosion.

8.2.3 Revegetation

The final land use at ROC will be predominantly returned to a woodland ecological community, interspersed with pasture. A typical list of tree and shrub species used for rehabilitation at ROC is shown in ***Table 8-3***.

Woodland Rehabilitation				**Pasture**
Overstorey	**Middle storey**	**Understorey**	**Riparian**	
Acacia implexa	*Acacia decurrens*	*Dianella caerulea*	*Juncus usitatus*	*Japanese Millet*
Acacia salicina	*Acacia filicifolia*	*Lomandra multiflora subsp. multiflora*	*Lomandra multiflora*	*Ryecorn/ Oats*
Allocasuarina luehmannii	*Acacia longifolia subsp. Multiflora*	*Austrodanthonia linkii*	*Casuarina glauca*	*Couch Grass*
Angophora floribunda	*Acacia parvipinnula*	*Austrostipa scabra*		*Wimmera Ryegrass*
Brachychiton populneus subsp populneus	*Bursaria spinosa*	*Chloris verticosa*		*White Clover*
Callitris endlicheri	*Notelaea microcarpa var. macrocarpa*	*Cynodon dactylon*		*Lucerne*
Eucalyptus crebra	*Acacia decora*	*Dichondra repens*		*Sub Clover*
Eucalyptus tereticornis	*Acacia paradoxa*	*Themada australis*		*Phalaris sirosa*
Eucalyptus molucanna	*Dodonaea viscosa*	*Bothriochloa macra*		*Kikuyu*
		Microlaena stipoides var		*Green Panic*
				Setaria
				Sephic Medic

Table 8-3 - Typical Species used for Woodland and Pasture Rehabilitation at ROC

Once overburden dumping is completed, emplacements are bulk shaped to the final landform profile. On completion of overburden bulk shaping, and prior to topsoiling; ameliorate application (if required), deep ripping, and rock raking is conducted to remove any large rocks in the upper profile. During this process, gypsum is incorporated into the overburden to improve the soil structure. Topsoil is then spread across the rehabilitation areas and appropriate application of fertilisers or other ameliorants as determined by soil / subsoil characterisation analysis is incorporated into the topsoil, which is then re-ripped and seeded.

Sowing and planting times are generally conducted, where practical, in autumn and/or spring to increase germination and survival rate.

Areas that have been previously used for overburden, tailings and coarse rejects emplacement from the Ravensworth Complex will be shaped and rehabilitated, using a combination of woodland and grassland species mix.

RUM

There are minimal areas available for revegetation at RUM. Subsequently, during the reporting period no rehabilitation activities occurred at RUM.

8.3 Rehabilitation Performance

8.3.1 Rehabilitation Status at the End of the Reporting Period

Ravensworth Complex rehabilitation and disturbance areas are summarised in ***Table 8-4***. A total of 25.6 Ha of new disturbance associated with the progression of the Ravensworth North pit occurred during the reporting period. A total of 70 ha was prepared for rehabilitation in 2020 and 10.7 ha of previously rehabilitated land was redisturbed.

Figure 8.5 includes a map of areas disturbed and rehabilitated during 2020. Photographs of rehabilitation are also provided. Annual rehabilitation implementation performance monitoring was conducted during 2020, a summary is reported in ***Table 8-5***.

Mine Area Type	Previous Reporting Period (Actual)	This Reporting Period (Actual)	Next Reporting Period (Forecast)
Total Mine Footprint (Ha)	2585.6	2614.5	2625.9
Disturbance (Ha)	1712.6	1603.0	1587.5
Land Being Prepared for Rehabilitation (Ha)	70.0	70.0	30.0
Land under Active Rehabilitation (Ha)	950.76	932.9	1009.7
Completed Rehabilitation (Ha)	0	0	0

* Project Approval granted in 2011 (PA_09_0176) allowed for re-disturbance of existing rehabilitated areas for overburden emplacement and mining. During 2020 previously rehabilitated areas were re-disturbed reducing the total land under active Rehabilitation figures.

Table 8-4 - Ravensworth Complex Annual Rehabilitation and Disturbance

Rehabilitation Site Name	Rehabilitation Type	Rehabilitation Area (Ha)	Rehabilitation Summary
Ravensworth Eastern Emplacement	Central Hunter Grey Box Ironbark Woodland	56.7	Final landform seeded with a native woodland mix and cover crop
Ravensworth Eastern Emplacement	Grazing Pasture	13.3	Final landform seeded with pasture species and cover crop

Table 8-5 - Rehabilitation Performance - Ravensworth Operations

Previous Reporting Period (m^3)	This Reporting Period (m^3)	Next Reporting Period (m^3)
68,256	115,776	134,605

Table 8-6 - Topsoil salvage - Ravensworth Operations

Photo 1 – Habitat tree installed on Eastern Emplacement Area geomorphic landform

Photo 2 – Progressive establishment of geomorphic landform on Eastern Emplacement Area

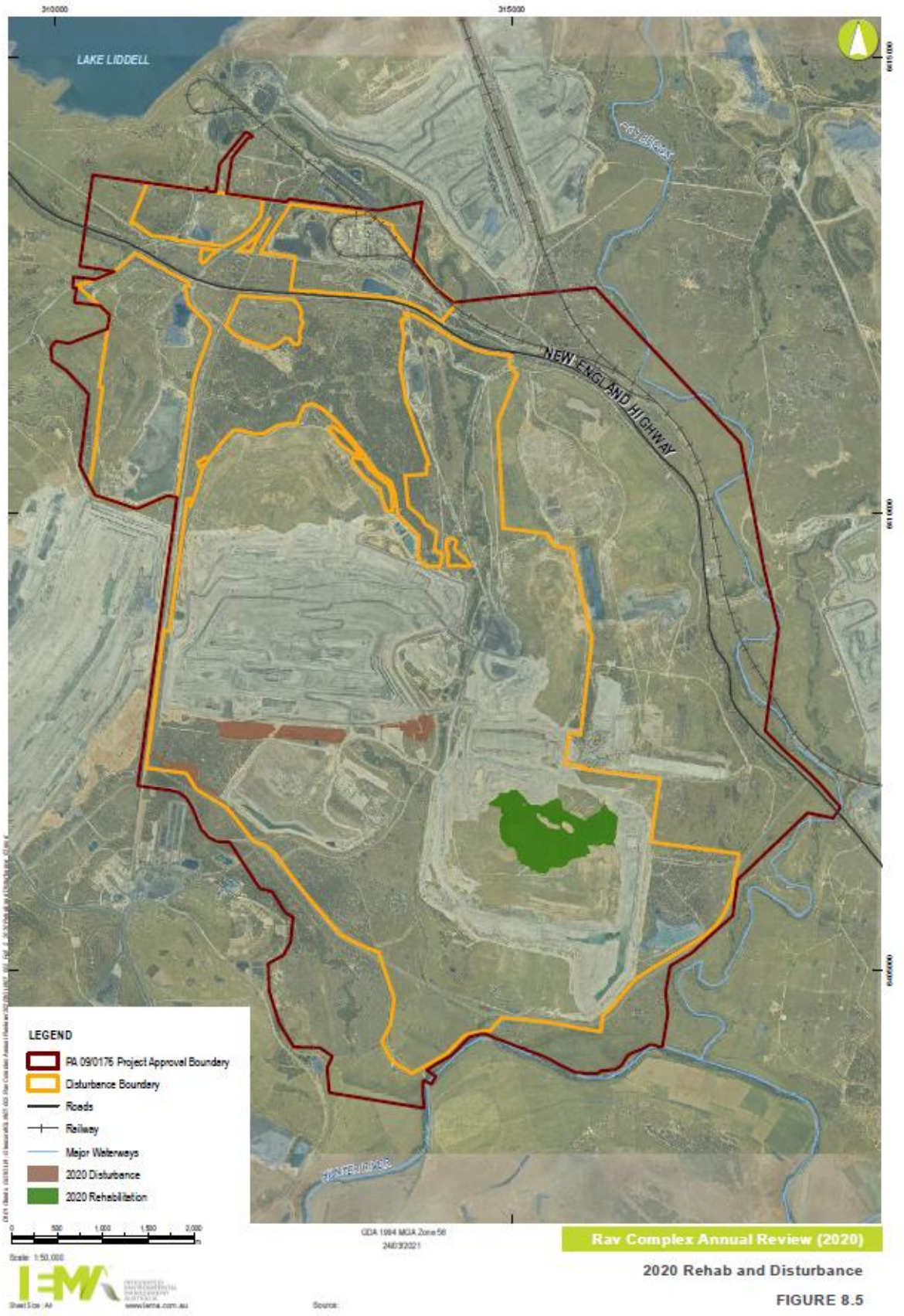
Photo 3 – Establishing cover crop across geomorphic landform design

Photo 4 – Remediation works undertaken during 2020 across lower Western Emplacement Area slopes

Photo 5 – Establishing cover crop on area seeded to native woodland

Photo 6 – Monitoring of vegetation establishment on geomorphic landform slope

Figure 8-5 - 2020 Rehabilitation and Disturbance



8.3.2 Summary of Rehabilitation Monitoring

During the reporting period long-term rehabilitation monitoring and a rehabilitation walkover assessment was conducted to compare current conditions of the rehabilitation with closure criteria outlined in the MOP. This information developed management recommendations to guide the rehabilitation towards targeted Ecological Communities and final landform criteria.

8.3.2.1 Rehabilitation Monitoring

Koru Environmental were engaged to undertake rehabilitation monitoring in 2020 at the Ravensworth Complex. Monitoring approaches and methods were slightly amended in 2020 to incorporate the requirements of the newly revised Glencore procedure '*GCAA 11.16 - Completion Criteria and Rehabilitation Monitoring*'. The revised approach employs monitoring according to two distinct time periods:

- Initial establishment monitoring (IEM) – rapid monitoring of rehabilitation aged 1 to 3 years, mainly focussing on germination success, landform stability and early identification of problematic weeds; and

- Long-term monitoring (LTM) – detailed scientific monitoring of older rehabilitation (≥4 years) to evaluate and track progress toward defined rehabilitation objectives and completion criteria.

Field surveys were undertaken in October 2020 with a total of 16 rehabilitation blocks and 46 transects/plots assessed across Ravensworth North and Narama rehabilitation areas. In total 11 rehabilitation blocks were monitored for IEM and five blocks monitored for LTM. Monitoring blocks comprised areas being returned to pasture (approximately 99ha) and native woodland (approximately 257ha).

Appendix H contains tables which summarise the progress of rehabilitation against the MOP completion criteria and the MOP Trigger Action Response Plan.

8.3.2.2 Fauna Monitoring

Fauna monitoring in rehabilitation is required every three years. Biodiversity Australia Pty Ltd were engaged to conduct the 2020 fauna monitoring component of the rehabilitation monitoring program. This was the third fauna monitoring event, following monitoring conducted in 2014 and 2017.

A total of six fauna monitoring sites were surveyed, including two previously established sites and four newly established sites. Fauna detected included a range of avian, mammalian, reptilian and amphibian species. Two threatened species were recorded during the surveys in November 2020; the Dusky Woodswallow within the Narama South Rehabilitation Area and the Speckled Warbler within the Cumnock Rehabilitation Area. Repeat records of the Speckled Warbler in the same location, likely indicates the presence of breeding habitat for this species. Targeted survey for the Green and Golden Bell Frog did not identify this species.

The monitoring surveys indicated the continuation of fauna use with a range of species recorded. Species richness' were comparable to those recorded during the 2017 monitoring program (equivalent sites); however direct comparisons cannot be made due to variations in survey effort. One notable difference since the previous monitoring event is the increased presence of feral species within the Rehabilitation Areas. Of particular concern was the extent of evidently breeding Feral Dogs within the Cumnock Rehabilitation Area.

Assessments of habitat suitability were conducted at each Rehabilitation Area. These included an evaluation on the availability of foraging, nesting, denning and breeding habitat; along with the inspection of artificial habitat structures such as nest boxes and bat caves. Assessments identified that all monitoring sites provided some form of habitat suitability. Increasing the quality, extent and connectivity of these habitats to allow for the introduction of a broader range of fauna would beneficial.

Biodiversity Australia (2021) concluded that the continued richness of species recorded and the continued presence of threatened species within the Rehabilitation Areas affirms the conservation values of these areas and suggests that overall habitat conditions not only continue to remain suitable but are improving with time.

8.3.3 Rehabilitation Maintenance

8.3.3.1 Western Emplacement Area

In 2019, the Resource Regulator, issued a Notice (NTCE0003754) under Section 240(1)(e) and Section 240(1)(a) of the Mining Act 1992 to the Ravensworth Complex requiring the following actions to be undertaken by 30 July 2020:

- Carry out a program of works to backfill or otherwise repair all scours and gullies on the Western Emplacement Area northern batters as identified in the approved Mining Operations Plan (Appendix 4) in accordance with the methods described in the Mining Operations Plan (section 7.3.2 and Appendix 4).

A Rehabilitation Survey of the WEA was completed by Koru Environmental in August 2019 which risk ranked the works required in order of priority. Areas of the WEA were re-worked in 2019/2020 based on this survey and works have included the following:

- Backfiling and reshaping of gullies;
- Topsoil stripping/clearing of underperforming rehabilitation ;
- Removal of sediment from toe drain;
- Design and installation of contour drainage structures across linear slopes;
- Repairs to 600 m of ‘geofluv’ drainage lines on the western slopes;
- Re-application of topsoil and ameliorants;
- Deep ripping and re-seeding of all areas with Central Hunter Grey Box Ironbark Woodland community species;
- Salvage and reinstallation of rocks and logs to create habitat features; and
- Installation of erosion and sediment controls.

These works were completed in June 2020. A site inspection of the WEA was undertaken by the Resources Regulator on 25 September 2020, and a letter dated 1 October 2020 confirms that Cumnock Colliery No. 1 Pty Ltd have demonstrated compliance with the specified measures of the Direction 1 of Section 240(1)(c) NTCE0003754.

Ongoing maintenance of the WEA in 2021 will focus on weed management and repair of any erosion as required. The WEA will be included in the annual rehabilitation monitoring program (see **Section 8.3.2)**.

8.3.3.2 Cumnock

Rehabilitation works at Cumnock were generally undertaken between 2009 and 2011 using a combination of direct seeding and tubestock planting methods, and including a range of understorey, shrub and tree species (including non-endemic species). This included use of Rhodes grass as the rehabilitation status/landform at time of Ravensworth North Project was pasture.

In June 2016, rehabilitation monitoring identified and mapped the vegetation types currently establishing across the rehabilitation areas. The monitoring report concluded that many areas were not progressing towards the targeted CHGBIW, and that all areas required at least some level of management inputs to achieve the rehabilitation objectives.

Following the 2018 Annual Review inspection the DPIE issued a Section 240 notice for areas of Cumnock Rehabilitation which are not trending towards the final land use defined in the Project Approval 09_0176 or rehabilitation criteria outlined in the current MOP.

Ravensworth was required to prepare a management plan to address risks to achieving the approved final land use for the Cumnock rehabilitation area. The *Cumnock Rehabilitation Plan* has been developed and approved by the DPIE - Resources Regulator to satisfy the Section 240 Notice. This document states the planned remediation activities between 2019 and 2024, along with rehabilitation monitoring to be undertaken.

Additionally, a *Cumnock Rehabilitation/Remediation Plan* was prepared by Koru Environmental in 2020 to define management strategies aimed at improving the condition of the rehabilitation. This report suggested using cattle grazing in progressive cells to manage areas of exotic grassland. Throughout 2020 the required infrastructure (cattle yards, fencing, pumps, water and tanks) have been installed in preparation for cell grazing to begin in 2021. The 2020 plan also recommended a number of other management activities which were completed in 2020:

- Targeted vegetation improvement works in approximately 7.1ha of regenerating Box-Ironbark Woodland that require establishment of middle and understory species. This involved poisoning of existing exotic groundcover, ripping and seeding of target native species in 20 x 20 metre plots (8).

- 6.7ha of select thinning of Sugar Gum Forest at a rate of 1 in 5 trees. This process will be completed each year for 5 years in order to progressively open the canopy and allow infill planting to occur. Trees were lopped where stems were below 20cm in diameter. Those trees greater than 20cm were basal bark poisoned to provide ongoing habitat.

In addition, HCBRLM compiled the Rehabilitation and Buffer Zones Weed Action Plan 2020 (previously discussed in ***Section 6.10***) and undertook extensive weed management activities in the Cumnock area during the 2020 reporting period, which in addition to the above works, included:

- 8.6ha of exotic grasses sprayed in areas of regenerating Box-Ironbark Woodland;

- 2.5ha of Galenia sprayed in Grassland areas;

- 44ha of Acacia saligna cut and paste, and

- 37ha of spraying and manual removal of, Prickly Acacia, Castor Oil, St John's Wort, Bitou Bush, Blue Heliotrope and Fennel.

The continued implementation of Cumnock Rehabilitation Plan will be undertaken in 2021 along with crash grazing in cells. Crash grazing of exotic grassland, Regenerating Box Ironbark Woodland and exotic shrubland will be used to control exotic grasses and improve soil nutrients. Up to 5 cells of approximately 8ha each will be grazed and remediated each year using approximately 30 head of cattle in spring and autumn. Following grazing the area will be ripped then seeded and planted with the required species.

The WEA will be included in the annual rehabilitation monitoring (see **Section 8.3.2**). Maintenance will include management of key weed species and repair of erosion as required.

8.3.3.3 2021 Rehabilitation Maintenance

During the next reporting period, Ravensworth will continue to develop and implement a rehabilitation maintenance strategy to progress rehabilitation to final landform consistent with final land use objectives. In 2021 Ravensworth will complete ongoing maintenance in previously rehabilitated areas. Priority actions for rehabilitation maintenance include:

- Erosion repairs;
- Control of priority weed species as identified during rehabilitation monitoring and inspections;
- Increasing lower-storey species richness in areas where priority weed grasses are absent (or following weed suppression) through hand seeding or tubestock planting;
- Increasing tree densities of rehabilitated areas through supplementary seeding and or tube stock planting; and
- Increasing habitat potential through adding rocks, logs, woody debris and next boxes to rehabilitation areas for fauna.

8.4 Rehabilitation Trials and Research

8.4.1 Rehabilitation Trail Results

Nutrient Cycling Teabag Trial

In accordance with Schedule 3, Condition 36 of PA 09_0176 ROC and the University of Newcastle, NSWimplemented a research program to understand mapping and recovery of EECs affected by the project. A PhD study has continued on the site developed for the Hunter Ironbark Research Program (HIRP). This study looks at the ability of the ecosystem to cycle nutrients which will ensure the development of a self-sustaining community.

During the reporting period a decomposition study was performed using tea bags. This novel method is particularly applicable to the mining industry where there may be a range of different flora communities or those communities may be at different successional stages. Using this method then allows for direct comparison of decomposition capacity independently of the vegetation composition. The green tea is more susceptible to leaching through water and showed the highest decomposition

from the Spoil OGM treatment. The rooibos tea requires active decomposition and showed near uniform loss from all treatments except for spoil which appeared not to decompose at all.

Recent work has been looking at microorganisms found in the soils of the experiment. Analysis has so far focused on Fungi species using genetic sequencing to determine species. Soil microbes in the spoil were so few in number that they could not be detected using genetic approaches, supporting the lack of decomposition found using the tea bags. For the other treatments, the total number of fungal species is highest in the Subsoil OGM Mulch, all other treatments are significantly lower than the references in species richness. Functionally, there is significantly more decomposing fungi species in the subsoil OGM Mulch than in the spoil OGM treatment however fungal symbionts are generally low throughout all treatments compared to the reference.

The study concluded that many of the treatments can provide a quality restoration outcome but careful management will be required.

8.5 Next Reporting Period

Rehabilitation activities proposed in 2021 include:

- Rehabilitation of 30 Ha;
- Maintenance works as outlined in ***Section 8.3.3***;
- Crash grazing using cattle at Cumnock;
- Investigate long term land use options for Cumnock;
- Ongoing inspections and long-term rehabilitation monitoring; and
- Continued pest and weed management across the complex and in offset areas.

9. Community Relations

9.1 Employment Status

At the end of the reporting period, the Ravensworth Complex had approximately 547 full time employees.

9.2 Complaints

A complaints register is maintained and available on the Ravensworth Complex Website.

There were two complaints received during the 2020 reporting period for the Ravensworth Complex, both of which related to blast events.

9.2.1 Complaint 1

12 August 2020

The Environment and Community Manager was contacted directly by a local resident at 4.26pm on 12 August 2020 to complain about a blast that shook the house and windows. The complainant resides near the Camberwell Village on the New England Highway.

The Environment and Community Manager confirmed that Ravensworth did blast that day at 4.19 pm. A blast overpressure of 109.9 dB and vibration of 0.03 m/s were recorded at the nearest monitor at Camberwell Village, which are within compliance levels.

The wind direction at the time was from the south south-east (156 degrees) at a speed of 2.9m/s. Ravensworth immediately investigated the complaint and recorded the complaint. A follow up call was made to the complainant on 13 August 2020, and a face to face meeting was organised to discuss the complaint on 17 August 2020.

9.2.2 Complaint 2

30 November 2020

The Environment and Community Manager was emailed by a local resident at 1.28 pm on 30 November 2020 to ask if a blast had taken place at Ravensworth at 1.19 pm. The complainant resides near the Camberwell Village on the New England Highway.

The complainant was called on 30 November 2020 to confirm that Ravensworth had blasted twice at 1.19pm and 1.20 pm and confirmed that both vibration and overpressure results recorded at Camberwell Village were within compliance limits.

The wind direction at the time was from the east south-east (107 degrees) at a speed of 7.2m/s. Ravensworth immediately investigated the complaint and recorded the complaint.

The blast at 1.19pm recorded an overpressure of 98.0 dB and vibration of 0.38 m/s, and the blast at 1.20pm recorded an overpressure of overpressure of 102.9 dB and vibration of 0.05 m/s. The Rix's Creek blast monitor located at the residence was also reviewed, with results also within criteria limits for both blasts.

9.2.3 Complaints Trend Analysis

Trend analysis on complaints by year since 2011 in ***Table 9-1*** shows that annual complaint numbers have been stable since 2016.

Year	Number of Complaints
2011	6
2012	8
2013	3
2014	5
2015	0
2016	3
2017	2
2018	3
2019	2
2020	2

Table 9-1 - Complaints Trend Analysis

9.3 Community Engagement

The Stakeholder Engagement Plan contains a Community Investment Plan which outlines key projects to be undertaken by the Ravensworth Complex throughout the year.

Community/stakeholder related activities undertaken during the reporting period include:

- Community Consultative Committee Meetings;
- Distribution of community newsletters;
- Mine tour/career talks with local primary schools;
- Vocational student placement from Macquarie University;
- Active participation in Wild Dog Groups and the LLS; and
- Direct engagement with nearby landholders.

During 2020, the Ravensworth Complex continued to foster positive relationships with the local community through engagement and ongoing financial support provided to a range of community groups and events, including, but not limited to:

- Westpac Rescue Helicopter Service;
- Singleton High School;
- NSW Rural Fire Service;
- Salvation Army;
- Men's Shed;

- St Phillips Christian College;
- Singleton Neighbourhood Centre; and
- Upper Hunter Homelessness Support Service.

In total, the Ravensworth Complex provided approximately $40,000 in community donations during 2020 to 14 community groups, businesses and events through its Community Investment Plan.

The Ravensworth Complex operates a website to display key information to the community (*https://www.glencore.com.au/operations-and-projects/coal/current-operations/ravensworth-operations*). Schedule 5, Condition 10 of PA09_0176 and Schedule 2, Condition 43 of DA104/96 requires the following information in ***Table 9-2*** to be maintained on the website.

Requirement	Status
The Environmental Assessment (EA)	EAs are available on the website.
All current statutory approvals for the project.	Project approvals / consents and the EPL are available on the website. Other statutory information, such as the MOP, is posted on the website.
Approved strategies, plans and programs required under the conditions of approval.	Approved management plans are available on the website.
A summary of the monitoring results of the project, which have been reported in accordance with the various plans and programs approved under the conditions of this approval.	Annual Review and monthly monitoring results are on the website. The Ravensworth Complex reports monitoring data in accordance with EPA's monitoring reporting requirements.
A complaints register, which is to be updated on a monthly basis.	Complaints register is available on website and updated monthly.
Minutes of CCC meetings.	CCC minutes are available on the website.
The Annual Reviews (over the last five years).	The last five years of AEMRs / Annual Reviews are available on the website.
Any independent environmental audit and the Proponent's response to the recommendations in any audit.	Independent environmental audits and responses to recommendations are available on the website.
Any other matter required by the Secretary.	No other information is currently required by Secretary.

Table 9-2 - Summary of Website Reporting Requirement

9.4 Community Consultative Committee

The Ravensworth Complex maintains a close partnership with the local community. The Community Consultative Committee (CCC) includes Glencore representatives and local community members. This provides a formal forum for interaction between the community, mine management and relevant government departments. The Ravensworth Complex CCC meets three times a year, with meetings in 2020 held in February, June and October. The community representatives may share information from meetings with the rest of the community and relate any items for discussion at the CCC meetings.

The following key topics were discussed at the CCC meetings:

- Discussion of previous meeting minutes;
- Update on mining and processing activities at the Ravensworth Complex;
- Update on key environment and community aspects, including monitoring results and incidents;
- Update on safety performance; and
- Update on community support programs.

Ravensworth is currently attempting to recruit additional CCC members.

Minutes from the CCC meetings are posted on Ravensworth Complex's website: *https://www.glencore.com.au/operations-and-projects/coal/current-operations/ravensworth-operations/community-documents*.

9.5 Community Newsletter

The Ravensworth Complex circulates a community newsletter every 6 months to neighbouring residents, its employees, CCC members and other stakeholders and are on the Ravensworth Complex website. The newsletter provides information about the operational progress of the Complex, environmental and safety performance, plus other news of community interest.

10. Independent Audit

An Independent Environmental Audit (IEA) was undertaken in 2018 in accordance with Schedule 5, Condition 8 of Project Approval 09_0176 and Schedule 4, Condition 7 of DA 104/96.

The audit included a review of:

- Conditions contained with Project Approval 09_0176 and Development Consent 104/96, including the statement of commitments;
- EPL2652;
- Mining Lease(s);
- Implementation of management plans prepared under Project Approval 09_0176; and
- Water Access Licences.

The IEA was submitted to the DPIE in March 2019 (including an action table addressing the audit findings). The current status of any remaining actions is provided in ***Table 10-1***. The IEA Report and Action Plan are uploaded to the Ravensworth website.

Requirement	Ravensworth Operations Response	Completion
Biodiversity Management Plan The plan needs to be updated to include a document number referencing the topsoil stripping management plan as currently there are no details in regard to conserving and reusing topsoil (as required).	At the time of the Audit, the Biodiversity Management Plan (BOMP) (Section 7.2) referenced topsoil management/soil resource salvage at Ravensworth. It was recommended that the procedure document ID be included in a future revision of the Biodiversity Management Plan. The Biodiversity Management Plan (BOMP) was last reviewed and approved by the DPE in September 2018. Given the minor nature of this recommendation, it will be included in the next revision of the BOMP.	The BOMP was reviewed and submitted to DPIE in 2020. BOMP awaiting approval from DPIE.
Closure and Rehabilitation The BOMP should include specific references/linkages regarding how the vegetation communities listed in Condition 6.4.2 have been/are to be incorporated into the approach for regeneration and revegetation. At present the	The Biodiversity Management Plan (BOMP) was last reviewed and approved by the DPE in September 2018. Ravensworth will include specific references regarding how the vegetation communities listed in Condition 6.4.2 have been/are to be incorporated into the approach	The BOMP was reviewed and submitted to DPIE in 2020. BOMP awaiting approval from DPIE.

Requirement	Ravensworth Operations Response	Completion
regeneration and revegetation approach only mentions Endangered Ecological Communities (EECs).	for regeneration and revegetation in a future revision of the BOMP.	
Groundwater If mine planning changes in the future, appropriate remedial and recovery plans for identified stands of Eucalyptus camaldulensis along the Hunter River in the southern extent of the Project area will be developed	Noted. Ravensworth will revise the Water Management Plan (WMP) and Biodiversity Management Plan (BOMP) should mine plan changes occur and include appropriate remedial and recovery plans for identified stands of Eucalyptus camaldulensis.	The WMP was submitted to DPIE on 30 September 2019. The WMP was approved by DPIE in March 2020. The BOMP was reviewed and submitted to DPIE in 2020. Awaiting approval from DPIE.
Aboriginal Heritage The Aboriginal Cultural Heritage Management Plan requires updating to include a salvage recovery procedure.	The 2014 Aboriginal Cultural Heritage Management Plan (ACHMP) included a section (S4 and S8) on *salvage, excavation and/or management of Aboriginal sites and potential archaeological deposits within the project disturbance area.* Following the complete salvage of all sites within the Project disturbance area, this section of the plan was removed from the 2017 update to the ACHMP. The ACHMP will be revised to include a salvage recovery procedure in accordance with Schedule 3, Condition 42 of Project Approval 09_0176.	The ACHMP was submitted to DPIE and BCD on 30 September 2020. The ACHMP was approved by DPIE in February 2021.
Aboriginal Cultural Heritage Management Plan The conditions in Table 2.1 of the Aboriginal Cultural Heritage Management Plan are the conditions for the Open Cut and are for Heritage Protection not Aboriginal Cultural Heritage.	Noted. The Aboriginal Cultural Heritage Management Plan (ACHMP) was approved in 2017. The ACHMP covers the Complex. Notwithstanding, the ACHMP will be revised in 2019.	The ACHMP was submitted to DPIE and BCD on 30 September 2020. The ACHMP was approved by DPIE in February 2021.

Table 10-1 - IEA Findings and Status of Actions

In accordance with Schedule 5, Condition 8 of Project Approval 09_0176, and Schedule 4, Condition 7 of Development Consent 104/96 Ravensworth is required to commission, commence and pay the full cost of the next IEA in 2021.

11. Environmental Incidents and Non-Compliances

All 2020 incidents, non-compliances and exceedances related to PA 09_0176, DA 104/96 and EPL 2652 are summarised in ***Table 11-1***.

Date	Details/Location	Non-Compliance	Action/Response
Throughout the reporting period (refer to Appendix B for dates of exceedances).	22 exceedances of the PM_{10} short term criteria occurred in 2020 (refer to **Section 6.4.2.2**)	PA09_0176	Incident reports were provided to the DPIE on each occasion. 18 of these 22 exceedances were on days declared as extraordinary events by the DPIE.
Throughout the reporting period	Continuous PM_{10} data was not acquired.	EPL 2652	TEOMs were inspected and repaired.
August 2020	Sewage treatment plant quality results for August were outside of the acceptable limits imposed by Singleton Council	Schedule 3, Condition 51(c) of PA 09_0176 OSSM Approval 4305/2012 Condition 5	A CHPP shutdown prior to monitoring resulted in increased short term usage. There was also a possible pump failure/incorrect float switch level causing system to be flooded.
Throughout the reporting period	Monitoring at Point 16 has not occurred during the reporting period due to issues obtaining access to the property.	EPL 2652	Ravensworth Operations is continuing to negotiate access however a licence variation has been lodged with EPA to monitor Point 16 at an alternative location.
Throughout the reporting period	The proponent shall implement the biodiversity offset strategy as outlined in Table 16 and as generally described in the EA (and shown conceptually in Appendix 7), to the satisfaction of the Secretary.	PA09_0176	Ravensworth has notified the DPIE of the discrepancy and is seeking further advice on resolving the issue.

Table 11-1 - Incidents, Non-Compliances and Exceedances

12. Activities Proposed in the Next Annual Review Period

12.1 ROC and RCHPP

Key activities proposed for 2021 at ROC / RCHPP include:

- Revision of the NMP, AQGGMP, and EMS;
- Continuation of mining operations at Ravensworth North;
- Undertake exploration activities;
- Continued support for key community projects;
- Continued participation in the CCC;
- Continue progressive rehabilitation of final landform profiles;
- Continuation of rehabilitation monitoring and maintenance;
- Infrastructure relocations within existing disturbance footprint;
- Independent Environmental Audit to occur in accordance with Schedule 5, Condition 8 of Project Approval 09_0176, and Schedule 4, Condition 7 of Development Consent 104/96; and
- Consultation with all relevant stakeholders.

12.2 RUM

Key activities proposed for 2021 at RUM include:

- Undertake care and maintenance activities;
- Undertake underground dewatering activities;
- Undertake flaring and gas management;
- Prepare detailed mine closure plans;
- Continued erosion and sediment control maintenance; and
- Continued spontaneous combustion monitoring.

13. Document Information

Relevant legislation, standards and other reference information must be regularly reviewed and monitored for updates and should be included in the site management system. Related documents and reference information in this section provides the linkage and source to develop and maintain site compliance information.

13.1 Related Documents

Related documents, listed in ***Table 13-1*** below, are *documents* directly related to or referenced from within this document.

Number	Title
RAVUG-27619932-35	Ravensworth Underground Mining Operations Plan – Care and Maintenance (1 January 2021 – 31 December 2022)
RAVCX-307024981-8541	Ravensworth Open Cut Mining Operations Plan (1 January 2021 – 31 December 2023)

Table 13-1 – Related documents

13.2 Reference Information

Reference information, listed in ***Table 13-2*** below, is *information* that is directly referred to for the development of this document.

Reference	Title
NSW Government (2015)	Post-approval requirements for State significant mining developments – Annual Review Guideline
Robert James Scanlon (2020)	Examining the Myth of Fast-Forwarding in the Ecological Restoration of Mined Land
Biodiversity Australia (2020)	Annual Conservation Agreement Offset Monitoring Report, Ravensworth Coal Mine
Biodiversity Australia (2021)	Ravensworth Rehabilitation Monitoring Report 2020 - Fauna
Biodiversity Australia (2021)	Ravensworth Biodiversity Offset Area Monitoring 2020, Glencore - Ravensworth Coal Mine
Koru Environmental (2021)	Rehabilitation Monitoring 2020, Ravensworth Operations
OzArk Environment and Heritage (2021)	2020 Archaeological Monitoring Report, Ravensworth Operations

Reference	Title
HCBRLM (2021)	Glencore Ravensworth Open Cut, Land Management Completed Works 2020, Rehabilitation and Buffers
Spectrum Acoustics (2020)	Attended Noise Monitoring (12 separate reports)
Umwelt (2021)	2020 Surface Water and Groundwater Management and Monitoring Report, Ravensworth Complex

Table 13-2 – Reference information

13.3 Change Information

Full details of the document history are recorded in the document control register, by version. A summary of the current change is provided in ***Table 13-3*** below.

Version	Date	Change Details
1.0	31 March 2021	2020 Annual Review submitted to DPIE

Table 13-3 – Change information

Appendix A - Train Movements

2020 Ravensworth Complex Train Movement Records

Train Index	Load Finish Date	Load Finish Time	Net Weight (t)
0	1-Jan-20	9:40:00 AM	9,471
1	1-Jan-20	12:40:00 PM	9,413
2	1-Jan-20	4:51:00 PM	9,371
3	1-Jan-20	9:18:00 PM	9,325
4	2-Jan-20	3:09:00 AM	9,297
5	2-Jan-20	11:11:00 AM	8,847
6	2-Jan-20	3:16:00 PM	9,529
7	2-Jan-20	7:49:00 PM	9,310
8	2-Jan-20	10:53:00 PM	9,284
9	3-Jan-20	9:23:00 AM	8,897
10	3-Jan-20	6:48:00 PM	9,363
11	4-Jan-20	2:14:00 PM	9,332
12	4-Jan-20	7:25:00 PM	9,244
13	5-Jan-20	9:38:00 AM	8,355
14	6-Jan-20	10:21:00 AM	9,388
15	7-Jan-20	2:11:00 AM	9,278
16	7-Jan-20	6:13:00 AM	9,379
17	8-Jan-20	12:15:00 PM	9,223
18	8-Jan-20	8:51:00 PM	9,478
19	9-Jan-20	5:04:00 AM	9,141
20	10-Jan-20	2:13:00 AM	8,915
21	10-Jan-20	6:44:00 AM	9,424
22	10-Jan-20	2:05:00 PM	9,314
23	10-Jan-20	7:47:00 PM	9,395
24	11-Jan-20	2:34:00 AM	8,989
25	11-Jan-20	8:37:00 AM	9,148

Train Index	Load Finish Date	Load Finish Time	Net Weight (t)
26	12-Jan-20	6:55:00 AM	9,123
27	12-Jan-20	11:48:00 PM	9,091
28	13-Jan-20	4:17:00 AM	9,401
29	13-Jan-20	8:47:00 AM	9,108
30	13-Jan-20	1:02:00 PM	9,134
31	16-Jan-20	4:25:00 AM	9,551
32	16-Jan-20	10:40:00 AM	9,401
33	16-Jan-20	3:27:00 PM	9,215
34	16-Jan-20	8:56:00 PM	9,427
35	17-Jan-20	9:31:00 AM	9,442
36	17-Jan-20	2:50:00 PM	9,185
37	17-Jan-20	10:20:00 PM	9,227
38	20-Jan-20	4:45:00 AM	9,465
39	20-Jan-20	9:35:00 AM	9,274
40	20-Jan-20	4:40:00 PM	9,368
41	21-Jan-20	2:01:00 AM	8,932
42	21-Jan-20	5:44:00 AM	9,344
43	21-Jan-20	3:27:00 PM	9,178
44	21-Jan-20	7:43:00 PM	9,300
45	22-Jan-20	6:04:00 AM	9,231
46	22-Jan-20	1:19:00 PM	9,014
47	22-Jan-20	9:51:00 PM	8,920
48	23-Jan-20	9:44:00 AM	9,430
49	23-Jan-20	1:33:00 PM	9,010
50	23-Jan-20	6:42:00 PM	9,507
51	24-Jan-20	2:33:00 AM	9,505
52	24-Jan-20	7:30:00 AM	9,331
53	24-Jan-20	12:18:00 PM	9,453
54	24-Jan-20	6:47:00 PM	9,430

Train Index	Load Finish Date	Load Finish Time	Net Weight (t)
55	25-Jan-20	12:55:00 AM	9,394
56	25-Jan-20	10:03:00 AM	9,265
57	25-Jan-20	5:38:00 PM	9,303
58	26-Jan-20	4:54:00 AM	9,464
59	26-Jan-20	9:12:00 PM	9,233
60	27-Jan-20	12:21:00 AM	9,389
61	27-Jan-20	10:19:00 AM	9,445
62	28-Jan-20	1:04:00 AM	9,354
63	28-Jan-20	5:39:00 AM	9,434
64	28-Jan-20	8:53:00 AM	9,540
65	28-Jan-20	1:18:00 PM	9,414
66	29-Jan-20	12:50:00 AM	9,201
67	29-Jan-20	9:19:00 AM	9,631
68	29-Jan-20	4:09:00 PM	9,316
69	29-Jan-20	8:42:00 PM	9,183
70	30-Jan-20	1:38:00 AM	9,189
71	30-Jan-20	5:25:00 AM	9,185
72	30-Jan-20	9:19:00 AM	9,421
73	30-Jan-20	5:42:00 PM	9,179
74	31-Jan-20	5:35:00 PM	9,179
75	1-Feb-20	2:58:00 AM	9,287
76	1-Feb-20	6:20:00 AM	9,312
77	1-Feb-20	6:18:00 PM	9,464
78	1-Feb-20	11:26:00 PM	9,584
79	2-Feb-20	2:44:00 AM	9,240
80	2-Feb-20	6:37:00 PM	8,635
81	3-Feb-20	12:00:00 AM	9,358
82	3-Feb-20	6:46:00 AM	9,550
83	4-Feb-20	12:04:00 AM	9,437

Train Index	Load Finish Date	Load Finish Time	Net Weight (t)
84	4-Feb-20	6:42:00 AM	9,244
85	4-Feb-20	10:29:00 AM	9,462
86	4-Feb-20	8:20:00 PM	9,384
87	4-Feb-20	11:25:00 PM	9,436
88	5-Feb-20	9:57:00 AM	9,437
89	5-Feb-20	2:24:00 PM	9,392
90	6-Feb-20	12:38:00 AM	9,392
91	6-Feb-20	3:25:00 AM	9,392
92	6-Feb-20	1:08:00 PM	9,518
93	6-Feb-20	8:14:00 PM	9,420
94	7-Feb-20	4:06:00 PM	9,471
95	8-Feb-20	7:14:00 AM	9,408
96	8-Feb-20	4:54:00 PM	9,745
97	9-Feb-20	1:03:00 PM	9,480
98	10-Feb-20	1:21:00 AM	9,442
99	10-Feb-20	6:01:00 PM	9,056
100	10-Feb-20	9:26:00 PM	9,316
101	14-Feb-20	2:04:00 PM	8,172
102	14-Feb-20	5:38:00 PM	8,358
103	15-Feb-20	3:38:00 PM	9,403
104	16-Feb-20	1:10:00 AM	9,171
105	16-Feb-20	12:52:00 PM	8,930
106	16-Feb-20	3:57:00 PM	9,295
107	16-Feb-20	7:16:00 PM	9,272
108	17-Feb-20	3:14:00 AM	9,278
109	17-Feb-20	10:57:00 AM	9,363
110	17-Feb-20	4:29:00 PM	9,490
111	17-Feb-20	8:36:00 PM	9,159
112	17-Feb-20	11:57:00 PM	9,484

Train Index	Load Finish Date	Load Finish Time	Net Weight (t)
113	18-Feb-20	8:01:00 AM	9,185
114	18-Feb-20	3:40:00 PM	9,151
115	19-Feb-20	8:17:00 AM	9,516
116	20-Feb-20	8:27:00 PM	9,486
117	21-Feb-20	8:55:00 AM	9,491
118	21-Feb-20	4:01:00 PM	9,384
119	22-Feb-20	7:07:00 PM	9,665
120	23-Feb-20	8:40:00 AM	9,539
121	23-Feb-20	7:24:00 PM	9,567
122	24-Feb-20	7:51:00 AM	9,525
123	25-Feb-20	1:39:00 AM	9,478
124	27-Feb-20	6:32:00 PM	9,282
125	28-Feb-20	3:52:00 PM	9,368
126	29-Feb-20	4:44:00 AM	9,473
127	29-Feb-20	1:48:00 PM	9,481
128	29-Feb-20	8:45:00 PM	9,282
129	1-Mar-20	2:14:00 AM	9,568
130	1-Mar-20	6:59:00 AM	9,450
131	1-Mar-20	4:42:00 PM	9,431
132	2-Mar-20	4:08:00 AM	9,402
133	2-Mar-20	1:31:00 PM	9,399
134	2-Mar-20	8:47:00 PM	9,462
135	3-Mar-20	1:36:00 AM	9,512
136	4-Mar-20	1:52:00 AM	9,542
137	4-Mar-20	9:08:00 AM	9,563
138	4-Mar-20	6:35:00 PM	9,523
139	4-Mar-20	11:36:00 PM	9,559
140	5-Mar-20	9:33:00 AM	9,407
141	6-Mar-20	4:58:00 AM	9,434

Train Index	Load Finish Date	Load Finish Time	Net Weight (t)
142	8-Mar-20	5:38:00 AM	9,579
143	8-Mar-20	7:37:00 PM	9,537
144	9-Mar-20	9:59:00 AM	9,551
145	12-Mar-20	3:46:00 PM	8,814
146	12-Mar-20	11:15:00 PM	9,152
147	15-Mar-20	7:43:00 AM	9,399
148	15-Mar-20	5:41:00 PM	9,431
149	15-Mar-20	9:29:00 PM	9,386
150	16-Mar-20	12:19:00 AM	8,700
151	16-Mar-20	1:12:00 PM	9,468
152	16-Mar-20	4:43:00 PM	9,438
153	16-Mar-20	8:49:00 PM	9,399
154	17-Mar-20	5:36:00 PM	9,219
155	18-Mar-20	9:00:00 AM	9,327
156	19-Mar-20	10:09:00 PM	9,257
157	20-Mar-20	5:40:00 AM	9,306
158	21-Mar-20	2:45:00 AM	9,156
159	21-Mar-20	2:20:00 PM	5,289
160	21-Mar-20	1:46:00 PM	9,437
161	21-Mar-20	11:05:00 PM	9,299
162	22-Mar-20	10:35:00 AM	9,493
163	22-Mar-20	5:38:00 PM	9,254
164	23-Mar-20	8:34:00 AM	8,847
165	24-Mar-20	6:19:00 PM	9,278
166	25-Mar-20	5:13:00 AM	9,378
167	25-Mar-20	8:42:00 AM	9,435
168	25-Mar-20	8:48:00 PM	9,347
169	25-Mar-20	11:40:00 PM	9,489
170	26-Mar-20	8:41:00 AM	9,430

Train Index	Load Finish Date	Load Finish Time	Net Weight (t)
171	26-Mar-20	12:33:00 PM	9,026
172	27-Mar-20	12:15:00 AM	9,398
173	27-Mar-20	5:18:00 AM	9,128
174	28-Mar-20	9:18:00 AM	8,921
175	29-Mar-20	6:03:00 AM	9,317
176	31-Mar-20	5:54:00 AM	8,754
177	3-Apr-20	2:21:00 AM	8,414
178	4-Apr-20	12:20:00 AM	9,201
179	4-Apr-20	8:30:00 AM	8,643
180	4-Apr-20	11:18:00 AM	8,919
181	4-Apr-20	3:43:00 PM	9,425
182	5-Apr-20	2:19:00 AM	9,225
183	5-Apr-20	11:31:00 AM	9,157
184	5-Apr-20	4:05:00 PM	9,063
185	6-Apr-20	1:01:00 AM	9,084
186	6-Apr-20	6:55:00 AM	9,127
187	6-Apr-20	7:15:00 PM	9,462
188	7-Apr-20	10:54:00 AM	9,379
189	7-Apr-20	7:43:00 PM	9,372
190	8-Apr-20	4:47:00 AM	9,433
191	8-Apr-20	10:19:00 PM	9,053
192	10-Apr-20	12:17:00 PM	9,087
193	12-Apr-20	1:38:00 AM	9,082
194	12-Apr-20	5:01:00 AM	8,934
195	13-Apr-20	12:00:00 AM	8,782
196	13-Apr-20	9:32:00 PM	9,317
197	14-Apr-20	8:35:00 AM	9,403
198	14-Apr-20	5:03:00 PM	9,386
199	16-Apr-20	10:31:00 AM	8,698

Train Index	Load Finish Date	Load Finish Time	Net Weight (t)
200	16-Apr-20	11:43:00 PM	8,806
201	17-Apr-20	4:44:00 PM	9,320
202	20-Apr-20	7:01:00 PM	9,296
203	22-Apr-20	6:58:00 PM	9,194
204	24-Apr-20	12:48:00 AM	8,885
205	25-Apr-20	8:10:00 AM	9,285
206	26-Apr-20	8:48:00 AM	9,471
207	27-Apr-20	7:00:00 PM	8,755
208	29-Apr-20	5:41:00 PM	8,912
209	30-Apr-20	5:34:00 PM	8,967
210	1-May-20	12:09:00 AM	8,952
211	3-May-20	4:25:00 AM	9,281
212	4-May-20	4:41:00 AM	9,225
213	4-May-20	8:14:00 PM	6,601
214	5-May-20	10:22:00 AM	9,189
215	6-May-20	5:56:00 PM	9,280
216	7-May-20	6:33:00 PM	9,296
217	8-May-20	3:23:00 AM	9,231
218	8-May-20	4:13:00 PM	9,261
219	9-May-20	2:38:00 AM	9,246
220	9-May-20	1:49:00 PM	9,476
221	9-May-20	11:17:00 PM	9,264
222	10-May-20	4:47:00 AM	8,952
223	10-May-20	6:17:00 PM	8,840
224	11-May-20	6:17:00 AM	9,163
225	12-May-20	4:29:00 AM	9,167
226	12-May-20	10:15:00 AM	9,350
227	12-May-20	1:47:00 PM	9,566
228	12-May-20	7:12:00 PM	9,136

Train Index	Load Finish Date	Load Finish Time	Net Weight (t)
229	13-May-20	8:38:00 AM	9,118
230	13-May-20	6:34:00 PM	9,144
231	14-May-20	8:53:00 AM	9,458
232	14-May-20	2:08:00 PM	9,040
233	14-May-20	8:31:00 PM	9,052
234	16-May-20	7:52:00 PM	9,471
235	18-May-20	2:50:00 PM	9,370
236	19-May-20	12:47:00 AM	8,299
237	19-May-20	6:00:00 AM	9,539
238	22-May-20	3:09:00 PM	8,812
239	22-May-20	10:31:00 PM	9,022
240	23-May-20	10:34:00 AM	8,230
241	23-May-20	4:41:00 PM	9,486
242	24-May-20	12:10:00 AM	9,382
243	24-May-20	7:09:00 AM	8,811
244	25-May-20	8:49:00 PM	9,690
245	27-May-20	2:50:00 AM	9,575
246	27-May-20	9:26:00 PM	9,344
247	28-May-20	12:00:00 AM	9,511
248	28-May-20	4:32:00 AM	9,506
249	28-May-20	11:34:00 AM	9,246
250	29-May-20	5:10:00 AM	9,325
251	29-May-20	12:27:00 PM	9,254
252	29-May-20	4:47:00 PM	9,014
253	30-May-20	12:47:00 AM	9,211
254	30-May-20	7:27:00 AM	9,500
255	30-May-20	11:46:00 AM	9,542
256	31-May-20	8:24:00 PM	9,519
257	1-Jun-20	9:26:00 PM	9,374

Train Index	Load Finish Date	Load Finish Time	Net Weight (t)
258	2-Jun-20	2:20:00 AM	9,560
259	3-Jun-20	12:17:00 AM	9,412
260	3-Jun-20	3:39:00 AM	9,621
261	3-Jun-20	6:28:00 PM	9,511
262	4-Jun-20	7:52:00 PM	9,468
263	5-Jun-20	12:24:00 AM	9,613
264	5-Jun-20	10:41:00 PM	9,140
265	7-Jun-20	12:31:00 AM	9,261
266	7-Jun-20	9:07:00 AM	9,088
267	7-Jun-20	12:25:00 PM	9,185
268	8-Jun-20	5:19:00 AM	9,451
269	8-Jun-20	9:56:00 AM	9,399
270	8-Jun-20	8:15:00 PM	9,526
271	9-Jun-20	6:31:00 AM	9,578
272	9-Jun-20	9:28:00 AM	9,639
273	9-Jun-20	12:57:00 PM	9,441
274	9-Jun-20	4:22:00 PM	9,530
275	9-Jun-20	10:01:00 PM	9,130
276	11-Jun-20	12:46:00 AM	8,750
277	11-Jun-20	4:14:00 AM	8,920
278	11-Jun-20	7:13:00 PM	8,934
279	12-Jun-20	9:15:00 AM	9,407
280	12-Jun-20	2:18:00 PM	9,532
281	12-Jun-20	9:47:00 PM	9,054
282	14-Jun-20	2:17:00 AM	9,511
283	14-Jun-20	2:41:00 PM	9,552
284	17-Jun-20	6:20:00 AM	9,204
285	17-Jun-20	9:04:00 AM	9,261
286	17-Jun-20	12:37:00 PM	9,293

Train Index	Load Finish Date	Load Finish Time	Net Weight (t)
287	17-Jun-20	4:37:00 PM	9,271
288	18-Jun-20	5:52:00 AM	9,263
289	18-Jun-20	3:18:00 PM	9,330
290	19-Jun-20	3:47:00 AM	9,293
291	19-Jun-20	11:04:00 PM	9,168
292	20-Jun-20	1:48:00 AM	9,240
293	20-Jun-20	5:04:00 AM	9,248
294	20-Jun-20	11:54:00 AM	9,273
295	20-Jun-20	10:11:00 PM	9,080
296	21-Jun-20	2:28:00 AM	9,150
297	21-Jun-20	8:49:00 AM	9,179
298	23-Jun-20	8:46:00 AM	9,518
299	24-Jun-20	12:37:00 PM	9,548
300	25-Jun-20	10:35:00 PM	9,530
301	26-Jun-20	4:14:00 AM	9,017
302	26-Jun-20	11:50:00 AM	8,951
303	26-Jun-20	4:11:00 PM	8,965
304	26-Jun-20	11:07:00 PM	8,929
305	27-Jun-20	5:01:00 AM	8,911
306	27-Jun-20	9:34:00 AM	8,876
307	28-Jun-20	5:02:00 AM	9,217
308	28-Jun-20	1:17:00 PM	9,223
309	29-Jun-20	8:42:00 AM	9,398
310	29-Jun-20	11:24:00 AM	9,466
311	1-Jul-20	12:49:00 PM	9,014
312	1-Jul-20	7:25:00 PM	9,394
313	1-Jul-20	11:58:00 PM	9,357
314	3-Jul-20	1:26:00 AM	9,186
315	3-Jul-20	9:52:00 AM	9,086

Train Index	Load Finish Date	Load Finish Time	Net Weight (t)
316	3-Jul-20	12:48:00 PM	9,073
317	3-Jul-20	8:45:00 PM	9,087
318	3-Jul-20	11:37:00 PM	9,247
319	4-Jul-20	4:51:00 AM	9,343
320	4-Jul-20	7:35:00 AM	9,447
321	5-Jul-20	9:26:00 AM	8,902
322	9-Jul-20	6:45:00 AM	9,145
323	12-Jul-20	8:40:00 AM	9,146
324	13-Jul-20	2:10:00 AM	9,136
325	13-Jul-20	6:45:00 AM	8,860
326	13-Jul-20	1:31:00 PM	8,880
327	14-Jul-20	7:38:00 AM	9,093
328	14-Jul-20	2:08:00 PM	9,155
329	15-Jul-20	10:19:00 PM	9,155
330	17-Jul-20	11:34:00 AM	8,821
331	18-Jul-20	5:06:00 PM	9,052
332	19-Jul-20	3:17:00 PM	9,035
333	19-Jul-20	10:11:00 PM	9,179
334	20-Jul-20	7:11:00 AM	9,169
335	21-Jul-20	8:06:00 AM	9,227
336	22-Jul-20	9:20:00 AM	9,183
337	23-Jul-20	9:40:00 AM	9,081
338	25-Jul-20	4:21:00 AM	9,252
339	28-Jul-20	5:47:00 AM	9,253
340	29-Jul-20	4:49:00 AM	9,581
341	30-Jul-20	11:22:00 PM	9,225
342	31-Jul-20	3:39:00 AM	9,051
343	31-Jul-20	8:06:00 AM	9,267
344	31-Jul-20	1:20:00 PM	9,266

Train Index	Load Finish Date	Load Finish Time	Net Weight (t)
345	1-Aug-20	8:01:00 PM	9,166
346	2-Aug-20	12:07:00 AM	9,310
347	2-Aug-20	3:48:00 AM	9,398
348	3-Aug-20	4:10:00 AM	8,815
349	4-Aug-20	3:05:00 AM	8,587
350	7-Aug-20	2:20:00 AM	9,547
351	7-Aug-20	7:54:00 AM	9,482
352	7-Aug-20	3:56:00 PM	9,437
353	8-Aug-20	11:14:00 AM	8,542
354	8-Aug-20	10:50:00 PM	9,097
355	9-Aug-20	1:41:00 AM	9,150
356	9-Aug-20	2:27:00 PM	9,230
357	10-Aug-20	8:46:00 AM	9,202
358	11-Aug-20	2:48:00 AM	9,137
359	12-Aug-20	5:10:00 AM	9,044
360	12-Aug-20	3:51:00 PM	9,047
361	12-Aug-20	11:11:00 PM	9,090
362	13-Aug-20	10:11:00 AM	9,061
363	13-Aug-20	3:57:00 PM	9,512
364	13-Aug-20	9:15:00 PM	9,081
365	14-Aug-20	8:13:00 AM	8,999
366	14-Aug-20	11:19:00 AM	8,963
367	14-Aug-20	5:45:00 PM	9,042
368	14-Aug-20	9:17:00 PM	8,935
369	15-Aug-20	5:40:00 AM	9,080
370	15-Aug-20	9:18:00 AM	8,861
371	16-Aug-20	8:59:00 AM	9,481
372	16-Aug-20	12:09:00 PM	9,555
373	16-Aug-20	7:18:00 PM	9,089

Train Index	Load Finish Date	Load Finish Time	Net Weight (t)
374	17-Aug-20	1:40:00 AM	9,098
375	17-Aug-20	5:36:00 AM	9,195
376	18-Aug-20	1:41:00 AM	9,443
377	18-Aug-20	12:52:00 PM	9,496
378	21-Aug-20	5:43:00 AM	9,171
379	21-Aug-20	8:49:00 PM	9,119
380	22-Aug-20	1:39:00 AM	8,739
381	22-Aug-20	10:41:00 AM	9,071
382	22-Aug-20	2:21:00 PM	8,971
383	22-Aug-20	11:36:00 PM	9,668
384	23-Aug-20	3:33:00 AM	9,504
385	23-Aug-20	11:25:00 AM	9,613
386	23-Aug-20	7:03:00 PM	9,459
387	24-Aug-20	4:45:00 AM	9,117
388	24-Aug-20	4:05:00 PM	9,149
389	25-Aug-20	12:39:00 AM	9,072
390	25-Aug-20	12:55:00 PM	9,070
391	25-Aug-20	8:43:00 PM	9,082
392	26-Aug-20	1:24:00 AM	8,987
393	26-Aug-20	5:10:00 PM	9,582
394	27-Aug-20	1:59:00 AM	9,626
395	27-Aug-20	5:06:00 AM	9,652
396	27-Aug-20	8:41:00 AM	9,006
397	27-Aug-20	12:04:00 PM	9,082
398	28-Aug-20	7:44:00 AM	9,170
399	28-Aug-20	12:13:00 PM	9,518
400	28-Aug-20	3:47:00 PM	9,516
401	29-Aug-20	4:14:00 AM	9,180
402	29-Aug-20	11:03:00 AM	9,153

Train Index	Load Finish Date	Load Finish Time	Net Weight (t)
403	29-Aug-20	4:10:00 PM	8,790
404	29-Aug-20	11:13:00 PM	8,762
405	30-Aug-20	6:13:00 AM	8,119
406	30-Aug-20	11:16:00 AM	9,107
407	30-Aug-20	4:07:00 PM	8,823
408	30-Aug-20	11:24:00 PM	9,460
409	31-Aug-20	6:14:00 AM	9,100
410	31-Aug-20	9:58:00 AM	9,133
411	31-Aug-20	3:03:00 PM	9,108
412	31-Aug-20	9:15:00 PM	9,126
413	1-Sep-20	12:28:00 AM	9,052
414	1-Sep-20	6:34:00 AM	8,308
415	1-Sep-20	9:34:00 AM	9,089
416	1-Sep-20	1:19:00 PM	9,089
417	2-Sep-20	8:33:00 AM	9,510
418	2-Sep-20	9:42:00 PM	9,218
419	3-Sep-20	4:20:00 AM	9,231
420	3-Sep-20	8:26:00 AM	9,183
421	3-Sep-20	11:09:00 AM	9,186
422	3-Sep-20	2:30:00 PM	9,185
423	3-Sep-20	10:08:00 PM	9,111
424	4-Sep-20	11:09:00 AM	9,018
425	4-Sep-20	5:33:00 PM	9,176
426	5-Sep-20	4:54:00 AM	9,476
427	5-Sep-20	8:28:00 AM	9,612
428	5-Sep-20	4:29:00 PM	9,267
429	6-Sep-20	3:11:00 AM	9,384
430	6-Sep-20	3:44:00 PM	8,812
431	6-Sep-20	6:35:00 PM	8,880

Train Index	Load Finish Date	Load Finish Time	Net Weight (t)
432	7-Sep-20	4:48:00 AM	9,137
433	8-Sep-20	10:38:00 AM	9,538
434	8-Sep-20	5:39:00 PM	9,507
435	9-Sep-20	7:29:00 AM	9,638
436	9-Sep-20	10:34:00 AM	8,906
437	9-Sep-20	10:37:00 PM	9,437
438	10-Sep-20	6:37:00 AM	9,169
439	10-Sep-20	10:49:00 PM	8,862
440	11-Sep-20	7:30:00 PM	9,091
441	12-Sep-20	10:34:00 PM	8,811
442	13-Sep-20	4:05:00 AM	8,952
443	13-Sep-20	3:24:00 PM	8,479
444	14-Sep-20	3:46:00 AM	9,268
445	14-Sep-20	8:17:00 PM	9,464
446	17-Sep-20	11:43:00 AM	9,041
447	17-Sep-20	10:00:00 PM	9,381
448	18-Sep-20	11:08:00 PM	9,062
449	19-Sep-20	1:14:00 PM	9,032
450	21-Sep-20	2:59:00 AM	9,467
451	22-Sep-20	1:16:00 AM	8,961
452	26-Sep-20	1:25:00 PM	9,579
453	27-Sep-20	9:33:00 AM	9,575
454	27-Sep-20	3:41:00 PM	9,608
455	27-Sep-20	7:04:00 PM	9,490
456	27-Sep-20	10:11:00 PM	9,534
457	28-Sep-20	2:16:00 PM	9,475
458	29-Sep-20	5:33:00 PM	9,200
459	29-Sep-20	8:51:00 PM	9,205
460	30-Sep-20	1:26:00 AM	9,468

Train Index	Load Finish Date	Load Finish Time	Net Weight (t)
461	30-Sep-20	9:16:00 AM	9,170
462	30-Sep-20	2:30:00 PM	9,400
463	30-Sep-20	8:36:00 PM	8,813
464	1-Oct-20	4:38:00 AM	9,329
465	1-Oct-20	8:55:00 AM	9,412
466	1-Oct-20	12:41:00 PM	9,548
467	1-Oct-20	10:09:00 PM	8,987
468	2-Oct-20	6:44:00 AM	9,481
469	2-Oct-20	7:18:00 PM	9,507
470	3-Oct-20	7:28:00 AM	9,456
471	3-Oct-20	12:48:00 PM	9,609
472	3-Oct-20	9:21:00 PM	9,117
473	4-Oct-20	4:50:00 AM	8,951
474	5-Oct-20	12:04:00 AM	8,994
475	5-Oct-20	4:32:00 AM	8,681
476	5-Oct-20	9:12:00 AM	9,045
477	5-Oct-20	12:48:00 PM	8,824
478	5-Oct-20	7:59:00 PM	9,128
479	6-Oct-20	2:48:00 AM	9,214
480	6-Oct-20	2:25:00 PM	9,181
481	6-Oct-20	6:20:00 PM	9,013
482	7-Oct-20	2:31:00 AM	8,982
483	8-Oct-20	2:36:00 PM	8,712
484	8-Oct-20	10:19:00 PM	8,963
485	9-Oct-20	9:32:00 AM	9,754
486	9-Oct-20	12:39:00 PM	9,134
487	9-Oct-20	10:32:00 PM	9,076
488	10-Oct-20	5:59:00 AM	9,207
489	10-Oct-20	10:01:00 AM	9,127

Train Index	Load Finish Date	Load Finish Time	Net Weight (t)
490	10-Oct-20	12:59:00 PM	9,571
491	10-Oct-20	4:15:00 PM	8,898
492	10-Oct-20	11:55:00 PM	9,113
493	11-Oct-20	5:44:00 AM	8,717
494	11-Oct-20	4:12:00 PM	8,958
495	11-Oct-20	8:08:00 PM	8,968
496	12-Oct-20	4:21:00 PM	8,824
497	13-Oct-20	7:58:00 AM	9,081
498	13-Oct-20	10:45:00 AM	9,561
499	13-Oct-20	7:32:00 PM	9,250
500	14-Oct-20	1:45:00 AM	9,392
501	16-Oct-20	9:05:00 AM	8,941
502	16-Oct-20	6:46:00 PM	9,052
503	17-Oct-20	9:51:00 AM	9,158
504	18-Oct-20	12:23:00 AM	9,106
505	19-Oct-20	1:11:00 AM	9,195
506	21-Oct-20	10:33:00 AM	8,986
507	22-Oct-20	5:03:00 PM	8,902
508	23-Oct-20	8:22:00 AM	8,793
509	23-Oct-20	11:15:00 AM	8,910
510	24-Oct-20	8:12:00 PM	9,089
511	26-Oct-20	7:30:00 AM	9,538
512	26-Oct-20	10:25:00 AM	9,474
513	27-Oct-20	7:44:00 PM	9,157
514	28-Oct-20	11:13:00 AM	8,863
515	28-Oct-20	2:29:00 PM	9,158
516	29-Oct-20	12:35:00 AM	8,863
517	29-Oct-20	10:48:00 AM	8,863
518	29-Oct-20	10:36:00 PM	9,062

Train Index	Load Finish Date	Load Finish Time	Net Weight (t)
519	30-Oct-20	7:09:00 AM	9,137
520	30-Oct-20	9:26:00 PM	9,656
521	31-Oct-20	4:08:00 AM	9,171
522	31-Oct-20	7:26:00 AM	9,188
523	1-Nov-20	7:25:00 PM	9,198
524	2-Nov-20	12:37:00 AM	9,586
525	2-Nov-20	8:31:00 AM	9,522
526	3-Nov-20	1:02:00 AM	8,928
527	3-Nov-20	10:14:00 AM	9,476
528	3-Nov-20	1:10:00 PM	9,587
529	4-Nov-20	12:15:00 PM	9,537
530	5-Nov-20	6:02:00 AM	9,043
531	5-Nov-20	5:39:00 PM	9,490
532	5-Nov-20	11:32:00 PM	9,435
533	6-Nov-20	5:14:00 AM	9,422
534	6-Nov-20	8:30:00 AM	9,472
535	6-Nov-20	1:23:00 PM	8,787
536	6-Nov-20	5:14:00 PM	9,398
537	6-Nov-20	9:56:00 PM	9,426
538	7-Nov-20	6:22:00 AM	8,886
539	7-Nov-20	5:10:00 PM	9,331
540	8-Nov-20	6:25:00 AM	8,774
541	8-Nov-20	9:15:00 PM	9,010
542	9-Nov-20	1:34:00 AM	9,414
543	10-Nov-20	1:19:00 AM	9,441
544	10-Nov-20	5:00:00 AM	9,143
545	10-Nov-20	8:14:00 AM	9,105
546	10-Nov-20	7:10:00 PM	9,146
547	11-Nov-20	12:28:00 AM	9,271

Train Index	Load Finish Date	Load Finish Time	Net Weight (t)
548	11-Nov-20	9:26:00 AM	9,064
549	11-Nov-20	12:47:00 PM	9,183
550	12-Nov-20	2:33:00 AM	9,020
551	12-Nov-20	9:46:00 AM	9,140
552	12-Nov-20	6:53:00 PM	9,213
553	12-Nov-20	9:48:00 PM	8,998
554	13-Nov-20	5:35:00 PM	9,438
555	14-Nov-20	1:00:00 PM	9,369
556	14-Nov-20	5:09:00 PM	9,402
557	16-Nov-20	9:20:00 PM	9,103
558	20-Nov-20	7:50:00 AM	8,651
559	20-Nov-20	11:47:00 AM	9,278
560	20-Nov-20	10:19:00 PM	9,166
561	21-Nov-20	10:07:00 AM	9,225
562	21-Nov-20	1:25:00 PM	9,259
563	21-Nov-20	9:14:00 PM	9,339
564	22-Nov-20	10:15:00 AM	9,258
565	22-Nov-20	2:35:00 PM	9,205
566	23-Nov-20	10:58:00 AM	9,293
567	24-Nov-20	12:44:00 AM	9,160
568	24-Nov-20	10:10:00 PM	9,472
569	26-Nov-20	9:18:00 AM	9,062
570	28-Nov-20	10:29:00 AM	8,741
571	29-Nov-20	12:02:00 PM	8,973
572	29-Nov-20	3:36:00 PM	9,285
573	30-Nov-20	4:29:00 PM	9,364
574	1-Dec-20	4:49:00 AM	8,691
575	2-Dec-20	8:11:00 AM	8,840
576	2-Dec-20	6:22:00 PM	9,008

Train Index	Load Finish Date	Load Finish Time	Net Weight (t)
577	5-Dec-20	1:01:00 PM	8,794
578	7-Dec-20	6:33:00 PM	9,297
579	8-Dec-20	3:06:00 AM	9,223
580	8-Dec-20	9:49:00 AM	9,215
581	8-Dec-20	10:45:00 PM	9,248
582	9-Dec-20	6:03:00 PM	9,190
583	9-Dec-20	9:14:00 PM	9,316
584	9-Dec-20	11:59:00 PM	9,386
585	10-Dec-20	2:45:00 AM	9,418
586	10-Dec-20	6:46:00 AM	9,314
587	10-Dec-20	3:46:00 PM	8,589
588	12-Dec-20	12:02:00 PM	9,363
589	13-Dec-20	7:14:00 AM	8,965
590	15-Dec-20	5:05:00 PM	9,252
591	15-Dec-20	8:44:00 PM	9,299
592	16-Dec-20	7:33:00 AM	8,695
593	16-Dec-20	5:05:00 PM	9,255
594	17-Dec-20	4:39:00 AM	9,162
595	18-Dec-20	4:58:00 PM	8,776
596	18-Dec-20	8:58:00 PM	9,126
597	19-Dec-20	9:17:00 AM	9,126
598	22-Dec-20	7:43:00 AM	9,358
599	23-Dec-20	9:14:00 AM	9,341
600	23-Dec-20	1:14:00 PM	9,317
601	23-Dec-20	6:55:00 PM	9,195
602	23-Dec-20	11:30:00 PM	9,215
603	27-Dec-20	5:00:00 AM	9,277
604	27-Dec-20	1:20:00 PM	9,087
605	27-Dec-20	8:40:00 PM	9,475

Train Index	Load Finish Date	Load Finish Time	Net Weight (t)
606	28-Dec-20	12:07:00 AM	9,161
607	28-Dec-20	12:38:00 PM	9,343
608	28-Dec-20	7:38:00 PM	9,255
609	29-Dec-20	9:56:00 PM	8,871
610	30-Dec-20	3:13:00 PM	9,138
611	30-Dec-20	8:56:00 PM	9,086
612	31-Dec-20	1:35:00 AM	8,697
613	31-Dec-20	4:54:00 AM	8,836
614	31-Dec-20	8:27:00 AM	9,168
615	31-Dec-20	7:47:00 PM	8,724

Appendix B - Noise Monitoring Results (Spectrum Acoustics, 2020)

15 January 2020

Site	Time	Ravensworth Contribution LAEQ (dB)	EA Prediction	Within Predicted level	Compliance Limit	Compliant	LA1 Ravensworth Contribution	LA1 Criterion (dB)	Compliant	Cumulative Noise LAEQ(dB)	Criteria	Compliant
R2 (Site 2) A. Bowman	10:00pm	25	<30-33	Yes	35	Yes	28	45	Yes	25	40	Yes
R3 (Site 3) W. Bowman	10:29pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	20	40	Yes
R3 (Site 5) Camberwell South	10:51pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R4 (Site 6) Camberwell North	11:12pm	25	<30-34	Yes	35	Yes	26	45	Yes	25	40	Yes
R7 (Site 7) Spiteri	9.19pm	<20	-	-	35	Yes	<20	45	Yes	<20	40	Yes

10 February 2020

Site	Time	Ravensworth Contribution LAEQ (dB)	EA Prediction	Within Predicted level	Compliance Limit	Compliant	LA1 Ravensworth Contribution	LA1 Criterion (dB)	Compliant	Cumulative Noise LAEQ(dB)	Criteria	Compliant
R2 (Site 2) A. Bowman	9:41pm	24	<30-33	Yes	35	Yes	27	45	Yes	31	40	Yes
R3 (Site 3) W. Bowman	10:38pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	28	40	Yes

Site	Time	Ravensworth Contribution LAEQ (dB)	EA Prediction	Within Predicted level	Compliance Limit	Compliant	LA1 Ravensworth Contribution	LA1 Criterion (dB)	Compliant	Cumulative Noise LAEQ(dB)	Criteria	Compliant
R3 (Site 5) Camberwell South	11:00pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	30	40	Yes
R4 (Site 6) Camberwell North	11:20pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	27	40	Yes
R7 (Site 7) Spiteri	9.05pm	<20	-	-	35	Yes	<20	45	Yes	<20	40	Yes

11 February 2020

Site	Time	Ravensworth Contribution LAEQ (dB)	EA Prediction	Within Predicted level	Compliance Limit	Compliant	LA1 Ravensworth Contribution	LA1 Criterion (dB)	Compliant	Cumulative Noise LAEQ(dB)	Criteria	Compliant
R2 (Site 2) A. Bowman	9:18pm	20	<30-33	Yes	35	Yes	23	45	Yes	20	40	Yes
R3 (Site 3) W. Bowman	10:13pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R3 (Site 5) Camberwell South	10:41pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R4 (Site 6) Camberwell North	11:02pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes

12 February 2020

Site	Time	Ravensworth Contribution LAEQ (dB)	EA Prediction	Within Predicted level	Compliance Limit	Compliant	LA1 Ravensworth Contribution	LA1 Criterion (dB)	Compliant	Cumulative Noise LAEQ(dB)	Criteria	Compliant
R2 (Site 2) A. Bowman	9:15pm	<20	<30-33	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R3 (Site 3) W. Bowman	10:14pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R3 (Site 5) Camberwell South	10:43pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R4 (Site 6) Camberwell North	11:04pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes

18 March 2020

Site	Time	Ravensworth Contribution LAEQ (dB)	EA Prediction	Within Predicted level	Compliance Limit	Compliant	LA1 Ravensworth Contribution	LA1 Criterion (dB)	Compliant	Cumulative Noise LAEQ(dB)	Criteria	Compliant
R2 (Site 2) A. Bowman	9:57pm	27	<30-33	Yes	35	Yes	30	45	Yes	27	40	Yes
R3 (Site 3) W. Bowman	10:50pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	28	40	Yes
R3 (Site 5) Camberwell South	11:16pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R4 (Site 6) Camberwell North	11:35pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R7 (Site 7) Spiteri	9.14pm	<20	-	-	35	Yes	<20	45	Yes	23	40	Yes

1 April 2020

Site	Time	Ravensworth Contribution LAEQ (dB)	EA Prediction	Within Predicted level	Compliance Limit	Compliant	LA1 Ravensworth Contribution	LA1 Criterion (dB)	Compliant	Cumulative Noise LAEQ(dB)	Criteria	Compliant
R2 (Site 2) A. Bowman	9:41pm	<20	<30-33	Yes	35	Yes	<20	45	Yes	24	40	Yes
R3 (Site 3) W. Bowman	10:36pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	26	40	Yes
R3 (Site 5) Camberwell South	11:02pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R4 (Site 6) Camberwell North	11:22pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	25	40	Yes
R7 (Site 7) Spiteri	9.03pm	<20	-	-	35	Yes	<20	45	Yes	21	40	Yes

4 May 2020

Site	Time	Ravensworth Contribution LAEQ (dB)	EA Prediction	Within Predicted level	Compliance Limit	Compliant	LA1 Ravensworth Contribution	LA1 Criterion (dB)	Compliant	Cumulative Noise LAEQ(dB)	Criteria	Compliant
R2 (Site 2) A. Bowman	9:03pm	<20	<30-33	Yes	35	Yes	<20	45	Yes	29	40	Yes
R3 (Site 3) W. Bowman	10:07pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	23	40	Yes
R3 (Site 5) Camberwell South	10:28pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	31	40	Yes
R4 (Site 6) Camberwell North	10:51pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	24	40	Yes

5 May 2020

Site	Time	Ravensworth Contribution LAEQ (dB)	EA Prediction	Within Predicted level	Compliance Limit	Compliant	LA1 Ravensworth Contribution	LA1 Criterion (dB)	Compliant	Cumulative Noise LAEQ(dB)	Criteria	Compliant
R2 (Site 2) A. Bowman	9:25pm	22	<30-33	Yes	35	Yes	26	45	Yes	29	40	Yes
R3 (Site 3) W. Bowman	10:16pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R3 (Site 5) Camberwell South	10:39pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	34	40	Yes
R4 (Site 6) Camberwell North	11:00pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	27	40	Yes

6 May 2020

Site	Time	Ravensworth Contribution LAEQ (dB)	EA Prediction	Within Predicted level	Compliance Limit	Compliant	LA1 Ravensworth Contribution	LA1 Criterion (dB)	Compliant	Cumulative Noise LAEQ(dB)	Criteria	Compliant
R2 (Site 2) A. Bowman	10:15pm	<20	<30-33	Yes	35	Yes	<20	45	Yes	32	40	Yes
R3 (Site 3) W. Bowman	11:07pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	36	40	Yes
R3 (Site 5) Camberwell South	11:28pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	39	40	Yes
R4 (Site 6) Camberwell North	11:47pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	30	40	Yes
R7 (Site 7) Spiteri	9.32pm	<20	-	-	35	Yes	<20	45	Yes	<20	40	Yes

3 June 2020

Site	Time	Ravensworth Contribution LAEQ (dB)	EA Prediction	Within Predicted level	Compliance Limit	Compliant	LA1 Ravensworth Contribution	LA1 Criterion (dB)	Compliant	Cumulative Noise LAEQ(dB)	Criteria	Compliant
R2 (Site 2) A. Bowman	10:19pm	<20	<30-33	Yes	35	Yes	<20	45	Yes	25	40	Yes
R3 (Site 3) W. Bowman	11:12pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	28	40	Yes
R3 (Site 5) Camberwell South	11:30pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R4 (Site 6) Camberwell North	11:50pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R7 (Site 7) Spiteri	9.29pm	<20	-	-	35	Yes	<20	45	Yes	29	40	Yes

21 July 2020

Site	Time	Ravensworth Contribution LAEQ (dB)	EA Prediction	Within Predicted level	Compliance Limit	Compliant	LA1 Ravensworth Contribution	LA1 Criterion (dB)	Compliant	Cumulative Noise LAEQ(dB)	Criteria	Compliant
R2 (Site 2) A. Bowman	9:51pm	<20	<30-33	Yes	35	Yes	<20	45	Yes	24	40	Yes
R3 (Site 3) W. Bowman	10:40pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	28	40	Yes
R3 (Site 5) Camberwell South	11:03pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	28	40	Yes
R4 (Site 6) Camberwell North	11:24pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	30	40	Yes
R7 (Site 7) Spiteri	9.07pm	<20	-	-	35	Yes	<20	45	Yes	29	40	Yes

3 August 2020

Site	Time	Ravensworth Contribution LAEQ (dB)	EA Prediction	Within Predicted level	Compliance Limit	Compliant	LA1 Ravensworth Contribution	LA1 Criterion (dB)	Compliant	Cumulative Noise LAEQ(dB)	Criteria	Compliant
R2 (Site 2) A. Bowman	9:03pm	<20	<30-33	Yes	35	Yes	<20	45	Yes	28	40	Yes
R3 (Site 3) W. Bowman	9:57pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	32	40	Yes
R3 (Site 5) Camberwell South	10:21pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	33	40	Yes
R4 (Site 6) Camberwell North	10:39pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	34	40	Yes

4 August 2020

Site	Time	Ravensworth Contribution LAEQ (dB)	EA Prediction	Within Predicted level	Compliance Limit	Compliant	LA1 Ravensworth Contribution	LA1 Criterion (dB)	Compliant	Cumulative Noise LAEQ(dB)	Criteria	Compliant
R2 (Site 2) A. Bowman	9:02pm	29	<30-33	Yes	35	Yes	33	45	Yes	29	40	Yes
R3 (Site 3) W. Bowman	9:53pm	25	<30-34	Yes	35	Yes	28	45	Yes	25	40	Yes
R3 (Site 5) Camberwell South	10:13pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R4 (Site 6) Camberwell North	10:33pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes

5 August 2020

Site	Time	Ravensworth Contribution LAEQ (dB)	EA Prediction	Within Predicted level	Compliance Limit	Compliant	LA1 Ravensworth Contribution	LA1 Criterion (dB)	Compliant	Cumulative Noise LAEQ(dB)	Criteria	Compliant
R2 (Site 2) A. Bowman	9:56pm	<20	<30-33	Yes	35	Yes	<20	45	Yes	30	40	Yes
R3 (Site 3) W. Bowman	10:46pm	26	<30-34	Yes	35	Yes	29	45	Yes	26	40	Yes
R3 (Site 5) Camberwell South	11:07pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R4 (Site 6) Camberwell North	11:29pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R7 (Site 7) Spiteri	9.07pm	<20	-	-	35	Yes	<20	45	Yes	32	40	Yes

23 September 2020

Site	Time	Ravensworth Contribution LAEQ (dB)	EA Prediction	Within Predicted level	Compliance Limit	Compliant	LA1 Ravensworth Contribution	LA1 Criterion (dB)	Compliant	Cumulative Noise LAEQ(dB)	Criteria	Compliant
R2 (Site 2) A. Bowman	9:49pm	<20	<30-33	Yes	35	Yes	<20	45	Yes	22	40	Yes
R3 (Site 3) W. Bowman	10:46pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	23	40	Yes
R3 (Site 5) Camberwell South	11:07pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	31	40	Yes
R4 (Site 6) Camberwell North	11:27pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	26	40	Yes
R7 (Site 7) Spiteri	9.08pm	<20	-	-	35	Yes	<20	45	Yes	28	40	Yes

21 October 2020

Site	Time	Ravensworth Contribution LAEQ (dB)	EA Prediction	Within Predicted level	Compliance Limit	Compliant	LA1 Ravensworth Contribution	LA1 Criterion (dB)	Compliant	Cumulative Noise LAEQ(dB)	Criteria	Compliant
R2 (Site 2) A. Bowman	9:30pm	<20	<30-33	Yes	35	Yes	<20	45	Yes	28	40	Yes
R3 (Site 3) W. Bowman	10:20pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	30	40	Yes
R3 (Site 5) Camberwell South	10:41pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R4 (Site 6) Camberwell North	11:00pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	30	40	Yes
R7 (Site 7)	9.04pm	<20	-	-	35	Yes	<20	45	Yes	24	40	Yes

Site	Time	Ravensworth Contribution LAEQ (dB)	EA Prediction	Within Predicted level	Compliance Limit	Compliant	LA1 Ravensworth Contribution	LA1 Criterion (dB)	Compliant	Cumulative Noise LAEQ(dB)	Criteria	Compliant
Spiteri												

17 November 2020

Site	Time	Ravensworth Contribution LAEQ (dB)	EA Prediction	Within Predicted level	Compliance Limit	Compliant	LA1 Ravensworth Contribution	LA1 Criterion (dB)	Compliant	Cumulative Noise LAEQ(dB)	Criteria	Compliant
R2 (Site 2) A. Bowman	9:28pm	<20	<30-33	Yes	35	Yes	<20	45	Yes	28	40	Yes
R3 (Site 3) W. Bowman	10:22pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R3 (Site 5) Camberwell South	10:43pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R4 (Site 6) Camberwell North	11:03pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	26	40	Yes
R7 (Site 7) Spiteri	9.05pm	<20	-	-	35	Yes	<20	45	Yes	29	40	Yes

18 November 2020

Site	Time	Ravensworth Contribution LAEQ (dB)	EA Prediction	Within Predicted level	Compliance Limit	Compliant	LA1 Ravensworth Contribution	LA1 Criterion (dB)	Compliant	Cumulative Noise LAEQ(dB)	Criteria	Compliant
R2 (Site 2) A. Bowman	9:03pm	<20	<30-33	Yes	35	Yes	<20	45	Yes	28	40	Yes
R3 (Site 3) W. Bowman	9:55pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R3 (Site 5) Camberwell South	10:16pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R4 (Site 6) Camberwell North	10:35pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	28	40	Yes

19 November 2020

Site	Time	Ravensworth Contribution LAEQ (dB)	EA Prediction	Within Predicted level	Compliance Limit	Compliant	LA1 Ravensworth Contribution	LA1 Criterion (dB)	Compliant	Cumulative Noise LAEQ(dB)	Criteria	Compliant
R2 (Site 2) A. Bowman	9:05pm	<20	<30-33	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R3 (Site 3) W. Bowman	9:56pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	31	40	Yes
R3 (Site 5) Camberwell South	10:19pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R4 (Site 6) Camberwell North	10:41pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes

30 December 2020

Site	Time	Ravensworth Contribution LAEQ (dB)	EA Prediction	Within Predicted level	Compliance Limit	Compliant	LA1 Ravensworth Contribution	LA1 Criterion (dB)	Compliant	Cumulative Noise LAEQ(dB)	Criteria	Compliant
R2 (Site 2) A. Bowman	9:04pm	<20	<30-33	Yes	35	Yes	<20	45	Yes	24	40	Yes
R3 (Site 3) W. Bowman	10:02pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R3 (Site 5) Camberwell South	10:23pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	<20	40	Yes
R4 (Site 6) Camberwell North	10:49pm	<20	<30-34	Yes	35	Yes	<20	45	Yes	28	40	Yes

Appendix C - Blast Monitoring Results

Annual Blast Overpressure Monitoring Results

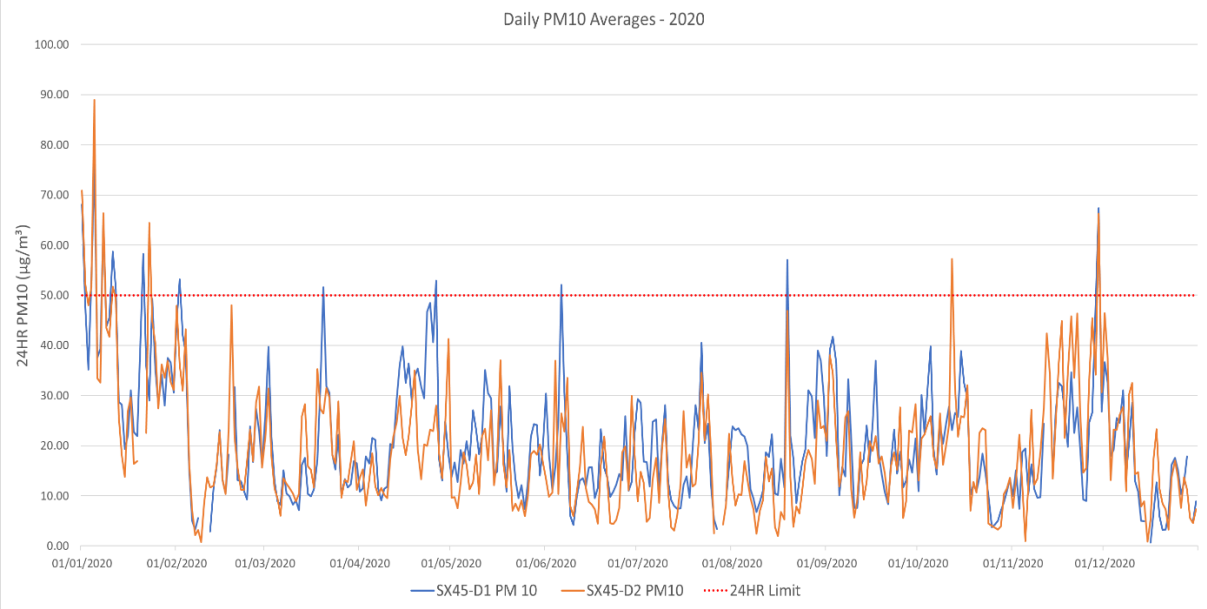
	Bowmans	Camberwell Village	Camberwell Church	Chain of Ponds Hotel	REA 86 Grinding Grooves	Ravensworth Public School	Ravensworth Homestead
Limit	120	120	120	133	N/A	133	126
Limit 5% up to 120 dBL	115	115	115	N/A	N/A	N/A	N/A
EA Prediction	115	115	N/A	N/A	N/A	N/A	115
Min	72.6	75	75.4	83.6	N/A	85.2	79.8
Mean	92.93	91.48	93.68	97.07	N/A	98.20	97.60
Max	113.5	112.7	114.4	120.0	N/A	116.4	114.4
Blast Events Exceeding 120 dBL	0	0	0	N/A	N/A	N/A	N/A
Blast Events Exceeding 15dBL	0	0	0	N/A	N/A	N/A	N/A
% > 115 dBL up to 120 dBL	0	0	0	N/A	N/A	N/A	N/A

Vibration Results

	Bowmans	Camberwell Village	Camberwell Church	Chain of Ponds Hotel	REA 86 Grinding Grooves	Ravensworth Public School	Ravensworth Homestead
Limit	10	10	10	10	175	10	10
Limit 5% up to 10mm/s	5	5	5	N/A	N/A	N/A	N/A
EA Prediction	5	5	5	N/A	N/A	N/A	N/A
Min	0.01	0.01	0	0.08	0.02	0.02	0
Mean	0.10	0.08	0.05	0.25	0.42	0.23	0.08
Max	0.74	0.55	0.4	7.33	3.15	1.86	1.52
Blast events exceeding 10mm/s	0	0	0	0	N/A	0	0
Blast events exceeding 5mm/s	0	0	0	N/A	N/A	N/A	N/A
%> 5mm/s up to 10mm/s	0	0	0	N/A	N/A	N/A	N/A

Appendix D - Air Quality Monitoring Results

Daily PM10 Averages



PM_{10} 24 hr Exceedances above 50 µg/m^3 during 2020

Date	TEOM Unit	Result (µg/m^3)
1/01/2020*	SX45-D2 PM10	70.9
1/01/2020*	SX45-D1 PM10	68.1
2/01/2020*	SX45-D2 PM10	52.2
4/01/2020*	SX45-D1 PM10	52.9
4/01/2020*	SX45-D2 PM10	51.6
5/01/2020*	SX45-D2 PM10	89.0
5/01/2020*	SX45-D1 PM10	76.3
8/01/2020*	SX45-D2 PM10	66.4
8/01/2020*	SX45-D1 PM10	64.4
11/01/2020*	SX45-D1 PM10	58.7
11/01/2020*	SX45-D2 PM10	51.7
12/01/2020*	SX45-D1 PM10	51.2
21/01/2020*	SX45-D1 PM10	58.2
23/01/2020*	SX45-D2 PM10	64.4
2/02/2020*	SX45-D1 PM10	53.2
20/03/2020	SX45-D1 PM10	51.6
26/04/2020	SX45-D1 PM10	52.9
06/06/2020	SX45-D1 PM10	52.1
19/08/2020*	SX45-D1 PM10	57.0
12/10/2020	SX45-D2 PM10	57.2
29/11/2020*	SX45-D1 PM10	67.4
29/11/2020*	SX45-D2 PM10	66.3

Note: * Extraordinary Events identified by DPIE

Appendix E - Biodiversity Offset Area Compliance (Biodiversity Australia, 2021)

Compliance with Objective and Target Criteria in Offset Area Management Programme (OAMP)

OAMP Reference	Objective	Target Criteria to be Achieved	2020 Monitoring Results	Corrective Actions
Table 6.4	Augment existing vegetation communities in areas zoned natural regeneration.	Evidence of natural regeneration (tree seedlings), decrease in target weeds or target weeds <10% (see weed management plan), no evidence that feral animals are significantly affecting regeneration (visual assessment).	Regeneration recorded in all BOAs. No regeneration in Clifton grassland sites. Increases in Target Weed Species were recorded with target weed species recorded all BOAs. At least one target weed species recorded at both grassland and woodland sites in these BOAs. Some impacts to vegetation from feral animals observed, particularly rabbits, hares and grazing cattle.	Additional assisted regeneration in open grassland areas. Continue to implement management actions outlined in OAMP. Undertake brush-matting (where resources permit) in grassland areas (as per Recommendations). Continue feral animal management within all BOAs.
	Re-establish regionally significant vegetation communities consistent with remnant vegetation in areas zoned assisted regeneration and remediation.	Assisted regeneration and remediation areas within the Offset Areas contain flora species assemblage characteristic of the vegetation communities that are being created.	Data was collected from established monitoring sites to allow for timeline comparisons. Differences in floristics between woodland and grassland sites remain.	Focus assisted regeneration efforts in grassland areas. Continue to undertake scheduled planting works. Undertake brush-matting and soil amelioration measures in grassland areas (as per Recommendations).
	Re-establish or augment fauna habitats for native and threatened fauna (woodland/forest).	Regeneration and remediation areas contain flora species that provide food, shelter and refuge opportunities for native and threatened fauna. Evidence of a range of vegetation structural habitats exists (e.g., canopy	Data was collected from established monitoring sites to allow for timeline comparisons. Habitat still provided for a range of species. Several threatened fauna species detected during monitoring.	No corrective actions required. Continue to implement management and monitoring actions as per the OAMP.

OAMP Reference	Objective	Target Criteria to be Achieved	2020 Monitoring Results	Corrective Actions
		species, shrubs, ground cover, developing litter layer etc.) that are commensurate with native and threatened fauna that occur within the area.	Differences in floristics between woodland and grassland sites remain. Regeneration of flora species that provide habitat to fauna species is advancing in HOA and SOAs.	
		Native/threatened woodland fauna are utilising offset areas.		
	Re-establish and augment habitat for the Green and Golden Bell Frog (wetland and open grassland areas).	Green and Golden Bell Frog habitat reestablishment and augmentation areas contain flora species that are commensurate with those known to provide habitat for this species.	Structural habitat elements present. Water now present in most dams during the Green and Golden Bell Frog survey period following a dry year where most aquatic vegetation had died off.	Continue to implement management actions as per the OAMP.
			Seven dams in RNOA and one dam in HOA had sufficient habitat features to support the Green and Golden Bell Frog. Evidence of flora plantings near dams at HOA. No green and Golden Bell Frogs were recorded during surveys.	Implement aquatic vegetation planting with the aim to create densely vegetated areas. Consider alternate monitoring methods (as per Recommendations).
Table 7.3	Targeted weed removal across all offset properties to remove noxious and perennial weed species.	Decrease in abundance of all target weed species in first ten years.	Target weed species recorded in all BOAs. Target weed species recorded at both grassland and woodland sites in these BOAs.	Continue weed mapping and focus on management plan priorities. Continue to implement management actions as per the OAMP with focus on areas described in this report.
		Weed infestations considered negligible across all four offset properties within 15 years.	Data was collected from established monitoring sites to allow for timeline comparisons and future analysis. Exotic species increased since previous monitoring year.	

OAMP Reference	Objective	Target Criteria to be Achieved	2020 Monitoring Results	Corrective Actions
	Primary, secondary and maintenance weeding within areas zoned assisted regeneration and remediation, to prepare the sites for planting and maintain them so that weed infestation does not compromise the survival of planted seedlings.	Assisted regeneration and remediation areas within the Offset Areas are dominated by native species in all strata (trees, shrubs, groundcover).	Monitoring did not cover any areas with assisted regeneration. The success of one area of assisted regeneration was noted in Hillcrest.	Continue to implement management actions as per the OAMP.
Table 8.1	To minimise browsing/disturbance of regeneration areas.	Minimal level of browsing observed (<10% of plants showing evidence of rabbit browsing in permanent plots).	Rabbits and Hares frequently observed within the RNOA during the 2020 monitoring programme.	Continue feral rabbit management at RNOA. Continue to implement management actions as per the OAMP.
		Disturbance by feral pigs (i.e. digging) is minimal (visual assessment).	Feral pigs were not recorded within the BOAs during the 2020 monitoring programme.	Continue to implement management actions as per the OAMP.
	To minimise predation of, or competition with, native species by feral pest species.	Evidence of foxes/feral cats/wild dogs (including scats, dens, signs of predation) is minimal (Visual assessment).	Evidence of fox use and feral cats at RNOA. Dog observed crossing through COA.	Continue to implement management actions for feral animals as per the OAMP. Ensure monitoring of feral animals is conducted.
		Regular monitoring by PIR cameras show only occasional use of the site by feral predators.	Cameras fixed at feral bait stations regularly recorded feral predators.	
Table 11.1	Increase habitat linkages between Davis and Bayswater Creeks in RNOA through	A series of 10 dams with habitat specific to the Green and Golden Bell Frog have been created /augmented between Davis and Bayswater Creeks.	N/A	Continue to implement management actions as per the OAMP and OMP.

OAMP Reference	Objective	Target Criteria to be Achieved	2020 Monitoring Results	Corrective Actions
	augmenting /creating a series of dams.			
	Removal of Mosquito Fish from dams on all four properties.	Dams and waterways are free of Mosquito Fish.	No evidence of Mosquito Fish in dams surveyed.	Continue monitoring for Mosquito Fish as per the OAMP.
	Maintain/augment Green and Golden Bell Frog habitat on RNOA and HOA.	All dams to include native emergent and fringing plant species, surrounding shelter sites and unshaded areas within three years.	An increase in augmented GGBF habitat was recorded however a number of dams contain sparse fringing vegetation or no aquatic vegetation.	Focus assisted plantings of suitable aquatic vegetation at dams identified as limited or not suitable habitat for the GGBF. Assisted plantings should aim to create dense patches of vegetation rather than sparse plantings. Continue to implement management actions as per the OAMP.
	Conduct ongoing annual Green and Golden Bell Frog surveys on RNOA and HOA to provide a better understanding of the local population.	Increased understanding of the Hunter Catchment Green and Golden Bell Frog population.	No records of the Green and Golden Bell Frog during the 2020 monitoring programme.	Continue to implement management and monitoring actions as described in the OAMP.

Appendix F - Meteorological Monitoring Results

Date/Time Sampled	Mean Relative Humidity (%)	Mean Air Temperature - 2M (°C)	Mean Air Temperature - 10M (°C)	Mean Wind Speed - 10M (m/s)	Mean Wind Direction (°)	Sigma Theta - 10M (°)	24Hr Rainfall (mm)
1/01/2020	53.5	26.3	25.8	4.1	129	31.024	1
2/01/2020	72.5	23.8	23.4	4.8	124	17.973	0
3/01/2020	59	28.7	28.2	2.8	134	31.441	0
4/01/2020	35.3	35.4	35.1	2.4	311	29.055	0
5/01/2020	44.2	27.3	26.8	6.5	126	21.515	0
6/01/2020	70.2	22.2	21.8	5.3	138	16.557	1
7/01/2020	59.9	28.1	27.7	0.8	159	41.733	0
8/01/2020	59.9	28.1	27.7	3.2	126	34.286	2.6
9/01/2020	79.4	22.9	22.7	4.6	126	16.114	0
10/01/2020	54.4	30.7	30.3	0.4	203	35.696	0
11/01/2020	59.5	25.1	25	3.4	131	20.742	0
12/01/2020	61.3	21.6	21.2	6	122	18.185	0
13/01/2020	58.9	23.3	22.8	5.1	126	20.336	0
14/01/2020	60.9	25.1	24.6	4.9	129	21.833	0
15/01/2020	63.3	25.6	25.2	3.1	133	23.89	0
16/01/2020	80.6	23.2	23.3	0.9	248	31.491	8.4
17/01/2020	75.4	22.3	22.2	3.6	154	17.192	0
18/01/2020	94	20.4	20.5	2.7	135	18.13	15.2
19/01/2020	83.7	22.5	22.3	3	131	18.884	0.6
20/01/2020	67	26.2	26.4	1	238	42.541	15.6
21/01/2020	40.4	27.3	27.3	2.7	271	33.702	0
22/01/2020	52.7	28.8	28.5	0.2	174	41.495	0

Date/Time Sampled	Mean Relative Humidity (%)	Mean Air Temperature - 2M (°C)	Mean Air Temperature - 10M (°C)	Mean Wind Speed - 10M (m/s)	Mean Wind Direction (°)	Sigma Theta - 10M (°)	24Hr Rainfall (mm)
23/01/2020	43.1	32.1	32.2	4.9	294	32.381	1.2
24/01/2020	69.2	27.4	27.4	1.1	262	26.441	15.2
25/01/2020	77.5	26.5	26.2	3.6	133	21.983	0
26/01/2020	65.1	28.9	28.5	1.2	277	39.148	0
27/01/2020	64.3	28	27.6	2.5	131	25.854	0
28/01/2020	60.9	29.8	29.5	0.7	211	35.449	3.4
29/01/2020	74.4	26.1	25.8	4.6	125	19.189	0.2
30/01/2020	68.7	26.9	26.4	4.2	135	21.726	0
31/01/2020	59.2	31.6	31.2	1.1	127	39.666	0
1/02/2020	40.3	35.5	35.4	3	298	30.678	0
2/02/2020	39.4	35.6	35.2	4.2	286	23.268	2.8
3/02/2020	67.8	28.3	28	1.3	219	30.852	0.2
4/02/2020	54.5	21	20.7	6.3	118	16.902	0
5/02/2020	59.7	22.3	22	4.2	137	21.397	0
6/02/2020	87	20.3	20.4	4.6	136	15.606	18
7/02/2020	97.3	20.3	20.3	4.5	149	13.756	19.4
8/02/2020	91.6	21.1	21.1	6	130	17.075	28.8
9/02/2020	98.7	21.2	21.3	5.9	139	15.638	42.4
10/02/2020	87.8	22.7	22.5	1.7	127	27.025	12.4
11/02/2020	73.5	24.7	24.6	1.7	115	39.047	0
12/02/2020	79.7	24.7	24.5	3.2	127	29.991	0
13/02/2020	83.7	24.1	24	4.9	129	16.589	0.2
14/02/2020	70.5	23.8	23.7	3.1	132	20.093	0.2
15/02/2020	73.1	23.4	23.4	0.6	190	34.606	6.8

Date/Time Sampled	Mean Relative Humidity (%)	Mean Air Temperature - 2M (°C)	Mean Air Temperature - 10M (°C)	Mean Wind Speed - 10M (m/s)	Mean Wind Direction (°)	Sigma Theta - 10M (°)	24Hr Rainfall (mm)
16/02/2020	80.7	22.8	22.7	3.8	131	18.063	0.2
17/02/2020	94.2	21.5	21.6	1.5	154	34.123	2.4
18/02/2020	73.7	26.2	26	1.9	292	30.205	0.2
19/02/2020	50.8	25.4	25.3	5	278	30.654	2.2
20/02/2020	57	21.8	22	1.7	122	43.43	0
21/02/2020	68	22.2	22	4.1	137	20.494	0
22/02/2020	73.7	21.4	21.3	4.9	129	18.553	0
23/02/2020	69.6	22.1	22.1	4.1	133	18.92	0
24/02/2020	85.2	21	21	2.2	152	30.698	2.4
25/02/2020	73.9	24.1	24.1	0.3	117	45.811	0.2
26/02/2020	69.8	24.9	24.9	2.8	293	29.929	0
27/02/2020	72.8	23.7	23.7	0	-99	29.005	0
28/02/2020	64.3	22.2	22.3	2.3	130	41.113	0
29/02/2020	69.6	22.2	22	3.5	138	20.47	0
1/03/2020	66.9	25.4	25.2	1.1	287	41.045	0
2/03/2020	51.7	27.9	28.1	1.4	274	26.858	0
3/03/2020	84.3	20.8	20.8	4.3	137	17.238	1.4
4/03/2020	83.7	22.2	22.1	3.9	139	16.515	0.2
5/03/2020	97.7	20.9	21	1.8	165	21.894	27.4
6/03/2020	78.9	24.7	24.6	2.7	289	28.505	4.4
7/03/2020	82.6	20.3	20.3	3.2	128	20.697	0
8/03/2020	79.7	19.3	19.2	3.5	124	19.611	0
9/03/2020	77.1	19	19	3.8	127	18.268	0
10/03/2020	70.7	19.7	19.6	3.5	123	22.692	0

Date/Time Sampled	Mean Relative Humidity (%)	Mean Air Temperature - 2M (°C)	Mean Air Temperature - 10M (°C)	Mean Wind Speed - 10M (m/s)	Mean Wind Direction (°)	Sigma Theta - 10M (°)	24Hr Rainfall (mm)
11/03/2020	74.7	19.4	19.3	4.4	134	17.395	0
12/03/2020	69.7	19.9	19.8	4.3	136	17.527	0
13/03/2020	69.4	19.6	19.7	1.5	144	34.998	0
14/03/2020	87.9	16	16.3	2.7	155	26.876	8
15/03/2020	75.1	17	17	3.9	143	16.371	0
16/03/2020	86.6	17.6	17.6	3.7	155	16.334	1.8
17/03/2020	84.5	17.8	17.9	2.1	136	22.53	0.8
18/03/2020	71.8	19.1	19.4	0.7	74	47.459	0.2
19/03/2020	50.8	22.7	23.2	0.7	359	49.383	0
20/03/2020	44.2	26.2	26.4	3.9	291	31.122	0
21/03/2020	67.7	22.9	22.8	3.2	140	25.505	0
22/03/2020	69	23.2	23	0.3	260	26.04	0
23/03/2020	68.3	20.2	20.2	4.3	120	20.405	0
24/03/2020	71.5	20.2	20.1	3.2	146	23.236	0
25/03/2020	86.4	18.9	19.1	0.4	322	38.304	25.4
26/03/2020	98.4	17.3	17.4	3.4	152	18.144	14.4
27/03/2020	80.7	18.5	18.5	3.7	131	19.884	0.2
28/03/2020	87.4	17.6	17.7	2.7	138	20.733	0
29/03/2020	81	21	20.9	1.4	141	31.725	0
30/03/2020	89.8	19.3	19.7	2.2	299	24.115	6.6
31/03/2020	75.4	21.8	21.9	0.8	270	35.819	0
1/04/2020	84.8	21.7	21.6	2.3	135	30.036	0
2/04/2020	94.4	19.8	19.9	0.6	272	35.976	7
3/04/2020	91.8	20.9	21.1	1.6	310	37.811	17.4

Date/Time Sampled	Mean Relative Humidity (%)	Mean Air Temperature - 2M (°C)	Mean Air Temperature - 10M (°C)	Mean Wind Speed - 10M (m/s)	Mean Wind Direction (°)	Sigma Theta - 10M (°)	24Hr Rainfall (mm)
4/04/2020	65.2	21.2	21.4	7.1	293	18.313	17.2
5/04/2020	53.5	18.3	18.4	5.3	288	19.673	0
6/04/2020	61.4	18.3	18.4	0.5	266	29.064	0
7/04/2020	76.1	17.7	17.7	3.5	135	20.328	0
8/04/2020	80.8	17.4	17.4	3.1	139	23.277	0
9/04/2020	85.1	17.5	17.6	2.9	140	17.913	0
10/04/2020	93.3	17.8	17.9	1.5	283	26.85	7.2
11/04/2020	53.9	19.8	19.9	8	283	22.859	0
12/04/2020	50.8	15.6	16.1	0.5	356	47.027	0
13/04/2020	69.9	15.4	15.9	0.5	90	42.804	0
14/04/2020	70.3	17.5	18	0.5	322	30.941	0
15/04/2020	63.9	20.3	20.9	1.2	311	45.717	0
16/04/2020	52.3	23.3	23.5	4.3	296	19.624	0
17/04/2020	43.7	22.7	22.8	5.6	286	29.277	0
18/04/2020	52.5	17.3	17.4	2.2	290	22.689	0
19/04/2020	63.2	15.3	15.9	0.3	53	49.219	0
20/04/2020	51.3	17.6	17.9	3.3	290	30.035	0
21/04/2020	49.2	20.4	20.5	2.8	300	28.875	0
22/04/2020	51.1	20.3	20.6	2.2	292	36.781	0
23/04/2020	54.6	18.1	18.5	1.6	289	31.152	0
24/04/2020	44.1	21.4	21.6	3.1	294	23.707	0
25/04/2020	55.6	19.5	20.2	0.7	310	40.206	0
26/04/2020	49.5	21	21.4	3.7	284	33.493	0
27/04/2020	76.5	18.4	18.5	3.1	149	23.357	0

Date/Time Sampled	Mean Relative Humidity (%)	Mean Air Temperature - 2M (°C)	Mean Air Temperature - 10M (°C)	Mean Wind Speed - 10M (m/s)	Mean Wind Direction (°)	Sigma Theta - 10M (°)	24Hr Rainfall (mm)
28/04/2020	87.1	18.8	18.8	2.5	135	21.315	0
29/04/2020	72.2	21.5	21.7	1.1	319	31.199	0
30/04/2020	82.6	15.5	15.9	4.7	293	27.77	12.4
1/05/2020	58.4	12.5	12.7	9.7	292	18.87	0
2/05/2020	60.9	14	14.1	9.5	290	19.948	0
3/05/2020	57	13.7	14	2.5	295	28.356	0
4/05/2020	67.9	12.8	13.4	0.5	122	40.729	0
5/05/2020	85.5	13.5	13.9	1.3	123	26.301	0
6/05/2020	82.4	14.5	15	0.5	301	37.549	0
7/05/2020	69.9	15.6	16.3	1.1	297	29.97	0
8/05/2020	60.2	18.1	18.9	1.4	293	35.51	0
9/05/2020	65.1	17.3	18.1	3.1	289	30.546	0.2
10/05/2020	50.7	13.7	13.9	3.3	285	35.774	0
11/05/2020	57.3	10.7	11.4	0.8	81	46.98	0
12/05/2020	68.5	10.8	11.5	0.6	58	50.657	0
13/05/2020	69	12.1	12.8	0.7	283	43.26	0
14/05/2020	77.4	11.5	12.1	2.2	127	29.539	0
15/05/2020	79.5	13.9	13.9	2.7	142	20.186	0
16/05/2020	78.6	14.4	14.6	2.1	126	29.481	0
17/05/2020	76.5	14	14.3	2.2	129	29.623	0
18/05/2020	86.7	14.6	14.6	2.6	137	27.45	0
19/05/2020	88.8	14.6	14.7	1.1	146	32.342	0.2
20/05/2020	71.9	16.8	17.1	1.9	311	27.837	0
21/05/2020	80.6	15	15.3	2.6	288	31.22	7.2

Date/Time Sampled	Mean Relative Humidity (%)	Mean Air Temperature - 2M (°C)	Mean Air Temperature - 10M (°C)	Mean Wind Speed - 10M (m/s)	Mean Wind Direction (°)	Sigma Theta - 10M (°)	24Hr Rainfall (mm)
22/05/2020	64.2	12.5	12.7	6	283	24.218	0
23/05/2020	79.5	10.7	10.9	5.3	299	15.25	2.8
24/05/2020	75.2	13.4	13.7	2.3	284	25.848	0.2
25/05/2020	80.5	13.2	13.7	1.2	262	37.77	12.2
26/05/2020	84.9	14.5	14.8	2.5	159	20.968	0.6
27/05/2020	88	13.7	14.1	0.7	68	44.939	0
28/05/2020	82.2	14.3	14.6	0.6	353	26.816	0.2
29/05/2020	85.5	14.3	14.5	1.4	109	36.764	0
30/05/2020	89.9	13.4	13.7	1	130	36.688	0.2
31/05/2020	78.9	15	15.3	1	303	37.344	0.2
1/06/2020	63	15.7	16.1	6.4	289	25.116	0
2/06/2020	61.8	10.2	10.2	7.7	293	17.592	0
3/06/2020	60	12.7	13.1	2.5	301	28.847	0
4/06/2020	69.7	11.2	11.8	1.3	91	36.436	0
5/06/2020	72.1	11.6	12.1	1.4	299	35.758	0
6/06/2020	74.3	11.2	11.8	0.4	102	41.312	0
7/06/2020	81.7	10.5	11.1	1.2	131	35.093	0
8/06/2020	74.9	12.5	13	1.2	139	41.546	0
9/06/2020	97.3	13.4	13.5	2.6	151	25.776	5.2
10/06/2020	99.6	14.7	14.8	1.4	168	23.26	2.2
11/06/2020	85.4	15.6	15.8	0.5	178	36.218	0
12/06/2020	86.5	14.8	14.9	2.5	146	19.774	0
13/06/2020	90.9	14.8	15	0.5	121	41.554	0
14/06/2020	75.8	15.3	15.5	4.4	287	29.665	25.2

Date/Time Sampled	Mean Relative Humidity (%)	Mean Air Temperature - 2M (°C)	Mean Air Temperature - 10M (°C)	Mean Wind Speed - 10M (m/s)	Mean Wind Direction (°)	Sigma Theta - 10M (°)	24Hr Rainfall (mm)
15/06/2020	63.7	13.3	13.6	3.4	297	20.463	0
16/06/2020	65.4	14.1	14.4	2.9	296	27.755	0
17/06/2020	80.1	13.4	13.6	1.8	129	27.011	2.2
18/06/2020	81.7	13.5	13.7	2.6	129	19.406	0.2
19/06/2020	88	11	11.6	0.6	89	33.2	0
20/06/2020	87	11.3	12	0.7	115	33.599	0.4
21/06/2020	85.4	12.4	12.9	1.9	284	40.4	7.4
22/06/2020	67.6	11.4	11.7	5.8	287	29.405	0.2
23/06/2020	69.3	10.8	11	5.3	294	17.743	0
24/06/2020	66.7	12	12	6.2	295	17.099	0
25/06/2020	67.3	12.2	12.3	4.7	290	22.395	0
26/06/2020	69.5	11.4	12	0.5	95	37.783	0
27/06/2020	81.9	11.3	11.5	2.3	125	34.695	0
28/06/2020	75.7	12.4	12.5	2.4	127	23.045	0
29/06/2020	85	10.4	10.8	1.3	117	30.366	0.2
30/06/2020	79.9	10.4	11	0.2	79	45.592	0
1/07/2020	65.8	11.8	12.6	0.9	295	31.221	0.2
2/07/2020	58	15.9	16.6	2.7	294	29.815	0
3/07/2020	56.1	14.9	15.1	4.4	276	30.367	0
4/07/2020	58	11.1	11.1	5.3	287	21.82	0.2
5/07/2020	60.1	11.2	11.3	3.6	294	15.888	0
6/07/2020	72.5	10	10.8	0.5	25	40.731	0
7/07/2020	76.3	10.5	10.9	1.5	121	29.755	0
8/07/2020	82.6	12.3	12.4	1.9	122	24.511	0.4

Date/Time Sampled	Mean Relative Humidity (%)	Mean Air Temperature - 2M (°C)	Mean Air Temperature - 10M (°C)	Mean Wind Speed - 10M (m/s)	Mean Wind Direction (°)	Sigma Theta - 10M (°)	24Hr Rainfall (mm)
9/07/2020	82.8	11.6	12	0.6	112	34.056	0
10/07/2020	96.9	12.1	12.4	0.5	109	34.865	0.8
11/07/2020	95.9	13.4	13.7	0.6	281	34.778	5.2
12/07/2020	77.5	13.5	13.8	1.7	288	30.83	1.4
13/07/2020	79.5	10	10.2	2.8	281	38.862	0.2
14/07/2020	72.9	11.2	11.5	2.5	251	25.835	1.4
15/07/2020	58.2	13.1	13.7	1.9	205	35.383	0
16/07/2020	63.7	11.4	12.1	1.6	284	31.905	0
17/07/2020	70.3	12.5	13.1	0.9	151	23.788	0
18/07/2020	76.1	12.7	13.1	1.3	93	32.866	0
19/07/2020	69.9	13.3	13.7	4	292	27.015	0
20/07/2020	46.7	13.6	13.8	3.9	284	27.63	0
21/07/2020	61.6	10.4	10.7	0.5	154	29.825	0
22/07/2020	79.7	9.6	10.1	0.6	40	48.892	0
23/07/2020	71.4	11.7	12.1	0.8	102	37.512	0
24/07/2020	90.1	10.7	11	1.4	130	34.864	0
25/07/2020	91.2	11.7	12	1.8	128	32.916	3.4
26/07/2020	99.3	12.8	13	1.4	241	31.625	32.6
27/07/2020	86.1	13.6	13.9	7.3	289	19.003	28
28/07/2020	96.1	12	12.2	4.8	295	16.493	25
29/07/2020	77.5	15	15.1	1.4	286	32.829	0
30/07/2020	78.9	13	13.4	1.2	125	38.48	0
31/07/2020	71.8	12.4	12.8	1.9	140	28.396	0
1/08/2020	77.6	11.1	11.6	1.1	312	29.522	0.2

Date/Time Sampled	Mean Relative Humidity (%)	Mean Air Temperature - 2M (°C)	Mean Air Temperature - 10M (°C)	Mean Wind Speed - 10M (m/s)	Mean Wind Direction (°)	Sigma Theta - 10M (°)	24Hr Rainfall (mm)
2/08/2020	65.4	12.7	13.2	1	297	40.276	0
3/08/2020	62.7	13.1	13.6	2.1	295	35.523	0
4/08/2020	50.3	15	15.4	4.5	273	31.257	0
5/08/2020	48.7	10.8	10.9	5.3	284	24.854	0
6/08/2020	53.9	9.8	9.9	1.5	273	29.205	0
7/08/2020	84.5	9.6	9.9	3.8	150	14.665	4.6
8/08/2020	86.2	11.5	11.6	2.8	285	37.239	0.8
9/08/2020	69.8	10.2	10.3	6.5	285	20.917	3.6
10/08/2020	83.8	10.9	11.1	2	167	32.207	19.8
11/08/2020	77.4	12.5	12.7	1.2	114	34.974	0
12/08/2020	84.1	13.1	13.4	0.2	338	36.374	0
13/08/2020	68.8	16	16.5	1.7	280	44.481	0.6
14/08/2020	88.3	12.3	12.7	0.2	125	46.92	5.2
15/08/2020	76.6	14.3	14.4	6.2	288	22.078	0
16/08/2020	61.8	14	14.1	7	287	19.21	0
17/08/2020	61.3	13.5	13.5	6.1	291	16.464	0
18/08/2020	58.4	14.4	14.5	4.1	289	25.084	0
19/08/2020	48	15.4	15.7	7.4	280	23.76	0
20/08/2020	58.5	12.9	12.9	8.7	282	23.304	0
21/08/2020	55.4	13.1	13.2	7.5	282	24.736	0.2
22/08/2020	61.5	10.6	10.6	8.3	280	25.053	0.4
23/08/2020	55.5	10.9	10.8	8.4	286	20.431	0.2
24/08/2020	51.1	11.8	11.7	5.2	287	21.733	0
25/08/2020	55.4	9.6	9.8	1.6	301	34.979	0

Date/Time Sampled	Mean Relative Humidity (%)	Mean Air Temperature - 2M (°C)	Mean Air Temperature - 10M (°C)	Mean Wind Speed - 10M (m/s)	Mean Wind Direction (°)	Sigma Theta - 10M (°)	24Hr Rainfall (mm)
26/08/2020	60.1	10	10.6	1	22	40.716	0
27/08/2020[3]	-	-	-	-	-	32.768	-
28/08/2020	41.8	15.5	15.6	0	-99	38.098	0
29/08/2020	61.6	11.3	12.1	0.8	12	50.905	0
30/08/2020	56.9	15.3	15.5	2.3	286	28.058	0
31/08/2020	57.4	16.3	16.8	1.2	205	31.921	0
1/09/2020	60.7	14.4	14.3	2.6	109	19.77	0
2/09/2020	66.5	14.8	15.1	1.4	294	31.206	0
3/09/2020	52.6	20.3	20.7	2.8	281	27.241	0
4/09/2020	45.4	22.6	22.7	2.8	264	24.96	0.8
5/09/2020	59.6	18.5	18.5	1.5	236	28.709	1.4
6/09/2020	71.4	15.3	15.4	3.4	110	20.288	0
7/09/2020	67.6	15.5	15.6	1.6	101	20.26	0
8/09/2020	66.1	16.3	16.6	0.8	341	37.463	0
9/09/2020	82.1	14.8	15	1.7	106	28.739	10.4
10/09/2020	80.3	13.2	13.3	3.5	119	19.626	2.6
11/09/2020	77.1	14.5	14.5	2.9	113	18.184	0.2
12/09/2020	75.5	13.8	14.1	0.9	312	38.66	0
13/09/2020	59.3	17.1	17.3	1.3	262	36.249	0
14/09/2020	60.6	18.7	18.7	0.7	152	31.132	0
15/09/2020	76.3	18	17.9	1.5	97	27.979	0
16/09/2020	67.1	18.7	18.9	1.5	291	28.457	0
17/09/2020	56.4	20.6	20.9	0.5	244	29.327	0

[3] Machine fault resulting in no data on this date

Date/Time Sampled	Mean Relative Humidity (%)	Mean Air Temperature - 2M (°C)	Mean Air Temperature - 10M (°C)	Mean Wind Speed - 10M (m/s)	Mean Wind Direction (°)	Sigma Theta - 10M (°)	24Hr Rainfall (mm)
18/09/2020	78	16.9	16.9	3.4	113	14.66	0
19/09/2020	73.7	19.8	19.8	2.5	125	25.941	0
20/09/2020	91.9	17.1	17.2	0.4	156	41.066	12.8
21/09/2020	82.5	19.7	19.7	1	285	35.436	9.8
22/09/2020	56.2	21.1	21.2	3.9	254	25.314	0.2
23/09/2020	41.2	18.4	18.4	3.6	243	33.106	0
24/09/2020	47.7	15.5	15.5	2.6	247	29.388	0
25/09/2020	55.2	14.4	14.6	4.1	265	23.527	0.8
26/09/2020	52.1	11.5	11.5	6.2	260	20.39	0
27/09/2020	53.5	13.4	13.3	0.3	223	25.222	0
28/09/2020	58.1	14.2	14.2	1.4	102	32.156	0
29/09/2020	65.7	13.6	13.7	1.8	99	29.769	0
30/09/2020	75.1	13.9	14.1	1.3	283	32.721	0
1/10/2020	58	18.6	18.7	3.1	249	34.17	0.2
2/10/2020	60.8	17.2	17.7	0.8	326	44.26	0
3/10/2020	52.9	19.4	19.7	0.8	37	41.886	0
4/10/2020	55.1	21.2	21.4	1.2	287	40.158	0
5/10/2020	52.1	22.2	22.5	2	300	35.574	0
6/10/2020	71.6	18.9	18.9	2.9	99	25.095	0
7/10/2020	76	19.7	19.6	2.8	103	20.696	0
8/10/2020	62.9	22.8	22.7	2.8	252	34.488	0
9/10/2020	40.3	19.1	19	3.6	255	24.196	0
10/10/2020	39.6	19.1	19.2	1.2	269	35.196	0
11/10/2020	42	18.8	19	0.6	9	49.512	0

Date/Time Sampled	Mean Relative Humidity (%)	Mean Air Temperature - 2M (°C)	Mean Air Temperature - 10M (°C)	Mean Wind Speed - 10M (m/s)	Mean Wind Direction (°)	Sigma Theta - 10M (°)	24Hr Rainfall (mm)
12/10/2020	55.2	19.2	19.3	2	99	27.079	0
13/10/2020	54	21.2	21.2	1.3	94	45.861	0
14/10/2020	65.5	19.4	19.3	3.7	107	21.088	0
15/10/2020	61.9	21.7	21.6	0.9	277	24.169	0
16/10/2020	55.6	21	21.1	2.7	97	33.131	0
17/10/2020	55.8	23.5	23.5	1.3	234	27.039	0
18/10/2020	67.7	20.2	20.2	3.6	257	25.315	7
19/10/2020	76.6	17.4	17.4	2.9	111	20.167	0
20/10/2020	73.8	17.9	17.8	2.7	107	22.848	0
21/10/2020	68.1	19.2	19	1.5	111	36.022	0
22/10/2020	61.5	21.7	21.5	1.5	88	28.082	0
23/10/2020	68.2	22.5	22.3	1.1	114	30.903	0
24/10/2020	94.1	19.9	20	1	285	31.407	38.8
25/10/2020	95.5	15	15.1	2.6	129	22.804	18.8
26/10/2020	93.3	14.3	14.3	3.4	142	17.044	13.8
27/10/2020	77.2	15.9	15.9	2.9	115	17.799	0
28/10/2020	88.9	15.3	15.3	2.6	108	24.637	18.2
29/10/2020	80.7	17	17	0.9	134	44.043	3.6
30/10/2020	81.7	16.6	16.6	2.6	109	25.057	0.8
31/10/2020	67.8	19.1	19.1	2.3	228	33.866	0.2
1/11/2020	67.4	17.7	17.7	1.6	184	26.28	3.8
2/11/2020	62.2	18.1	18.1	3	114	25.073	0
3/11/2020	68.8	17.4	17.4	2.5	94	23.827	0
4/11/2020	55.6	21	21	0.7	265	27.559	0

Date/Time Sampled	Mean Relative Humidity (%)	Mean Air Temperature - 2M (°C)	Mean Air Temperature - 10M (°C)	Mean Wind Speed - 10M (m/s)	Mean Wind Direction (°)	Sigma Theta - 10M (°)	24Hr Rainfall (mm)
5/11/2020	67.9	18.3	18.5	0.8	169	34.037	11.2
6/11/2020	61.1	17.1	17.1	2	128	31.284	1.4
7/11/2020	69.1	17	16.9	2.9	102	17.776	0
8/11/2020	63.6	17.2	17	4.1	102	19.244	0
9/11/2020	62	17.1	17	3.1	105	19.217	0
10/11/2020	65.5	17.8	17.6	1.9	107	24.817	0
11/11/2020	62.4	21.5	21.3	0.2	44	35.226	0
12/11/2020	56.2	24.2	24.3	1.4	291	17.143	0.2
13/11/2020	74	21.1	21.1	1.4	266	32.819	7.6
14/11/2020	58.2	22.3	22.1	2.6	243	28.16	0.2
15/11/2020	59.5	24.1	24	0.2	32	32.15	0
16/11/2020	54	27.3	27.3	1.6	276	27.013	2.2
17/11/2020	64.3	22.2	22	4	99	25.997	0
18/11/2020	64	20.7	20.5	4.5	109	19.667	0
19/11/2020	53.5	26.3	26	0	-99	31.633	0
20/11/2020	56.3	26.8	26.6	0.4	326	28.582	0
21/11/2020	64.4	23.3	23	3.6	109	22.941	0
22/11/2020	71.4	23.5	23.5	0.3	169	28.883	0
23/11/2020	63.4	24.3	24.4	2.8	251	26.355	0
24/11/2020	65.7	21.2	21	3.4	100	24.883	0
25/11/2020	62.7	21.8	21.4	3.3	108	23.545	0
26/11/2020	53.3	25.5	25.3	0.3	218	28.572	0
27/11/2020	62.5	25.5	25.2	2.7	109	28.769	0
28/11/2020	44.3	31.1	31	3	281	21.085	0

Date/Time Sampled	Mean Relative Humidity (%)	Mean Air Temperature - 2M (°C)	Mean Air Temperature - 10M (°C)	Mean Wind Speed - 10M (m/s)	Mean Wind Direction (°)	Sigma Theta - 10M (°)	24Hr Rainfall (mm)
29/11/2020	29.7	33.3	33.2	3.3	250	29.785	0
30/11/2020	65.7	20.8	20.6	5.2	100	16.501	0
1/12/2020	59.5	27.3	27	0.6	116	43.971	5.8
2/12/2020	83.9	21.8	21.8	3.9	102	23.523	0.2
3/12/2020	79.9	20.8	20.6	3.4	116	18.739	0
4/12/2020	56.6	26.7	26.5	1.6	214	27.293	0
5/12/2020	67.4	22.8	22.7	1.1	144	28.826	14.8
6/12/2020	50.6	26	25.9	5.9	249	27.131	0.8
7/12/2020	32.6	24.7	24.6	3.5	249	35.028	0
8/12/2020	38.2	20.7	20.5	1.7	212	37.792	0
9/12/2020	51.6	20.8	20.6	1.5	109	33.595	0
10/12/2020	59.9	21.9	21.7	2.4	116	31.155	0
11/12/2020	69.6	17.9	17.9	4.3	113	14.436	0.4
12/12/2020	60.4	19.1	18.9	4.9	103	17.168	0
13/12/2020	70.8	20	19.8	4.5	110	20.889	0.2
14/12/2020	78.2	20.4	20.3	4.7	108	16.661	0.6
15/12/2020	97.6	21.2	21.2	4.5	119	14.425	17.4
16/12/2020	82.9	25.2	25	1.4	95	32.393	4.2
17/12/2020	76.3	25.9	25.8	1.1	260	28.796	0.6
18/12/2020	80.4	24.3	24.4	1.3	262	29.017	9.6
19/12/2020	90.8	20.3	20.2	3.9	110	15.516	1.4
20/12/2020	91.7	19.9	19.9	2.1	122	20.641	0.8
21/12/2020	97.2	19.5	19.5	1.5	149	15.205	28.4
22/12/2020	67.5	22.4	22.4	4.7	258	21.689	7

Date/Time Sampled	Mean Relative Humidity (%)	Mean Air Temperature - 2M (°C)	Mean Air Temperature - 10M (°C)	Mean Wind Speed - 10M (m/s)	Mean Wind Direction (°)	Sigma Theta - 10M (°)	24Hr Rainfall (mm)
23/12/2020	50.6	21.3	21	0.8	99	30.294	0
24/12/2020	64.3	22.4	22.3	0.3	143	34.296	0
25/12/2020	70	21.7	21.7	4	112	20.802	0
26/12/2020	70.6	22.2	22	3	111	23.322	0
27/12/2020	67	25.1	24.9	2.2	275	16.416	1
28/12/2020	63.1	25.3	25.3	2.2	278	32.81	25.4
29/12/2020	91.9	19.7	19.7	2.4	115	22.639	2.2
30/12/2020	84.8	20.8	20.6	4	123	14.676	1
31/12/2020	95.6	19.8	19.8	3.8	132	9.9	3

Appendix G - Surface Water and Groundwater Management and Monitoring Report (Umwelt, 2021)

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GLENCORE

2020 SURFACE WATER AND GROUNDWATER MANAGEMENT AND MONITORING REPORT

Ravensworth Complex

FINAL

March 2021

GLENCORE

2020 SURFACE WATER AND GROUNDWATER MANAGEMENT AND MONITORING REPORT

Ravensworth Complex

FINAL

Prepared by
Umwelt (Australia) Pty Limited
on behalf of
Ravensworth Complex

Project Director:	Chris Bonomini
Project Manager:	Chris Bonomini
Report No.	21200/R01
Date:	March 2021

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Rev No.	Reviewer		Approved for Issue	
	Name	Date	Name	Date
1	Chris Bonomini	10/3/21	Chris Bonomini	10/3/21
2	Chris Bonomini	29/3/21	Chris Bonomini	29/3/21

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1.0 Surface Water and Groundwater Management and Monitoring

1.1 Background

In February 2011, Development Approval 09_0176 was granted for Ravensworth Complex (RC) allowing for the integration of operational aspects of mining in the area and a consistent and integrated approach to environmental management and mine planning. The approval consolidated previous project approvals for the Narama Mine, the former Ravensworth West Mine, Cumnock Open Cut, Ravensworth Underground Mine (RUM) surface facilities, Ravensworth Coal Handling and Processing Plant (RCHPP) and Ravensworth North Mine. As part of this process a number of existing development consents and Environment Protection Licences (EPL) were consolidated and surrendered in 2012 and early 2013, as per the requirements of Development Approval (DA) 09_0176. During the latter part of 2014 RUM went into care and maintenance.

Modifications were made to DA 09_0176 in August 2013 (MOD1) allowing the recovery of coal from the previously disturbed area within the RC water management system known as Narama West. EPL 2652 was modified in 2013 in accordance with the project approval and at the same time a trial for the beneficial reuse at RC of up to 500 ML of water from the Bayswater Power Station Void 4 was approved. In December 2014 (MOD2) DA 09_0176 was modified to provide for a revised design of the out of pit overburden emplacement area. In February 2016 (MOD3), DA 09_0176 was further modified to allow for the construction of a tailings pipeline between RC, Liddell Colliery and the Mount Owen Complex as well as the interim use of the Narama Void as central water storage for the Greater Ravensworth Area.

This 2020 Surface Water and Groundwater Management and Monitoring Report has been prepared in accordance with the requirements of the development consents and licences. The scope of this report includes the management of surface water and groundwater in relation to the operations of RC, but excludes stream health and stability monitoring, which is reported separately.

This report covers the period from 1 January to 31 December 2020.

1.2 Water Management

Water management for RC is detailed in the Ravensworth Complex Water Management Plan (WMP) (Ravensworth Open Cut, 2020). The WMP has been developed in order to satisfy the conditions of development consents and water access licenses (WALs) for the operations managed by RC. The WMP:

- details the water management strategies required by the development consent conditions in order to manage the quality and quantity of water on site and report on water quality in the area surrounding the mine; and
- outlines the management commitments and monitoring programs in place to address the specific requirements of the development consents relating to surface water and groundwater at the RC.

Monitoring programs have been developed as a part of WMP to enable RC to measure and assess changes to the surface water and groundwater regimes that could be attributed to the mining activities at the RC.

2.0 Surface Water Monitoring Program

The surface water monitoring program includes observation of the following elements of the RC water management system (WMS) and surrounding creeks:

- surface water quality;
- on-site water management; and
- discharge to the Hunter River via Bowmans Creek under the Hunter River Salinity Trading Scheme (HRSTS).

Details of the surface water monitoring locations for watercourses are provided in **Appendix 1**. Monitoring locations are shown on **Figure A1.1** in **Appendix 1**. Additional monitoring as detailed in the WMP (Ravensworth Open Cut, 2020) includes:

- daily rainfall, as recorded from a site weather station;
- daily water level monitoring of the main water storage dams;
- water level monitoring of other dams (to be conducted pre, during and post rainfall events of greater than 20 millimetres (mm) in 24 hours);
- monthly volume of water imported onto the site from offsite in accordance with the relevant WAL requirements;
- monthly monitoring of dams from which off-site discharge can occur, for the following water quality parameters:
  - pH
  - electrical conductivity (EC) (µS/cm)
  - total dissolved solids (TDS) (mg/L)
  - total suspended solids (TSS) (mg/L)
- six monthly speciation monitoring of the Narama In-pit Storage Dam for metals, nutrients and hydrocarbons;
- for dams in sensitive areas, other parameters also tested including:
  - BOD
  - oil and grease
  - phosphorus
- regular inspections of all sediment and erosion control structures, where possible during and after storm events (i.e. rainfall events of greater than 20 mm in 24 hours); and
- if hydrocarbon contamination of a dam or waterway is suspected (i.e. visible sheen), hydrocarbon monitoring will be undertaken. If contamination is detected, suitable remediation actions will be undertaken.

Impact assessment criteria (IAC), also referred to as 'trigger values', for pH, EC, TSS and TDS have been determined for specific receiving water monitoring locations as part of the WMP (Ravensworth Open Cut, 2020). All surface water quality data collected as part of the monitoring program are assessed against the IAC in order to identify deviations from the baseline water quality conditions. Surface water quality IAC are presented in **Appendix 1** (**Table A1.2**).

3.0 Groundwater Monitoring Program

The groundwater monitoring program includes assessment of the following elements of the alluvial and hard rock/coal measure aquifers underlying RC:

- groundwater quality;
- groundwater levels and aquifer depressurisation; and
- impacts on groundwater dependent ecosystems and riparian vegetation.

Further details on the groundwater monitoring program are included in the WMP (Ravensworth Open Cut, 2020).

Data from the monitoring program is also used to estimate the groundwater seepage into former underground workings and open cut voids.

Details of the groundwater monitoring locations are provided in **Appendix 2** (**Figure A2.1**). Groundwater water quality monitoring includes:

- pH and EC;
- various trace elements (i.e. speciation);
- water levels in up to eight aquifers;
- the volume of water extracted from the Cumnock Underground Storage; and
- the volume of water extracted from the open cut pits.

During the 2020 monitoring period, the groundwater monitoring program included monthly monitoring of water levels, quarterly monitoring of pH and EC, and annual monitoring of inorganic species (speciation data).

3.1 Groundwater Impact Assessment Criteria

All monitoring data collected as part of this program is assessed against established IAC in order to:

- determine whether groundwater extraction volumes are within WAL limits and are comparable with modelled predictions;
- identify deviations from the baseline water quality conditions; and
- identify deviations from the baseline groundwater level trends.

3.1.1 Groundwater Quality

3.1.1.1 pH and EC

Site-specific IAC values for pH and EC have been determined for each monitoring location as part of the WMP (Ravensworth Open Cut, 2020). These values are presented in **Appendix 2** (**Table A2.1** and **Figure A2.1**).

3.1.1.2 Speciation Data

Where site-specific values are not defined at any location, interim and site specific (sodium and chloride) water quality IAC are based on the ANZECC (2000) guidelines as per WMP (Ravensworth, 2017), using values from "Table 5.2.3 - Summary of water quality guidelines for recreational purposes". The interim and site specific IAC values for speciation data are presented in **Appendix 2** (**Table A2.2**).

4.0 Surface Water Monitoring Results

4.1 Surface Water Quality

Water quality sampling is undertaken once per month at upstream and downstream locations along Bowmans Creek, Bayswater Creek and Emu Creek and every two months in Davis Creek and Pikes Creek. During 2020, samples taken during 'flow' or 'no flow' conditions were documented on the field sheets. While water samples were collected from pooled water in watercourses during no-flow periods, the water quality results from these are not considered to be representative of typical receiving water quality. This understanding aligns with the statement in the WMP (Ravensworth Open Cut, 2020) which acknowledges that the method to determine IAC "does not allow for water quality variability caused by climatic conditions and the ephemeral nature of the creek systems present at the sites that form the Ravensworth Complex."

Water quality results (pH, EC, TDS and TSS) for the sampling program, with analysis (minimum, maximum and average) and time-series charts are presented in **Tables A3.1 to A3.6** and **Charts A3.1** to **A3.48** in **Appendix 3**. The mean and standard deviation values shown on **Charts A3.1** to **A3.48** are based on historical monitoring data from 2007 to 2018 which is the same data that the groundwater pH and EC IAC values presented in **Table A1.2** were based on.

Bowmans Creek

Due to dry conditions in early to mid 2020, only seven monthly samples could be collected from the upstream location for Bowmans Creek (EPL3) and nine monthly samples collected at the downstream monitoring location for Bowmans Creek (EPL4).

Five of seven upstream pH results and five of the pH nine results were below the IAC range of 7.7 to 8.1 during 2020. While seven of the ten low pH results may be considered as unrepresentative of typical water quality due to samples being taken from pooled water, three downstream low pH results (7.6 in August, 7.6 in November and 7.1 in December) were recorded for flowing water (moderate flow in August and November and slow flow in December). However, it is noted that all pH results were within the default ANZECC trigger value range for lowland river systems of 6.5 to 8.5.

One of seven upstream TSS result (26 mg/L) and one of nine downstream TSS result (38 mg/L) were above the IAC concentration of 18 mg/L. However, both results were well below the historically recorded (between January 2007 and December 2018) maximum value of 176 mg/L.

One of seven upstream EC results and two of seven upstream TDS results were above the IAC criteria of 1,331 µS/cm for EC and 817 mg/L for TDS during 2020. Seven of nine downstream EC and TDS results were above the IAC criteria of 1,331 µS/cm for EC and 817 mg/L for TDS during 2020. All but one of the EC results may be considered as unrepresentative of typical water quality due to samples being taken from pooled water. The downstream water sample that exceeded the IAC was collected from slow flowing water and had an EC of 1,440 µS/cm which is within the historically recorded range and default ANZECC trigger value range for lowland river systems of to 125 to 2,200 µS/cm.

Bayswater Creek

Only one water quality sample could be collected from the Bayswater Creek upstream of ROC location (W114) in 2020 due to the absence of water at the monitoring location. EC, TSS and TDS results for this one round of monitoring were all within IAC limits. The pH result of 6.9 was below the IAC lower value of 7.7 and the historically recorded (between January 2007 and December 2018) minimum pH of 7.1. The sample was collected from pooled water may be considered as unrepresentative of typical water quality. It is noted that the result is within the default ANZECC trigger value range for lowland river systems of 6.5 to 8.5.

Ten water quality samples were collected from the Bayswater Creek downstream of ROC location (W115) in 2020 with all EC, TSS and TDS results for this one round of monitoring within IAC limits. Two consecutive pH results for the Bayswater Creek downstream of ROC location (W115) were outside of the IAC range with one result below the lower value of 7.7 and one result above the upper value 8.5. Both pH results were within the historically recorded (between January 2007 and December 2018) pH range for Bayswater Creek of 7.1 to 9.4. The water samples for both pH IAC exceedances were collected from pooled water may be considered as unrepresentative of typical water quality.

12 water quality samples were collected from Bayswater Creek upstream of RUM location in 2020. During the monitoring period one pH result (7.6) was slightly below the IAC range lower value of 7.7 but within the historically recorded (between January 2007 and December 2018) pH range for Bayswater Creek of 7.1 to 9.4.

Two of the 12 EC and TDS results recorded at the Bayswater Creek upstream of RUM location were above the IAC values of 4,882 µS/cm for EC and 3,216 mg/L for TDS. However, the EC and TDS results were below the historically recorded (between January 2007 and December 2018) values of 13,320 µS/cm for EC and 8,850 for TDS.

Eight water quality samples were collected from Bayswater Creek downstream of RUM location in 2020. Five of the eight pH results were recorded marginally below the IAC range lower value of 7.7. However, all pH results were within the historically recorded (between January 2007 and December 2018) pH range for Bayswater Creek of 7.1 to 9.4.

Four of the eight TSS results recorded for the Bayswater Creek downstream of RUM location were above the IAC value of 23.2 mg/L with a maximum result of 479 mg/L in June above the historically recorded (between January 2007 and December 2018) maximum of 400 mg/L. Field sheets indicate that the 2020 water sample with the maximum TSS result in 2020 (i.e. 479 mg/L) was from a pool during no flow conditions as were the samples with the second highest and fourth highest TSS results (203 mg/L and 36 mg/L respectively). These three exceedances may be considered as unrepresentative of typical water quality due to samples being taken from pooled water. The water sample with the third highest TSS result in 2020 of 92 mg/L was recorded for a sample collected during low flow conditions was collected during slow flow conditions.

All eight EC and TDS results recorded for the Bayswater Creek downstream of RUM location were below the respective IAC values. Seven of the eight water samples were collected from pooled water and may be considered as unrepresentative of typical water quality.

Emu Creek

Six water quality samples were collected at the Emu Creek downstream monitoring location in 2020, with all results for pH, TSS, EC and TDS falling within the IAC values.

Davis Creek

Two water quality samples were collected at the Davis Creek upstream monitoring location in 2020. Both pH results were recorded below the IAC lower value of 7.5, however, the pH was within the historically recorded (between January 2007 and December 2018) pH range of 6.6 to 9.0. Water samples for these results were collected from pooled water and may be considered as unrepresentative of typical water quality. One TSS result (39 mg/L) was recorded above the IAC value of 31 mg/L, however, this TSS result was well below the historically recorded (between January 2007 and December 2018) maximum of 351 mg/L. Both EC and TDS results were below the respective IAC values.

No water quality samples could be collected from the Davis downstream (W164) monitoring location in 2020 due to the absence of water.

Pikes Creek

Four water quality samples were collected from the Pikes Creek upstream monitoring location (W135). All pH results were recorded below the IAC lower value of 7.8, however, the pH was within the historically recorded (between January 2007 and December 2018) pH range of 6.9 to 8.8. Water samples corresponding to the results with IAC pH exceedances were collected from pooled water may be considered as unrepresentative of typical water quality. Two of the four TSS results were above the IAC value of 32, however, both results were below the historically recorded (between January 2007 and December 2018) maximum of 417 mg/L. All four EC and TDS results were below the respective IAC values.

One water quality sample was collected from the New England Highway (W136) downstream monitoring location, with all results falling within the IAC values except for pH (7.1) which was below the lower IAC value of 7.8. However, it is noted that all pH results for Pikes Creek were within the default ANZECC trigger value range for lowland river systems of 6.5 to 8.5.

No water quality samples were collected at the downstream monitoring location CHPP Culvert (W137) due to absence of water.

4.2 Water Sources and Demands

The RC water management system (WMS) comprises a range of infrastructure including water storages, pipes and pumps for water transfers (within the mine complex and between external water sources and sinks) and instrumentation for flow and level measurement. This WMS infrastructure is monitored and controlled via the RC Citect supervisory control and data acquisition (SCADA) systems (separate systems are used by Ravensworth Open Cut (ROC) and RCHPP/RUM). The Citect SCADA system incorporates a graphical user interface (GUI) that displays the status of WMS infrastructure (e.g. dam levels, pump on/off, flow rates, etc.) and operator access to operate equipment and adjust WMS infrastructure set points. Operational WMS data collected by the Citect SCADA system is utilised in site water accounting models to monitor RC water sources and demands.

Water sources for the RC are listed below:

- rainfall/runoff within the ROC and RCHPP WMS;
- groundwater seepage into operating open cut pits, voids and underground mine pits (and spoils seepage to Narama Pit;
- moisture in ROM coal;
- groundwater extracted from the former Cumnock underground workings;
- water imported from the Mount Owen Complex or Liddell Mine under the Greater Ravensworth Area Water and Tailings Scheme (GRAWTS);
- fresh water pumped from the Hunter River; and
- potable water trucked to site.

Water demands for the ROC are listed below:

- evaporative losses from water storages;
- dust suppression (haul roads, stockpiles and handling) and vehicle wash bay losses;
- RCHPP losses: moisture bound with product coal and rejects (coarse and fine);

- discharges under the Hunter River Salinity Trading Scheme (HRSTS); and
- transfers to the Mount Owen Complex or Liddell Mine under the Greater Ravensworth Area Water and Tailings Scheme (GRAWTS).

Table 4.1 presents site water import and usage data for the 2020 year. Site measured rainfall for 2020 was 849 mm which is just under the 90th percentile rainfall for at the Jerry's Plains Bureau of Meteorology station (station #61086) of 904 mm. The overall water balance for RC in 2020 was a surplus of approximately 1,124 ML (3.07 ML/day) which was well above the predicted deficit of approximately -750 ML (-2.05 ML/day) for the Ravensworth Operations Project (ROP) water balance (Umwelt, 2010) in a 90th percentile rainfall year in 2020. At the time the ROP water balance was prepared, the current GRAWTS scheme was not anticipated and therefore not incorporated into the water balance model calculations. Water imports from other mining operations under the GRAWTS are significant (as can be seen in **Table 4.1**) and are likely to account for a significant portion of the discrepancy between the ROP water balance predictions and the observed 2020 site water balance.

Table 4.1 Ravensworth Complex Water Imports - Usage and Exports, 2020 (ML)

Month	Fresh Water Import	Import from GRAWTS	Potable Water Import	Dust Suppression and Wash-bays	Export to GRAWTS	HRSTS Discharge
Jan	6.7	244.6	1.2	88.8	0.0	0.0
Feb	8.3	187.4	1.3	70.2	0.0	0.0
Mar	8.8	346.0	1.4	52.6	0.0	0.0
Apr	69.2	358.7	4.7	104.2	0.0	0.0
May	106.3	353.3	2.8	102.4	0.0	0.0
Jun	72.8	439.3	0.6	41.6	0.0	0.0
Jul	50.8	521.6	2.2	35.8	0.0	0.0
Aug	66.0	489.2	1.1	49.6	0.0	0.0
Sep	5.3	252.8	1.9	60.7	0.0	0.0
Oct	6.3	313.6	1.3	68.8	0.0	0.0
Nov	7.1	580.9	0.5	55.7	0.0	0.0
Dec	6.2	506.3	0.5	61.7	0.0	0.0
Total	**413.8**	**4593.6**	**19.6**	**792.0**	**0.0**	**0.0**

4.3 Surface Water Discharge

Surplus surface water at ROC is transferred to RCHPP or discharged from the Narama In-pit Storage Dam to the Hunter River via Bowmans Creek under the conditions of Ravensworth Operations EPL No. 2652 and the Hunter River Salinity Trading Scheme (HRSTS) or transferred to other Glencore mine sites under the GRAWTS.

EPL No. 2652 permits a maximum discharge of 400 ML/day from the Narama In-pit Storage Dam under the HRSTS Regulations. On 1st July 2018, ROC reduced its holding of salt credits from 175 to 150. This holding was sufficient for ROC to operate under the conditions of the HRSTS and EPL No. 2652 in 2020.

In 2020, ROC did not discharge any water from the Narama In-pit Storage Dam under the conditions of the HRSTS and EPL 2652. Furthermore, no unregulated discharges from RC occurred during 2020.

4.4 Surface Water Extraction

RC holds water access licences WAL 9050, WAL 10771 and WAL 18317 that allow RC to extract water from the Hunter River and Bayswater Creek. In addition, RCHPP holds water access licences WAL 1046, WAL 8964, and WAL 1325 allowing RC to extract water from the Hunter River.

In 2020, six (6) water allocation assignments totalling 860.4 ML with entitlement transferred from WAL 8964 to the Mangoola Open Cut mine (271.4 ML) and Singleton Shire Council (589 ML) occurred. **Table 4.2** presents the surface water extraction for each RC WAL for the 2020 calendar year.

Table 4.2 Surface water extractions (01 January 2020 to 31 December 2020)

Licence Number	Water Source/Management Zone	Category	Entitlement (ML)	Extracted Volume (ML)
WAL 18317 (20AL21098)	Hunter Unregulated and Alluvial Water Source/Jerrys Water Source/Jerrys Management Zone (extraction from Bayswater Creek)	General Security	20	0
WAL 9050 (20AL200462)	Hunter River Regulated/Zone 1b (Hunter River from Goulburn River Junction to Glennies Creek Junction)	General Security	500	414
WAL 10771 (20AL200744)	Hunter River Regulated/Zone 1b (Hunter River from Goulburn River Junction to Glennies Creek Junction)	High Security	25	0
WAL 8964 (20AL203224)	Hunter River Regulated/Zone 1b (Hunter River from Goulburn River Junction to Glennies Creek Junction)	General Security	729.6[A]	0
WAL 1046 (20AL201444)	Hunter River Regulated/Zone 1b (Hunter River from Goulburn River Junction to Glennies Creek Junction)	High Security	3	0
WAL 1325 (20AL203042)	Hunter River Regulated/Zone 1b (Hunter River from Goulburn River Junction to Glennies Creek Junction)	Supplementary	13	0

NOTE [A] General security entitlement is 1,590 ML less 860.4 ML transferred to Mangoola Open Cut and Singleton Shire Council

5.0 Groundwater Monitoring Results

5.1 Groundwater Quality

Groundwater quality data for pH, EC and trace elements (speciation) are provided in **Appendix 5**.

A summary of the pH and EC results for each monitoring location is presented in **Appendix 4** (**Table A4.1**), with individual results presented in **Appendix 4** (**Table A4.2** to **A4.4**).

Historical pH and EC results for all current and decommissioned monitoring bores are presented in **Charts A4.1** to **A4.6**. Historical pH and EC results for current monitoring bores are presented in **Charts A4.7** to **A4.32** with the mean and standard deviation for each bore shown on each chart. The mean and standard deviation values shown on these charts are based on historical monitoring data from 2008 to 2018 which is the same data that the groundwater pH and EC IAC values presented in **Table A2.1** were based on.

Historically, elevated concentrations of sodium, chloride, sulphate and manganese relative to ANZECC Guidelines (as shown in **Appendix 2**, **Table A2.2**) have been recorded at numerous monitoring sites. As a result, closer attention is given to these parameters, as in previous annual water reports (Umwelt 2017, Umwelt 2018, Umwelt 2019 and Umwelt 2020).

5.1.1 Overview of Groundwater Quality Results

Alluvium and Underlying Weathered Coal Measures

Quarterly monitoring of groundwater from the alluvium has been undertaken since 2009 at the monitoring location NPZ5B P2 and near Bayswater Creek upstream of the confluence with Emu Creek. Note that NPZ5B P2 was blocked from January 2014 to November 2019 and no water quality data could be collected during this period.

It is noted that NPZ7 Small, located near the Hunter River, is listed as a monitoring bore for the Hunter River alluvium in the site WMP (Ravensworth Operations, 2020), however, an investigation of groundwater trigger exceedances undertaken by Umwelt in 2021 has confirmed that the bore is monitoring weathered Permian coal measures underlying the Hunter River alluvium. This corresponds with the water quality results for the bore that are more saline than what would be expected for the Hunter River alluvium.

The ranges in water quality for NPZ7 Small and NPZ5B P2 is shown in **Appendix 4** (**Tables A4.2** to **A4.4**).

pH results for NPZ7 Small show that pH was consistent with historical data and ranged from pH 7.2 to 7.4, with the lower result of 7.2 in April 2020 just below the adopted IAC pH range of 7.3 to 7.5. All NPZ7 Small EC results were above the IAC of 5,259 µS/cm for NPZ7 Small, ranging from 6,070 µS/cm to 6,940 µS/cm. Despite all 2020 values exceeding the IAC for EC, the mean value of 6,530 µS/cm for 2020 is below the mean EC for 2013, 2014, 2016, 2017 and 2018 and is just above the 2019 mean of 6,480 µS/cm. The results are also within the standard deviation of the historical data set which includes EC results in excess of 8,000 µS/cm. The elevated EC results are therefore considered to be consistent with historical data and the target aquifer in which the bore is screened (i.e. weathered Permian coal measures underlying the Hunter River alluvium).

Analysis of speciation results at NPZ7 (Small) monitoring bore showed consistent or reduced concentrations of sodium and chloride relative to 2018 results:

- both sodium results were below the recently adopted sodium IAC range and the maximum result of 1200 mg/L was up marginally from a maximum of 1,100 mg/L in 2019; and
- both chloride results were below the recently adopted chloride IAC range and the maximum chloride result of 1,597 mg/L was down from a maximum of 1,784 mg/L in 2019.

All other speciation results for NPZ7 (Small) were below interim IAC values.

Ten of twelve pH results for NPZ5B P2 (Bayswater Creek alluvium) were up to 0.3 pH points below the IAC lower value of 7.1 during 2020. An investigation of the trigger exceedances (Umwelt 2021) indicates that the exceedances are minor, consistent with historical trends and recommends the trigger value for EC be reviewed.

Water quality results for NPZ5B P2 (Bayswater Creek alluvium) exhibit lower salinity levels than the Hunter River alluvium (NPZ7 (Small)) but elevated levels of manganese above the interim IAC value of 100 μg/L. In particular, the April 2020 manganese concentration of 1,400 μg/L which was 14 times the interim IAC value but below the Australian and New Zealand Fresh and Marine Water Quality (Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia ,2018) (ANZG) freshwater 95% species protection default guideline value of 1,900 μg/L. While the October 2020 manganese result of 472 μg/L was much lower it was still above the interim IAC which is below the ANZG freshwater 99% species protection default guideline value of 1,200 μg/L. It is possible that the elevated manganese results are a consequence of the dissolution of manganese bearing alluvial sediments that were wetted following an extended dray period prior to increased rainfall from early 2020. The April 2020 chloride result (426 mg/L) for NPZB5 P2 marginally above the interim IAC value of 400 mg/L, however, the October result was below the interim IAC value. The elevated April chloride result may also be indicative of chloride dissolution associated with increased rainfall following an extended dry period.

Bayswater Seam

Since 2008 monitoring of groundwater quality in the Bayswater Seam has been undertaken at two locations, NPZ3 Mid and NPZ4 Mid. Both monitoring bores have now been decommissioned due to mining activities. In 2010 an additional monitoring location was included at NPZ7 Tall, which is currently the only monitoring bore used for quarterly sampling of groundwater from the Bayswater Seam. Water quality results for NPZ7 Tall monitoring bore are shown in **Appendix 4** (**Tables A4.2** to **A4.4**).

pH results for the monitoring bore were relatively consistent, with a mean of pH 7.4, within the adopted IAC range of pH 7.4 to 7.5. EC results ranged between 6,380 μS/cm and 6,900 μS/cm and were below the IAC of 8,678 μS/cm for NPZ7 Tall. EC results for 2020 were consistent with historical results measured at the bore, which have demonstrated a downward trend in EC since 2012 before stabilising at around 6,650 μS/cm in 2019 and 2020.

Analysis of speciation results at NPZ7 Tall monitoring bore showed:

- both sodium results were below the recently adopted sodium IAC range and the maximum result of 1200 mg/L was equal to the maximum of 1,200 mg/L in 2019;
- both chloride results were below the recently adopted chloride IAC range and the maximum chloride result of 1,724 mg/L was down marginally from a maximum of 1,880 mg/L in 2019; and

- the April 2020 result for Selenium of 35 μg/L was above the interim IAC value of 10, however, the October 2020 result was 2 μg/L which is below both the interim IAC value and the ANZG freshwater 99% species protection default guideline value of 4 μg/L.

Broonies Seam

Monitoring of groundwater quality in the Broonies Seam has been undertaken since 2008 at NPZ6 (Tall) and since 2009 at NPZ5B P1. In the past, two other monitoring locations have been used to sample groundwater within Broonies Seam, namely CS4545B Small used from 2009 to 2016 (decommissioned as a result of the progression of the North pit to the south) and NPZ7 Mid which was used from 2010 to 2012. NPZ6 Tall was blocked from May 2017 to November 2019 and sampling was not possible in this period. Water quality results for NPZ5B P1 and NPZ6 Tall are presented in **Appendix 4** (**Tables A4.2** to **A4.4**).

One of twelve pH results was recorded below the IAC lower value of 7.2 at NPZ5B P1 during 2020, while all EC results were below the IAC value of 6,340 μS/cm. Analysis of the speciation results for NPZ5B P1 showed:

- the April sodium result of 955 mg/L was marginally above the recently adopted IAC of upper value of 939 mg/L but was down from a maximum of 1010 mg/L in 2019;
- both chloride results were within the recently adopted IAC range of 830 to 1020 mg/L;
- both sulphate results above the interim IAC of 400 mg/L, however, the maximum sulphate concentration of 437 mg/L is consistent with historical results dating back to 2015; and
- both Manganese results were above the interim IAC of 100 μg/L, however, these results (a maximum of 527 μg/L) were below the ANZG freshwater 99% species protection default guideline value of 1,200 μg/L. The Manganese concentrations recorded in 2020 are consistent with historical results dating back to 2015.

Nine of twelve pH results for NPZ6 Tall were up to 0.2 pH points above the IAC lower value of 7.7 and seven of twelve EC results were up to 500 μS/cm above the EC IAC value of 7,120 μS/cm during 2020. An investigation of the trigger exceedances (Umwelt 2021) indicates that the pH has been typically above the IAC since 2014 and recommends that the bore be cleared of any sediment that may be impacting water quality results.

All NPZ6 Tall sodium (up to 1,620 mg/L) and chloride (up to 1,660 mg/L) results were above the interim IAC of 400 mg/L for both sodium and chloride. However, these results are considered typical of groundwater extracted from a coal seam and the IAC for sodium and chloride which are based on ANZECC 2000 guidelines for recreational water use are not considered applicable. All other speciation results for NPZ6 Tall were below interim IAC values.

Lemington Seam

Monitoring of groundwater quality in the Lemington Seam has been undertaken since 2005 at four monitoring locations, NPZ1 Tall, NPZ2 Tall, NPZ3 Tall, NPZ4 Tall and since 2009 at CS4545B Mid. Sites NPZ3 Tall and NPZ4 Tall were decommissioned in April 2010 and CS4545B Mid in April 2014 due to the progression of mining operations. The ranges in water quality for each monitoring bore are shown in **Appendix 4** (**Tables A4.2** to **A4.4**).

Two of four pH results were recorded at 7.4, marginally above the adopted IAC pH range of 7.0 to 7.3 for NPZ1 Tall and two of four pH results for NPZ2 Tall were recorded at 8.2, marginally below the IAC pH range of 8.3 to 8.4.

EC results at NPZ1 Tall were below the adopted IAC of 9,736 µS/cm. All four of the quarterly EC results at were above the adopted IAC of 9,765 µS/cm, with a maximum result of 10,270 µS/cm recorded in October. The pH and EC results for both monitoring locations were generally consistent with historical data.

An investigation of the trigger exceedances (Umwelt 2021) indicates that pH has fluctuated over time with an increasing trend since 2010 (range 6.9 to 7.4). pH levels have frequently been above the trigger level since 2018 and EC has declined with water levels over a corresponding period. The groundwater investigation recommends the bore be cleared of any sediment that may be impacting water quality results.

Analysis of the speciation results for NPZ1 Tall showed:

- both sodium results were below the recently adopted IAC of lower value of 1,820 mg/L;
- both chloride results were below the recently adopted IAC range of 2,225 mg/L; and
- both manganese results were above the interim IAC of 100 µg/L, however, these results (a maximum of 160 µg/L) were below the ANZG freshwater 99% species protection default guideline value of 1,200 µg/L. The manganese concentrations recorded in 2020 are consistent with historical results dating back to 2014.

Analysis of the speciation results for NPZ2 Tall showed:

- the April sodium result was below the recently adopted IAC range of 2,100 to 2,178 mg/L while the October result was above the IAC range;
- both chloride results were within the recently adopted IAC range of 2,430 to 2,685 mg/L; and
- both barium (a maximum of 1400 µg/L) results were above the interim IAC of 1000 µg/L. The barium concentrations recorded in 2020 are consistent with historical results dating back to 2014.

Pikes Gully Seams

Monitoring of groundwater quality in the Pikes Gully Seam has been undertaken at two locations, CS4641C which lies within the Lower Pikes Gully Seam and CS4539A (S2) which lies within the Upper and Lower Pikes Gully Seams. CS4539A (S2) was decommissioned in 2019 due to the progression of the North Pit to the south. The range in water quality for CS4641C is presented in **Appendix 4** (**Tables A4.2** to **A4.4**).

All four pH results recorded at monitoring location CS4641C during 2020 were below the adopted IAC pH range of 8.8 to 11.9, with the recorded pH ranging from 7.8 to 7.9. All four EC results for CS4641C were above the adopted IAC of 8,552 µS/cm, with the maximum of 9,330 µS/cm also recorded in October.

An investigation of the trigger exceedances (Umwelt 2021) indicates that groundwater levels have declined with the dewatering of the former Cumnock underground workings which has impacted EC and pH levels since 2014 and that the 2020 results are consistent with the previous five years.

Insufficient water was available to be sampled from the bore during the speciation monitoring rounds and therefore no speciation is available at CS4641C for 2020.

Liddell Seam

Historically, monitoring of groundwater within the Liddell Seam has occurred at a range of locations, with some decommissioned as mining has progressed in the area. **Table 5.1** below shows a history of monitoring locations for the Liddell Seam. In 2020 only the Coffey Dam Borehole monitoring site remained with CS4545B (S4) P1 and CS4545B P3 being decommissioned after April 2016 as a result of the progression of North Pit to the south.

Table 5.1 History of Monitoring Locations for Liddell Seam

Sites	Dates
CS4547 (EE4)	2004 - 2008
W6C	2008 - 2009
SDH 18	2004 - 2013
CS4536 (HF7)	2004 - 2014
CS4545 (S4)	2004 - 2016
CS4545B (Tall)	2009 - 2016
Coffey Dam Borehole	2008 - 2019 (Current)

For the 2020 monitoring period, all four pH results at Coffey Dam Borehole were below the adopted IAC pH range of 9.2 to 10.0, with the lowest value of pH 7.6 measured in January. pH was observed to increase following the April monitoring round and the mean pH value for the Coffey Dam Borehole in 2020 was 8.3. Prior to 2020 (and since 2014), a downward trend in pH in the Coffey Dam Borehole had been observed, however, the mean pH of 8.3 in 2020 was 0.3 pH points above the 2019 mean of 8.0 indicating pH maybe stabilising.

All four EC results were above the adopted IAC of 3,160 µS/cm, with the highest results of 6,330 µS/cm recorded in April, however, EC results were lower in the second half of the year reducing to 5,820 µS/cm in October. This borehole has seen a trend of steadily increasing salinity since 2012, when a mean value of 2,840 µS/cm was recorded (refer to **Appendix 4**, **Chart A4.18**) which corresponds with a falling water level since 2012 (refer to **Appendix 5**, **Chart A5.1**). Analysis of speciation results for the Coffey Dam Borehole showed:

- all sodium and chloride results were above the interim IAC of 400 mg/L (for both sodium and chloride). However, these results are considered typical of groundwater extracted from a coal seam and the IAC for sodium and chloride which are based on ANZECC 2000 guidelines for recreational water use are not considered applicable;
- both sulphate results were above the interim IAC with a maximum of 850 mg/L in April and a lower result of 630 mg/L in October which may be reflective of increased surface water recharge due to higher rainfall in 2020. Sulphate concentrations have generally trended upward since April 2014 with period of consistent results of just over 400 mg/L from October 2015 and April 2017 before continuing to rise during a period of below average rainfall (i.e. 547 mm in 2017, 452 mm in 2018, 354 mm in 2019). Water levels in the Coffey Dam borehole have declined over this period which is most likely associated with dewatering of the former Cumnock Underground workings. An investigation of groundwater trigger exceedances (Umwelt 2021) indicates the change in water quality may also reflect a change in the local flow regime and water source to the Liddell Seam locally and recommends further review of surrounding land use and further analysis of water types; and
- the April manganese result of 210 µg/L was above the interim IAC of 100 µg/L, however, this result was below the ANZG freshwater 99% species protection default guideline value of 1,200 µg/L and the October result of 68 µg/L was below the interim IAC value.

Other Groundwater Monitoring Locations

Monitoring of groundwater quality in the vicinity of the former Cumnock Wash Plant Pit has been undertaken since 2010 at two locations: WPPP1 and WPPP2. The ranges in water quality within each monitoring bore are shown in **Appendix 4** (**Tables A4.2** to **A4.4**).

All pH results at the WPP1 and WPP2 monitoring locations were within the respective IAC pH ranges.

One of four WPP1 results (January) was above the IAC for EC of 8,604 µS/cm. Two of four WPP2 results (January and October) were recorded above the IAC for EC of 9,352 µS/cm. However, the ECs are considered to be consistent with the overall range of historically recorded monitoring results at WPP1 and WPP2.

Analysis of speciation results for the WPP1 and WPP2 showed:

- all sodium and chloride results were above the interim IAC of 400 mg/L (for both sodium and chloride). However, these results are considered typical of groundwater extracted from a coal affected aquifer and the IAC for sodium and chloride which are based on ANZECC 2000 guidelines for recreational water use are not considered applicable;
- all sulphate results were well above the interim IAC of 400 mg/L with concentrations ranging from 1,500 to 3,600 mg/L which is consistent with historical monitoring. Sulphate concentrations at WPP1 did, however, fall over the 2020 period which may reflect increased surface water recharge due to higher rainfall in 2020; and
- all manganese results were above the interim IAC of 100 µg/L, however, these results (including a maximum of 390 µg/L) were below the ANZG freshwater 99% species protection default guideline value of 1,200 µg/L. Since 2015, manganese concentrations at WPP2 have typically exceeded the interim IAC value while WPP1 has only recorded two exceedances. In 2020, WPP1 manganese concentrations increased as sulphate and chloride concentrations decreased suggesting the possibility of increased surface water recharge due to higher rainfall in 2020 may have mobilised manganese from overlying manganese bearing strata.

5.1.2 Groundwater Levels

In 2020, groundwater levels were measured at thirteen locations, with monitoring results shown in **Appendix 5** (**Tables A5.1** to **A5.3** and **Charts A5.1** and **A5.2**) and monitoring locations are shown on in **Appendix 2** (**Figure A2.1**).

Following a period of declining groundwater levels from early 2018, believed to be a consequence of an extended period low rainfall, recorded levels at NPZ7 Small (Hunter River Alluvium) showed an increase over the 2020 monitoring period, rising from 30.08 mAHD in February to 32.52 mAHD in December. It is considered that increased rainfall over 2020 has resulted in increased surface water recharge to the alluvial aquifer.

Recorded water levels at CS4641C (Pikes Gully seam) were relatively stable of the 2020 period following a steady decline in level since 2015, which followed the sharp decline observed from 2013 to 2015 as a result of and dewatering of the former Cumnock underground workings to allow mining in the Ravensworth North Pit. Water levels in SDH16 and Borehole P also stabilised over 2020 which is reflective of reduced Cumnock Underground dewatering rates from April 2020 onward. The rate of decline in the Coffey Dam Borehole (Liddell seam) water level slowed over 2020 which may also reflect reduced Cumnock Underground dewatering rates.

NPZ7 Tall (Bayswater seam) and NPZ1 Tall (Lemington seam) both exhibited rising water levels over the 2020 period with increases of 2.38 m and 1.74 m respectively. This may reflect an increase in surface water recharge to the aquifers as a result of higher rainfall in 2020.

NPZ6 Tall (Broonies Seam) exhibited a steady decline in water level over the 2020 period with a decrease of 1.3 m, however, NPZ5B P1 which also targets the Broonies seam was stable over 2020. The decrease in NPZ6 Tall water level may be a consequence of the progression of mining in the North Pit, however, it is unclear why a corresponding decrease in NPZ5B P2 did not accompany these results.

MW1, MW2, MW3, MW5, MW6, MW9, MW10 and MW12 all exhibited a decline in water levels with decreases ranging from -0.09 m (MW9) to -1.62 m (MW12). The cause of these decreases is likely to be a consequence of the progression of mining in the North Pit and appear to be consistent with the groundwater model predictions for the Ravensworth Project as presented in *Ravensworth Operations – Review of Groundwater Model Predictions* (Australasian Groundwater and Environmental Consultants (AGE), 2020) (refer to **Section 5.1.4**). MW4 showed a slight increase in water level (0.06 m), however, the cause for this increase was not apparent.

5.1.3 Groundwater Pressure Response

The groundwater pressure response to mining operations for the 2020 reporting period was measured at 12-hourly intervals using vibrating wire piezometers. The vibrating wire piezometers were installed in 2007 at four locations (CS4655, CS4656, CS4657 and CS4658), in 2008 at four locations (RNVW1, RNVW2, RNVW3, RNVW4), in 2009 in two locations (RVVW5, RNVW6) and in 2010 at two locations (RVVW7, RNVW8).

Piezometers CS4655, CS2656, CS4545, CS4657 and CS4539A have been decommissioned as a result of the progression of the North Pit to the south. The locations of the vibrating wire piezometers are shown in **Appendix 2** (**Figure A2.1**). Monitoring results are presented graphically in **Appendix 5** (**Charts A5.3** to **A5.11**).

Results for vibrating wire piezometer CS4658 (refer to **Appendix 5, Charts A5.3**) showed further depressurisation of groundwater at all monitored depths. Depressurisation at a depth of 239 mbgl was observed to be to a lesser degree than predicted in the Ravensworth Project groundwater model results as reported in Ravensworth Project as presented in *Ravensworth Operations – Review of Groundwater Model Predictions* (AGE, 2020)

Results for bore RNVW1 show depressurisation at depths of 48 mbgl, 68 mbgl, 150 mbgl, 190 mbgl and 240 mbgl (refer to **Appendix 5**, **Chart A5.4**) but to a lesser degree than predicted in the Ravensworth Project groundwater model results as presented in Ravensworth Project as presented in *Ravensworth Operations – Review of Groundwater Model Predictions* (AGE, 2020). Depressurisation at a depth of 109 mbgl was also observed with the degree of depressurisation exceeding that predicted by the groundwater model and this is consistent with observations in previous years. The groundwater model for the Ravensworth Project also predicted depressurisation at a depth of 326 mbgl for RNVW1, however, results over recent years indicate pressure recovery at this depth.

Results for bore RNVW2 show depressurisation at depths of 239 mbgl and 305 mbgl (refer to **Appendix 5**, **Chart 5.5**) but to a lesser degree than predicted in the Ravensworth Project groundwater model results as presented in Ravensworth Project as reported in *Ravensworth Operations – Review of Groundwater Model Predictions* (AGE, 2020). The groundwater model for the Ravensworth Project also predicted depressurisation at a depth of 140 mbgl for RNVW2, however, results over recent years indicate pressure recovery at this depth.

Results for RNVW3 (refer to **Appendix 5, Chart A5.6**) indicate depressurisation from 2015 onward at all depths. The depressurisation at depths of 103 mbgl, 180 mbgl and 254 mbgl is to a lesser degree than predicted in the Ravensworth Project groundwater model results as reported in Ravensworth Project as reported in *Ravensworth Operations – Review of Groundwater Model Predictions* (AGE, 2020).

Results for RNVW4 (refer to **Appendix 5, Chart A5.7**) show ongoing depressurisation at 102 mbgl, 114 mbgl, 163 mbgl, 201 mbgl and 225 mbgl. The depressurisation at depths of 102 mbgl and 163 mbgl is to a lesser degree than predicted in the Ravensworth Project groundwater model results as presented in Ravensworth Project as reported in *Ravensworth Operations – Review of Groundwater Model Predictions* (AGE, 2020).

Results for RNVW5 (refer to **Appendix 5, Chart A5.8**), indicate minimal or no depressurisation for the 2020 monitoring period. It is noted that the RNVW5 instrument is outputting zero readings on channels 1 (depth of 19 mbgl), 3 (depth of 87 mbgl) and 6 (depth of 279 mbgl) and therefore no observations of depressurisation at these depths can be made.

Results for RNVW6 (refer to **Appendix 5, Chart A5.9**) have previously indicated depressurisation at depths of 19 mbgl and 66 mbgl in excess of those predicted in the Ravensworth Project groundwater model results as presented in Ravensworth Project as reported in *Ravensworth Operations – Review of Groundwater Model Predictions* (AGE, 2020). However, pressures have stabilised at a depth of 19 mbgl and recovered at a depth of 66 mbgl in recent years. Depressurisation at a depth of 265 mbgl was observed to continue but to a lesser degree than predicted by the groundwater model.

Results for RNVW7 (refer to **Appendix 5, Chart A5.10**) show ongoing depressurisation at depths from 121 mbgl to 335 mbgl which is consistent with groundwater model predictions for the Ravensworth Project. It is noted that channel 1 (depth of 83 mbgl) appears to be outputting erroneous results and therefore no observations of depressurisation at this depth can be made.

Results for RNVW8 (refer to **Appendix 5, Chart A5.11**) show depressurisation at a depth of 252 mbgl but to a lesser degree than predicted in the Ravensworth Project groundwater model results as presented in Ravensworth Project as reported in *Ravensworth Operations – Review of Groundwater Model Predictions* (AGE, 2020).

5.1.4 Groundwater Model Review

Condition 6.8.4 of the RC development consent requires biennial review of the groundwater model.

A review of the model was completed in 2020 by AGE. The review concluded that the groundwater model continues to predict groundwater impacts with satisfactory accuracy, and that no further calibration of the model is required at this stage. A review of groundwater model predictions will be undertaken again in 2022.

5.1.5 Groundwater Extraction

RC holds six water licences that allow the extraction of groundwater. During the 2020 monitoring period the extraction of groundwater was undertaken in compliance with the conditions of all relevant licences as shown in **Table 5.2** below.

Table 5.2 Groundwater extractions (01 January 2020 to 31 December 2020)

Licence No.	Water Source Management Zone	Entitlement (ML)	Extracted Volume (ML)
WAL 41496 (20AL216920)	Cumnock UG Extraction	2,520	498
WAL 41531 (20AL218993)	Narama Void Incidental Groundwater Interception	150	146
WAL 41530 (20AL218992)	Ravensworth West Pit Void Incidental Groundwater Interception	100	0
WAL 41507 (20AL217068)	Ravensworth North Pit Incidental Groundwater Interception	576	9
WAL 41529 (20AL218991)	Ravensworth Underground Mine Dewatering	400	0
WAL 41505 (20AL217052)	Cumnock Wash Plant Pit	300	0
WAL 41554 (20AL219016)	South Open Cut	576	0

6.0 References

Australian Groundwater and Environmental Consultants (AGE) 2019. *Groundwater Impact Assessment - Glendell Continued Operations Project*, November 2019.

Australian Groundwater and Environmental Consultants (AGE) 2020. *Re: Ravensworth Operations - Review of Groundwater Model Predictions,* 21 February 2020. Briefing note prepared for Ravensworth Operations Pty Ltd.

ANZECC/ARMCANZ, 2000. *National Water Quality Management Strategy: Australian Guidelines for Fresh and Marine Water Quality*

ANZG 2018. *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia

Mackie Environmental Research (MER) 2009. *Groundwater Management Studies – Ravensworth Operations Project*. November 2009. Report prepared for Ravensworth Operations Pty Ltd.

Ravensworth, 2020. *Plan for Ravensworth Complex Water Management V6.0*, Ravensworth Operations Pty Ltd.

Umwelt, 2010. *Appendix 8 -Surface Water Assessment* in *Ravensworth Operations Project. Environmental Assessment*. Volume 4, Appendices 8-10. Report prepared by for Ravensworth Operations Pty Ltd.

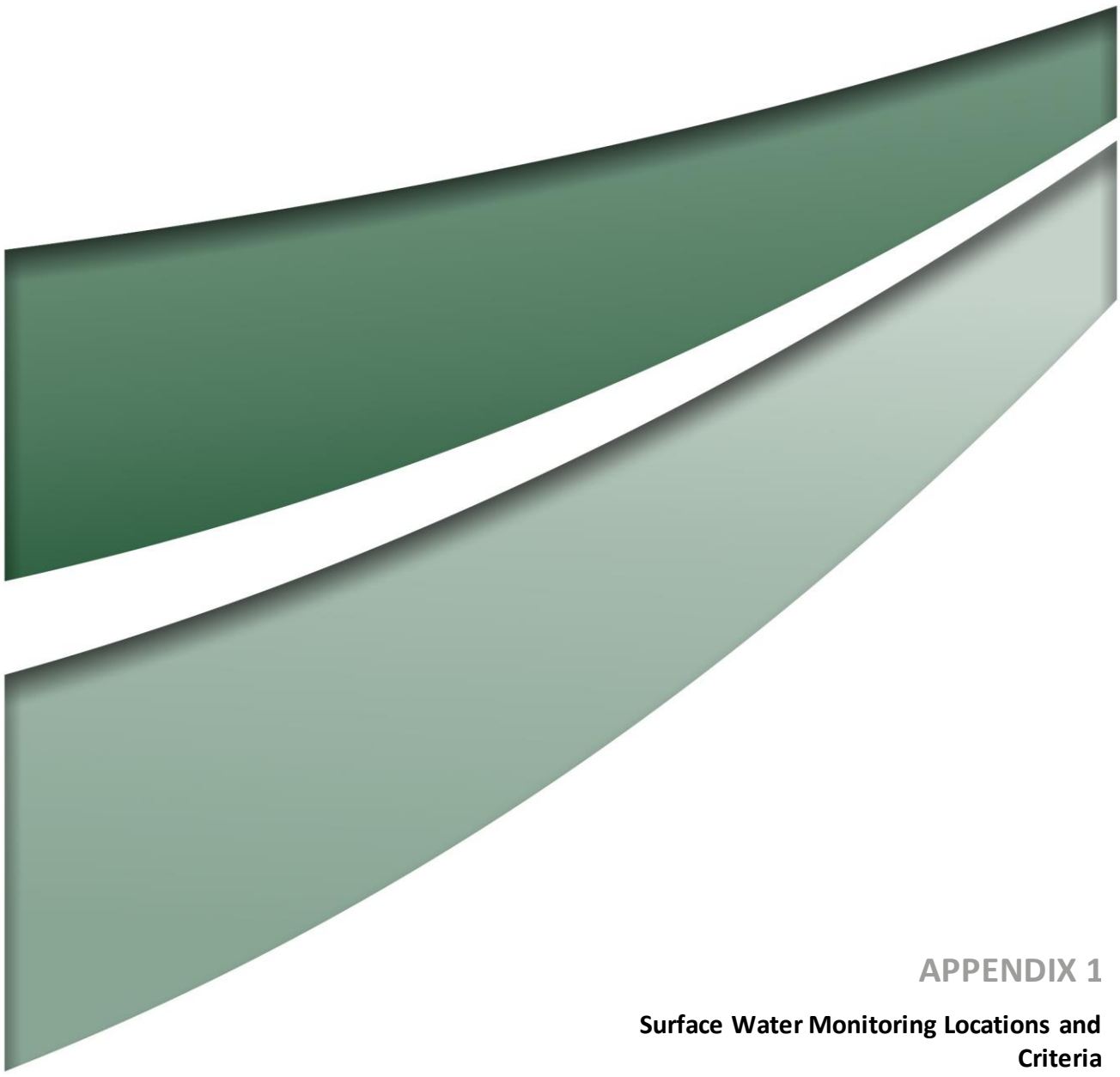
Umwelt, 2017. *2016 Surface Water and Groundwater Management and Monitoring Report - Ravensworth Complex*, March 2017. Report prepared for Ravensworth Operations Pty Ltd.

Umwelt, 2018. *2017 Surface Water and Groundwater Management and Monitoring Report - Ravensworth Complex*, February 2018. Report prepared for Ravensworth Operations Pty Ltd.

Umwelt 2019. *2018 Surface Water and Groundwater Management and Monitoring Report - Ravensworth Complex*, March 2019. Report prepared for Ravensworth Operations Pty Ltd.

Umwelt 2020. *2019 Surface Water and Groundwater Management and Monitoring Report - Ravensworth Complex*, March 2020. Report prepared for Ravensworth Operations Pty Ltd.

Umwelt 2021. *Groundwater Trigger Investigation – Ravensworth Complex,* March 2021. Report prepared for Ravensworth Operations Pty Ltd.



APPENDIX 1

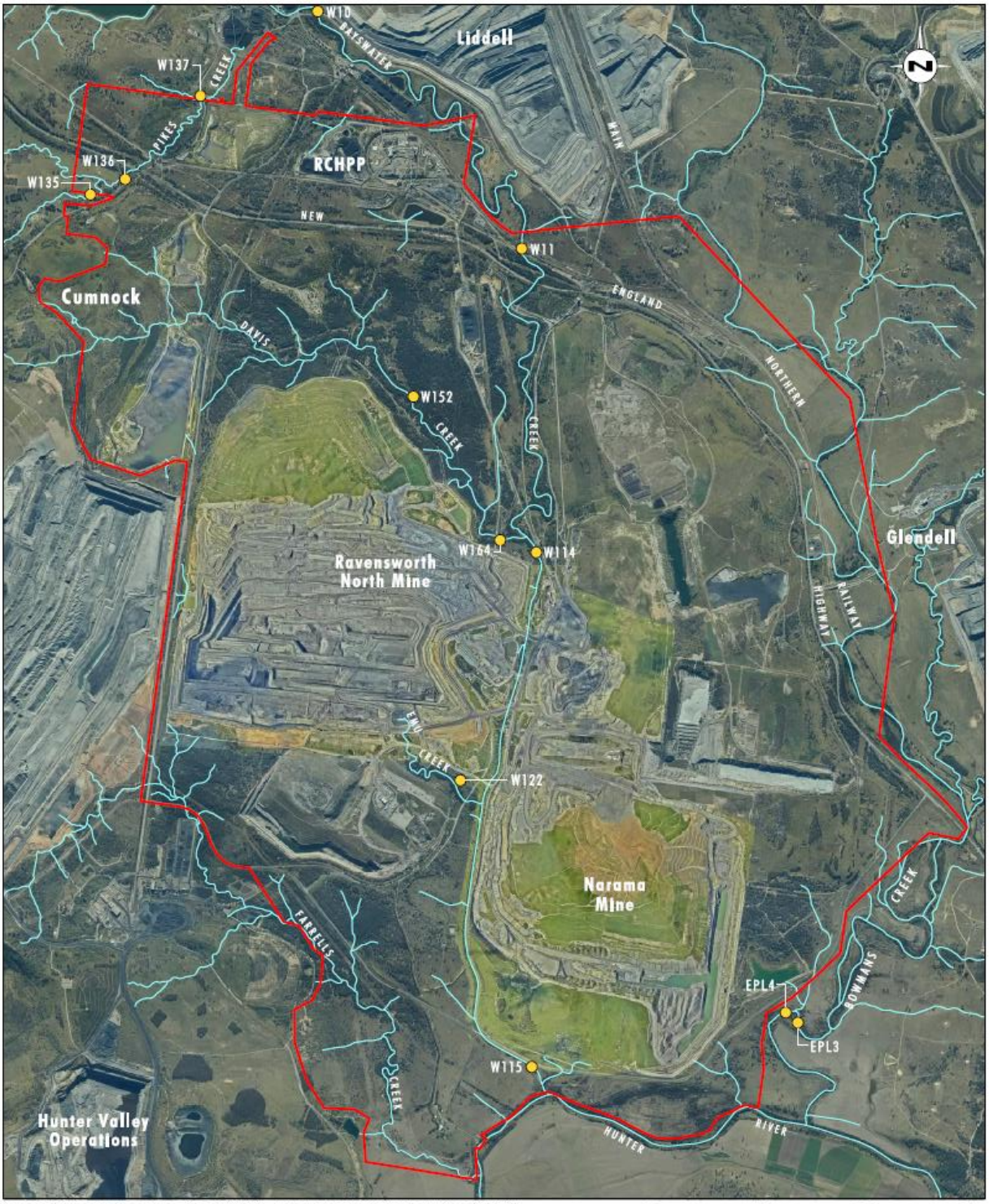
Surface Water Monitoring Locations and Criteria

Table A1.1 Surface Water Monitoring Locations

Watercourse	Monitoring Location	Site Description
Bowmans Creek	EPL 3	Bowmans Creek Upstream
	EPL 4	Bowmans Creek Downstream
Bayswater Creek	W114	Bayswater Creek Upstream
	W115	Bayswater Creek Downstream
Emu Creek	W122	Emu Creek Downstream
Davis Creek	W152	Davis Creek Upstream 2
	W164	Davis Creek Downstream
Pikes Creek	W135	Pikes Creek Upstream
	W136	Pikes Creek at New England Highway
	W137	Pikes Creek Road at CHPP Culvert

Table A1.2 Adopted Impact Assessment Criteria Values for Key Water Quality Parameters

Watercourse	pH	EC (µS/cm)	TSS (mg/L)	TDS (mg/L)
Bowman's Creek	7.7 – 8.1	1,331	18	817
Bayswater Creek	7.7 – 8.5	4,882	23.2	3,216
Emu Creek	7.4 – 8.2	3,336	47	2,014
Davis Creek	7.5 – 8.3	7,378	31	4,630
Pikes Gully	7.8 – 8.3	13,832	32	10,818



Legend

- Ravensworth Mining Complex
- Drainage Lines
- Surface Water Monitoring Location

FIGURE A1.1

Ravensworth Mining Complex
Surface Water Monitoring Locations

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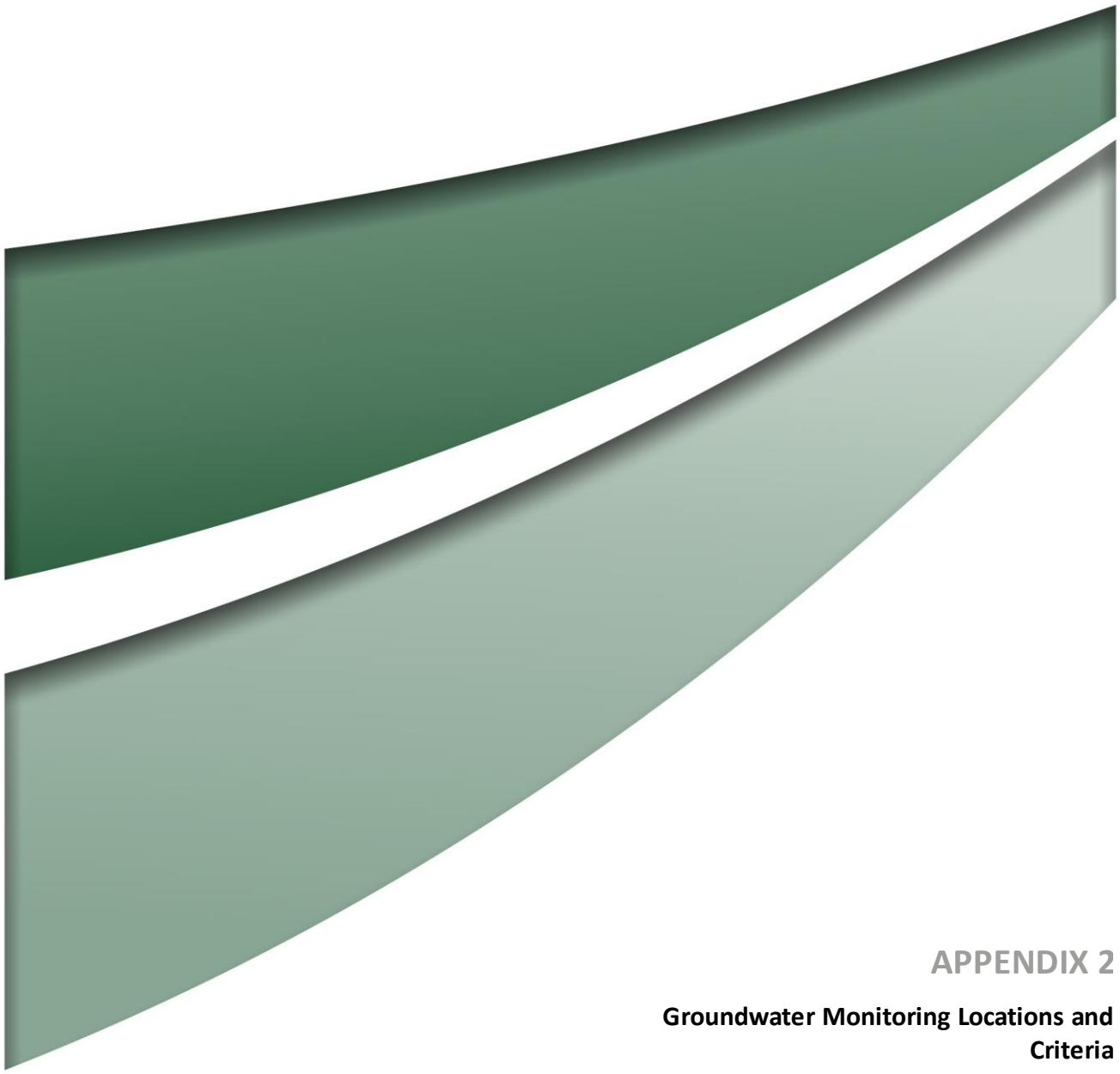

APPENDIX 2

Groundwater Monitoring Locations and Criteria

Table A2.1 Adopted Impact Assessment Criteria for pH and EC

Monitoring Location	Target	Water Quality Parameter	IAC
Coffey Dam Borehole	Liddell	pH	9.2 – 10.0
		EC (µS/cm)	3,160
CS4641C	Pikes Gully	pH	8.8 – 11.9
		EC (µS/cm)	8,522
NPZ1 Mid	Bayswater	pH	6.6 – 6.8
		EC (µS/cm)	15,015
NPZ1 Tall	Lemington	pH	7.0 – 7.3
		EC (µS/cm)	9,736
NPZ2 Tall	Lemington	pH	8.3 – 8.4
		EC (µS/cm)	9,765
NPZ5B P1	Broonies	pH	7.2 – 7.4
		EC (µS/cm)	6,340
NPZ5B P2	Bayswater Creek Alluvium	pH	7.1 – 7.3
		EC (µS/cm)	2,193
NPZ6 Tall	Broonies	pH	7.5 – 7.7
		EC (µS/cm)	7,120
NPZ7 Small	Weathered Permian Coal Measures Underlying Hunter River Alluvium	pH	7.3 – 7.5
		EC (µS/cm)	5,259
NPZ7 Tall	Bayswater	pH	7.4 – 7.5
		EC (µS/cm)	8,678
NPZ7 Mid	Broonies	pH	7.3 – 7.7
		EC (µS/cm)	8,446
WPP1	-	pH	7.0 – 7.1
		EC (µS/cm)	8,604
WPP2	-	pH	7.0 – 7.3
		EC (µS/cm)	9,352

Table A2.2 Interim Impact Assessment Criteria Values for Speciation Data

Parameter	Units	IAC Values
Sodium	mg/L	300
Sulphate	mg/L	400
Chloride	mg/L	400
Iron	µg/L	300
Silver	µg/L	50
Aluminium	µg/L	200
Barium	µg/L	1,000
Cadmium	µg/L	5

Parameter	Units	IAC Values
Copper	µg/L	1,000
Manganese	µg/L	100
Nickel	µg/L	100
Lead	µg/L	50
Selenium	µg/L	10
Zinc	µg/L	5,000
Mercury	µg/L	1
Nitrite as N	mg/L	1
Nitrate as N	mg/L	10

Table A2.3 Site Specific Impact Assessment Criteria for Sodium and Chloride

Monitoring Location	Water Quality Parameter	Units	IAC – 20th Percentile	IAC – 80th Percentile
CS4641C	Sodium	mg/L	1,980	1820
	Chloride		2,482	2310
NPZ1 Tall	Sodium		2,048	1820
	Chloride		2,744	2,225
NPZ2 Tall	Sodium		2,178	2,100
	Chloride		2,685	2,430
NPZ5B P1	Sodium		939	820
	Chloride		1,020	830
NP27 Small	Sodium		1,496	1,300
	Chloride		2,492	1,990
NPZ7 Tall	Sodium		1,602	1,320
	Chloride		2,542	2,099

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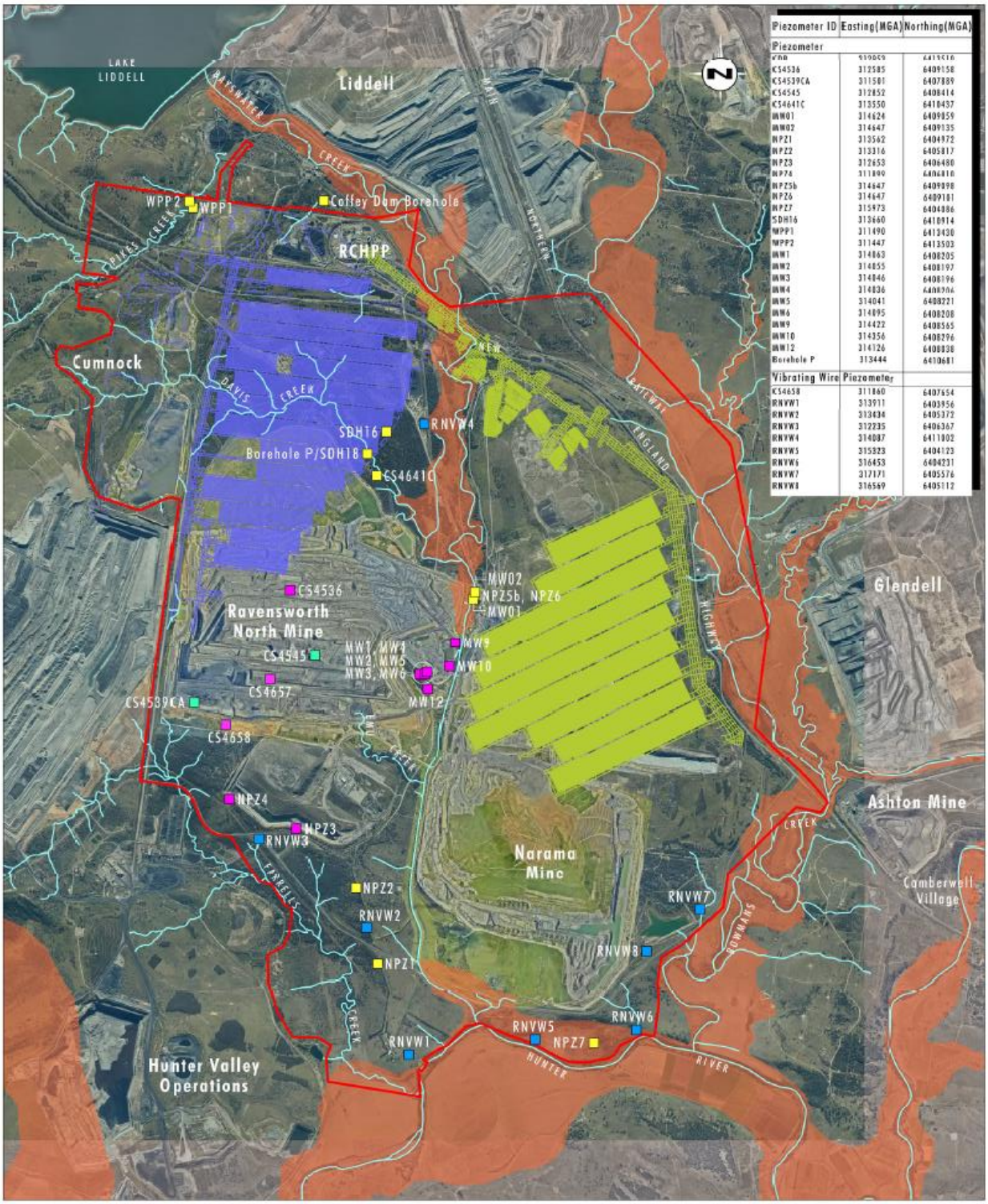

Image Source: Nearmap (Jan 2020), Ravensworth Complex (Dec 2020)
Data Source: Glencore (2020), Mackie Environmental Research (2009), AGE (2019)

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Legend

- Ravensworth Mining Complex
- Mapped Alluvium (AGE 2019)
- Cumnock Underground Workings
- Ravensworth Underground Workings
- Geological Features
- Piezometer Locations
- Vibrating Wire Piezometer Locations
- Formet Piezometer Locations
- Formet Vibrating Wire Piezometer Locations

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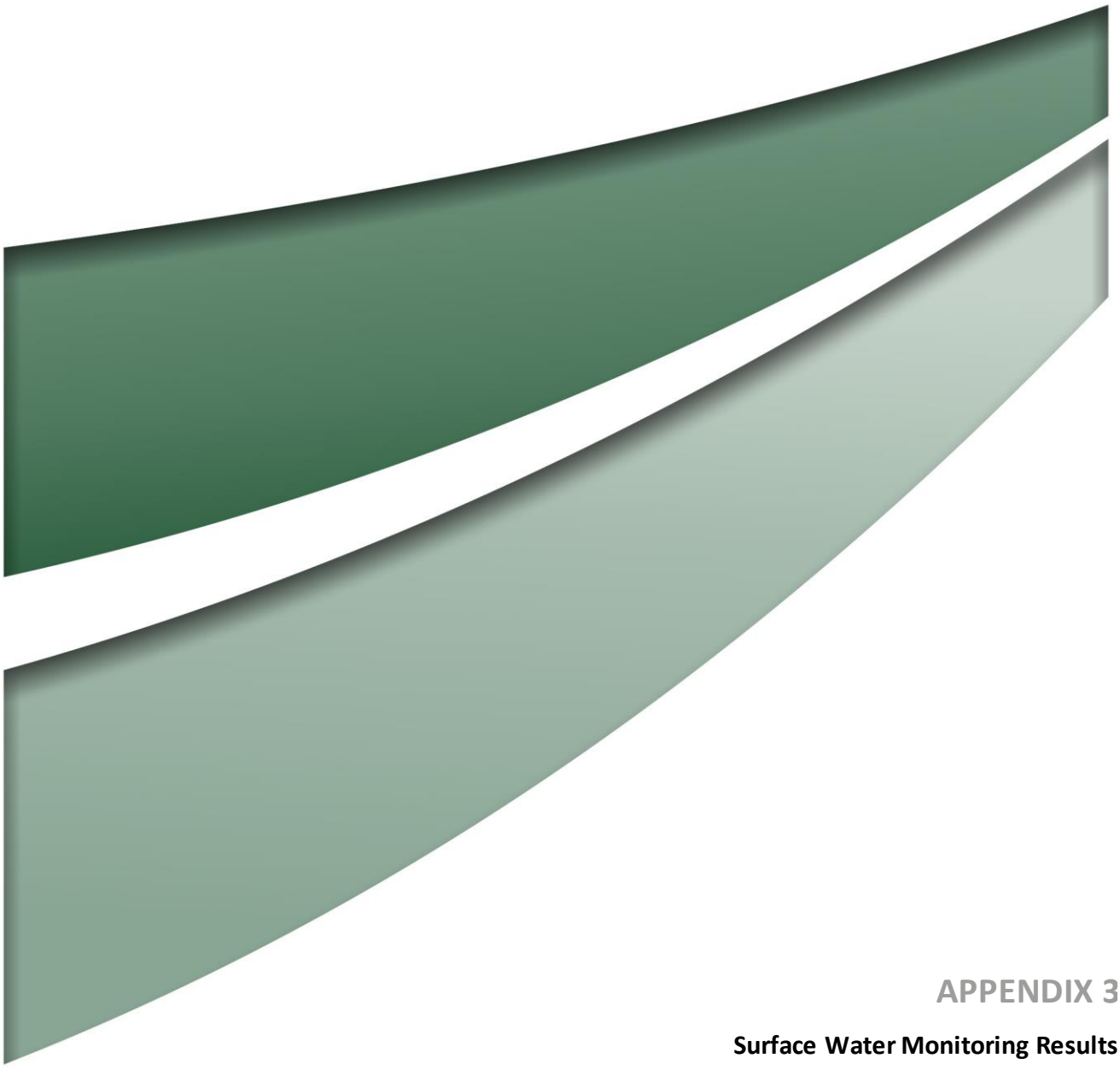
FIGURE A2.1

Ravensworth Mining Complex Groundwater Monitoring Locations



APPENDIX 3

Surface Water Monitoring Results

Table A3.1 2020 Surface Water Quality Summary (pH and TSS)

Water Course	Monitoring Location	pH			TSS (mg/L)			No. Samples
		Min	Max	Mean	Min	Max	Mean	
Bowmans Creek	EPL3	6.9	7.7	7.3	1	26	7	7
	EPL4	7.1	8.1	7.6	1	38	7	9
Bayswater Creek (ROP)	W114	6.9	6.9	6.9	44	44	44	1
	W115	7.4	8.6	8.0	3	102	32	6
Bayswater Creek (RUM)	W10	7.6	8.1	7.9	1	11	3	6
	W11	7.4	7.8	7.6	9	479	110	2
Emu Creek	W122	7.4	7.7	7.5	4	30	15	5
Davis Creek	W152	6.8	7.1	7.0	20	39	30	2
	W164							0
Pikes Creek	W135	7.1	7.7	7.3	5	131	52	4
	W136	7.1	7.1	7.1	22	22	22	1
	W137							0

Table A3.2 2020 Surface Water Quality Summary (EC and TDS)

Water Course	Monitoring Location	Electrical Conductivity (µS/cm)			TDS (mg/L)			No. Samples
		Min	Max	Mean	Min	Max	Mean	
Bowmans Creek	EPL3	592	1781	1071	430	1400	742	7
	EPL4	701	8680	2951	458	6180	2041	9
Bayswater Creek (ROP)	W114	268	268	268	270	270	270	1
	W115	743	3450	1938	459	2190	1238	6
Bayswater Creek (RUM)	W10	3100	6100	4406	1940	4380	2916	6
	W11	212	961	576	315	730	482	2
Emu Creek	W122	457	827	659	270	550	448	5
Davis Creek	W152	148	252	200	215	245	230	2
	W164							0
Pikes Creek	W135	201	1823	719	242	1480	618	4
	W136	1491	1491	1491	1060	1060	1060	1
	W137							0

The 2020 surface water monthly water quality monitoring results for pH, EC, TSS and TDS for surface waters are presented in **Tables A3.3** to **A3.6** respectively. These tables identify when sampling was not undertaken due to the monitoring location being dry, or due to two monthly sampling regimes. **Tables A3.3** to **A3.6** also indicate when monitoring results are higher than the adopted impact assessment criteria values for surface water using the legend included below.

Tables A3.3 to **A3.6** contain the following formatting:

	Indicates monitoring location was dry
	Indicates a non-sampling month
x	**Indicates result exceeds the adopted impact assessment criteria**

Table A3.3 2020 pH Data for Watercourse Monitoring Locations

Site	Jan-20	Feb-20	Mar-20	Apr-20	May-20	Jun-20	Jul-20	Aug-20	Sep-20	Oct-20	Nov-20	Dec-20
EPL3 - Bowmans Creek Upstream				7.0	6.9			7.7	7.3	7.0	7.7	7.3
EPL4 - Bowmans Creek Downstream			8.1		7.7	7.8	8.1	7.6	7.1	7.1	7.6	7.1
W114 - Bayswater Creek Upstream								6.9				
W115 - Bayswater Creek Downstream							8.6	7.4	7.9	8.1	7.8	8.2
W122 - Emu Creek Downstream			7.7		7.4			7.5	7.4		7.4	
W152 - Davis Creek 2		7.1						6.8				
W164 - Davis Creek Down												
W135 - Pikes Gully Upstream		7.1		7.7		7.2		7.2				
W136 - Pikes Gully @ New England Highway		7.1										
W137 - Pikes Gully Road @ CHPP Culvert												
W10 - Bayswater Creek Upstream of RUM	7.7	7.6	7.9	7.9	8.1	8.0	8.1	8.0	8.0	8.0	7.7	7.9
W11 - Bayswater Creek Downstream of RUM				7.4	7.5	7.6		7.4	7.8	7.7	7.5	7.8

Table A3.4 2020 TSS Data (mg/L) for Watercourse Monitoring Locations

Site	Jan-20	Feb-20	Mar-20	Apr-20	May-20	Jun-20	Jul-20	Aug-20	Sep-20	Oct-20	Nov-20	Dec-20
EPL3 - Bowmans Creek Upstream				26.0	5.0			4.0	3.0	7.0	1.0	4.0
EPL4 - Bowmans Creek Downstream			7.0		2.0	3.0	<1	3.0	1.0	2.0	2	38.0
W114 - Bayswater Creek Upstream								44.0				
W115 - Bayswater Creek Downstream			50.0	17.0	11.0	102.0	3.0	59.0	27.0	20.0	9.0	17.0
W122 - Emu Creek Downstream			<1	30.0	4.0			18.0	18.0		6.0	
W152 - Davis Creek 2		39.0						20.0				
W164 - Davis Creek Down												
W135 - Pikes Gully Upstream		56.0		15.0		131.0		5.0				
W136 - Pikes Gully @ New England Highway		22.0										
W137 - Pikes Gully Road @ CHPP Culvert												
W10 - Bayswater Creek Upstream of RUM	1.0	<1	3.0	2.0	1.0	3.0	1.0	11.0	2.0	4.0	2.0	8.0
W11 - Bayswater Creek Downstream of RUM				19.0	20.0	479.0		92.0	9.0	203.0	19.0	36.0

Table A3.5 2020 EC Data (µS/cm) for Watercourse Monitoring Locations

Site	Jan-20	Feb-20	Mar-20	Apr-20	May-20	Jun-20	Jul-20	Aug-20	Sep-20	Oct-20	Nov-20	Dec-20
EPL3 - Bowmans Creek Upstream				592	1781			849	1109	1291	714	1162
EPL4 - Bowmans Creek Downstream			8680		3750	3750	4340	749	1458	1691	701	1440
W114 - Bayswater Creek Upstream								268				
W115 - Bayswater Creek Downstream			1296	3340	3450	3400	3220	935	997	1072	743	930
W122 - Emu Creek Downstream			765	525	827			457	639		738	
W152 - Davis Creek 2		252						148				
W164 - Davis Creek Down												
W135 - Pikes Gully Upstream		325		528		201		1823				
W136 - Pikes Gully @ New England Highway		1491										
W137 - Pikes Gully Road @ CHPP Culvert												
W10 - Bayswater Creek Upstream of RUM	4510	3100	4270	4330	4200	3830	4120	3620	4710	5860	4220	6100
W11 - Bayswater Creek Downstream of RUM				326	401	212		271	871	873	692	961

Table A3.6 2020 TDS Data (mg/L) for Watercourse Monitoring Locations

Site	Jan-20	Feb-20	Mar-20	Apr-20	May-20	Jun-20	Jul-20	Aug-20	Sep-20	Oct-20	Nov-20	Dec-20
EPL3 - Bowmans Creek Upstream				430	1400			458	707	960	486	750
EPL4 - Bowmans Creek Downstream			6180		2590	2590	2900	469	1030	1210	458	943
W114 - Bayswater Creek Upstream								270				
W115 - Bayswater Creek Downstream			808	2090	2150	2190	2090	611	753	653	459	574
W122 - Emu Creek Downstream			537	323	550			270	477		531	
W152 - Davis Creek 2		245						215				
W164 - Davis Creek Down												
W135 - Pikes Gully Upstream		374		376		242		1480				
W136 - Pikes Gully @ New England Highway		1060										
W137 - Pikes Gully Road @ CHPP Culvert												
W10 - Bayswater Creek Upstream of RUM	2950	1940	2800	2890	2770	2500	2760	2320	3010	3740	2930	4380
W11 - Bayswater Creek Downstream of RUM				344	417	341		315	591	682	438	730

2020 monthly water quality monitoring results for pH, TSS, EC and TDS are shown for the following waterways in the charts below; Bowmans Creek **Charts A3.1** to **A3.8**, Bayswater Creek **Charts A3.9** to **A3.24**, Emu Creek **Charts A3.25** to **A.28**, Davis Creek **Charts A3.29** to **A3.36** and Pikes Creek **Charts A3.37** to **A3.48**. The mean and standard deviation values shown on these charts are based on historical monitoring data from 2007 to 2018 which is the same data that the groundwater pH and EC IAC values presented in **Table A1.2** were based on.

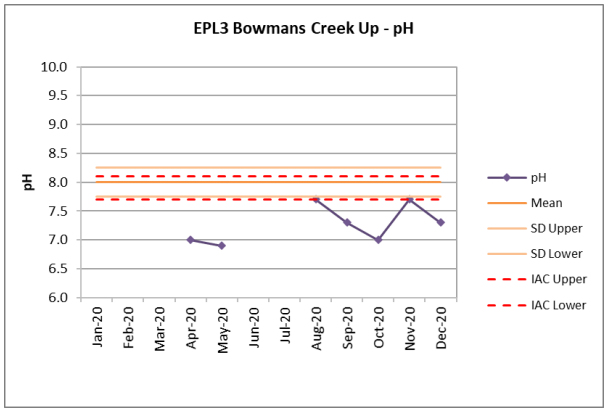


Chart A3.1 EPL3 Upstream pH

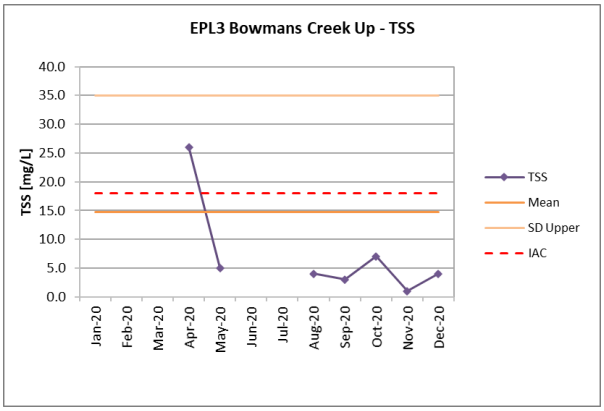


Chart A3.2 EPL3 Upstream TSS

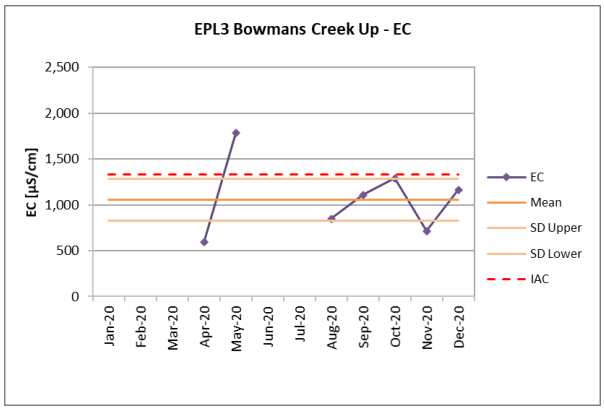


Chart A3.3 EPL3 Upstream EC

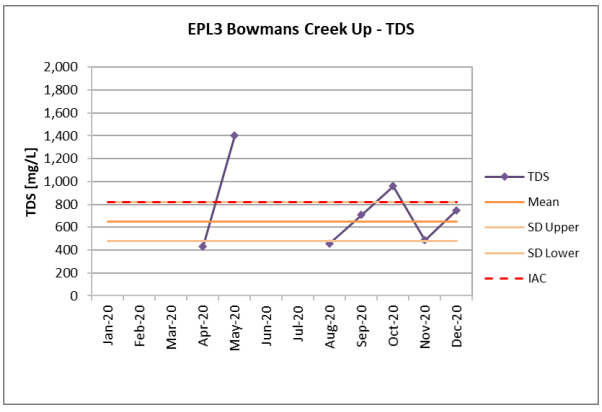


Chart A3.4 EPL3 Upstream TDS

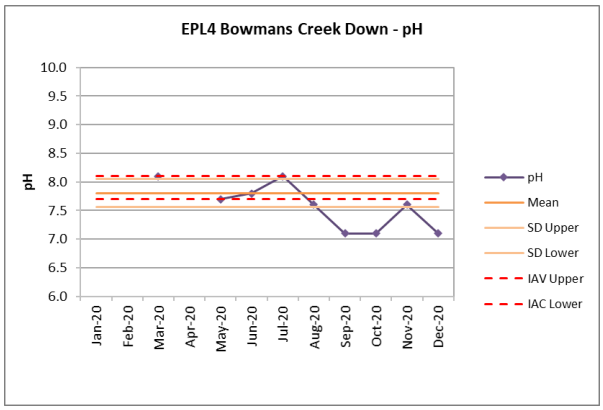


Chart A3.5 EPL4 Upstream pH

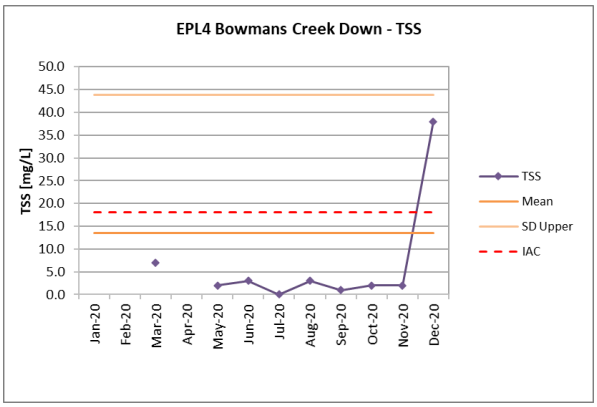


Chart A3.6 EPL4 Upstream TSS

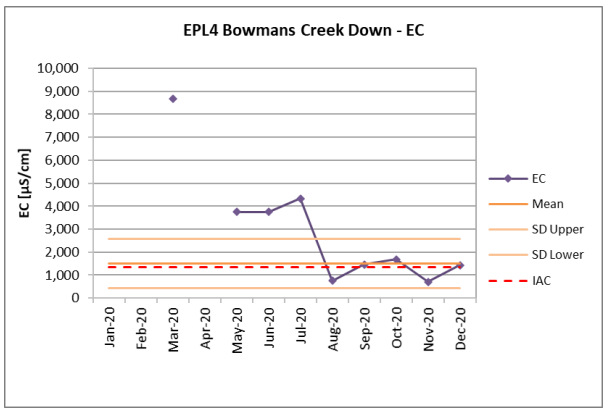


Chart A3.7 EPL4 Upstream EC

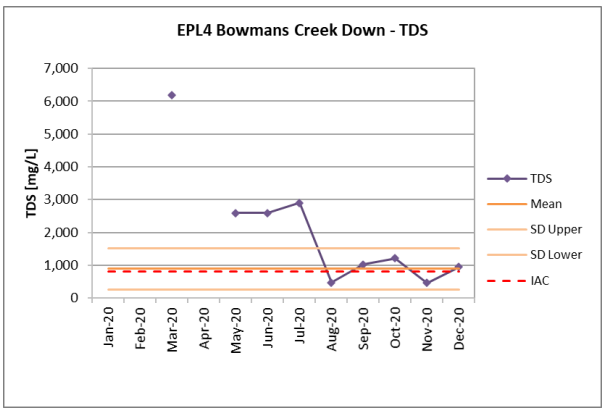


Chart A3.8 EPL4 Upstream TDS

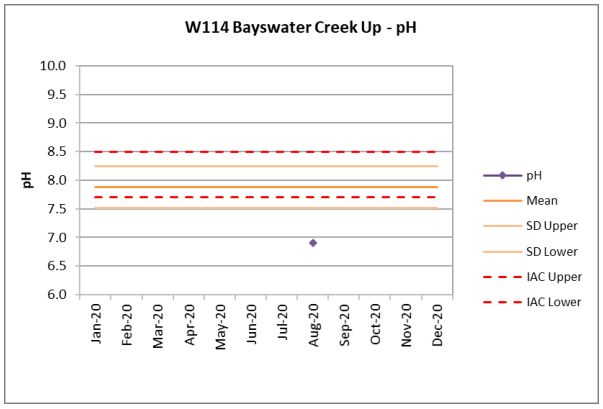


Chart A3.9 W114 Upstream pH

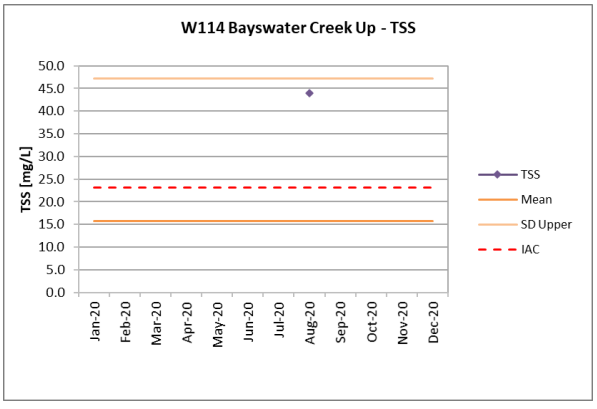


Chart A3.10 W114 Upstream TSS

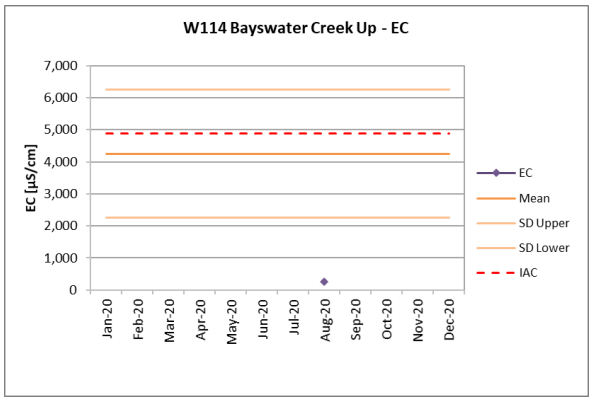


Chart A3.11 W114 Upstream EC

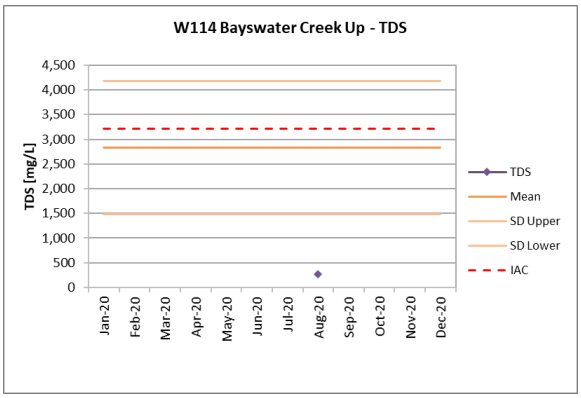


Chart A3.12 W114 Upstream TDS

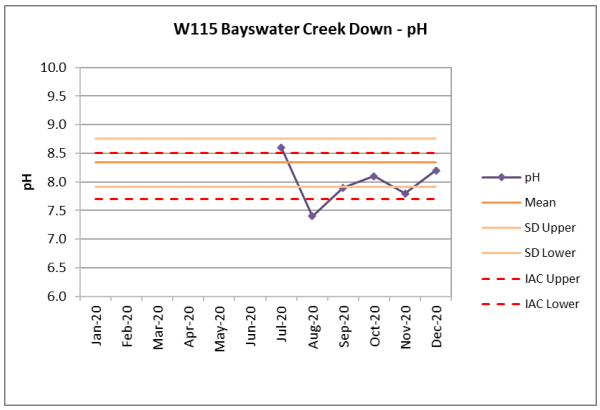


Chart A3.13 W115 Downstream pH

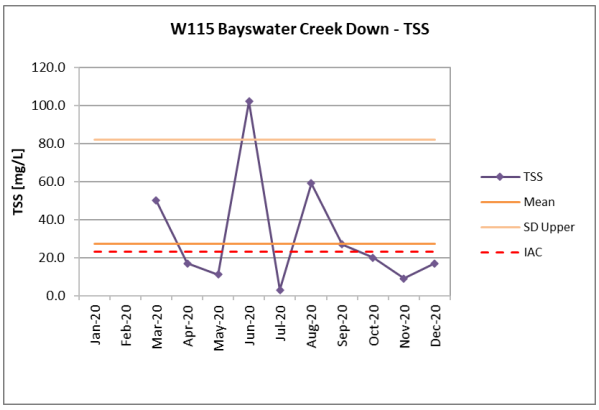


Chart A3.14 W115 Downstream TSS

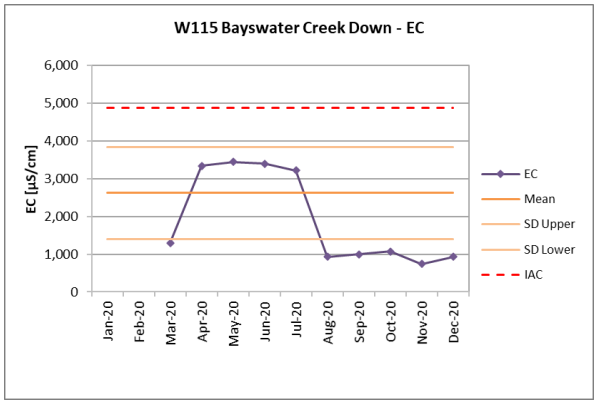


Chart A3.15 W115 Downstream EC

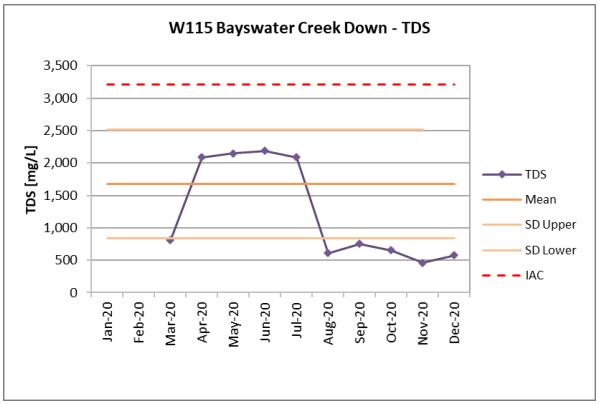


Chart A3.16 W115 Downstream TDS

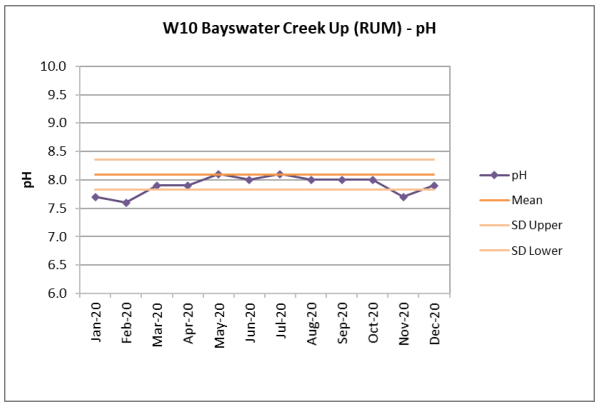


Chart A3.17 W10 Upstream pH

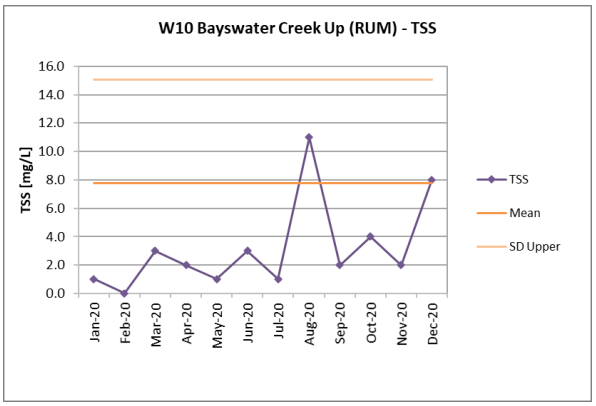


Chart A3.18 W10 Upstream TSS

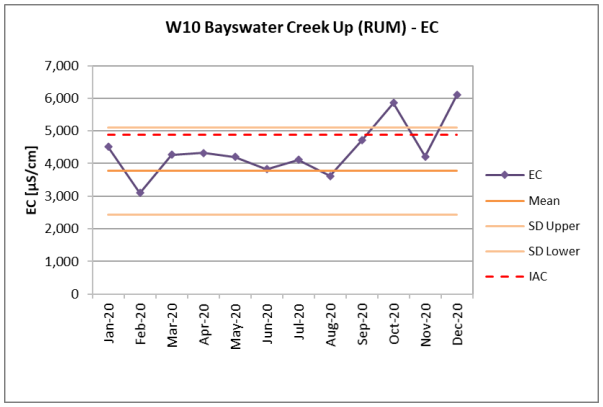


Chart A3.19 W10 Upstream EC

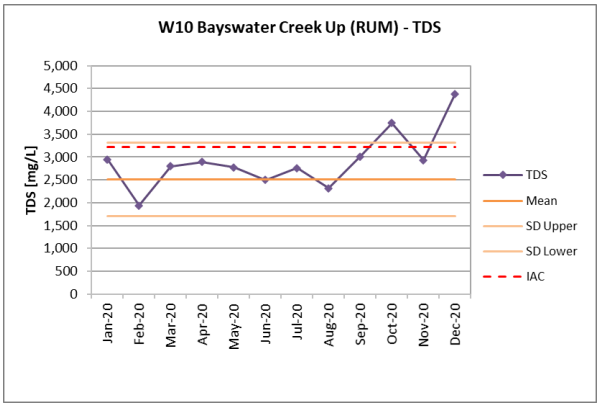


Chart A3.20 W10 Upstream TDS

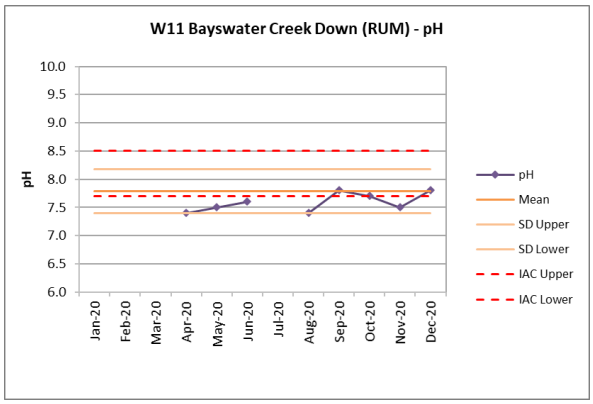


Chart A3.21 W11 Upstream pH

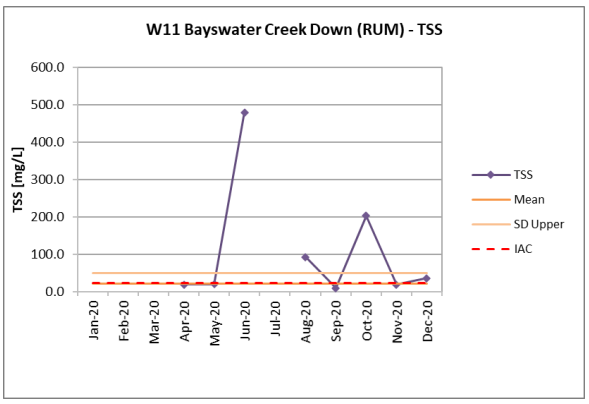


Chart A3.22 W11 Upstream TSS

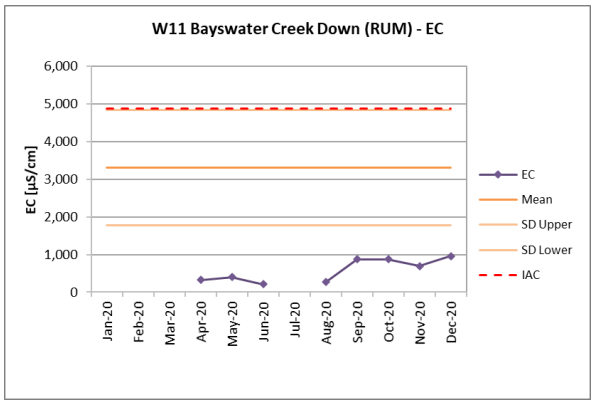


Chart A3.23 W11 Upstream EC

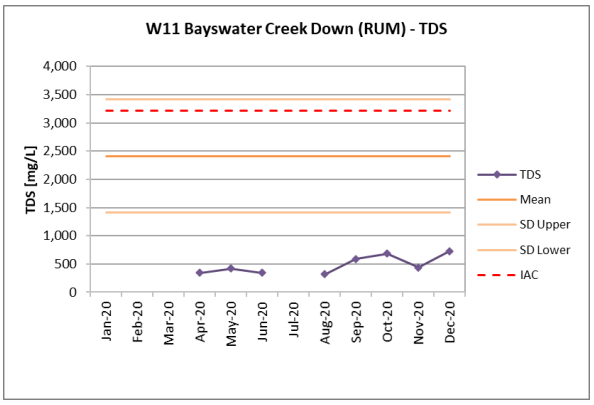


Chart A3.24 W11 Upstream TDS

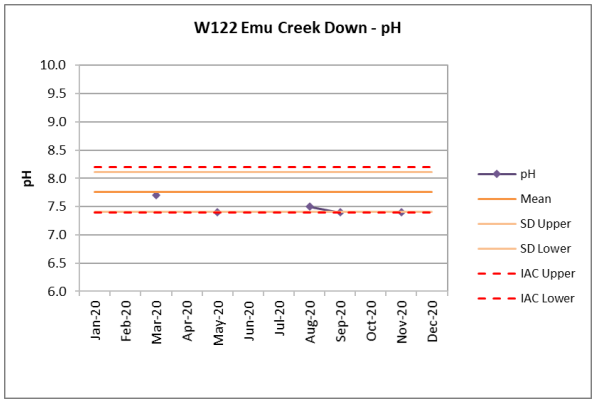


Chart A3.25 W122 Downstream pH

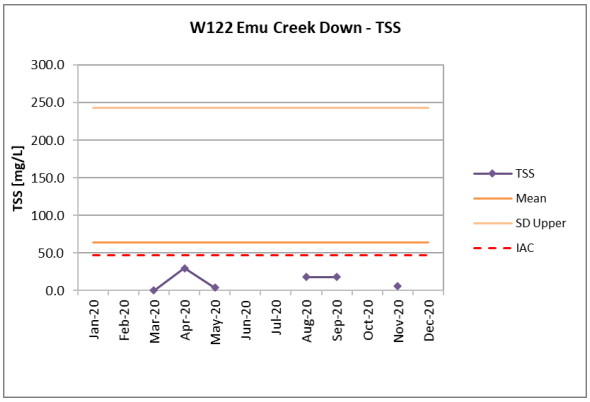


Chart A3.26 W122 Downstream TSS

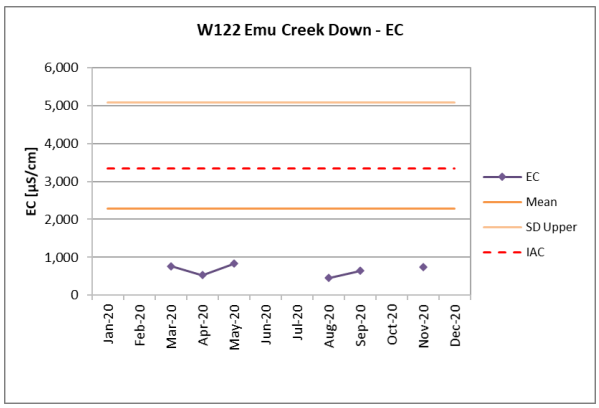


Chart A3.27 W122 Downstream EC

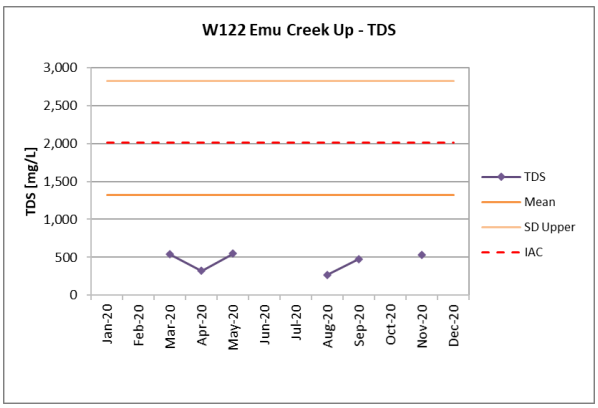


Chart A3.28 W122 Downstream TDS

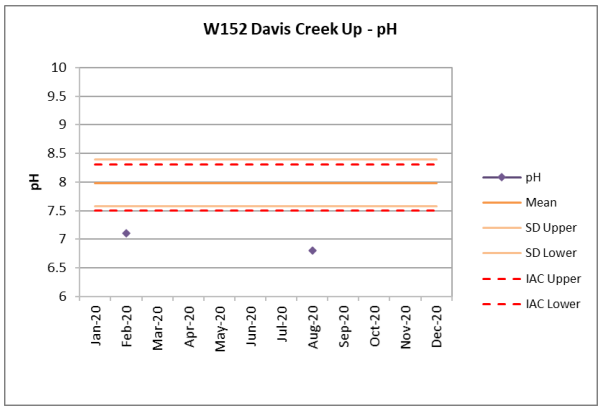


Chart A3.29 W152 Upstream pH

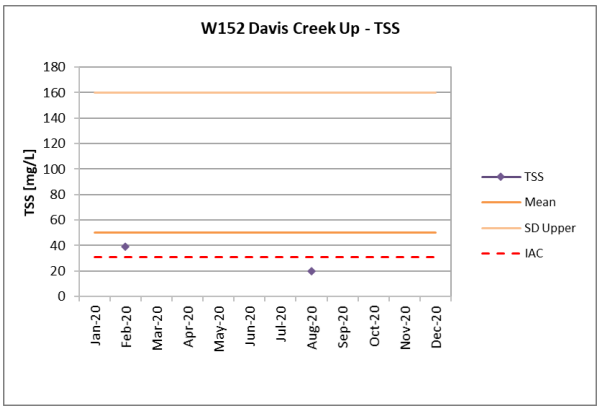


Chart A3.30 W152 Upstream TSS

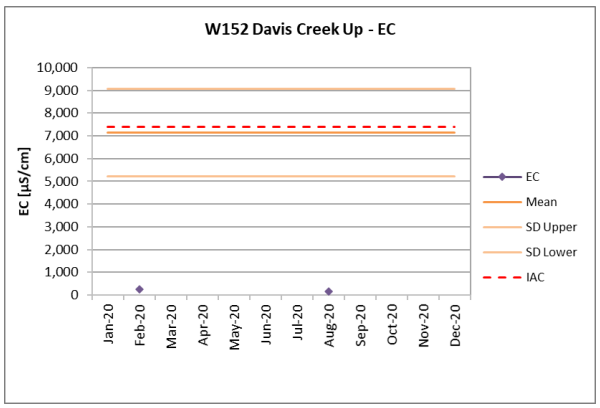


Chart A3.31 W152 Upstream EC

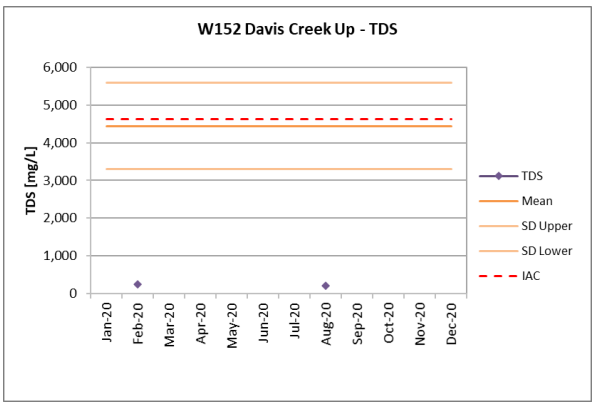


Chart A3.32 W152 Upstream TDS

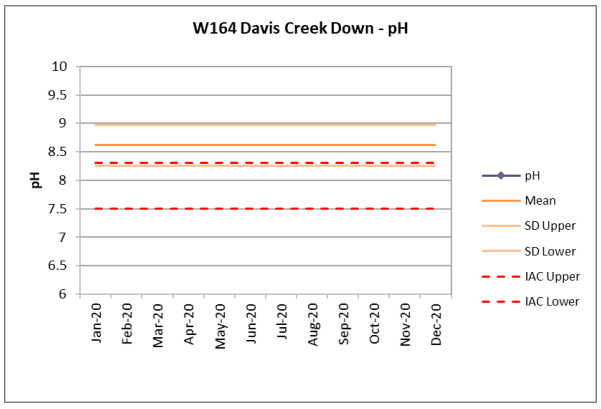


Chart A3.33 W164 Downstream pH

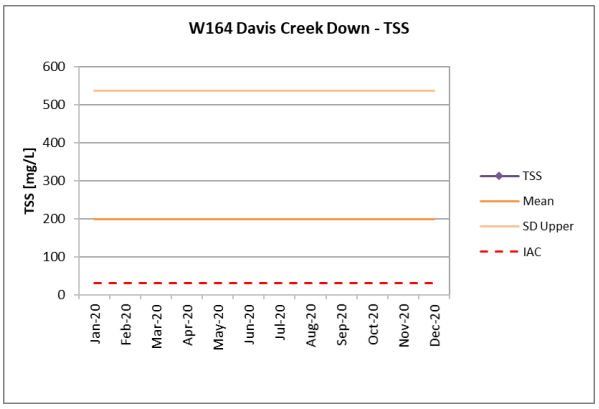


Chart A3.34 W164 Downstream TSS

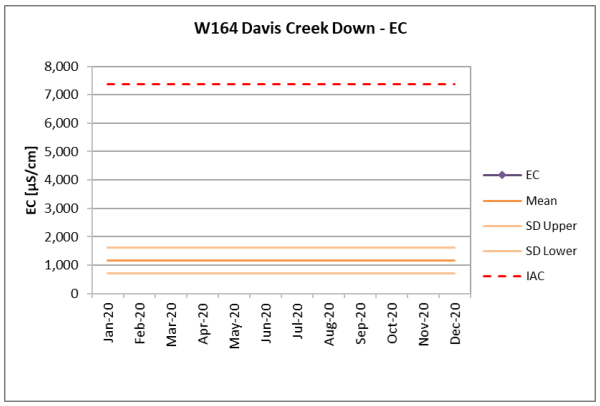


Chart A3.35 W164 Downstream EC

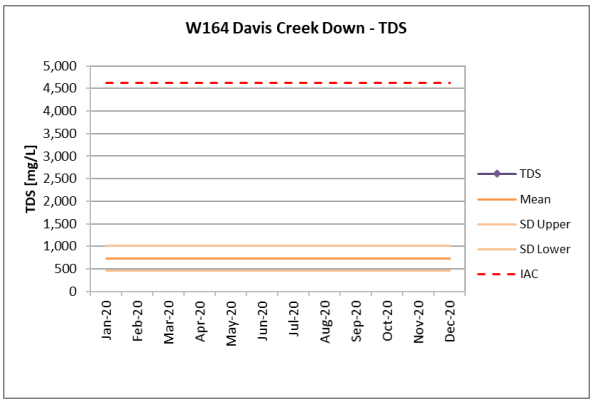


Chart A3.36 W164 Downstream TDS

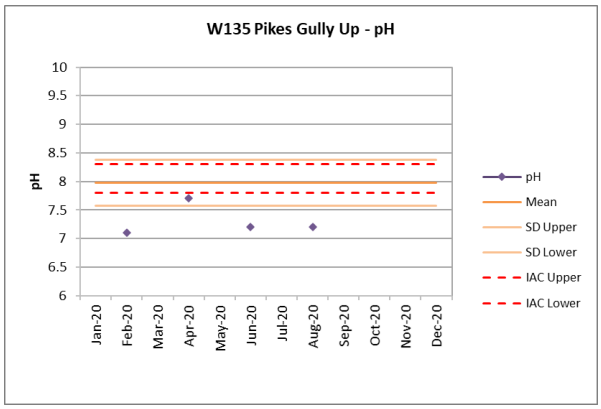


Chart A3.37 W135 Upstream pH

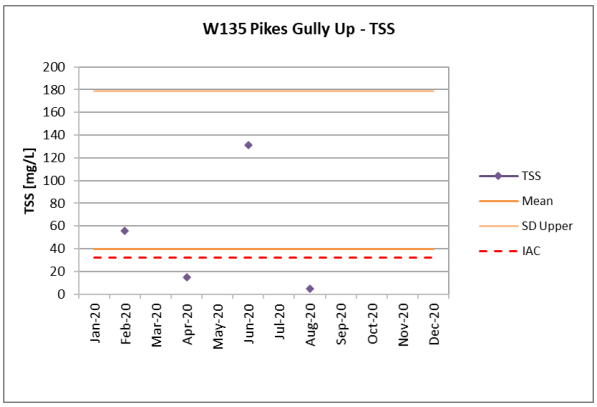


Chart A3.38 W135 Upstream TSS

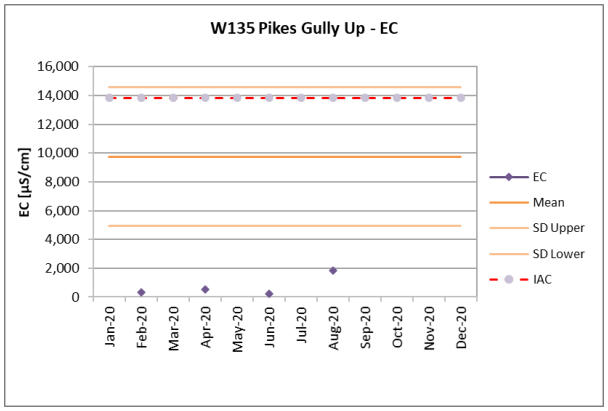


Chart A3.39 W135 Upstream EC

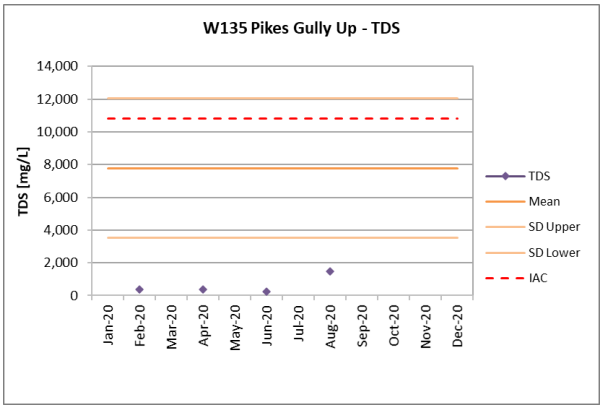


Chart A3.40 W135 Upstream TDS

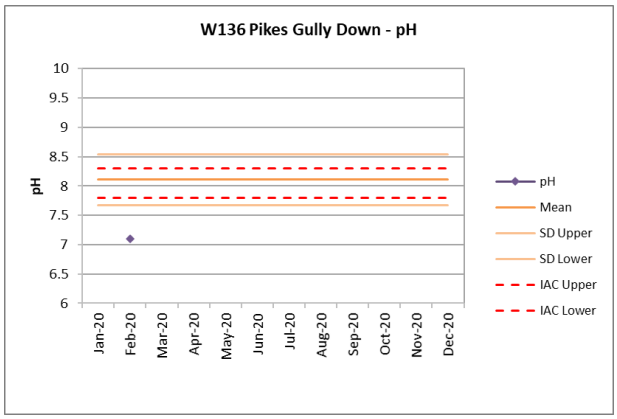


Chart A3.41 W136 Downstream pH

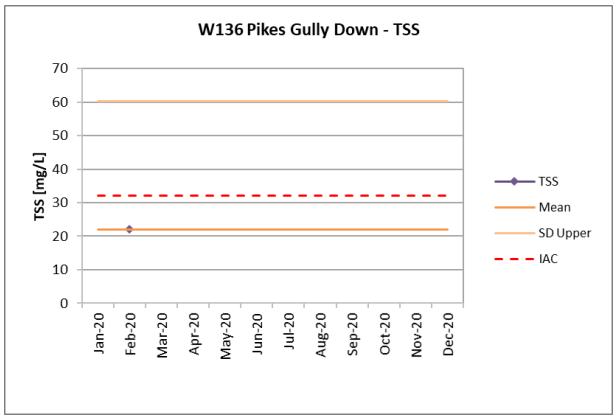


Chart A3.42 W136 Downstream TSS

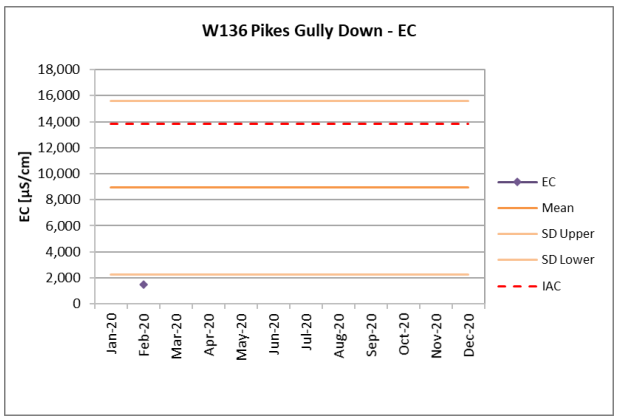


Chart A3.43 W136 Downstream EC

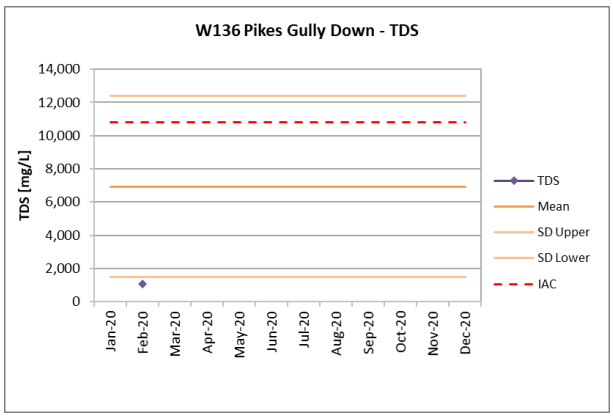


Chart A3.44 W136 Downstream TDS

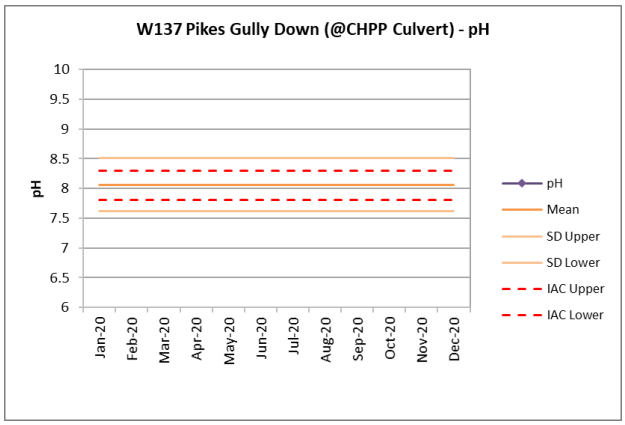


Chart A3.45 W137 Downstream pH

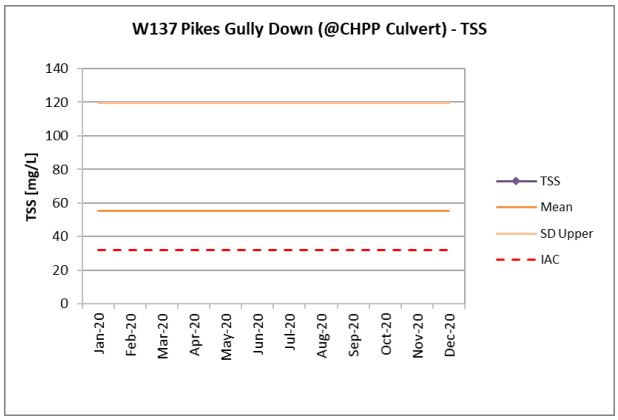


Chart A3.46 W137 Downstream TSS

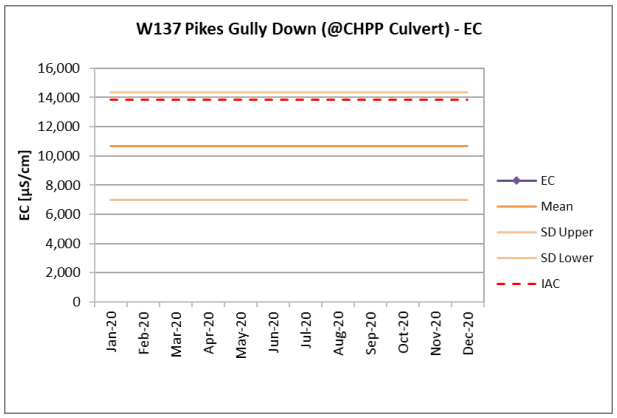


Chart A3.47 W137 Downstream EC

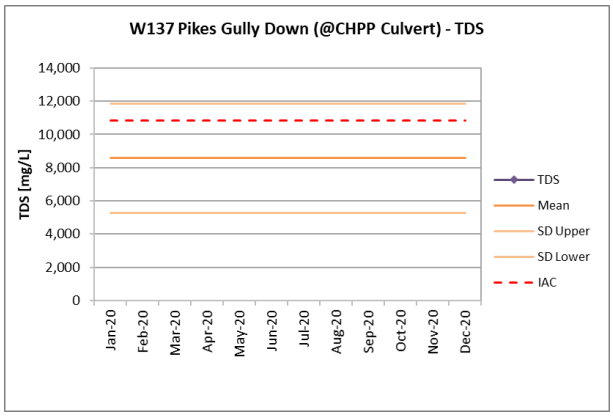
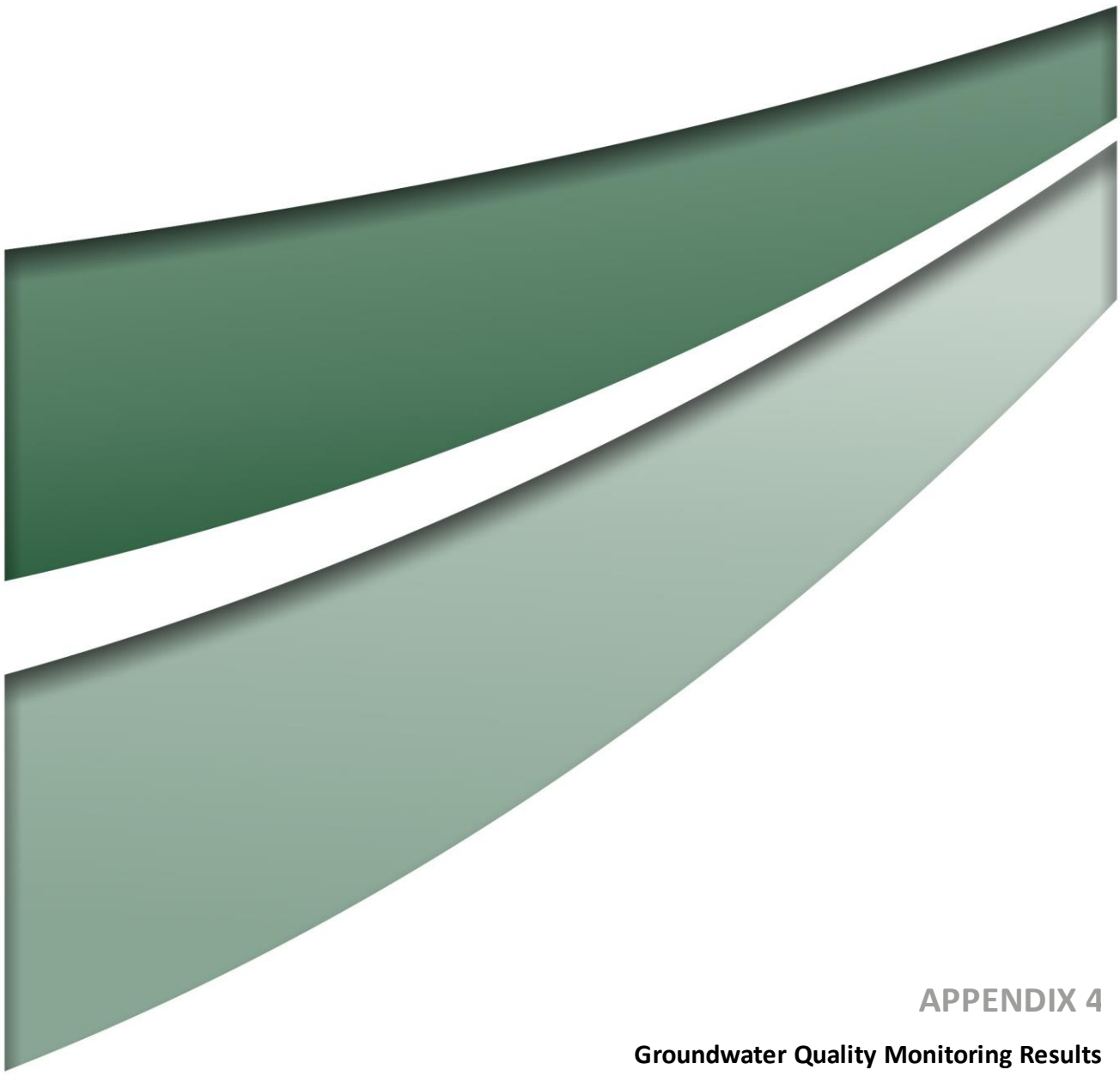


Chart A3.48 W137 Downstream TDS



APPENDIX 4

Groundwater Quality Monitoring Results

Table A4.1 Groundwater Quality 2020 Summary Statistics

Monitoring Location	Target	pH			Electrical Conductivity (µS/cm)		
		Min	Max	Mean	Min	Max	Mean
Coffey Dam Borehole	Liddell	7.6	8.8	8.3	5,820	6,330	6,070
CS4641C	Pikes Gully	-	-	-	-	-	-
NPZ1 Mid	Bayswater	-	-	-	-	-	-
NPZ1 Tall	Lemington	-	-	-	-	-	-
NPZ2 Tall	Lemington	-	-	-	-	-	-
NPZ5B P1	Broonies	-	-	-	-	-	-
NPZ5B P2	Bayswater Creek Alluvium	7.8	7.9	7.8	9,000	9,330	9,210
NPZ6 Tall	Broonies	-	-	-	-	-	-
NPZ7 Small	Weathered Permian Coal Measures Underlying Hunter River Alluvium	7.3	7.4	7.4	7,800	8,220	7,990
NPZ7 Tall	Bayswater	8.2	8.4	8.3	9,850	10,270	10,030
NPZ7 Mid	Broonies	7.1	7.3	7.2	4,840	5,320	5,120
WPP1	-	6.8	7.4	7.0	1,645	2,250	1,950
WPP2	-	7.6	7.9	7.8	7,100	7,620	7,210

The 2020 groundwater monthly water quality monitoring results for pH and EC, are presented in **Tables A4.2** to **A4.3** respectively. 2020 groundwater speciation results are presented in **Table A4.4**.

Charts A4.1 to **A4.6** present historical pH and EC results for all current and decommissioned monitoring bores. Historical pH and EC results for current monitoring bores are presented in **Charts A4.7** to **A4.32** with the mean and standard deviation for each bore shown on each chart. The mean and standard deviation values shown on these charts are based on historical monitoring data from 2008 to 2018 which is the same data that the groundwater pH and EC IAC values presented in **Table A2.1** were based on.

Table A4.2 Ravensworth Mining Complex Groundwater pH for 2020

pH		Monitoring Results												Statistical Analysis				
Target	BOREHOLE	Jan-20	Feb-20	Mar-20	Apr-20	May-20	Jun-20	Jul-20	Aug-20	Sep-20	Oct-20	Nov-20	Dec-20	Min	Max	Range	Mean	IAC
Liddell	Coffey	7.6	-	-	8.2	-	-	8.8	-	-	8.7	-	-	7.6	8.8	1.2	8.3	9.2 - 10
Pikes Gully	CS4539A (S2)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7 - 7.1
Liddell	CS4545 (S4)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10.6 - 11
Liddell	CS4545B Tall	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7 - 7.3
Lemington	CS4545B Mid	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7 - 7.9
Broonies	CS4545B Small	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7.1 - 8
Pikes Gully	CS4641C	7.8	-	-	7.8	-	-	7.8	-	-	7.9	-	-	7.8	7.9	0.1	7.8	8.8 - 11.9
Bayswater	NPZ1 Mid	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.6 - 6.8
Lemington	NPZ1 Tall	7.3	-	-	7.4	-	-	7.4	-	-	7.3	-	-	7.3	7.4	0.1	7.4	7 - 7.3
Lemington	NPZ2 Tall	8.2	-	-	8.2	-	-	8.4	-	-	8.3	-	-	8.2	8.4	0.2	8.3	8.3 - 8.4
Broonies	NPZ5B P1	7.3	7.3	7.3	7.3	7.2	7.3	7.2	7.2	7.3	7.2	7.2	7.1	7.1	7.3	0.2	7.2	7.2 - 7.4
Bayswater Creek Alluvium	NPZ5B P2	7.1	7.0	7.0	6.9	6.8	7.0	6.9	7.0	7.0	7.4	7.0	7.1	6.8	7.4	0.6	7.0	7.1 - 7.3
Broonies	NPZ6 Tall	7.8	7.9	7.8	7.8	7.6	7.7	7.7	7.8	7.8	7.8	7.9	7.9	7.6	7.9	0.3	7.8	7.5 - 7.7
Weathered Coal Measures	NPZ7 Small	7.4	-	-	7.2	-	-	7.4	-	-	7.3	-	-	7.2	7.4	0.2	7.3	7.3 - 7.5
Bayswater	NPZ7 Tall	7.5	-	-	7.3	-	-	7.4	-	-	7.4	-	-	7.3	7.5	0.2	7.4	7.4 - 7.5
Broonies	NPZ7 Mid	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
-	WPP1	7.0	-	-	7.0	-	-	7.0	-	-	7.0	-	-	7.0	7.0	-	7.0	7.0 -7.1
-	WPP2	7.0	-	-	7.0	-	-	7.0	-	-	7.0	-	-	7.0	7.0	-	7.0	7.0 - 7.3

Table A4.3 Ravensworth Mining Complex Groundwater EC for 2020

Electrical Conductivity (µS/cm)		Monitoring Results												Statistical Analysis				
SEAM	BOREHOLE	Jan-20	Feb-20	Mar-20	Apr-20	May-20	Jun-20	Jul-20	Aug-20	Sep-20	Oct-20	Nov-20	Dec-20	Min	Max	Range	Mean	IAC
Liddell	Coffey	6,210	-	-	6,330	-	-	5,900	-	-	5,820	-	-	5,820	6,330	510	6,070	3,160
Pikes Gully	CS4539A (S2)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7,462
Liddell	CS4545 (S4)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8,690
Liddell	CS4545B Tall	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12,542
Lemington	CS4545B Mid	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10,545
Broonies	CS4545B Small	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10,888
Pikes Gully	CS4641C	9,000	-	-	9,320	-	-	9,190	-	-	9,330	-	-	9,000	9,330	330	9,210	8,522
Bayswater	NPZ1 Mid	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15,015
Lemington	NPZ1 Tall	8,100	-	-	7,820	-	-	7,800	-	-	8,220	-	-	7,800	8,220	420	7,990	9,736
Lemington	NPZ2 Tall	10,060	-	-	9,850	-	-	9,920	-	-	10,270	-	-	9,850	10,270	420	10,030	9,765
Broonies	NPZ5B P1	5,160	5,110	5,140	5,080	5,040	5,050	5,290	4,840	5,250	5,320	4,960	5,220	4,840	5,320	480	5,120	6,340
Bayswater Creek Alluvium	NPZ5B P2	1,859	2,150	2,210	2,250	2,150	2,000	1,922	1,903	1,848	1,746	1,712	1,645	1,645	2,250	605	1,950	
Broonies	NPZ6 Tall	7,180	7,100	7,130	7,120	7,180	7,120	7,190	7,110	7,460	7,620	7,120	7,170	7,100	7,620	520	7,210	7,120
Weathered Coal Measures	NPZ7 Small	6,920	-	-	6,180	-	-	6,620	-	-	6,410	-	-	6,180	6,920	740	6,530	5,259
Bayswater	NPZ7 Tall	6,900	-	-	6,380	-	-	6,550	-	-	6,760	-	-	6,380	6,900	520	6,650	8,678
Broonies	NPZ7 Mid	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
-	WPP1	8,850	-	-	6,870	-	-	8,490	-	-	5,200	-	-	5,200	8,850	3,650	7,350	8,604
-	WPP2	9,840	-	-	9,310	-	-	9,240	-	-	9,680	-	-	9,240	9,840	600	9,520	9,352

Table A4.4 Ravensworth Mining Complex Groundwater Speciation for 2020

Analysis	ANZECC Guidelines*	PIKES GULLY SEAM				BROONIES SEAM				ALLUVIUM & WEATHERED COAL MEASURES			
		CS4641C		CS4539A (S2)		NPZ6 Tall		NPZ5B P1		NPZ7 Small		NPZ5B P2	
		Apr-20	Oct-20	Apr-20	Oct-20	Apr-20	Oct-20	Apr-20	Oct-20	Apr-20	Oct-20	Apr-20	Oct-20
pH	6.5 - 8.5	7.8	7.9	-	-	7.8	7.8	7.3	7.2	7.2	7.3	6.9	7.4
Conductivity (uS/cm)	X	9320	9330	-	-	7120	7620	5080	5320	6180	6410	2250	1746
Calcium (mg/L)	X	-	-	-	-	11	11	61	60	40	41	90	61
Magnesium (mg/L)	X	-	-	-	-	6	5	92	94	100	110	72	51
Sodium (mg/L)	300	-	-	-	-	1620	1600	955	934	990	1200	290	248
Potassium (mg/L)	X	-	-	-	-	7	8	10	12	11	9.4	5	5
Hydroxide Alkalinity as CaCO3	X	-	-	-	-	<1	<1	<1	<1	0	0	<1	<1
Carbonate Alkalinity as CaCO3	X	-	-	-	-	<1	<1	<1	<1	0	0	<1	<1
Bicarbonate Alkalinity as CaCO3	X	-	-	-	-	1000	1020	709	728	631	746	359	281
Alkalinity as $CaCO_3$ (mg/L)	X	-	-	-	-	1000	1020	709	728	631	746	359	281
Sulphate (mg/L)	400	-	-	-	-	<1	<1	417	437	88	91	288	328
Chloride (mg/L)	400	-	-	-	-	1590	1660	984	898	1597	1521	426	215
Iron (µg/L)	300	-	-	-	-	<50	250	100	790	7	9	170	<50
Silver (µg/L)	50	-	-	-	-	<1	<1	<1	<1	<1	<1	<1	<1
Aluminium (µg/L)	200	-	-	-	-	10	<10	<10	<10	<5	<5	<10	<10
Barium (µg/L)	1000	-	-	-	-	211	274	64	52	460	450	87	61
Cadmium (µg/L)	5	-	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Copper (µg/L)	1000	-	-	-	-	<1	<1	<1	3	<1	<1	1	2
Manganese (µg/L)	100	-	-	-	-	96	87	527	479	50	16	1400	472
Nickel (µg/L)	100	-	-	-	-	<1	<1	3	4	<1	<1	3	3
Lead (µg/L)	50	-	-	-	-	<1	<1	<1	<1	<1	<1	<1	<1
Antimony (µg/L)	X	-	-	-	-	<11	<1	<1	<1	<1	<1	<1	<1
Selenium (µg/L)	10	-	-	-	-	<10	<10	<10	<10	2	3	<10	<10
Zinc (µg/L)	5000	-	-	-	-	<5	5	10	19	<5	<5	11	<5
Mercury (µg/L)	1	-	-	-	-	<0.1	-	<0.1	-	<0.1	<0.1	<0.1	-
Hexavalent Chromium (mg/L)	X	-	-	-	-	-	-	-	-	-	-	-	-
Reactive Silica (mg/L)	X	-	-	-	-	23.4	19.6	22.8	24.6	14	12	38.3	35.2
Ammonia as N (mg/L)	X	-	-	-	-	1.63	1.72	0.42	0.44	2.8	2.8	1.02	0.39
Nitrite as N (mg/L)	1	-	-	-	-	0.02	<0.01	0.01	<0.01	0.007	0.075	0.01	0.01
Nitrate as N (mg/L)	10	-	-	-	-	0.07	0.25	0.1	0.08	<0.05	<0.05	0.44	0.12
Nitrite & Nitrate as N (mg/L)	X	-	-	-	-	0.09	0.25	0.11	0.08	0.007	0.075	0.45	0.13
TKN as N (mg/L)	X	-	-	-	-	4.6	2.7	2	2.5	4.1	3.3	5.3	2.4
Total Nitrogen as N (mg/L)	X	-	-	-	-	4.7	3	2.1	2.6	4.1	3.4	5.8	2.5
Total Cations (me/L)	X	-	-	-	-	71.7	70.8	52.4	51.7	-	-	23.2	18.2
Total Anions (me/L)	X	-	-	-	-	64.8	67.2	50.6	49	-	-	25.2	18.5

Analysis	ANZECC Guidelines*	LIDDELL SEAM		BAYSWATER SEAM		LEMINGTON SEAM				CUMNOCK OPEN CUT			
		Coffey		NPZ7 Tall		NPZ1 Tall		NPZ2 Tall		WPP1		WPP2	
		Apr-20	Oct-20	Apr-20	Oct-20	Apr-20	Oct-20	Apr-20	Oct-20	Apr-20	Oct-20	Apr-20	Oct-20
pH	6.5 - 8.5	8.2	8.7	7.3	7.4	7.4	7.3	8.2	8.3	7	7	7	7
Conductivity (uS/cm)	X	6330	5820	6380	6760	7820	8220	9850	10270	6870	5200	9310	9680
Calcium (mg/L)	X	35	15	41	42	11	9.9	17	15	220	180	220	210
Magnesium (mg/L)	X	130	130	110	110	11	8.5	9.9	7.6	220	260	270	410
Sodium (mg/L)	300	1400	1200	1100	1200	1600	1800	1900	2300	1300	890	1800	1700
Potassium (mg/L)	X	20	14	10	9.8	8.8	8	13	12	7.9	5.8	15	13
Hydroxide Alkalinity as CaCO3	X	0	0	0	0	0	0	0	0	0	0	0	0
Carbonate Alkalinity as CaCO3	X	0	0	0	0	0	0	0	0	0	0	0	0
Bicarbonate Alkalinity as CaCO3	X	1303	1196	737	771	1200	1177	1453	1434	721	552	883	891
Alkalinity as $CaCO_3$ (mg/L)	X	1303	1196	737	771	1200	1177	1453	1434	721	552	883	891
Sulphate (mg/L)	400	850	630	100	110	6.2	3.2	5.9	2.3	2400	1500	3600	3500
Chloride (mg/L)	400	1060	659	1724	1724	1977	1876	2636	2535	583	406	1010	836
Iron (µg/L)	300	32	18	<5	5	36	83	26	43	<5	6	<5	5
Silver (µg/L)	50	<1	<1	<1	<1	<1	1	<1	<1	<1	<1	<1	<1
Aluminium (µg/L)	200	<5	<5	<5	7	9	8	11	5	<5	<5	<5	<5
Barium (µg/L)	1000	20	18	490	480	450	450	1300	1400	32	53	14	14
Cadmium (µg/L)	5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Copper (µg/L)	1000	<1	2	<1	<1	<1	<1	<1	<1	2	4	<1	<1
Manganese (µg/L)	100	210	68	52	50	150	160	98	100	240	390	150	230
Nickel (µg/L)	100	2	3	<1	<1	<1	1	<1	<1	5	5	4	5
Lead (µg/L)	50	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Antimony (µg/L)	X	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Selenium (µg/L)	10	<1	<1	35	2	<1	<1	<1	<1	<1	<1	<1	<1
Zinc (µg/L)	5000	<5	6	<5	<5	<5	5	<5	<5	7	12	5	8
Mercury (µg/L)	1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Hexavalent Chromium (mg/L)	X	-	-	-	-	-	-	-	-	-	-	-	-
Reactive Silica (mg/L)	X	8.6	4.8	16	12	27	18	21	15	29	19	34	26
Ammonia as N (mg/L)	X	2.4	2	2.8	2.8	2.1	2.2	3	3	<0.01	0.03	<0.01	0.03
Nitrite as N (mg/L)	1	0.009	0.058	0.027	0.032	<0.005	0.035	<0.005	0.021	<0.005	<0.005	<0.005	<0.005
Nitrate as N (mg/L)	10	0.1	0.22	<0.05	<0.05	<0.05	0.07	<0.05	<0.05	0.092	<0.025	<0.05	<0.05
Nitrite & Nitrate as N (mg/L)	X	0.109	0.278	0.027	0.032	<0.05	0.105	<0.05	0.021	0.092	<0.025	<0.05	<0.05
TKN as N (mg/L)	X	3.5	3.4	5.3	4	5.2	3.7	5.4	4.2	1.1	1.6	0.18	0.5
Total Nitrogen as N (mg/L)	X	3.6	3.7	5.3	4	5.2	3.8	5.4	4.2	1.1	1.6	0.19	0.51
Total Cations (me/L)	X	-	-	-	-	-	-	-	-	-	-	-	-
Total Anions (me/L)	X	-	-	-	-	-	-	-	-	-	-	-	-

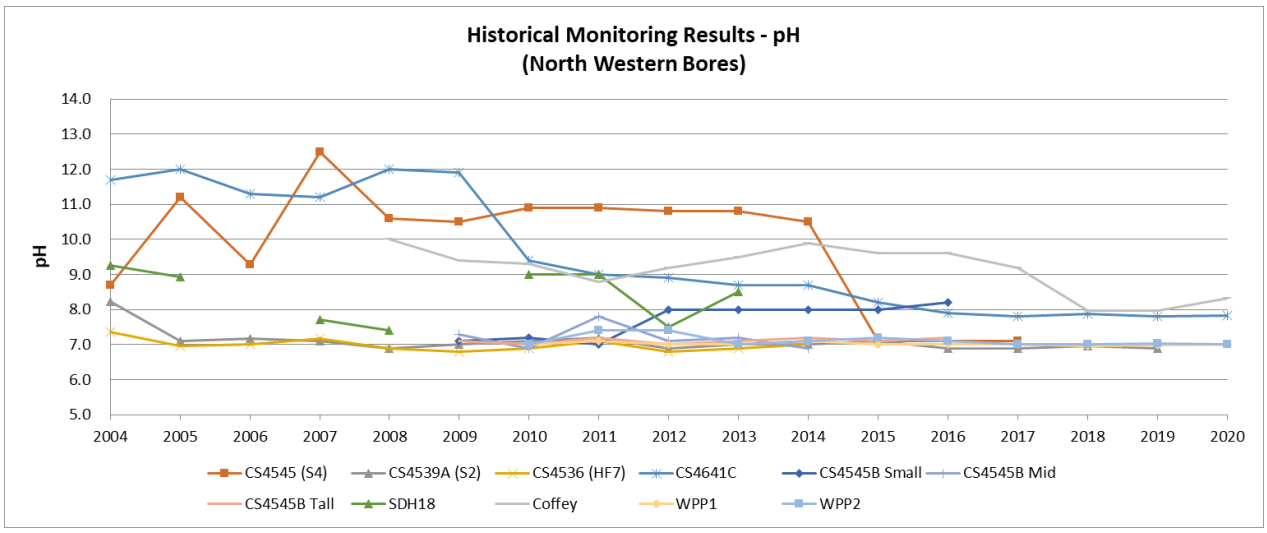


Chart A4.1 Ravensworth Mining Complex Groundwater Historical pH – North Western Bores

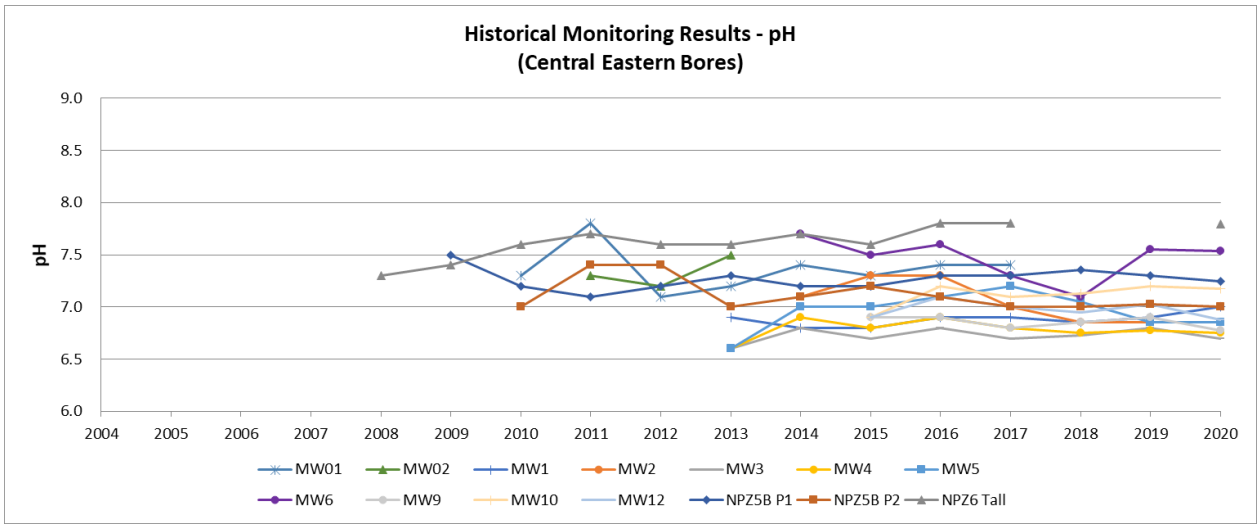


Chart A4.2 Ravensworth Mining Complex Groundwater Historical pH – Central Eastern Bores

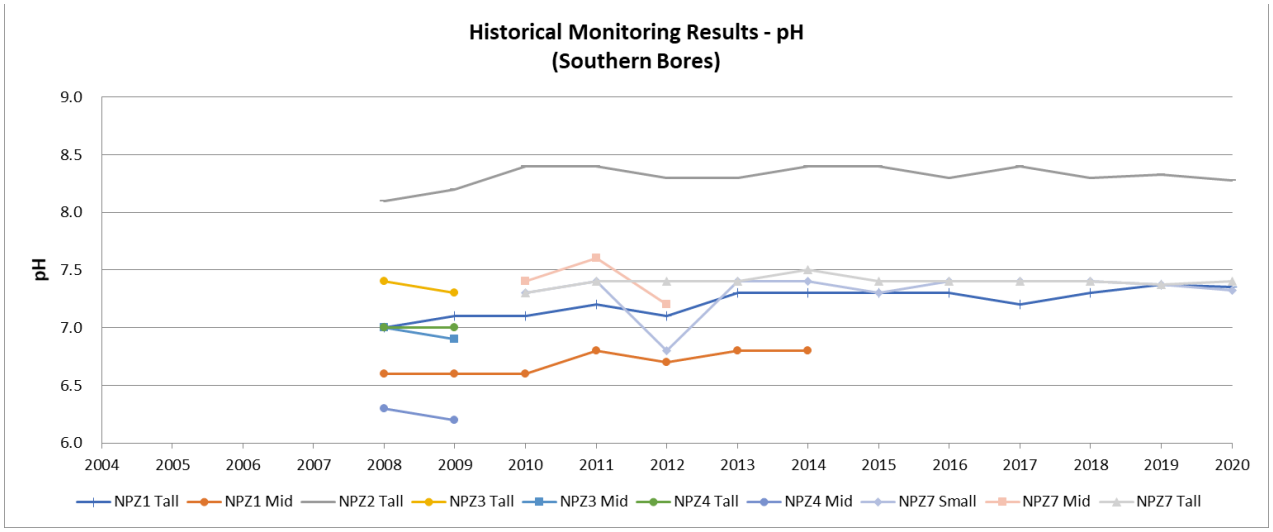


Chart A4.3 Ravensworth Mining Complex Groundwater Historical pH – Southern Bores

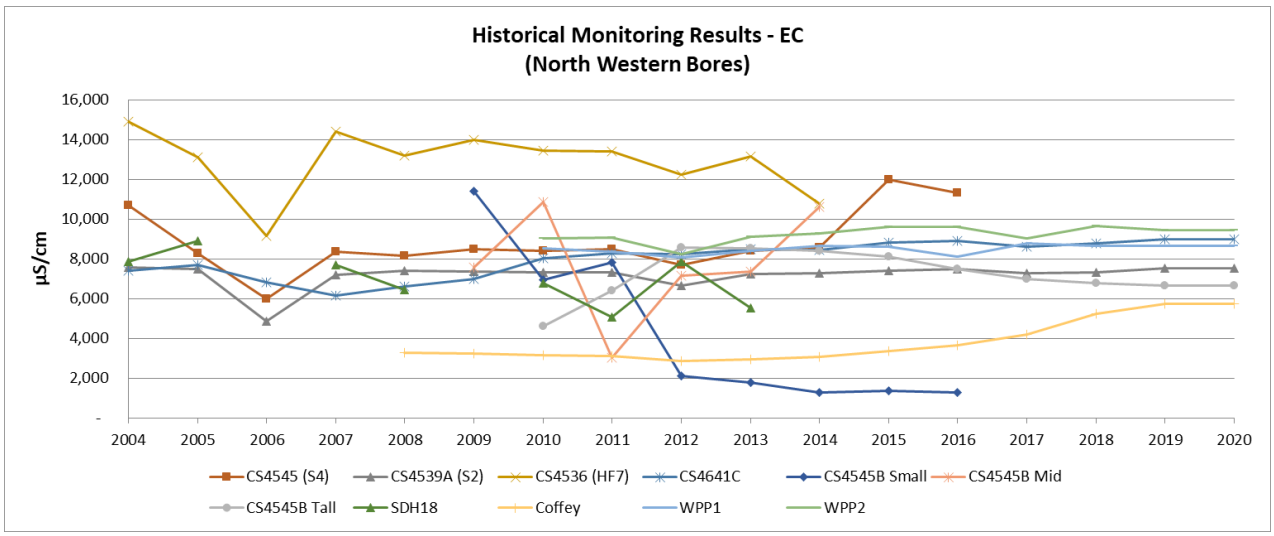


Chart A4.4 Ravensworth Mining Complex Groundwater Historical EC – North Western Bores

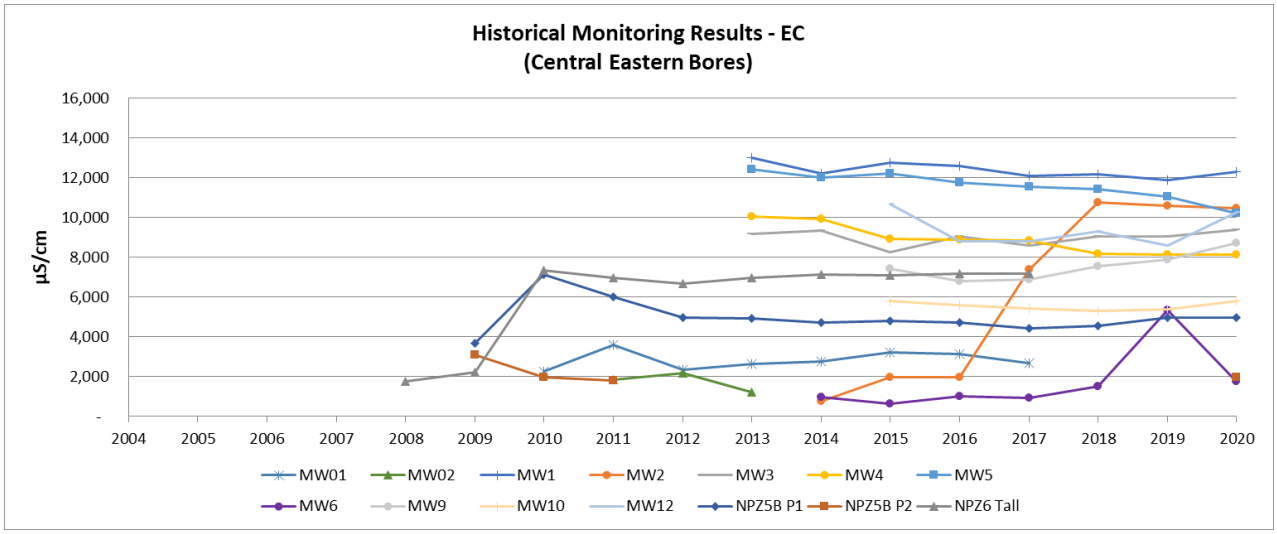


Chart A4.5 Ravensworth Mining Complex Groundwater Historical EC – Central Eastern Bores

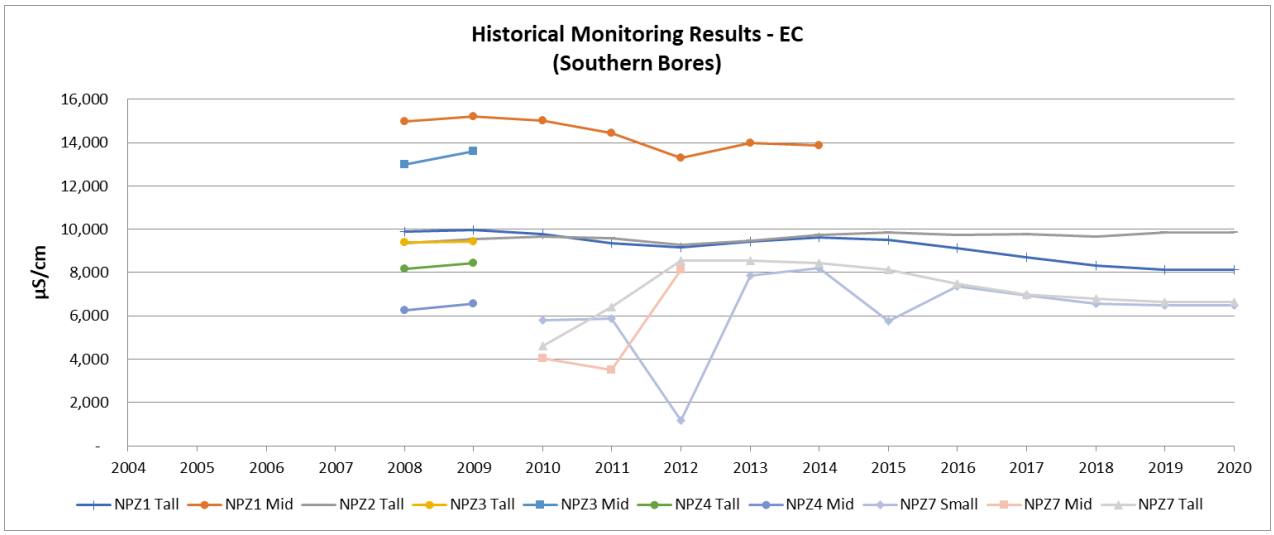


Chart A4.6 Ravensworth Mining Complex Groundwater Historical EC – Southern Bores

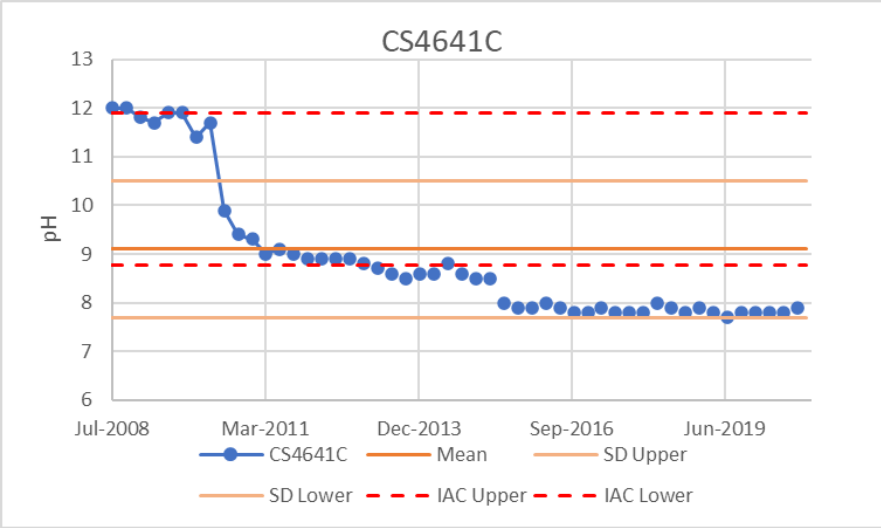


Chart A4.7 CS4641C Historical pH

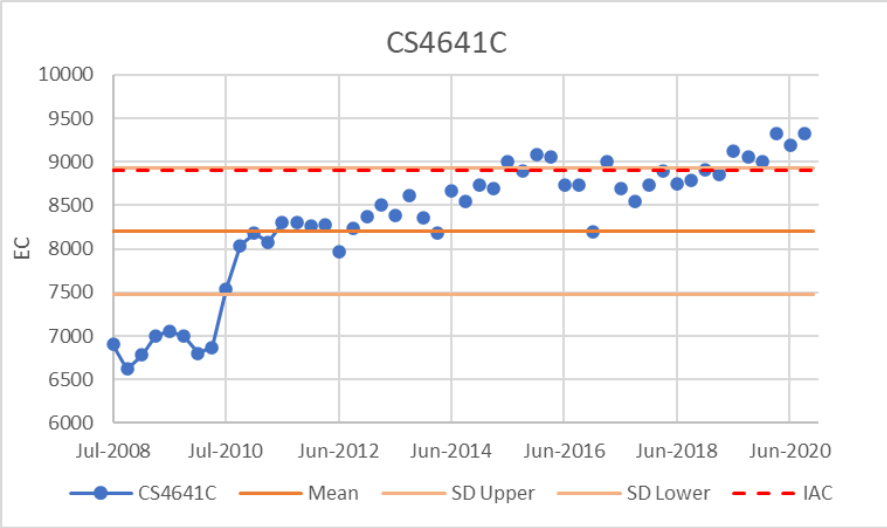


Chart A4.8 CS4641C Historical EC

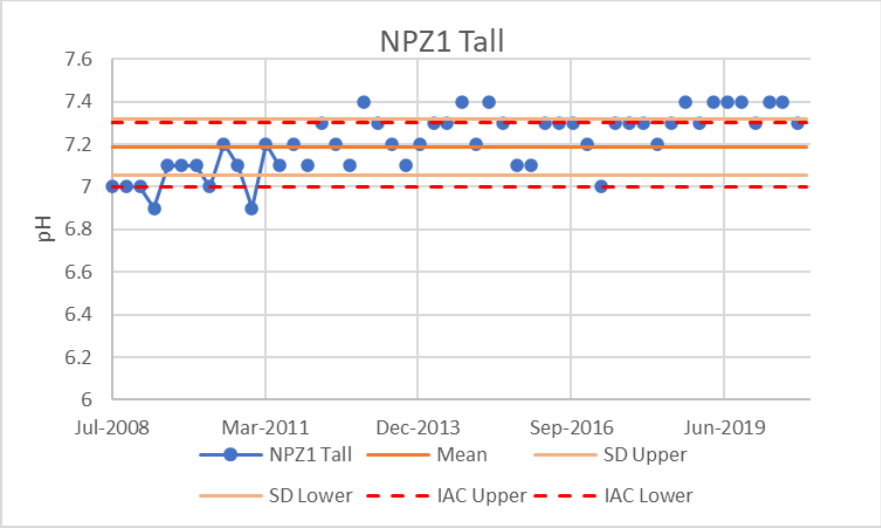


Chart A4.9 NPZ1 Tall Historical pH

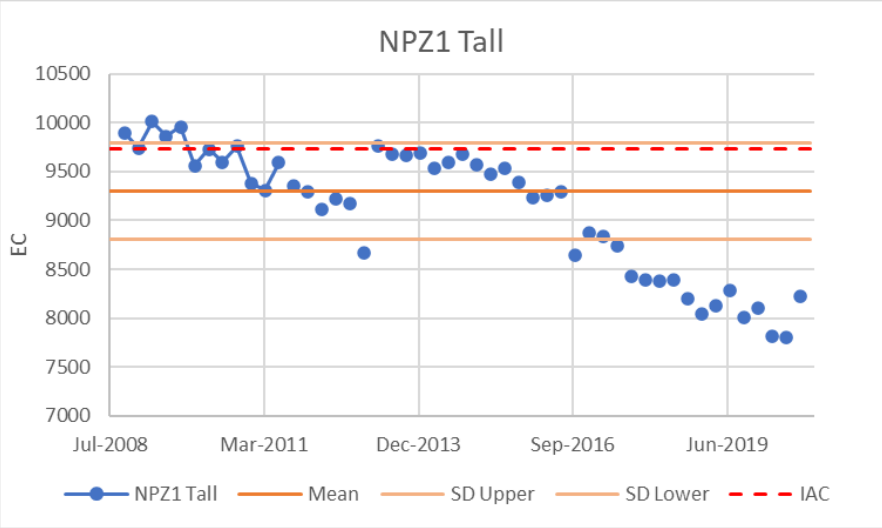


Chart A4.10 NPZ1 Tall Historical EC

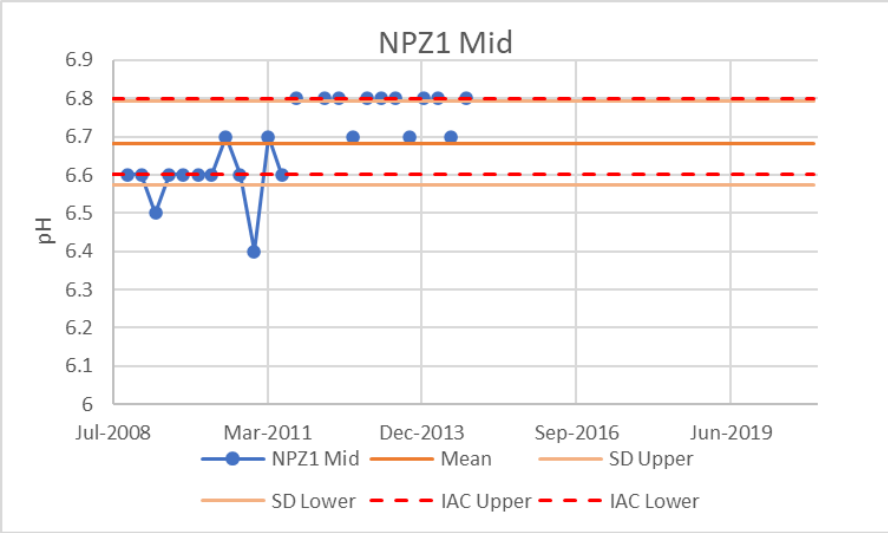


Chart A4.11 NPZ1 Mid Historical pH

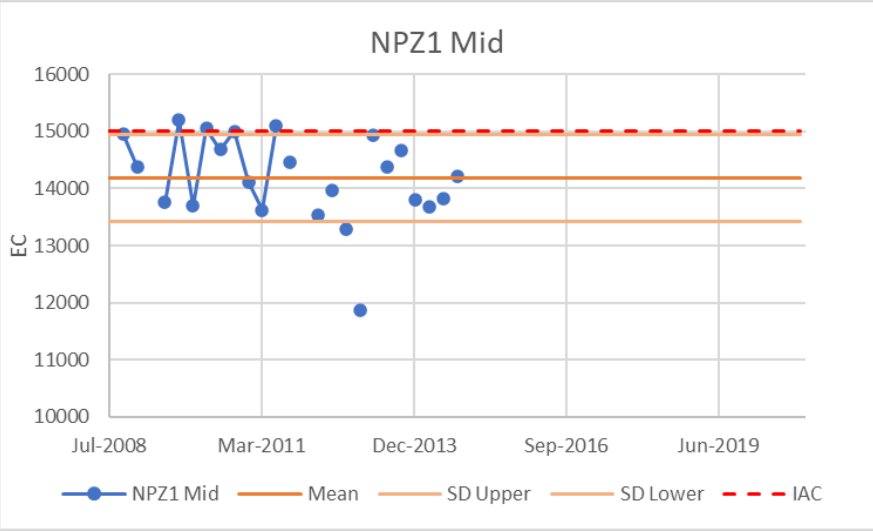


Chart A4.12 NPZ1 Mid Historical EC

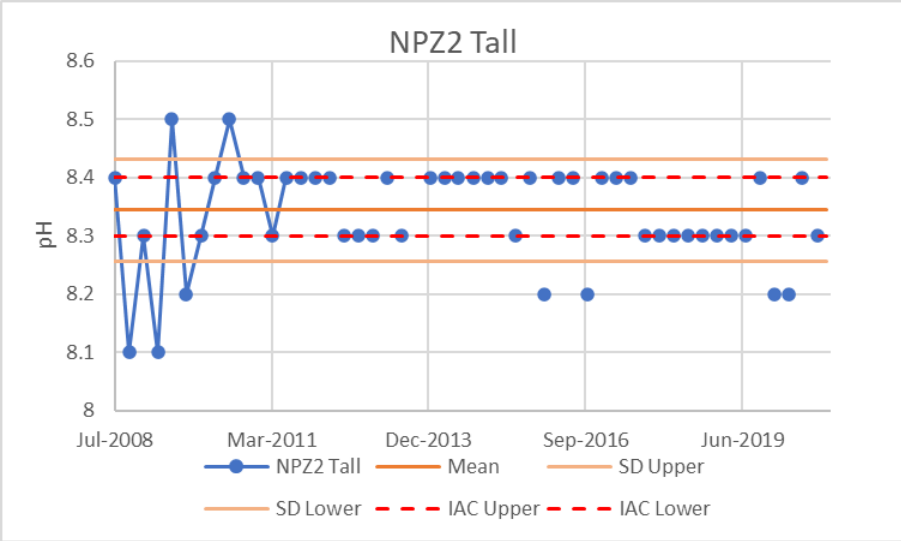


Chart A4.13 NPZ2 Tall Historical pH

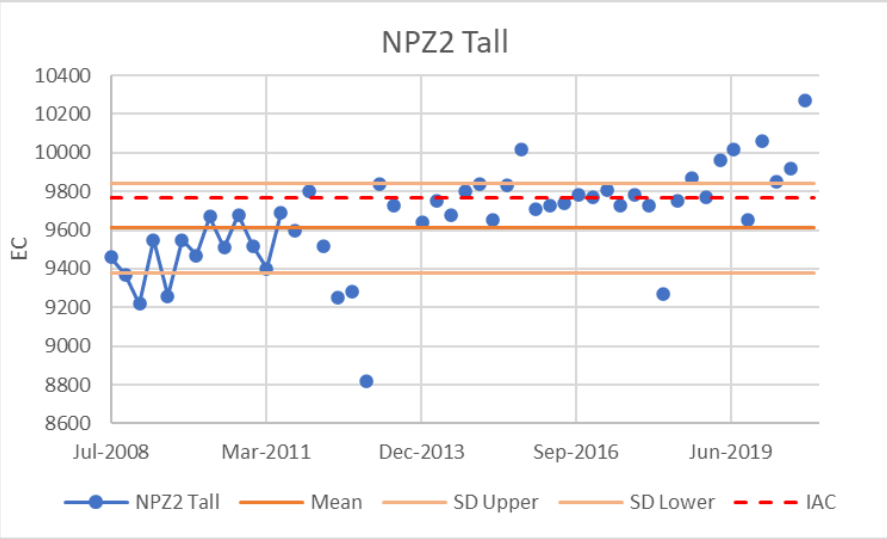


Chart A4.14 NPZ2 Tall Historical EC

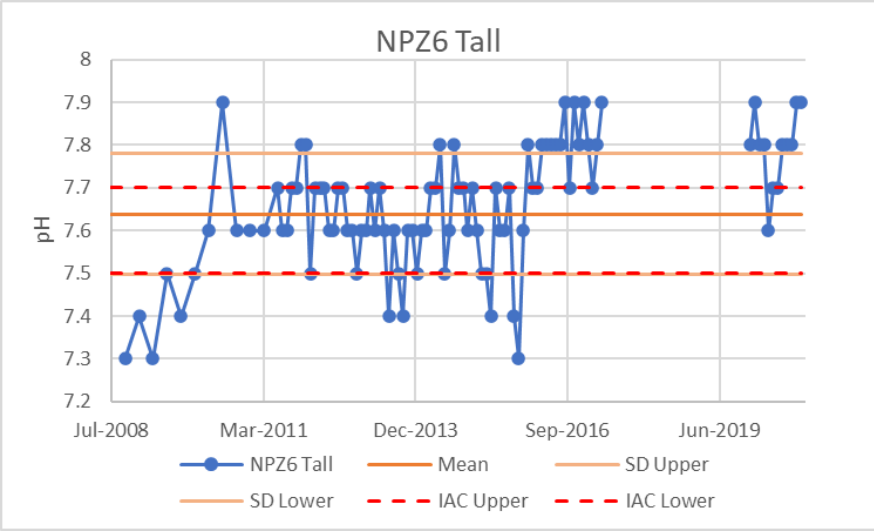


Chart A4.15 NPZ6 Tall Historical pH

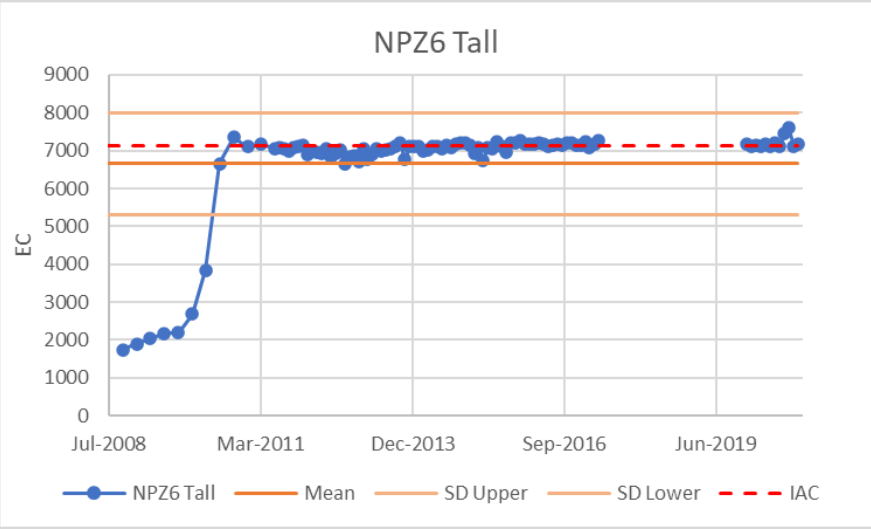


Chart A4.16 NPZ6 Tall Historical EC

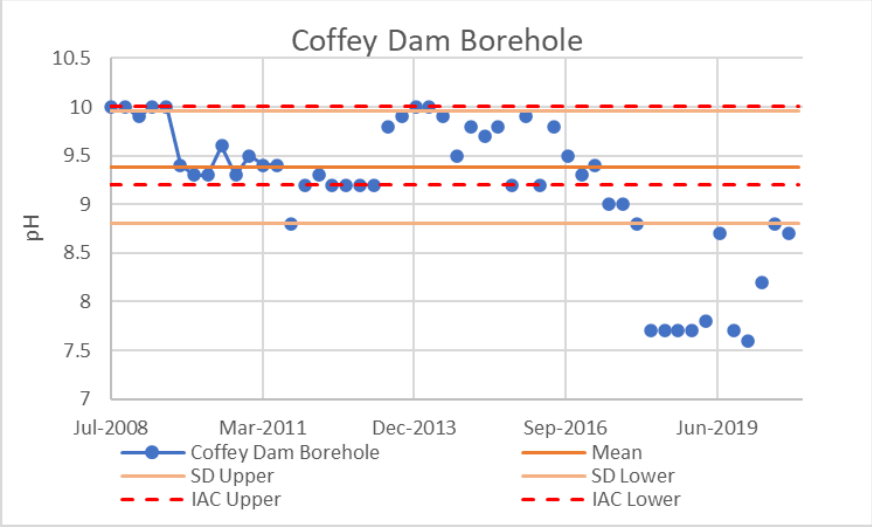


Chart A4.17 Coffey Dam Borehole Historical pH

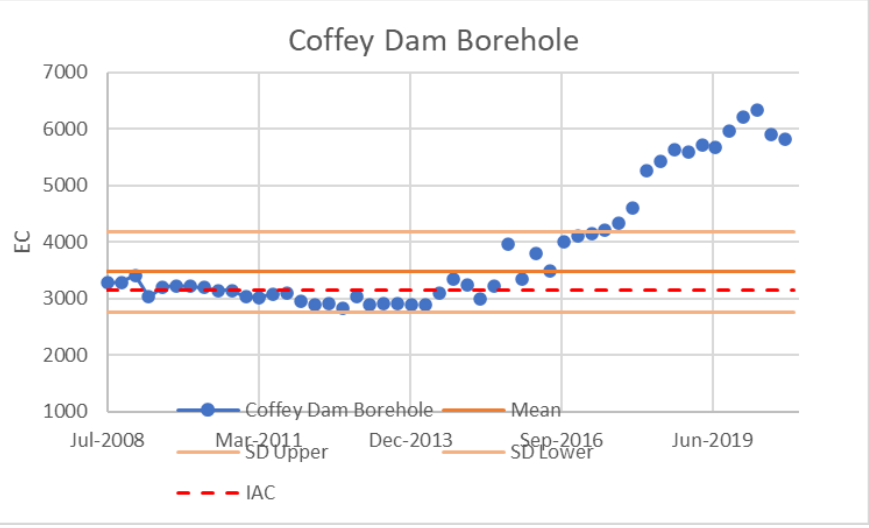


Chart A4.18 Coffey Dam Borehole Historical EC

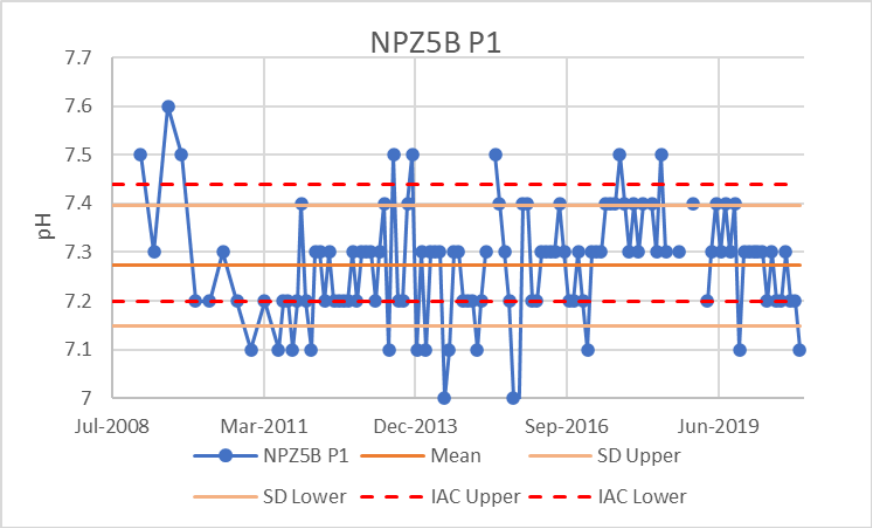


Chart A4.19 NPZ5BP1 Historical pH

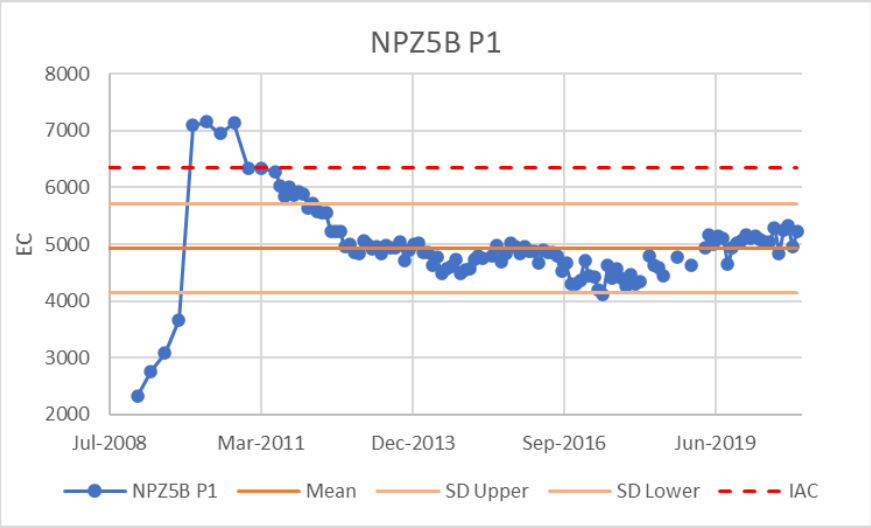


Chart A4.20 NPZ5B P1 Historical EC

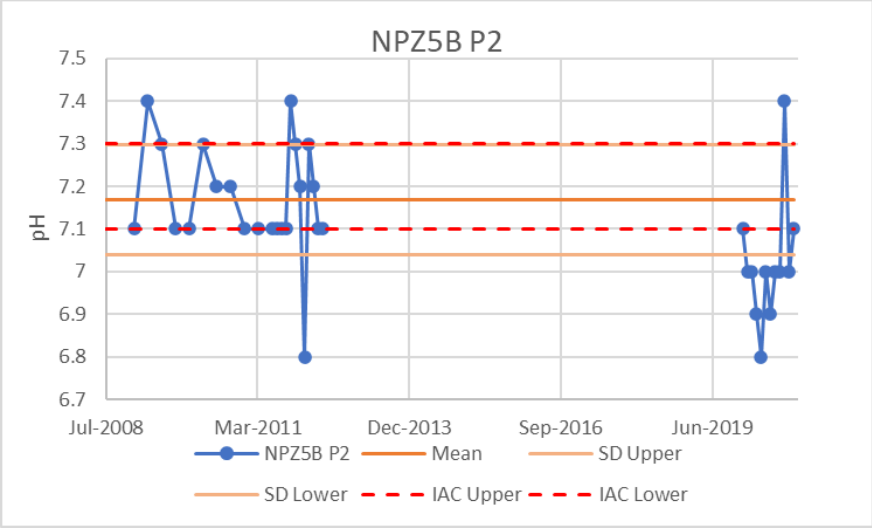


Chart A4.21 NPZ5B P2 Historical pH

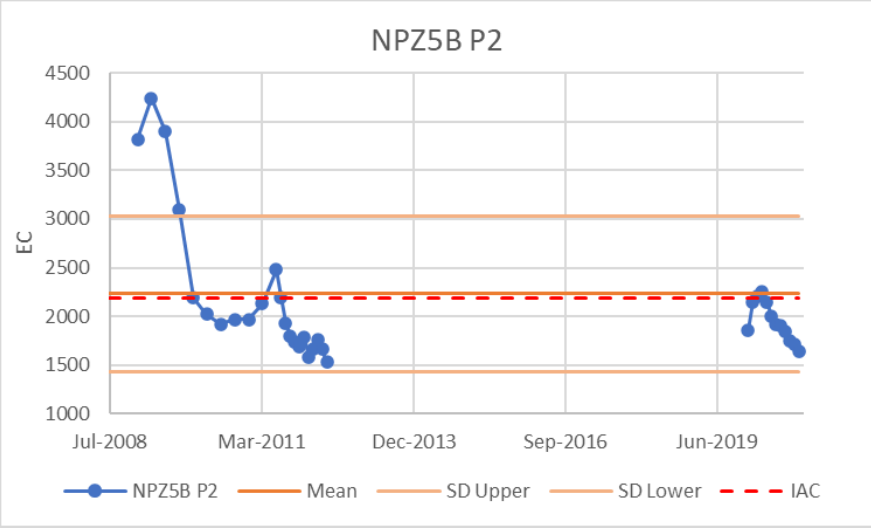


Chart A4.22 NPZ5B P2 Historical EC

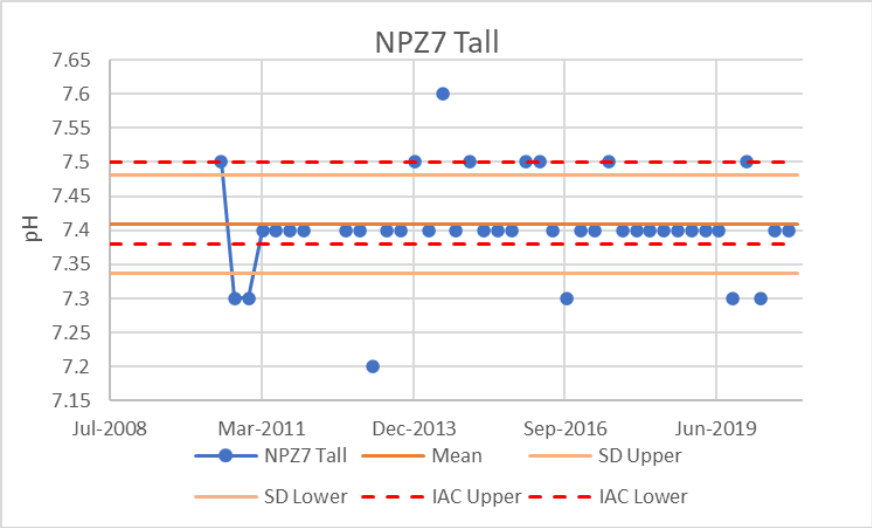


Chart A4.23 NPZ7 Tall Historical pH

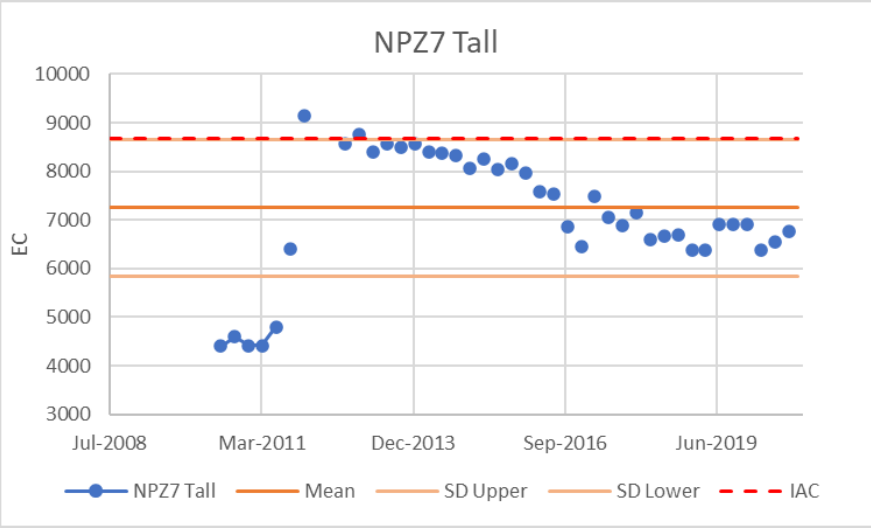


Chart A4.24 NPZ7 Tall Historical EC

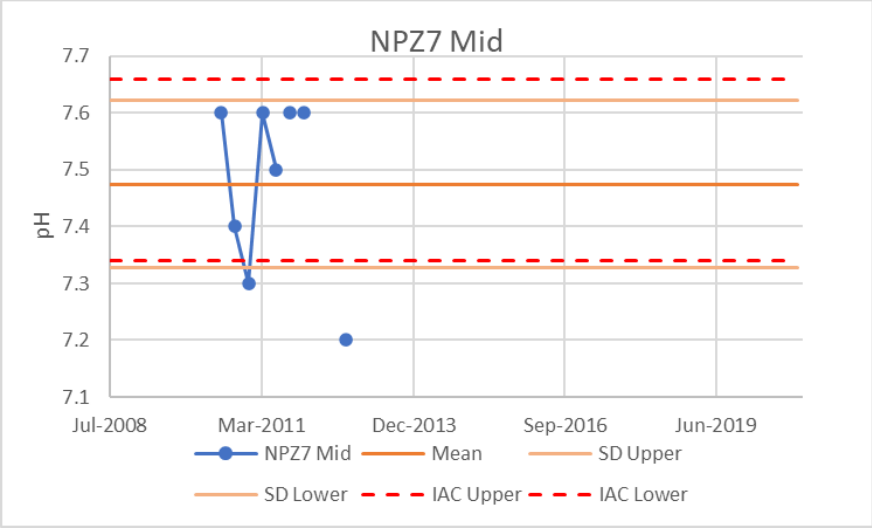


Chart A4.25 NPZ7 Mid Historical pH

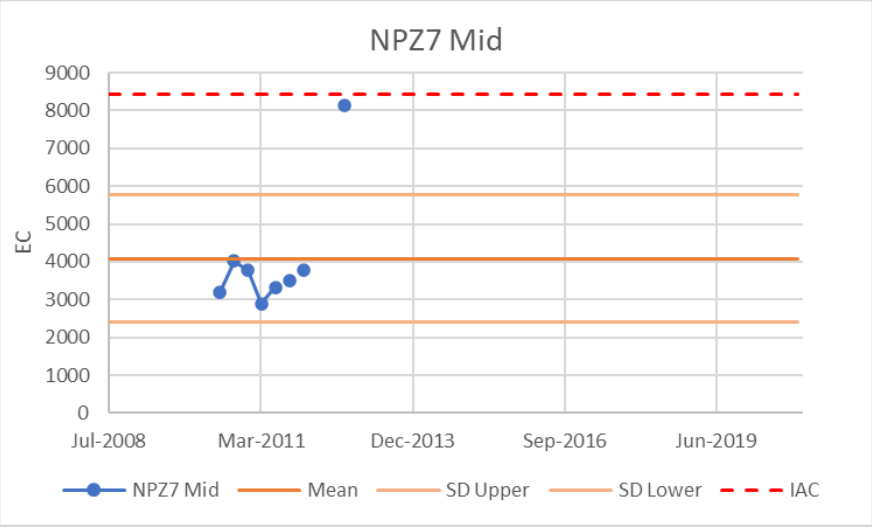


Chart A4.26 NPZ7 Mid Historical EC

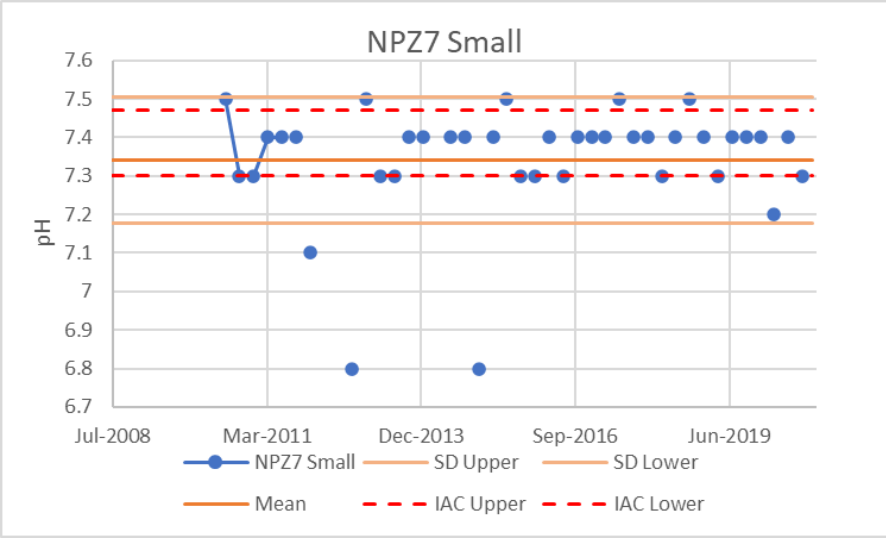


Chart A4.27 NPZ7 Small Historical pH

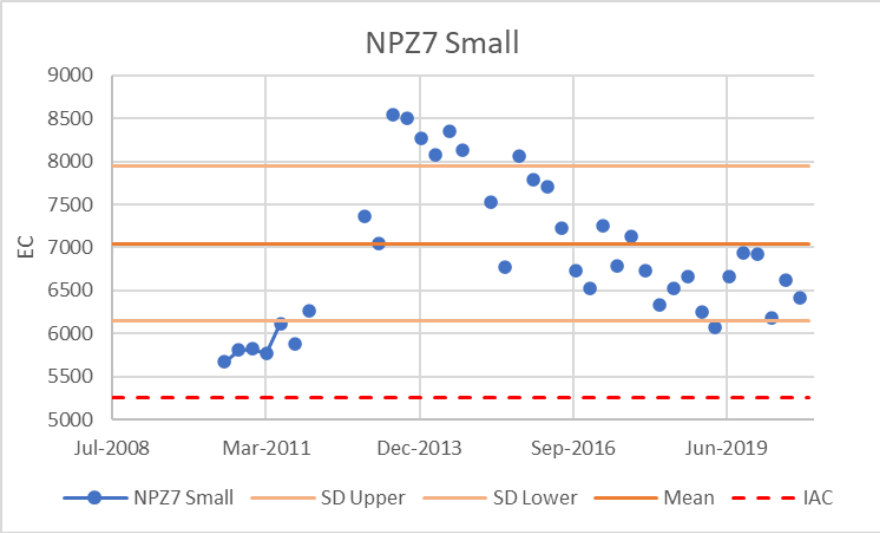


Chart A4.28 NPZ7 Small Historical EC

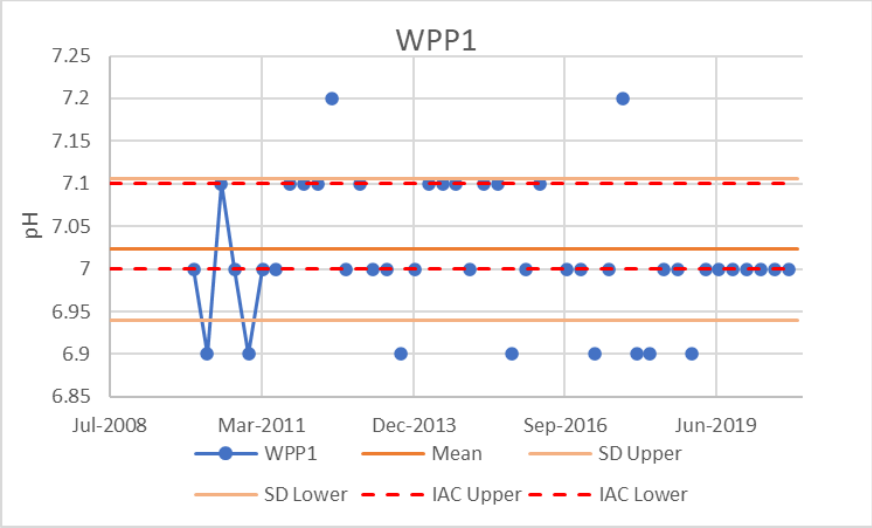


Chart A4.29 WPP1 Historical pH

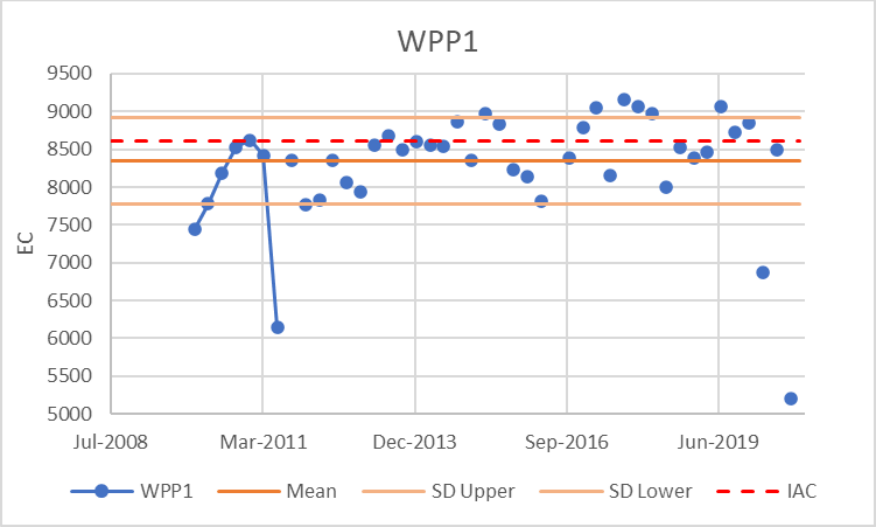


Chart A4.30 WPP1 Historical EC

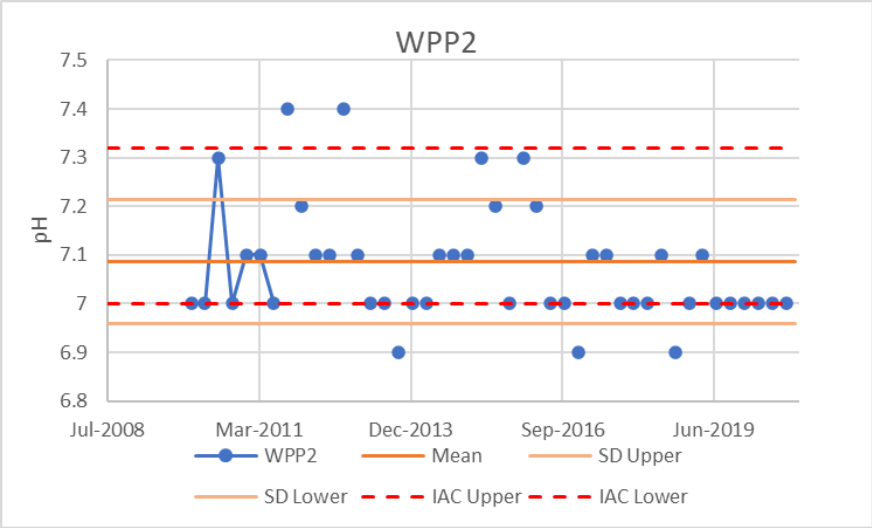


Chart A4.31 WPP2 Historical pH

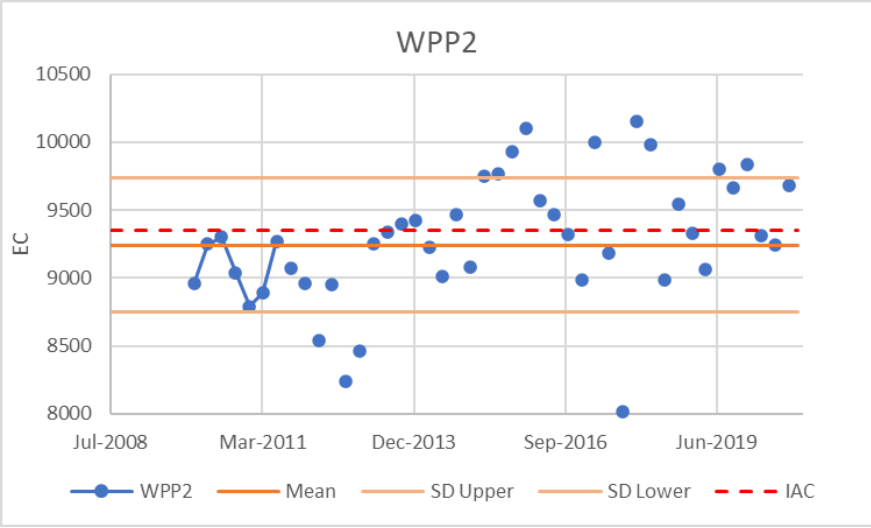
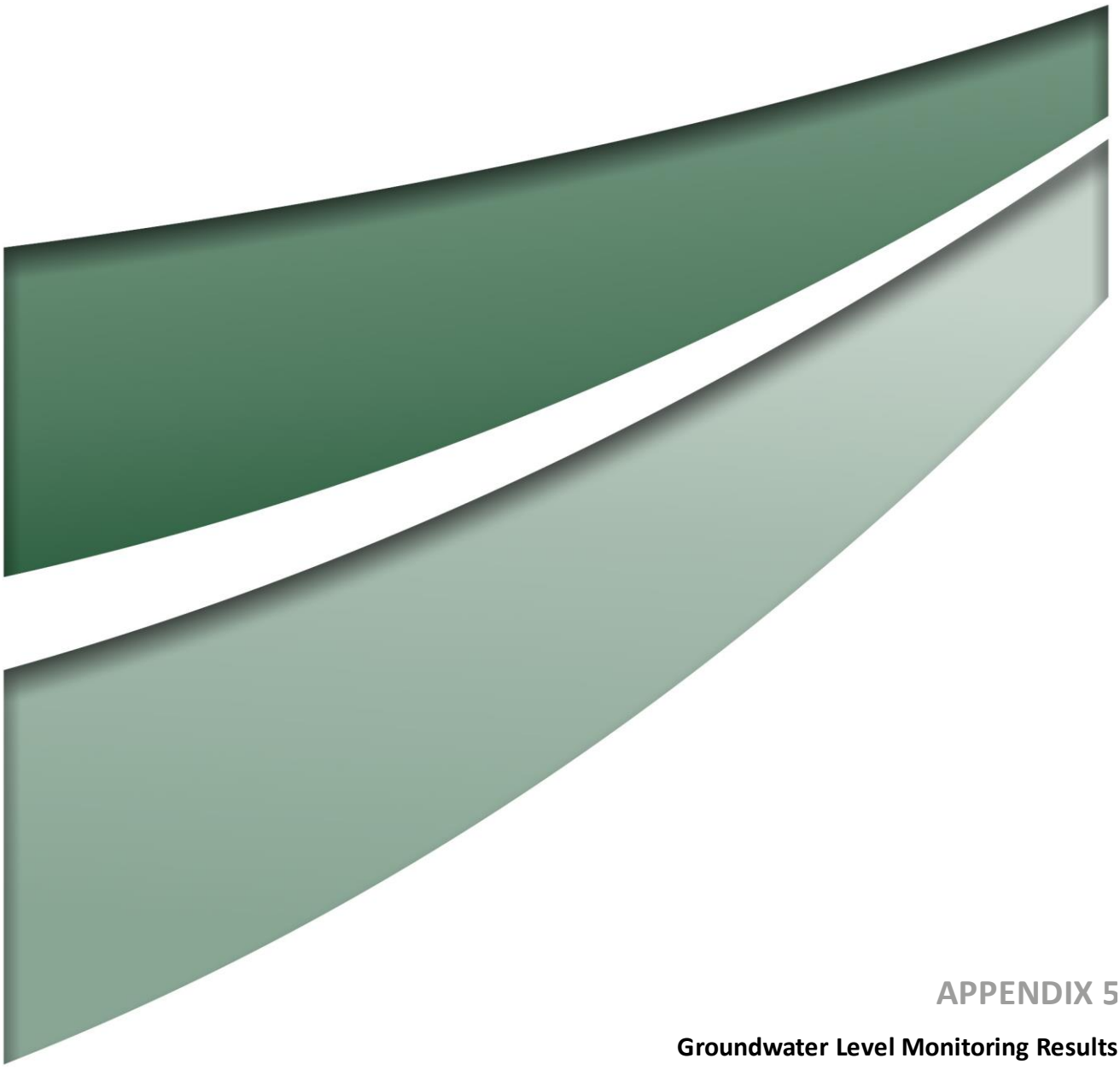


Chart A4.32 WPP2 Historical EC



APPENDIX 5

Groundwater Level Monitoring Results

Table A5.1 Ravensworth Mining Complex Groundwater Levels for 2020

BOREHOLE	Coffey Dam Borehole		CS4539A (S2)		CS4545 (S4)		CS4545B (Tall)		CS4545B (Small)		CS4641C		NPZ1 Tall		NPZ2 Tall		NPZ6 Tall	
COLLAR LEVEL (RL)	100.35		135.32		82.65		82.65		82.65		81.64		91.43		100.86		76.32	
DATE	DEPTH	RL	DEPTH	RL	DEPTH	RL	DEPTH	RL	DEPTH	RL	DEPTH	RL	DEPTH	RL	DEPTH	RL	DEPTH	RL
Jan-20	44.52	55.83									100.76	-19.12	60.07	31.36	67.61	33.25	11.75	64.57
Feb-20	44.57	55.78									100.80	-19.16	60.13	31.30	67.38	33.48	11.73	64.59
Mar-20	44.61	55.74									100.70	-19.06	60.28	31.15	67.67	33.19	11.85	64.47
Apr-20	44.65	55.70									100.56	-18.92	60.62	30.81	67.77	33.09	12.00	64.32
May-20	44.72	55.63									100.51	-18.87	59.08	32.35	67.93	32.93	12.00	64.32
Jun-20	44.77	55.58									100.49	-18.85	58.99	32.44	67.54	33.32	11.95	64.37
Jul-20	44.79	55.56									100.85	-19.21	58.10	33.33	68.17	32.69	12.09	64.23
Aug-20	44.85	55.50									100.48	-18.84	58.42	33.01	67.57	33.29	12.51	63.81
Sep-20	44.89	55.46									100.57	-18.93	57.50	33.93	67.58	33.28	12.64	63.68
Oct-20	44.92	55.43									100.53	-18.89	57.49	33.94	67.83	33.03	12.82	63.50
Nov-20	44.94	55.41									100.51	-18.87	57.41	34.02	67.30	33.56	12.97	63.35
Dec-20	45.01	55.34									100.73	-19.09	57.33	34.10	67.42	33.44	13.05	63.27

Table A5.2 Ravensworth Mining Complex Groundwater Levels for 2020

BOREHOLE	NPZ5B P1		WPPP1		WPPP2		NPZ7 Tall		NPZ7 Mid		NPZ7 Small		MW01		MW02		SDH16	
COLLAR LEVEL (RL)	76.00		108.00		110.00		62.00		62.00		62.00		72.00		76.00		96.90	
DATE	DEPTH	RL	DEPTH	RL	DEPTH	RL	DEPTH	RL	DEPTH	RL	DEPTH	RL	DEPTH	RL	DEPTH	RL	DEPTH	RL
Jan-20	17.35	58.65	4.14	103.86	6.23	103.77	28.33	33.58			31.77	30.14					82.36	14.54
Feb-20	17.24	58.76	2.91	105.09	5.37	104.63	28.19	33.72			31.83	30.08					82.56	14.34
Mar-20	16.80	59.20	3.37	104.63	5.57	104.43	28.05	33.86			31.61	30.30					82.77	14.13
Apr-20	16.32	59.68	2.77	105.23	5.06	104.94	27.88	34.03			31.34	30.57					82.95	13.95
May-20	16.16	59.84	3.15	104.85	5.32	104.68	27.94	33.97			31.35	30.56					83.26	13.64
Jun-20	16.10	59.90	3.26	104.74	5.33	104.67	27.74	34.17			31.06	30.85					83.48	13.42
Jul-20	16.08	59.92	3.49	104.51	5.51	104.49	27.58	34.33			30.69	31.22					83.56	13.34
Aug-20	15.68	60.32	1.85	106.15	4.32	105.68	25.17	36.74			29.21	32.70					83.69	13.21
Sep-20	15.73	60.27	2.53	105.47	4.65	105.35	25.47	36.44			29.28	32.63					83.84	13.06
Oct-20	15.93	60.07	2.76	105.24	4.85	105.15	26.55	35.36			29.37	32.54					83.85	13.05
Nov-20	15.93	60.07	2.03	105.97	4.25	105.75	26.49	35.42			29.30	32.61					83.69	13.21
Dec-20	16.06	59.94	2.60	105.40	4.69	105.31	26.59	35.32			29.39	32.52					83.41	13.49

Table A5.3 Ravensworth Mining Complex Groundwater Levels for 2020

BOREHOLE	MW1		MW2		MW3		MW4		MW5		MW6		MW9		MW10		MW12		Borehole P	
COLLAR LEVEL (RL)	86.76		87.25		86.58		86.75		86.50		82.08		77.29		81.47		79.75		82.06	
DATE	DEPTH	RL	DEPTH	RL	DEPTH	RL	DEPTH	RL	DEPTH	RL	DEPTH	RL	DEPTH	RL	DEPTH	RL	DEPTH	RL	DEPTH	RL
Jan-20	20.45	66.31	24.08	63.17	23.97	62.61	23.67	63.08	23.42	63.08	0.42	81.66	20.11	57.00	14.61	66.85	13.56	66.10	79.62	2.44
Feb-20																			85.64	-3.58
Mar-20																			91.92	-9.86
Apr-20	20.97	65.79	24.03	63.22	23.92	62.66	23.59	63.16	23.32	63.18	3.23	78.85	20.17	56.94	14.43	67.03	13.79	65.87	90.66	-8.60
May-20																			92.09	-10.03
Jun-20																			92.04	-9.98
Jul-20	21.55	65.21	24.13	63.12	24.02	62.56	23.78	62.97	23.48	63.02	5.69	76.39	20.27	56.84	14.57	66.89	14.18	65.48	91.99	-9.93
Aug-20																			91.96	-9.90
Sep-20																			92.04	-9.98
Oct-20	21.70	65.06	24.30	62.95	24.14	62.44	23.61	63.14	23.61	62.89	6.39	75.69	20.20	56.91	14.93	66.53	15.18	64.48	91.99	-9.93
Nov-20																			91.91	-9.85
Dec-20																			91.81	-9.75

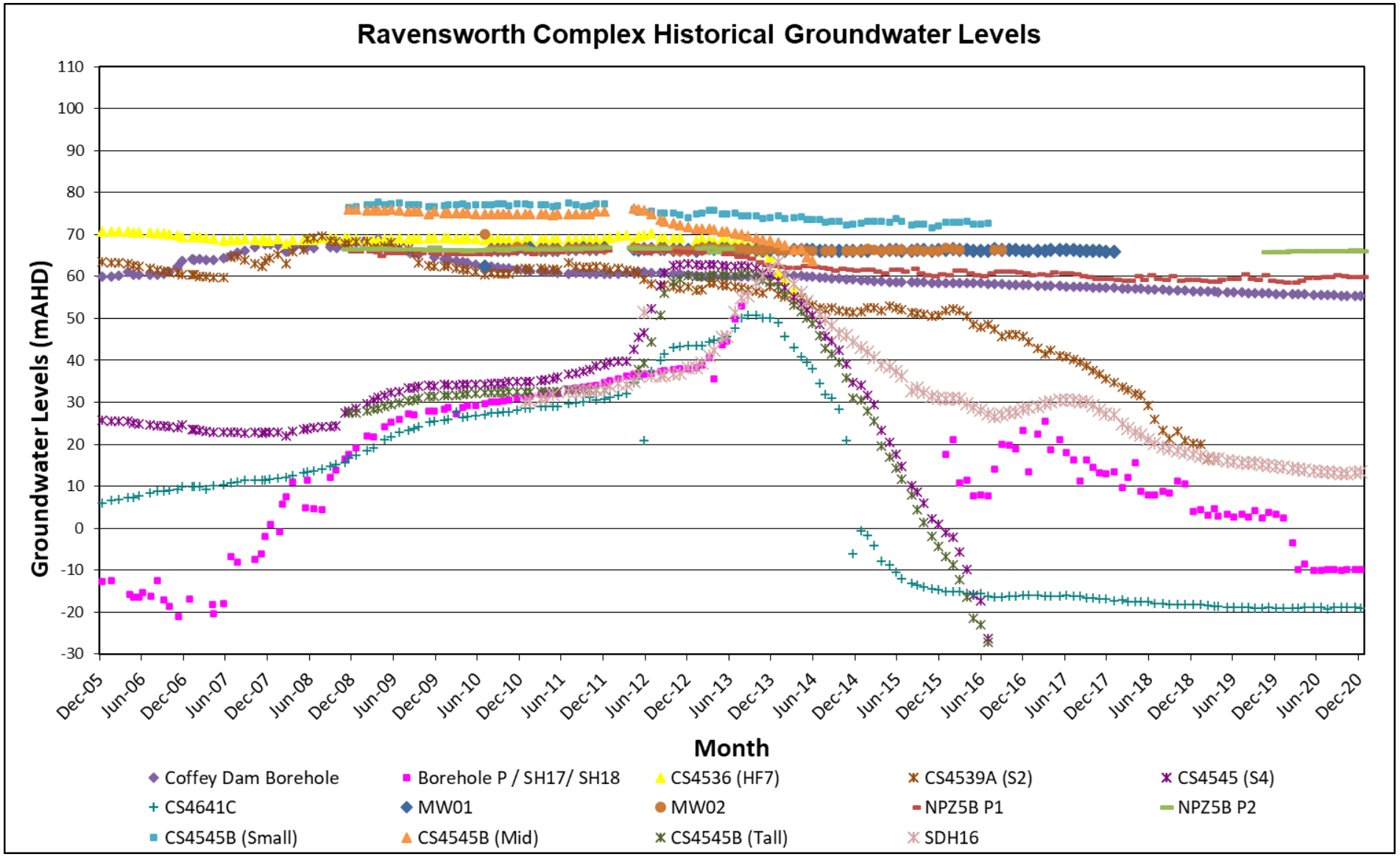


Chart A5.1 Ravensworth Mining Complex Historical Groundwater Levels

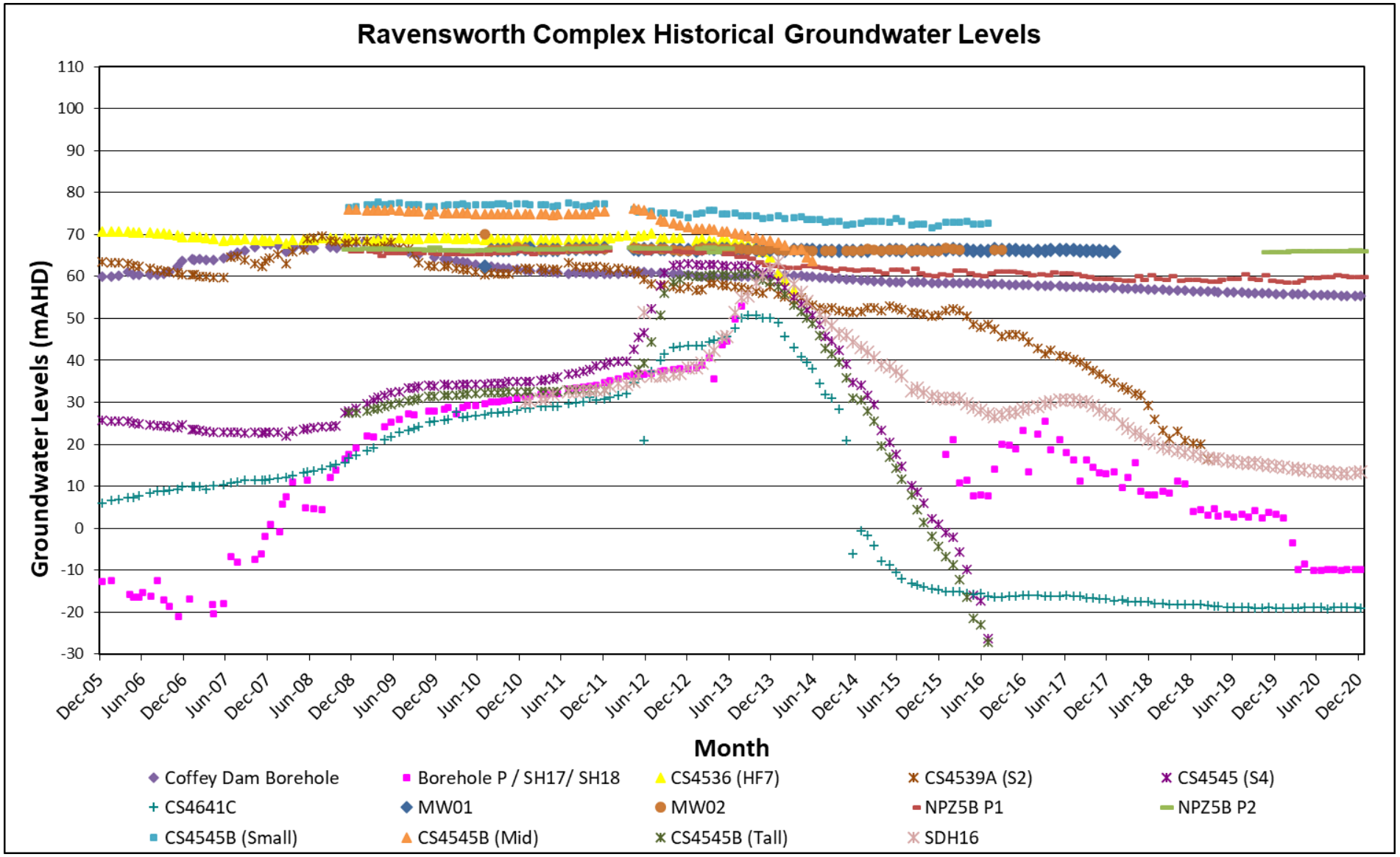


Chart A5.2 Ravensworth Mining Complex Historical Groundwater Levels

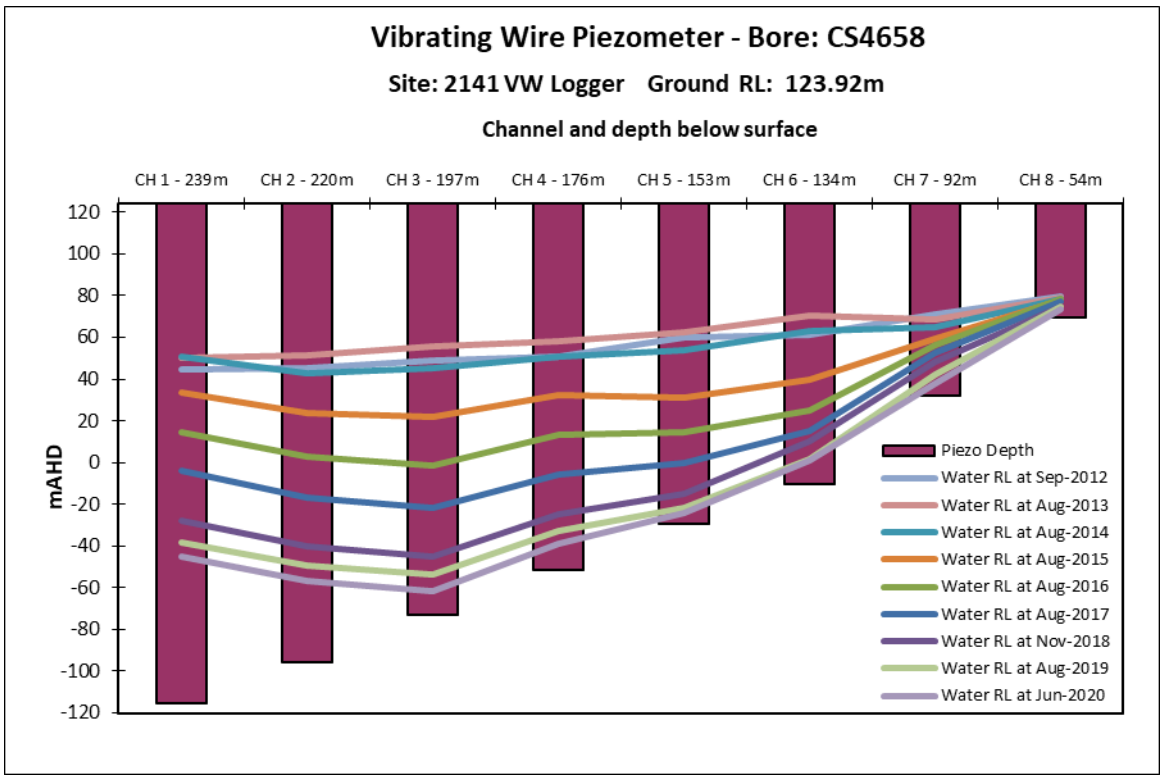


Chart A5.3 Vibrating Wire Piezometer - Bore: CS4658 (Site 2141)

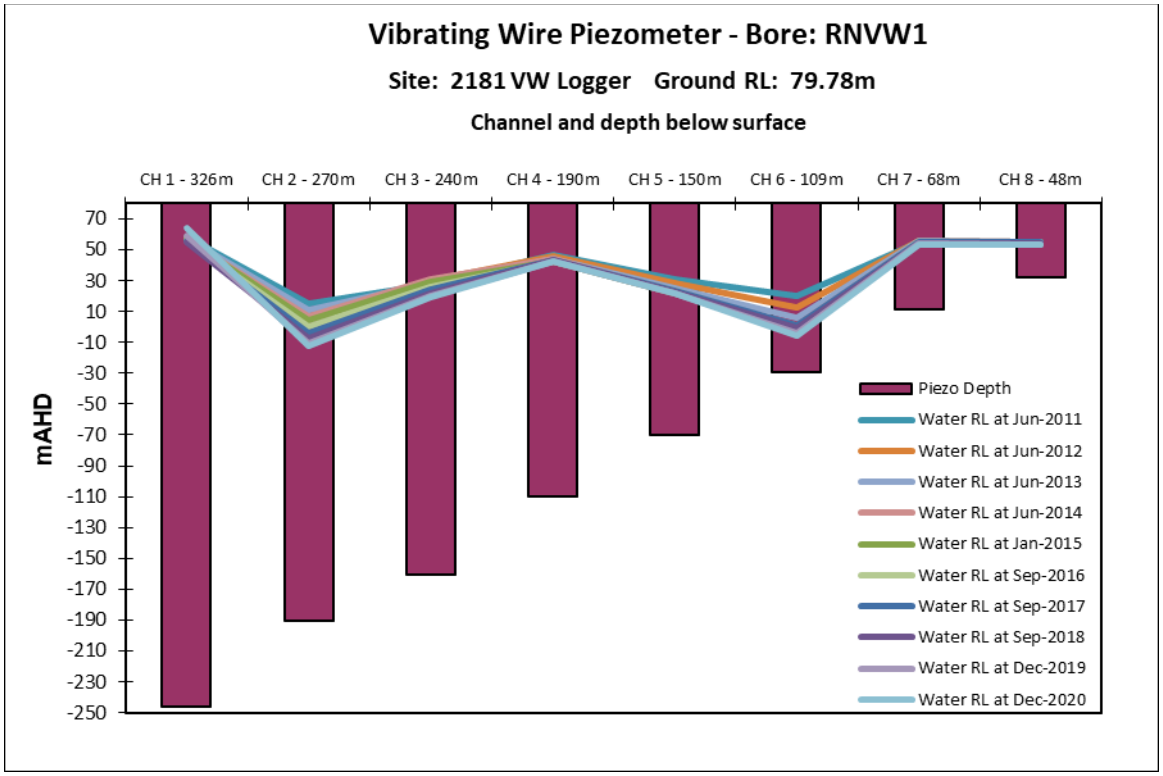


Chart A5.4 Vibrating Wire Piezometer - Bore: RNVW1 (Site 2181)

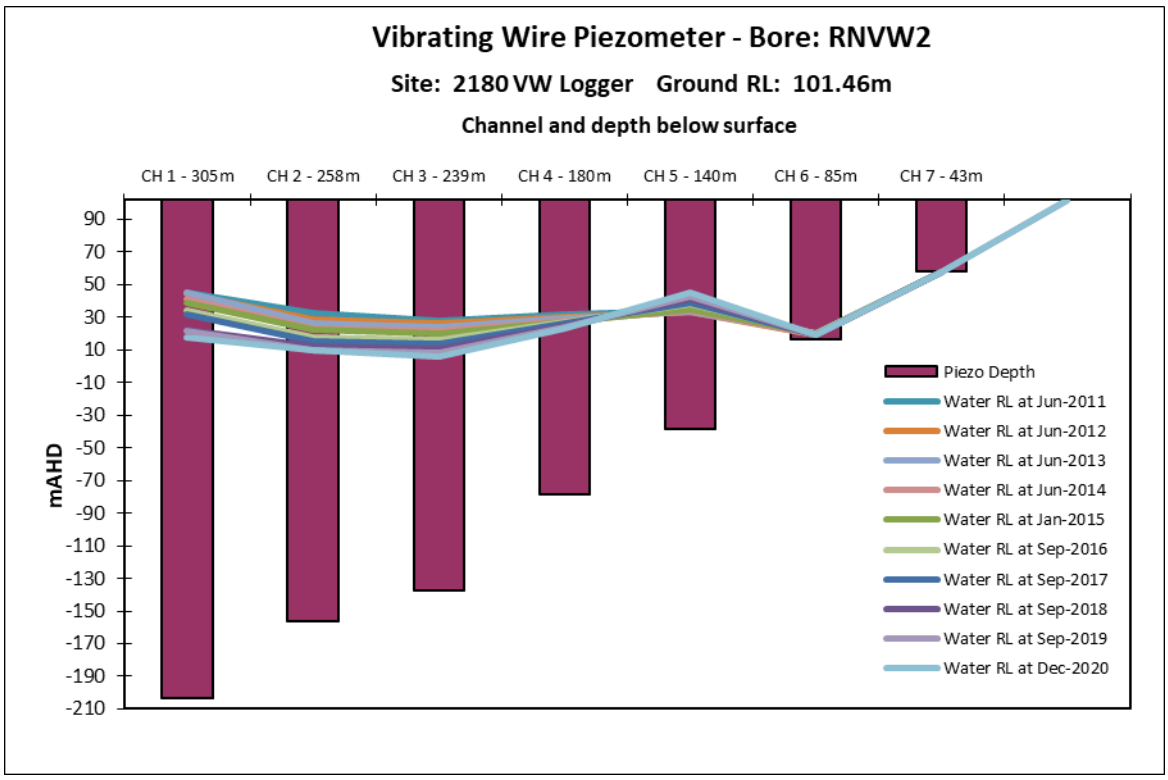


Chart A5.5 Vibrating Wire Piezometer - Bore: RNVW2 (Site 2180)

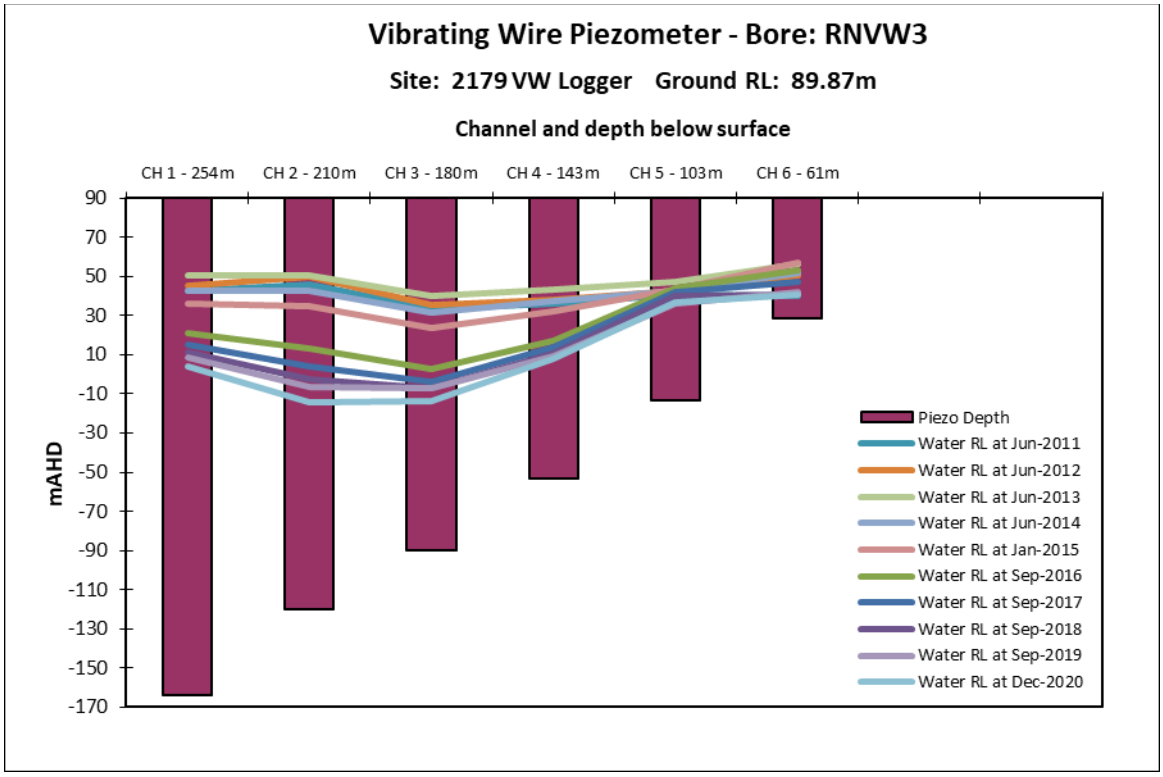


Chart A5.6 Vibrating Wire Piezometer - Bore: RNVW3 (Site 2179)

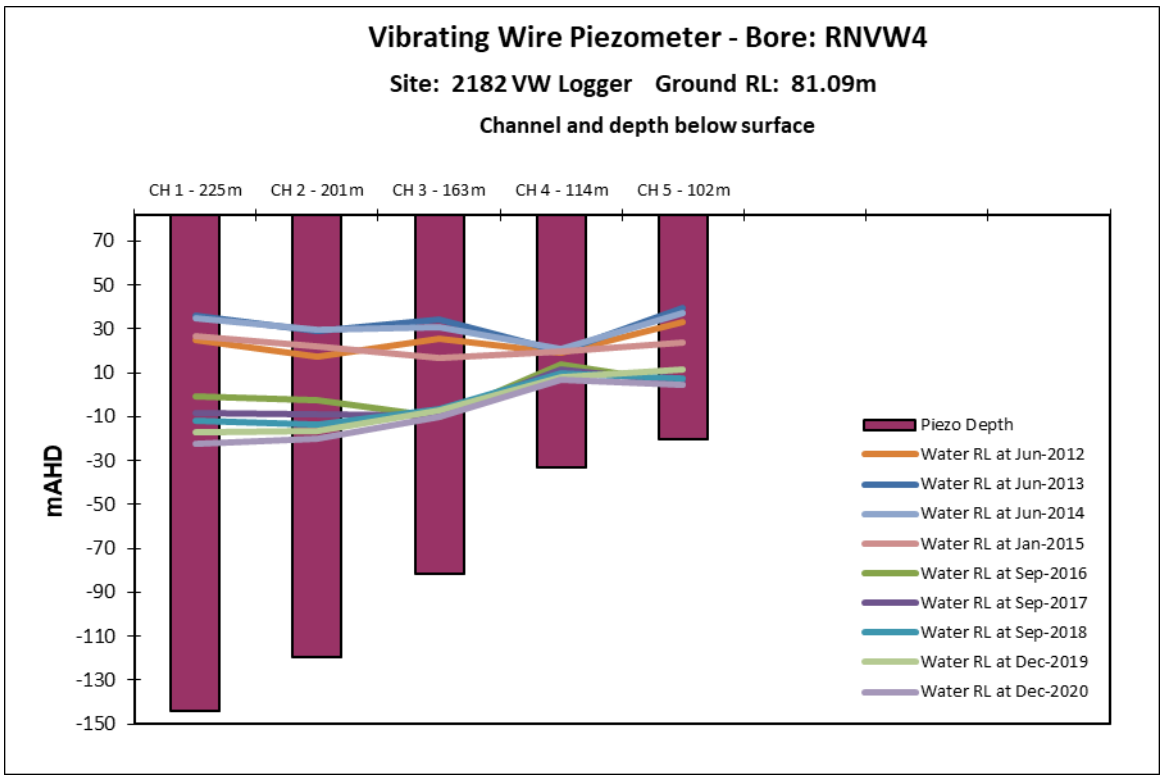


Chart A5.7 Vibrating Wire Piezometer - Bore: Bore RNVW4 (Site 2182)

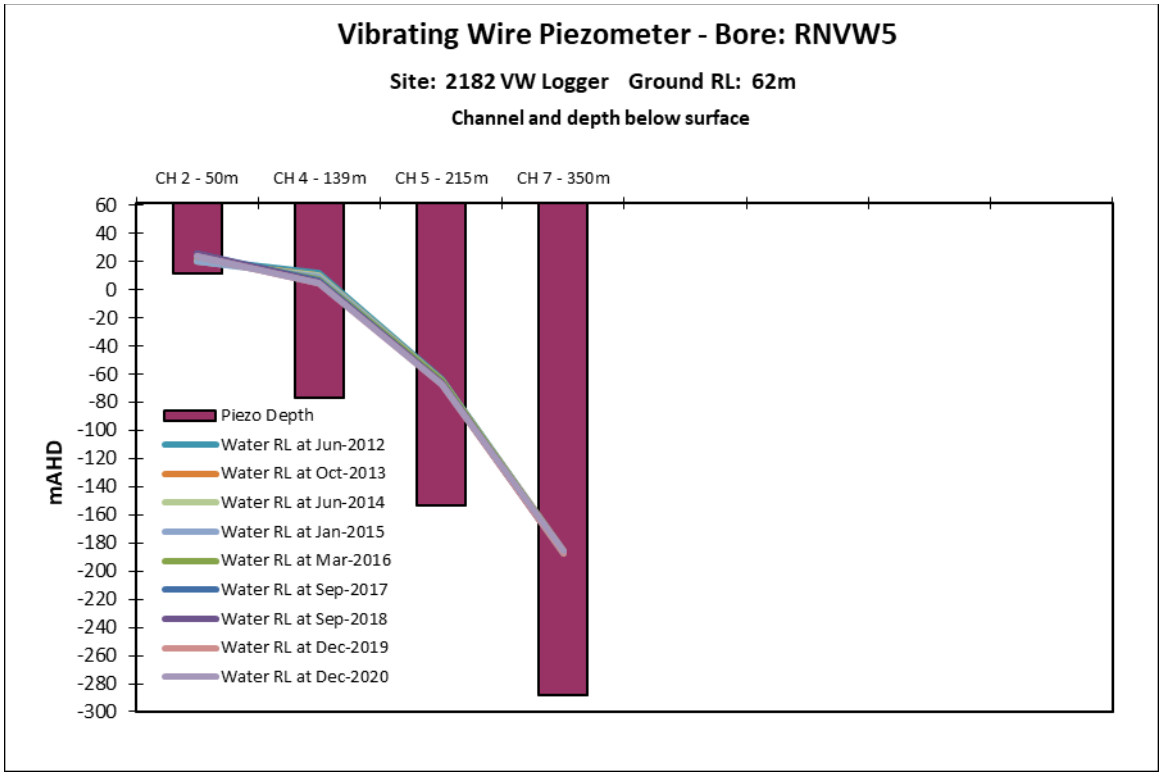


Chart A5.8 Vibrating Wire Piezometer - Bore: RNVW5 (Site: 2182)

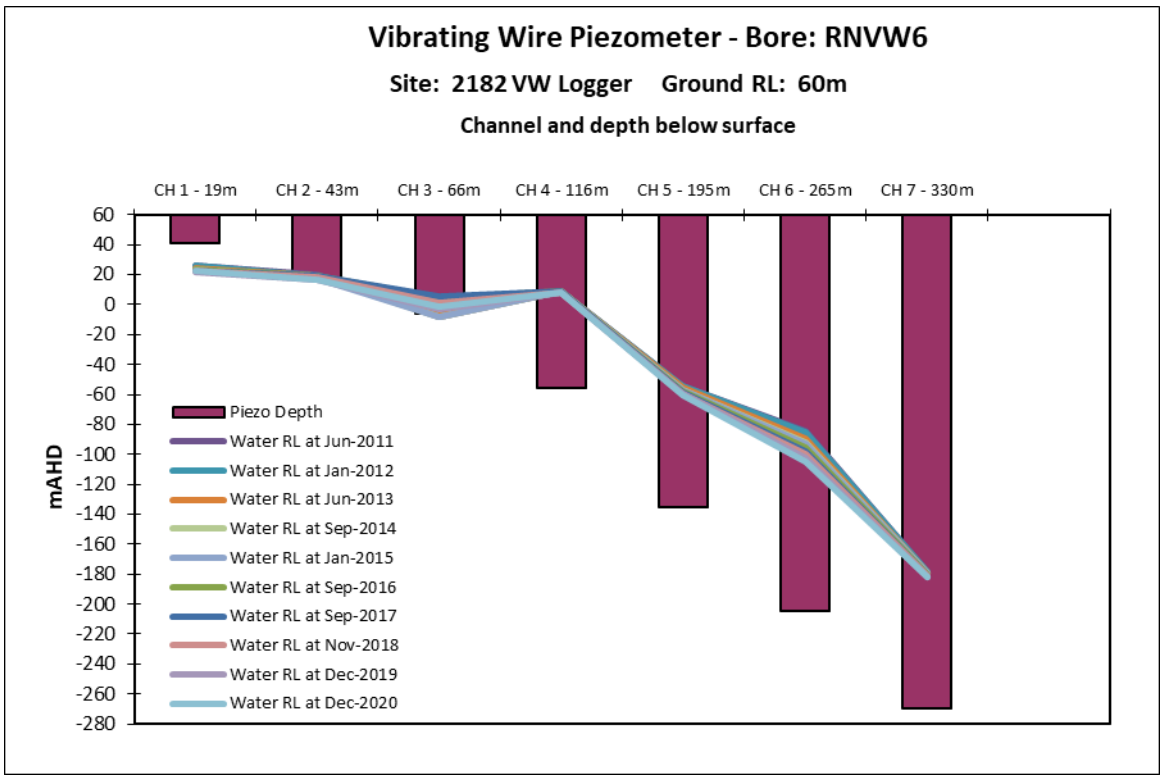


Chart A5.9 Vibrating Wire Piezometer - Bore: RNVW6 (Site: 2282)

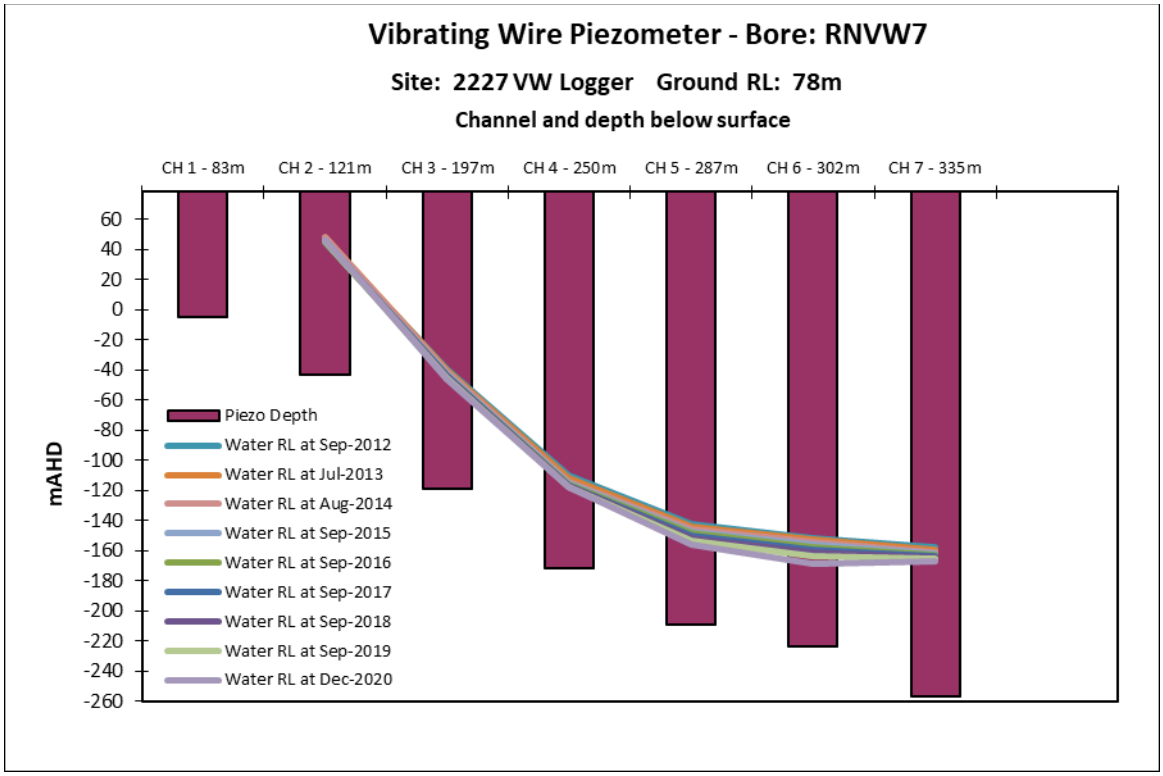


Chart A5.10 Vibrating Wire Piezometer - Bore: RNVW7 (Site: 2227)

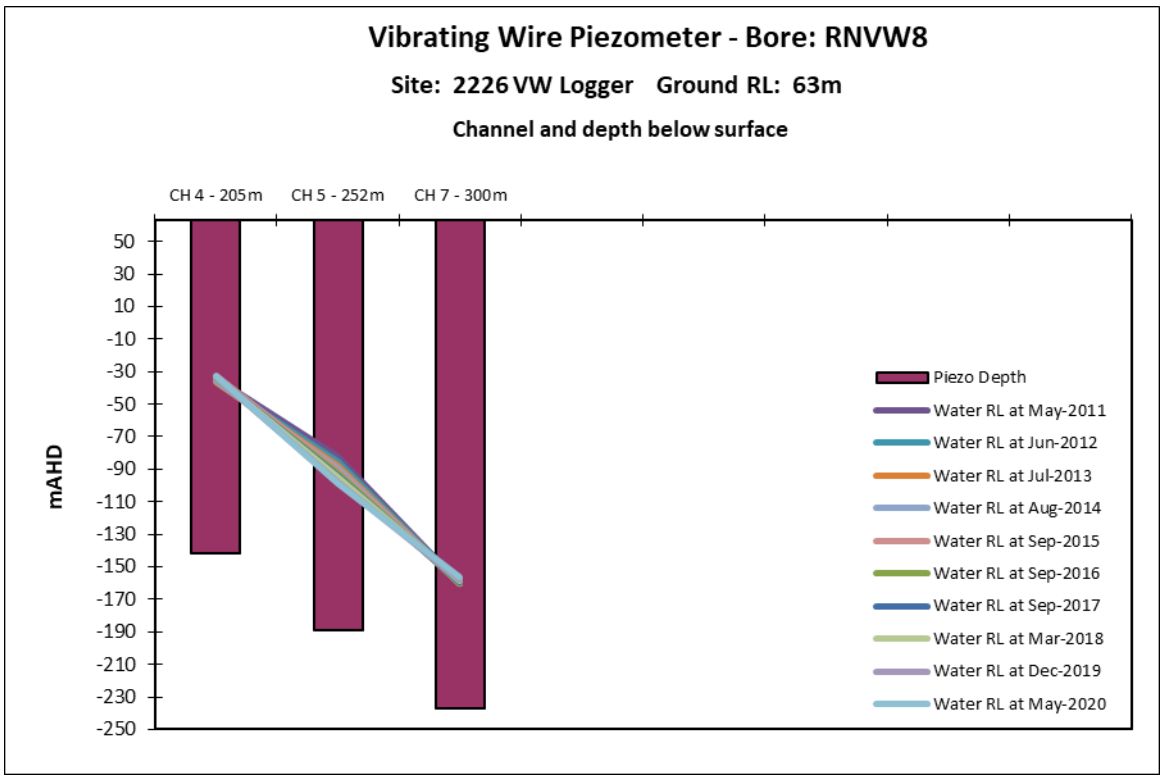


Chart A5.11 Vibrating Wire Piezometer - Bore: RNVW8 (Site: 2226)

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Appendix H - Rehabilitation Monitoring Summary (Koru Environmental, 2021)

Progress against MOP Completion Criteria – Pasture IEM Blocks

Indicator	Completion Criteria	Rehabilitation Progress	Monitoring Block Status 2020		
			NA-GP-2018-1	NA-GP-2018-2	NA-GP-2017
Landform Establishment Phase					
Land shaping	Overburden dumps developed progressively to a height of ~230m RL (northern dump) and ~190m RL (eastern dump), or final landform as agreed with RR.	Rehabilitation is being undertaken progressively, and land shaping across all blocks appeared consistent with approved final landform design.	Acceptable	Acceptable	Acceptable
Slopes	Slopes are generally consistent with MOD 2 EA.	Established slopes with moderate to steep gradients (10-20 degrees), but consistent with MOD 2 EA specifications in inspected areas.	Acceptable	Acceptable	Acceptable
Deep ripping	Deep ripping undertaken to allow bedding of the topdressing materials.	Deep ripping was consistently implemented across the contour in inspected areas.	Acceptable	Acceptable	Acceptable
Growth Medium Development Phase					
Ameliorates	Ameliorants are spread at the recommended rate per hectare as recommended by soil analysis appropriate to the final land use.	Soil testing is routinely implemented prior top-dressing to determine ameliorants requirements, and documented in internal 'rehabilitation establishment record' forms or internal GIS database.	Acceptable	Acceptable	Acceptable
Soils	Topsoil or suitable alternative spread uniformly at the specified depth appropriate to the final land use.	Excellent topsoil cover recorded across all monitoring locations (measured during the 2019 monitoring event), ranging from 120mm to 400+ mm in depth.	Acceptable	Acceptable	Acceptable
Pasture seed mix	Pasture mix comprises palatable grasses and legumes appropriate to the district and suitable for cattle grazing.	The seed mix used for pasture rehabilitation areas is adequate and comprises a mix of suitable grasses and legume species.	Acceptable	Acceptable	Acceptable
Ecosystem and Land Use Establishment Phase					
Soil quality	Bare areas of soil >400m2 are tested for pH, EC, ESP, Macro nutrients and trace elements.	Not applicable to young rehabilitation at IEM stage where vegetation is considered as still establishing. However, good vegetation establishment observed throughout in the 2018 blocks, but very poor	Acceptable	Acceptable	Maintenance

Indicator	Completion Criteria	Rehabilitation Progress	Monitoring Block Status 2020		
			NA-GP-2018-1	NA-GP-2018-2	NA-GP-2017
		establishment in the eastern section of the 2017 block			
Weed presence	Weed presence does not pose a risk to the establishment of rehabilitation areas.	Severe infestations of Galenia and/or Golden wreath wattle (well-established or establishing) remained in all blocks, posing a real risk to successful pasture establishment.	Maintenance	Maintenance	Maintenance
Pest animal presence	Pest animal presence does not pose a risk to the establishment of rehabilitation areas.	Feral pigs and rabbits/hare were observed in the blocks during previous monitoring years. However, no evidence of damage from vertebrate pests was recorded as impacting the rehabilitation in 2020.	Acceptable	Acceptable	Acceptable
Species composition	Pasture composition comprises palatable grasses and legumes appropriate to the district and suitable for grazing.	Satisfactory diversity of desirable pasture species occurred in all blocks, however desirable species on average dominated the pasture live biomass only in the 2017 rehabilitation block.	Maintenance	Maintenance	Monitor

Assessment against TARP – Pasture IEM blocks

TARP element	Condition assessment	Status 2020
Monitoring block: NA-GP-2018-1		
Erosion control	Most low severity rill erosion assessed as stabilising, however localised gully channels to 40cm deep remain - **2nd level trigger activated.**	Monitor
Free draining landforms	No ponding or drainage issues recorded – **TARP not activated.**	Acceptable
Water management structures	No water management structures present in block – **TARP not activated.**	n/a
Ground cover protection	Average protective ground cover >95% – **TARP not activated.**	Acceptable
Weed presence	Priority weed cover measured at monitoring sites averaged ~66%. Widespread and severe infestations of Galenia and Golden wreath wattle recorded in block - **2nd level trigger activated.**	Maintenance
Pasture composition	Desirable pasture species on average comprising ~25% of pasture composition - **2nd level trigger activated.**	Maintenance
Pest animals	No significant impacts evidenced – **TARP not activated.**	Acceptable
Native fauna control	Macropods present, but minimal damage observed – **TARP not activated.**	Acceptable
Monitoring block: NA-GP-2018-2		

TARP element	Condition assessment	Status 2020
Erosion control	Most low severity rill erosion assessed as stabilising; however 2 x severe erosion gullies (55-90cm deep) remain requiring repair - **2nd level trigger activated.**	Maintenance
Free draining landforms	No ponding or drainage issues recorded – **TARP not activated.**	Acceptable
Water management structures	No water management structures present in block – **TARP not activated.**	n/a
Ground cover protection	Average protective ground cover >85% – **TARP not activated.**	Acceptable
Weed presence	Priority weed cover measured at monitoring sites averaged ~24%. Widespread and severe infestations of Galenia recorded in block - **2nd level trigger activated.**	Maintenance
Pasture composition	Desirable pasture species on average comprising ~63% of pasture composition – **1st level trigger activated.**	Maintenance
Pest animals	No significant impacts evidenced – **TARP not activated.**	Acceptable
Native fauna control	Macropods present, but minimal damage observed – **TARP not activated.**	Acceptable
Monitoring block: NA-GP-2017		
Erosion control	Erosion issues remained across eastern section of block, with numerous gully channels to 50-80cm deep and frequent rills of lower severity – **2nd level trigger activated.**	Rework
Free draining landforms	Significant drainage issues across the eastern section resulting from breached contour banks. Surface flows currently drain into the void through the many gully channels – **2nd level trigger activated.**	Rework
Water management structures	Contour banks have failed at a multitude of locations – **2nd level trigger activated.**	Rework
Ground cover protection	Average protective ground cover ~65%– **1st level trigger activated.**	Maintenance
Weed presence	Priority weed cover measured at monitoring sites averaged ~5%. Widespread infestation of Galenia recorded in block - **1st level trigger activated.**	Maintenance
Pasture composition	Desirable pasture species on average comprising ~78% of pasture composition – **TARP not activated.**	Acceptable
Pest animals	No significant impacts evidenced – **TARP not activated.**	Acceptable
Native fauna control	Macropods present, but minimal damage observed – **TARP not activated.**	Acceptable

Progress against MOP Completion Criteria – CHGBIW IEM Blocks

Indicator	Completion Criteria	Rehabilitation Progress	Monitoring Block Status 2020			
			NA-CHGBIW-2018-1	NA-CHGBIW-2018-2	RN-CHGBIW-2017	RN-CHGBIW-2017
Landform Establishment Phase						
Land shaping	Overburden dumps developed progressively to a height of ~230m RL (northern dump) and ~190m RL (eastern dump), or final landform as agreed with RR.	Rehabilitation is being undertaken progressively, and land shaping appeared consistent with approved final landform design in all blocks assessed.	Acceptable	Acceptable	Acceptable	Acceptable
Slopes	Slopes are generally consistent with MOD 2 EA.	Slopes and natural undulating landforms established as per MOD 2 EA specifications.	Acceptable	Acceptable	Acceptable	Acceptable
Deep ripping	Deep ripping undertaken to allow bedding of the topdressing materials.	Deep ripping was consistently implemented across the contour in inspected areas, where practical. Deep ripping was generally implemented in areas of natural relief landforms, where it is impractical to do so as a function of very steep gradients.	Acceptable	Acceptable	Acceptable	Acceptable
Growth Medium Development Phase						
Ameliorates	Ameliorants are spread at the recommended rate per hectare as recommended by soil analysis appropriate to the final land use.	Soil testing is routinely implemented prior top-dressing to determine ameliorants requirements, and documented in internal 'rehabilitation establishment record' forms or internal GIS database.	Acceptable	Acceptable	Acceptable	Acceptable
Soils	Topsoil or suitable alternative spread uniformly at the specified depth appropriate to the final land use.	Excellent topsoil cover recorded across all monitoring locations (measured during the 2019 monitoring event), ranging from 100mm to 500+ mm in depth	Acceptable	Acceptable	Acceptable	Acceptable
Pasture seed mix	Performance against benchmark values published by NSW Government or collects at analogue sites.	The seed mix used for woodland rehabilitation was revised by external consultants in 2017, 2018 and 2019 to better align with the targeted CHGBIW; and is regularly reviewed and improved based on the results of the rehabilitation monitoring program.	Acceptable	Acceptable	Acceptable	Acceptable
Ecosystem and Land Use Establishment Phase						

Indicator	Completion Criteria	Rehabilitation Progress	Monitoring Block Status 2020			
			NA-CHGBIW-2018-1	NA-CHGBIW-2018-2	RN-CHGBIW-2017	RN-CHGBIW-2017
Soil quality	Bare areas of soil >400m2 are tested for pH, EC, ESP, Macro nutrients and trace elements.	Not applicable to young rehabilitation at IEM stage where vegetation is considered as still establishing. Generally good ground cover establishment recorded throughout all blocks	Acceptable	Acceptable	Acceptable	Acceptable
Weed presence	Weed presence does not pose a risk to the establishment of rehabilitation areas.	Severe and widespread infestations of Galenia (well-established or establishing) recorded in two of the four blocks. Weed levels low in the other two blocks. A high diversity of priority weeds occurs in all blocks. The prevalence of most species is currently low but a potential risk exists for future spread without ongoing routine weed management.	Maintenance	Monitor	Monitor	Maintenance
Pest animal presence	Pest animal presence does not pose a risk to the establishment of rehabilitation areas.	Presence of rabbits/hares and mice was noted throughout most rehabilitation areas. However, associated damage/impacts were negligible and not threatening rehabilitation establishment	Acceptable	Acceptable	Acceptable	Acceptable
Species composition	Habitat features, including structures suitable for target species are incorporated into rehabilitation areas at required densities, where appropriate.	Satisfactory densities of artificial habitat features were established in all blocks where feasible in the landform (i.e. excluding areas of natural undulating landforms with very steep gradients). Incoprorated features included rock piles, log piles, fallen habitat trees and artificial pond/depressions to provide ephemeral aquatic habitat.	Acceptable	Acceptable	Acceptable	Acceptable

Assessment against TARP – CHGBIW IEM blocks

TARP element	Condition assessment	Status 2020
Monitoring block: NA-CHGBIW-2018-1		
Erosion control	One small localised gully channel to 50 cm deep recorded on slope along the eastern boundary. Assessed as unlikely to warrant repairs in current state but with potential to further degrade - **2nd level trigger activated**.	Monitor
Free draining landforms	No ponding or significant drainage issues recorded (other than erosion in water management structures) – **TARP not activated**.	Acceptable
Water management structures	One location recorded with fully breached contour bank. Assessed as unlikely to warrant repairs in current state but with potential to further degrade - **2nd level trigger activated**.	Monitor
Ground cover protection	Recorded average protective ground cover >95% – **TARP not activated**.	Acceptable
Weed presence	Priority weed cover measured at monitoring sites averaged ~17%. Widespread and severe infestations of Galenia recorded in block - **2nd level trigger activated**.	Maintenance
Pasture composition	Establishing shrub and tree seedlings observed as healthy and growing– **TARP not activated**.	Acceptable
Pest animals	No significant impacts evidenced **– TARP not activated**.	Acceptable
Native fauna control	Macropods present, but minimal damage observed – **TARP not activated**.	Acceptable
Monitoring block: NA-CHGBIW-2018-2		
Erosion control	Several areas recorded with superficial active rill erosion (<20cm deep) posing minimal concern. Instances of severe active gullying remained in areas of steeper gradients of the natural landform or at the convergence of slopes. Several channels recorded of moderate (20-50cm deep) to high (50-100cm) severity, some of the latter likely to require repair if not rapidly stabilising – **2nd level trigger activated**.	Maintenance
Free draining landforms	No ponding or drainage issues recorded – **TARP not activated**.	Acceptable
Water management structures	Drainage structure well performing with minimal erosion / scouring recorded– **TARP not activated**.	Acceptable
Ground cover protection	Recorded average protective ground cover ~90% – **TARP not activated**.	Acceptable
Weed presence	Priority weed cover measured at monitoring sites averaged <1.0%. No severe or widespread weed infestations recorded in block in 2020 following successful control of Galenia infestations mapped in 2019. Several priority weeds / HTEs occur at currently low intensities across the block, with potential risk of spread without the ongoing implementation of the routine and pro-active weed control program – **TARP not activated**.	Monitor
Pasture composition	Establishing shrub and tree seedlings observed as healthy and growing– **TARP not activated**.	Acceptable
Pest animals	No significant impacts evidenced – **TARP not activated**.	Acceptable

TARP element	Condition assessment	Status 2020
Native fauna control	Macropods present, but minimal damage observed – **TARP not activated**.	Acceptable
Monitoring block: RN-CHGBIW-2018		
Erosion control	All residual slope erosion processes assessed as fully stabilised, demonstrating successful outcomes of the 2018 localised remediation works – **TARP not activated.**	Acceptable
Free draining landforms	No ponding or significant drainage issues recorded (other than erosion in water management structures) – **TARP not activated.**	Acceptable
Water management structures	Localised breaching/overtopping of contour banks recorded in 2019 were all confirmed as stabilised and no longer threatening landform stability/integrity. Severe active gullying remained in and on the batters of the large dendritic rock-lined structure to the south of the block which will require repair works – **2nd level trigger activated.**	Maintenance
Ground cover protection	Recorded average protective ground cover ~80% – **TARP not activated.**	Acceptable
Weed presence	Priority weed cover measured at monitoring sites averaged <1.0%. No severe or widespread weed infestations recorded in block in 2020. Several priority weeds / HTEs occur at currently low intensities across the block, with potential risk of spread without the ongoing implementation of the routine and pro-active weed control program – **TARP not activated.**	Monitor
Pasture composition	Establishing shrub and tree seedlings observed as healthy and growing– **TARP not activated.**	Acceptable
Pest animals	No significant impacts evidenced – **TARP not activated.**	Acceptable
Native fauna control	Macropods present, but minimal damage observed – **TARP not activated.**	Acceptable
Monitoring block: RN-CHGBIW-2018		
Erosion control	Several areas remained with active moderate severity rill erosion to 20-50cm where ground cover has not yet successfully established on concave slopes of the undulating landforms. With considerations to the impracticalities of implementing repair works in areas of very steep slope, and provided that vegetation successfully establishes, these areas may not require repair in their current condition. However, several active gully channels of high severity (80-120cm deep) remained which will require remediation – **2nd level trigger activated**.	Maintenance
Free draining landforms	No ponding or significant drainage issues recorded (other than erosion in water management structures) – **TARP not activated.**	Acceptable
Water management structures	Localised breaching/overtopping of contour banks recorded in 2019 were all confirmed as stabilised and no longer threatening landform stability/integrity. Several of the recorded gully features occurred within the drainage channels of the undulating landform at the convergence of concave slopes, which will require to be repaired – **2nd level trigger activated.**	Maintenance

TARP element	Condition assessment	Status 2020
Ground cover protection	Recorded average protective ground cover >90% – **TARP not activated**.	Acceptable
Weed presence	Priority weed cover measured at monitoring sites averaged ~17%. Widespread and severe infestations of Galenia recorded in block, increased in extent and severity since assessed in 2019 - **2nd level trigger activated.** Several other priority weeds / HTEs also occur but at currently low intensities across the block, with potential risk of spread without the ongoing implementation of the routine and pro-active weed control program.	Maintenance
Pasture composition	Establishing shrub and tree seedlings observed as healthy and growing– **TARP not activated**.	Acceptable
Pest animals	No significant impacts evidenced – **TARP not activated**.	Acceptable
Native fauna control	Macropods present, but minimal damage observed – **TARP not activated**.	Acceptable

Progress against MOP Completion Criteria – CHGBIW LTM Blocks

Indicator	Completion Criteria	Rehabilitation Progress	Monitoring Block Status 2020				
			NA-CHGBIW-B1	NA-CHGBIW-B2	NA-CHGBIW-B3	RN-CHGBIW-B1	RN-CHGBIW-B2
Ecosystem and Land Use Establishment Phase							
Soil quality	Bare areas of soil >400m2 are tested for pH, EC, ESP, Macro nutrients and trace elements.	Bare patches were mapped and confirmed in two of the five blocks, from which soil sampled were collected and analysed. Potential issues of alkalinity, salinity, sodicity and/or spontaneous combustion were highlighted which will need to be further investigated. Vegetation establishment is satisfactory in the other three blocks with no bare patches recorded.	Maintenance	Maintenance	Acceptable	Acceptable	Acceptable
Weed presence	Weed presence does not pose a risk to the establishment of rehabilitation areas.	Severe and widespread infestations of tropical pasture grasses, Galenia, Golden wreath wattle and/or Saffron thistle were recorded in all blocks which will require continued management inputs A high diversity of other priority weeds also occurs in all blocks. The prevalence of most species is currently low but a potential risk exists for future spread without ongoing routine weed management.	Maintenance	Maintenance	Maintenance	Maintenance	Maintenance
Pest animal presence	Pest animal presence does not pose a risk to the establishment of rehabilitation areas.	Presence of rabbits/hares was noted throughout most rehabilitation areas. However, associated damage/impacts were negligible and not threatening rehabilitation establishment	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
Habitat features	Habitat features, including structures suitable for target species are incorporated into rehabilitation areas at required densities, where appropriate.	Habitat features have not been incorporated in all of the LTM blocks at Narama monitored in 2020. Habitat features are also generally lacking across the two blocks monitored at Ravensworth North (only a couple of isolated rock piles / fallen habitat trees recorded)	Maintenance	Maintenance	Maintenance	Maintenance	Maintenance

Indicator	Completion Criteria	Rehabilitation Progress	Monitoring Block Status 2020				
			NA-CHGBIW-B1	NA-CHGBIW-B2	NA-CHGBIW-B3	RN-CHGBIW-B1	RN-CHGBIW-B2
Ecosystem and Land Use Sustainability Phase							
Final rehabilitation	Revegetation areas contain flora species assemblages characteristic of each strata for the desired native vegetation communities.	The composition of the shrub layer is generally satisfactory throughout but the tree layer composition is overall inadequately aligned to the targeted CHGBIW in all blocks. In the ground layer, established native species are generally characteristic of CHGBIW but total species richness remains low. The prevalence of exotic species also remains locally high in the lower and/or mid storey layers.	Maintenance	Maintenance	Maintenance	Maintenance	Maintenance
Biometric vegetation attributes	Performance against benchmark values published by NSW government or collects at analogue sites.	Current vegetative performance remains below benchmarks for most structural and functional attributes, reflecting the young ecological age of the rehabilitation (i.e. expected to naturally improve as rehabilitation matures). Performance against compositional attributes benchmarks highly variable between and within blocks. However, total native species richness benchmarks (accounting for all strata) generally achieved in the Ravensworth North blocks, but no met in the Narama blocks where improvements in native biodiversity will be required to be achieved.	Maintenance	Maintenance	Maintenance	Monitor	Monitor

Indicator	Completion Criteria	Rehabilitation Progress	Monitoring Block Status 2020				
			NA-CHGBIW-B1	NA-CHGBIW-B2	NA-CHGBIW-B3	RN-CHGBIW-B1	RN-CHGBIW-B2
Habitat value	Habitat suitable for target species present.	Current habitat value of the rehabilitation is moderate. Locally high diversity of native species (especially at Ravensworth North), the established mid-storey layer and the accumulating litter layer provide some food sources and potential refuge/shelter for native fauna to utilise or move across the landscape. However, vegetation complexity and stratification remain limited due to ecologically young age of vegetation. The tree layer is not yet well-established and the low densities of canopy eucalypts may prove a barrier to this successfully occurring in the long term. In addition, artificial features have generally not been incorporated in the five blocks assessed which could enhance/complement habitat value.	Monitor	Monitor	Monitor	Monitor	Monitor
Faunal species	Monitoring confirms target native fauna species are recorded utilising rehabilitation areas.	Monitoring for fauna presence was not included in the scope of works of this rehabilitation monitoring program.	n/a	n/a	n/a	n/a	n/a
Final and use	Where infrastructure has been removed and rehabilitation is completed, woodland rehabilitation will consist of the following vegetation communities: • Central Hunter Box-Ironbark Woodland; • Central Hunter Swamp Oak Forest; • Central Hunter Bulloak Forest Regeneration.	Based on their current state, it is unlikely that in any of the five blocks assessed the vegetation communities will successfully progress towards the target communities without at least some level of active management / improvement actions. Required actions will include all or a combination of: weed suppression, improvement of native diversity in the ground layer and canopy layer, and/or increase in canopy tree stem densities (eucalypts).	Maintenance	Maintenance	Maintenance	Maintenance	Maintenance

Assessment against TARP – CHGBIW LTM blocks

TARP element	Condition assessment	Status 2020
Monitoring block: NA-CHGBIW-B1		
Erosion control	Erosion area to the south of the block mapped in 2016 assessed as stabilising. The area includes numerous residual rill/small gully channels to 30-50cm deep but unlikely to further degrade and not requiring repair considering satisfactory vegetation establishment. One isolated small gully channel to 50 cm deep was assessed as active on the western slope, unlikely to warrant repairs in current state but with potential to further degrade - **2nd level trigger activated**.	Monitor
Free draining landforms	No ponding or significant drainage issues recorded – **TARP not activated.**	Acceptable
Water management structures	Water management structures in the block limited to one contour bank, assessed as stable and well-functioning – **TARP not activated.**	Acceptable
Ground cover protection	Protective ground cover percent not measured at the monitoring site level under revised methods. One large bare area (~0.64ha) identified in the block requiring rework - **2nd level trigger activated.**	Rework
Weed presence	Priority weed cover measured at monitoring sites averaged ~10%. Widespread and severe infestations of Galenia and Golden wreath wattle recorded in block threatening the successful establishment of the target community - **2nd level trigger activated.**	Maintenance
Pasture composition	Vegetation growth rates have evidently been impacted by the drought during the past three years, however established shrubs and trees observed as healthy and growing in 2020 – **TARP not activated.**	Acceptable
Pest animals	No significant impacts evidenced – **TARP not activated.**	Acceptable
Native fauna control	Macropods present, but minimal damage observed – **TARP not activated.**	Acceptable
Monitoring block: NA-CHGBIW-B2		
Erosion control	Only localised superficial rill erosion recorded in the block, assessed as stabilising and not requiring intervention – **TARP not activated.**	Monitor
Free draining landforms	No ponding or significant drainage issues recorded – **TARP not activated.**	Acceptable
Water management structures	No drains or contour banks present in block. One sediment dam occurs in block which adequately capture surface runoff from upslope areas – **TARP not activated.**	Acceptable
Ground cover protection	Protective ground cover percent not measured at the monitoring site level under revised methods. Two large bare areas (respectively ~800m2 and ~3,000m2 in size) identified in the block, with potential issues of alkalinity, salinity and sodicity identified - **2nd level trigger activated.**	Rework

TARP element	Condition assessment	Status 2020
Weed presence	Very low priority weed cover measured at monitoring sites (~2.0% average). Severe infestation of Golden wreath wattle established to the north of the block threatening the successful establishment of the target community - **2nd level trigger activated.**	Maintenance
Pasture composition	Vegetation growth rates have evidently been impacted by the drought during the past three years, however established shrubs and trees observed as healthy and growing in 2020 – **TARP not activated.**	Acceptable
Pest animals	No significant impacts evidenced – **TARP not activated.**	Acceptable
Native fauna control	Macropods present, but minimal damage observed – **TARP not activated.**	Acceptable
Monitoring block: NA-CHGBIW-B3		
Erosion control	No active erosion processes recorded in block nor residual erosion features requiring repair – **TARP not activated.**	Acceptable
Free draining landforms	No ponding or significant drainage issues recorded – **TARP not activated.**	Acceptable
Water management structures	No water management structures present in block – **TARP not activated.**	Acceptable
Ground cover protection	Protective ground cover percent not measured at the monitoring site level under revised methods. Good vegetative cover present throughout the block with no identified large bare areas – **TARP not activated.**	Acceptable
Weed presence	Priority weed cover measured at monitoring sites averaged >60.0%. Established vegetation in the block dominated by exotic tropical grasses in the ground layer (particularly Guinea grass and Rhodes grass) and Golden wreath wattle in the mid-storey - **2nd level trigger activated.**	Maintenance
Pasture composition	Vegetation growth rates have evidently been impacted by the drought during the past three years, however established shrubs and trees observed as healthy and growing in 2020 – **TARP not activated.**	Acceptable
Pest animals	No significant impacts evidenced – **TARP not activated**.	Acceptable
Native fauna control	Macropods present, but minimal damage observed – **TARP not activated.**	Acceptable
Monitoring block: RN-CHGBIW-B1		
Erosion control	Satisfactory slope stability across most of the block. However, severe gullying to 70-120cm deep has occurred in the main drainage channel of the natural landform area. The channel has stabilised in some areas but erosion processes remain active in others. Good access exists to the erosion areas which should be repaired – **2nd level trigger activated.**	Maintenance
Free draining landforms	No ponding or significant drainage issues recorded – **TARP not activated.**	Acceptable
Water management structures	No water management structures present in block (other than natural drainage channels within undulating landform design) – **TARP not activated.**	Maintenance

TARP element	Condition assessment	Status 2020
Ground cover protection	Protective ground cover percent not measured at the monitoring site level under revised methods. Good vegetative cover present throughout the block with no identified large bare areas – **TARP not activated.**	Acceptable
Weed presence	Very low priority weed cover measured at monitoring sites (<2% average). Moderately severe infestation of Saffron thistle mapped across the lower eastern slope Established vegetation in the block dominated by exotic tropical grasses in the ground layer (particularly Guinea grass and Rhodes grass) and Golden wreath wattle in the mid-storey – **1st level trigger activated.**	Maintenance
Pasture composition	Vegetation growth rates have evidently been impacted by the drought during the past three years, however established shrubs and trees observed as healthy and growing in 2020 – **TARP not activated.**	Acceptable
Pest animals	No significant impacts evidenced – **TARP not activated.**	Acceptable
Native fauna control	Macropods present, but minimal damage observed – **TARP not activated.**	Acceptable
Monitoring block: RN-CHGBIW-B1		
Erosion control	All severe erosion identified in 2016 successfully remediated during the 2020 rework of the WEA lower slope areas. Due to the recent completion of the remediation works, vegetation was not yet well established in the repaired areas leading to active superficial sheet erosion processes. Two gully channels to 80-90 cm remain in the northwest section of the block on the second contour. Both were assessed as likely stabilised but could be repaired considering: 1) the currently good access to the areas and 2) the moderate quality of the surrounding vegetation - **2nd level trigger activated.**	Maintenance
Free draining landforms	No ponding or significant drainage issues recorded – **TARP not activated.**	Acceptable
Water management structures	No water management structures present in block – **TARP not activated.**	Acceptable
Ground cover protection	Protective ground cover percent not measured at the monitoring site level under revised methods. Good vegetative cover present throughout the block with no identified large bare areas (other than the areas of recent erosion repairs) – **TARP not activated.**	Acceptable
Weed presence	Priority weed cover measured at monitoring sites averaged ~27%. Widespread and severe infestations of Galenia occur across the lower slopes, particularly in the south of the block. Some of the recently repaired areas were also infested with annual environmental weeds at the time of inspection (principally Mustard weeds) - **2nd level trigger activated.**	Maintenance
Pasture composition	Vegetation growth rates have evidently been impacted by the drought during the past three years, however established shrubs and trees observed as healthy and growing in 2020 – **TARP not activated.**	Acceptable
Pest animals	No significant impacts evidenced – **TARP not activated.**	Acceptable
Native fauna control	Macropods present, but minimal damage observed – **TARP not activated.**	Acceptable