CENTENNIAL

CENTENNIAL COAL
NEWSTAN COLLIERY
ANNUAL REVIEW

March 2021

Centennial Coal
Environment Matters

Table 1: Annual Review Title Block

Name of Operation	Newstan Colliery
Name of Operator	Centennial Newstan Pty Ltd
Development Consent/ Project Approval #	DA 73_11_98 SSD-5145
Mining Lease #	Consolidated Coal Leases 727, 746, 763 and 764. Mining Leases 1380, 1452, 1480, 1586, and 1587. Mining Purposes Leases 304, 305, 327, 328. Private Lands Lease 497.
Name of Holder of Mining Lease	Centennial Newstan Pty Ltd
Water License #	WAL18735
Name of Holder of Water License	Centennial Newstan Pty Ltd
MOP/RMP Start Date	30 June 2020
MOP/RMP End Date	23 May 2023
Annual Review Start Date	1 January 2020
Annual Review End Date	31 December 2020

I, , certify that this audit report is a true and accurate record of the compliance status of Newstan Colliery for the period 1 January 2020 to 31 December 2020 and that I am authorized to make this statement on behalf of Centennial Newstan Pty Limited.

Note:

a) *The Annual Review is an 'environmental audit' for the purposes of s122B(2) of the Environmental Planning and Assessment Act 1979. Section 122E provides that a person must not include false or misleading information (or provide information for inclusion) in an audit report produced to the Minister in connection with an environmental audit if the person knows that the information is false or misleading in a material respect. The maximum penalty is, in the case of a corporation, $1 million and for an individual, $250,000.*

b) *The Crimes Act 1900 contains other offences relating to false and misleading information: section 192G (intention to defraud by false or misleading statement – maximum penalty 5 years imprisonment); sections 307A, 307B and 307C (False or misleading applications/information/documents –maximum penalty 2 years imprisonment or $22,000,or both).*

Name of Authorised Reporting Officer	**MICHAEL CLARK**
Title of Authorised Reporting Officer	Director
Signature of Authorised Reporting Officer	M Clark
Date	23/3/21

Contents

1. STATEMENT OF COMPLIANCE 5
2. INTRODUCTION 5
3. APPROVALS 8
4. OPERATIONS SUMMARY 10
5. ACTIONS FROM PREVIOUS ANNUAL REVIEW 11
6. ENVIRONMENTAL PERFORMANCE 11
7. REHABILITATION 33
8. COMMUNITY CONSULTATION 34
9. INDEPENDENT AUDIT 35
10. INCIDENTS AND NON-COMPLIANCES DURING THE REPORTING PERIOD 35
11. ACTIVITES TO BE COMPLETED IN THE NEXT REPORTING PERIOD 35

List of Tables

Table 1 – Statement of Compliance 5
Table 2 – Non-Compliances 5
Table 3 - Newstan Colliery Environmental Contact Details 6
Table 4 - Newstan Colliery Approvals 8
Table 5 – Production Summary 10
Table 6 – Actions from previous Annual Review 11
Table 7 - Environmental Monitoring Performance 11
Table 8 – Summary of Noise Monitoring 12
Table 9 – Newstan Shaft Site Noise Criteria 13
Table 10 – Average Depositional Dust 2020 (Insoluble Solids) 14
Table 11 – Annual Average PM10 (ug/m3) at HVS1 and HSV2 15
Table 12 – Annual Average TSP (ug/m3) at HVS1 and HSV2 15
Table 13 – Greenhouse Gas Emissions FY2016 - FY2020 18
Table 14 – Rainfall at Newstan Colliery 21
Table 15 – Licenced Discharge Points Volume 24
Table 16 – LDP001 Water Quality Summary 24
Table 17 – Alluvial Aquifer Results for 2020 28
Table 18 – Coal Seam Bedrock Aquifer Results for 2020 31
Table 19 – Discharge Data Recorded by Newstan for 2020 33
Table 20 – Newstan Awaba Rehabilitation Summary* 34
Table 21 – Newstan Complaints Summary 35

List of Figures

Figure 1 – Regional Context 7
Figure 2 – Monthly Dust Deposition 2020 (Insoluble Solids)..... 14
Figure 3 – Rolling Annual Average for High Volume Dust Sampling for PM10 16
Figure 4 - Newstan Rolling Annual Average for High Volume Dust Sampling for TSP 17
Figure 5 - Newstan High Volume Dust Sampling for PM2.5 18
Figure 6 – LDP001 pH 2020 22
Figure 7 - LDP001 Total Suspended Solids 2020 23
Figure 8 - LDP001 Oil and Grease 2020..... 23
Figure 9 - LDP001 Electrical Conductivity 2020..... 24
Figure 10 - Alluvial aquifer monitoring bores – level trends (2016 – 2020) 29
Figure 11 - Alluvial aquifer monitoring bores – pH trends (2016 – 2020) 29
Figure 12 - Alluvial aquifer monitoring bores – EC trends (2016 – 2020)..... 30
Figure 13 - Coal Seam monitoring bores – level trends (2016-2020)..... 31
Figure 14 - Coal Seam monitoring bores – pH trends (2016-2020) 32
Figure 15 - Coal Seam monitoring bores – EC trends (2016-2020)..... 32

Appendices

Appendix No	Appendix Name
1	Historical Review LDP001 Monitoring Results
2	Annual Flora and Fauna Report
3	Plans NS2541A – Location of Surface Water Monitoring Points NS3332 – Location of Air, Noise, Weather Monitoring Points NS3351 – Newstan Colliery Annual Review Plan 2020 and 2021 NS3394 – NREA Rehabilitation Areas NS3301 – Plan of Premises – Underground workings Newstan EPL395

1. STATEMENT OF COMPLIANCE

The compliance of Awaba Colliery in 2020 is provided in Table 1 below There were no non-compliances during the reporting period.

Table 1 – Statement of Compliance

Were all conditions of the relevant approval(s) complied with?	
Development consent DA 73-11-98	Yes
Development consent SSD-5145	Yes
Environmental Protection Licence 395	Yes
Mining Lease 1380	Yes
Mining Lease 1452	Yes
Mining Lease 1480	Yes
Mining Lease 1586	Yes
Mining Lease 1587	Yes

Table 2 – Non-Compliances

Relevant Approval	**Condition #**	**Condition summary**	**Compliance Status**	**Comment**	**Page # addressed in Annual Review**
N/A					

2. INTRODUCTION

The Northern Coal Logistics Project (NCL), owned and operated by Centennial Northern Coal Services Pty Limited (Northern Coal Services) and Centennial Newstan Pty Limited (Centennial Newstan) is located on the western side of Lake Macquarie approximately 140 kilometers north of Sydney in New South Wales. NCL comprises of the existing approved surface coal handling and processing facilities at the Newstan Colliery Surface Site and Mandalong Mine – Cooranbong Entry Site, along with existing private haul road and rail loading infrastructure (Figure 1).

For the purposes of this report Newstan will only be incorporated within this Annual Review. Cooranbong Entry Site and Cooranbong Haul Road have been incorporated in the Mandalong Colliery Annual Review.

The contact details for the operation are provided in Table 3, including the Community Information and Complaints Line.

Table 3 - Newstan Colliery Environmental Contact Details

Name	Position	Email	Phone
Terry O'Brien	Mine Manager	Terry.O'Brien@centennialcoal.com.au	02 49560205
Alanna Ryan	Environment & Community Coordinator	Alanna.Ryan@centennialcoal.com.au	02 49560206
Community Information and Complaints Line			1800 247 662

Figure 1 – Regional Context

3. APPROVALS

The approvals for Newstan Colliery and Northern Coal Services are listed in Table 4, identifying their expiry date and renewal procedure.

Table 4 - Newstan Colliery Approvals

Name	Description	Issued By	Expiry Date	Renewal Procedure
CCL727	Pit top, SREA, NREA & surrounds	Dept. Primary Industry (Mineral Resources)	11/08/2027	Manager Title and Property- North
MPL304	Part NREA	Dept. Primary Industry (Mineral Resources)	25/03/2035	Manager Title and Property- North
MPL305	Water Tanks	Dept. Primary Industry (Mineral Resources)	25/03/2035	Manager Title and Property- North
ML1380	Mining Lease	Dept. Primary Industry (Mineral Resources)	18/09/2037	Manager Title and Property- North
ML1452	Mining Lease	Dept. Primary Industry (Mineral Resources)	06/07/2020 *	Manager Title and Property- North
ML1480	Part NREA	Dept. Primary Industry (Mineral Resources)	20/07/2023	Manager Title and Property- North
CCL764	Area between the rail loops and the haul roads	Dept. Primary Industry (Mineral Resources)	18/05/2021	Manager Title and Property- North
CCL763	Parcel land south of the pit top, including Stony Creek Pipeline,	Dept. Primary Industry (Mineral Resources)	09/06/2022	Manager Title and Property- North
PLL497	NA	Dept. Primary Industry (Mineral Resources)	24/08/2038	Manager Title and Property- North
CCL746	Area above underground workings, within Crown Land.	Dept. Primary Industry (Mineral Resources)	31/12/2028	Manager Title and Property- North
MPL327	Awaba Nitrogen Plant	Dept. Primary Industry (Mineral Resources)	05/08/2036	Manager Title and Property- North

Name	Description	Issued By	Expiry Date	Renewal Procedure
MPL328	Part Awaba Stockpile	Dept. Primary Industry (Mineral Resources)	05/08/2036	Manager Title and Property- North
ML1586	Mining Lease	Dept. Primary Industry (Mineral Resources)	13/10/2022	Manager Title and Property- North
ML1587	Surface area incl SREA.	Dept. Primary Industry (Mineral Resources)	23/10/2027	Manager Title and Property- North
Mine Operations Plan (MOP)	Summary of Mining and Processing Activities – Newstan and Awaba	NSW Trade & Investment – Division of Resources & Energy	31/05/2023	MOP Approved for the period July 2020 to July 2023
Newstan Colliery Development Consent DA 73-11-98	Permits development and works to occur as described in the EIS	NSW Department of Planning & Environment	6/7/2021**	Permits development and works to occur as described in the EIS
Centennial Northern Coal Services Development Consent SSD-5145	Receipt, handling, processing and transport of run-of-mine coal from Centennial Coal's underground operations at Mandalong Mine, Newstan Colliery and Awaba Colliery.	NSW Department of Planning & Environment	31/12/2045	Requires new development consent after expiry date.
Environment Protection Licence 395	Permits scheduled activity "coal mining" and discharge of water from licensed discharge points.	Environment Protection Authority	Perpetual	Requires payment and Annual Return February each year

*An application for the renewal of this title was acknowledged by the Department 17 June 2019, and a request for additional information (RFI) was received by Centennial 13 August 2019

**The introduction of *COVID-19 Legislation Amendment (Emergency Measures – Miscellaneous) Act 2020* has extended expiry of the development consent to 6 July 2023.

3.1. Annual Review Development Consent Conditions

The Annual Review has been prepared in accordance Schedule 5 Condition 11 of SSD-5145 and Schedule 2 Condition 9.1 of DA 73-11-98.

The operation of Cooranbong and the Haul Road covered by SSD-5145 are described in the Mandalong Annual Review.

The 2020 Annual Review was provided to DPE, DRE, LMCC, NOW, EPA, NPWS and the Newstan Colliery CCC consistent with DA 73-11-98 condition 9.1.

4. OPERATIONS SUMMARY

4.1. Newstan Colliery

The Newstan Colliery surface facilities area includes: offices, a workshop and bathhouse as well as equipment and materials storage areas. The Newstan Colliery has approval to produce up to 4.5 Mtpa of coal from the Newstan Colliery.

Newstan Colliery underground operations were put on care and maintenance in August 2014. There was no production in 2019 and none currently planned for 2020.

The underground operations were maintained during the January to December 2019 reporting period. No other construction activities were undertaken during the reporting period.

4.2. Northern Coal Services Coal Handling and Preparation Plant (CHPP)

The Newstan Colliery surface facilities area includes: offices, a workshop and bathhouse as well as coal handling infrastructure consisting of a coal preparation plant, truck loading bins and a rail loading facility.

The NCS has approval to produce handle and process up to 4.5 Mtpa of coal from the Newstan Colliery, up to 0.88 Mtpa of coal from the Awaba Colliery and up to 6 Mtpa from the Mandalong Mine. The CHPP also has approval to receive waste rock material from Mandalong Mine, Mandalong Southern Extension Project and Newstan Extension of Mining Project.

The coal handling and preparation plant (CHPP) processes Newstan ROM coal for domestic and export markets as well as coal from various other Centennial operations for the export market. Newstan has approval to process up to 8 million tonnes per annum of ROM coal through the Newstan CHPP. Newstan CHPP operations for the reporting period are summarised in Table 5.

4.3. Production

Production figures in Table 5 consist only of coal from Mandalong which may also be included in the Mandalong Annual Review. No coal was extracted from Newstan during the reporting period and therefore no product coal was trucked to Eraring during the reporting period. No coal was extracted from Newstan Colliery during the reporting period.

Table 5 – Production Summary

Material	Approved Limit (and source)	Previous Reporting Period (Actual)	This Reporting Period (Actual)	Next Reporting Period (Forecast)
Waste Rock/ Overburden	4.5 Mtpa	1.423	1.187	1.8
ROM Coal	4.5 Mtpa	1.381	1.155	1.7
Coarse reject	8 Mtpa	1.253	1.033	1.7
Fine reject (Tailings)	24/7	24/7	24/7	24/7

4.4. Exploration

No exploration or land preparation and construction works occurred during the reporting period. No exploration is proposed in the next reporting period.

4.5. Land Preparation and Construction

No land preparation has been undertaken during the reporting period. Land preparation works to be undertaken in the next reporting works are associated with the Northern Reject Emplacement Area, in accordance with the MOP.

5. ACTIONS FROM PREVIOUS ANNUAL REVIEW

No actions are required following regulatory correspondence for the 2019 Annual Review, identified in Table 6.

Table 6 – Actions from previous Annual Review

Action Required	Requested By	Action Taken	Where addressed in Annual Review
N/A			

6. ENVIRONMENTAL PERFORMANCE

Schedule 2 Condition 9 of DA 73-11-98 and Schedule 5 Condition 11 of SSD-5145 require the presentation and discussion on all monitoring required under the Development Consents and other approvals. Table 7 includes a summary of the monitoring required by the Development Consents, status and report section in the Annual Review.

Table 7 - Environmental Monitoring Performance

Monitoring Type	Status	Report Section
Noise Monitoring	Quarterly	Section 6.1
Air Quality Monitoring	Ongoing	Section 6.2
Meteorological Monitoring	Ongoing	Section 6.8
Surface Water Monitoring Groundwater Monitoring	Ongoing Ongoing	Section 6.9.1 Section 6.9.2
Rehabilitation Monitoring	Annual survey	Section 6.5

6.1. NOISE

The Northern Region Noise Management Plan has been developed to ensure that operational and construction noise impacts on the local community are minimised and appropriate management measures are identified and response protocols detailed should noise criteria be exceeded and to comply with statutory approval conditions.

6.1.1. EIS Predictions

The Newstan EIS predictions for noise found that the noise emission levels at NC1 and NC2 were below or marginally (1 dBA) above the then daytime (39 dBA) and night-time (38 dBA) assessment criteria during calm and adverse weather conditions.

Noise emissions levels at NC4 and NC5 are below or only marginally (2dBA) above the then daytime (37 dBA) and night time (35 dBA) assessment criteria during calm conditions. During adverse weather conditions noise emissions may be up to 4 dBA (daytime) and 6 dBA (night time) above the assessment criteria when using the front end loader.

The Main West EA found that the potential noise impacts are predicted to meet the project specific noise criteria at all resident locations, with the exception of NC3. The NC3 site was predicted to have a 2 dBA exceedance of project specific noise criteria (35 dBA night time) under a temperature inversion.

The Northern Coal Services EIS found that the potential noise impacts are predicted to meet the project specific noise criteria at all resident locations, with the exception of NC3. The NC3 site is predicted to exceed the project specific noise criteria by up to 1dBA during night time calm conditions and by up to 4dBA during night time temperature inversions for the current existing and approved operations.

6.1.2. Summary of Noise Results

GHD Pty Ltd, were engaged by Centennial Newstan to conduct quarterly noise compliance assessments for the Newstan Colliery in accordance with the Development Consent criteria. A summary of the noise monitoring results are provided in Table 8.

Table 8 – Summary of Noise Monitoring

Monitoring Quarter	Compliance status
Quarter 1 10 March 202	Activities from Newstan Colliery complied with the relevant development consent noise limits during the Q1 monitoring at all monitoring locations.
Quarter 2 11 June 2020	Activities from Newstan Colliery complied with the relevant development consent noise limits during the Q2 monitoring at all monitoring locations.
Quarter 3 2 September 2020	Activities from Newstan Colliery complied with the relevant development consent noise limits during the Q3 monitoring at all monitoring locations.
Quarter 4 2 December 2020	Activities from Newstan Colliery complied with the relevant development consent noise limits during Quarter 4 monitoring at all monitoring locations.

6.1.3. Newstan Shaft Site (Awaba) Noise Monitoring

The requirements for the Newstan Ventilation Shaft Site at Awaba impact assessment criteria are included in the Table 9 in accordance with Newstan's Development Consent condition 6.4 D and the Newstan Colliery Modification of Development Consent Statement of Environmental Effects (2007).

No noise monitoring was conducted during the reporting period due to no operational activities occurring at the Newstan ventilation shaft site at Awaba.

A community complaint for noise was received on 6 August 2020 from a resident at Awaba. Noise and vibration monitoring was undertaken on 16 November 2020 by Advitch Pty Limited. The source of the complaint was found to be a compressor supporting the Newstan Colliery underground mine.

Table 9 – Newstan Shaft Site Noise Criteria

	Noise Criteria $L_{Aeq(15\ minute)}$ Noise Goals (dBA)		
Location	**Day**	**Evening**	**Night**
All privately owned residences	38 dBA	40 dBA	36 dBA

6.2. AIR QUALITY – DEPOSITIONAL DUST GAUGES

The Northern Region Air Quality and Greenhouse Gas Management Plan has been developed to ensure that operational and construction air quality impacts on the local community are minimised, appropriate management measures identified and response protocols detailed should air quality criteria be exceeded and to comply with statutory approval conditions.

6.2.1. Dust Deposition Gauges

Newstan has eight depositional dust gauges located around the Colliery pit top facilities, NREA, SREA and Fassifern. Dust monitoring locations are provided in Plan NS3332.

6.2.2. EIS Predictions

The Newstan Life Extension EIS results for DG's 1 to 8 found the monthly averages and annual averages were below 2 g/m2/month, which is within the EPA goal of 4 g /m2/month annual average. The EIS states that increases between 1 and 2 g/m2/month due to the Newstan extension would therefore be acceptable given the existing deposition levels. Annual average dust deposition rates due to existing operations were predicted to be approximately 1 g/m2/month or less at Fassifern and surrounding districts.

All particulate dust gauges recorded an annual average particulate monitoring result below the development consent limit of 4g/m2/month for the annual averaging period.

Dust gauge 1 has remained relatively stable since 2001, while the results for dust gauges 2, 5, 6, 7 and 9 have decreased. Some high results at dust gauges 3 and 4 have resulted in an increasing trend due to spikes in 2012, 2015, and 2017 to 2020. Visual inspections of the samples showed that approximately 90% of the samples were insect matter and or bird droppings.

6.2.3. Summary of Monitoring Results

All particulate dust gauges recorded an annual average particulate monitoring result below the development consent limit of 4g/m2/month for the annual averaging period, shown in Table 10. The following graph, Figure 2, displays Newstan's Monthly depositional dust results in 2020 (Insoluble Solids).

Table 10 – Average Depositional Dust 2020 (Insoluble Solids)

	Insoluble Solids (Combustible Matter + Ash) g/m^2/month							
	DG1	DG2	DG3	DG4	DG5	DG6	DG7	DG9
Long Term Average	0.83	1.11	0.99	3.07	1.24	0.92	1.30	0.78
Average 2020 (Reporting Period)	1.23	2.99	1.37	2.11	3.70	1.93	3.52	2.17
Air Quality Criteria	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0

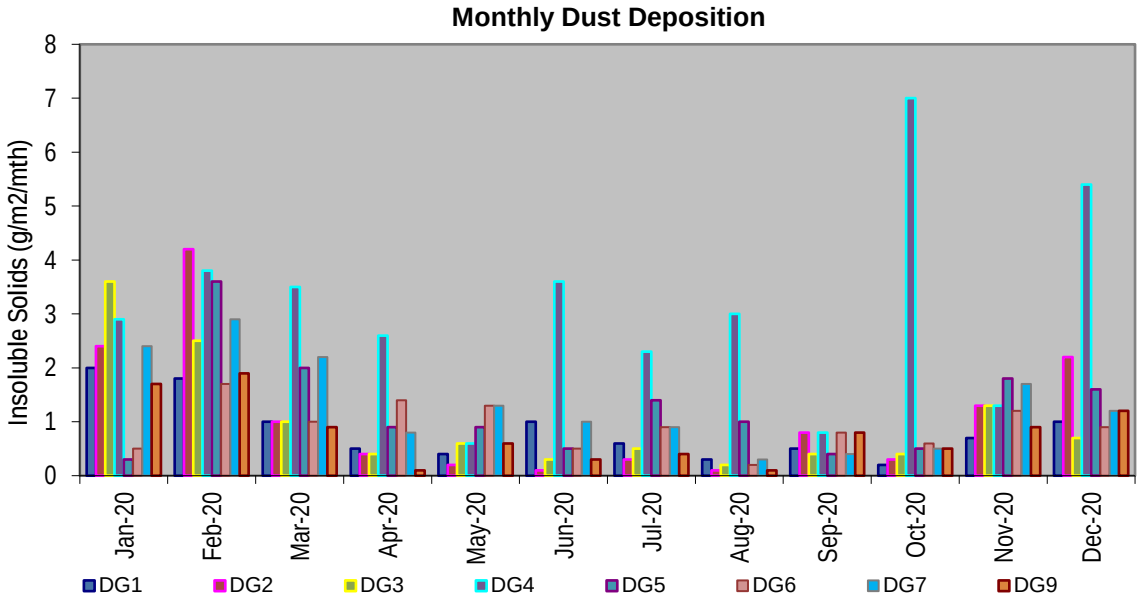


Figure 2 – Monthly Dust Deposition 2020 (Insoluble Solids)

6.2.4. Air Quality Monitoring - High Volume Dust Sampling

6.2.5. High Volume Air Samplers

The Hill Top High Volume dust sampling point (HVS1) is located to the north of the NREA near Culgan's property. The Water Tank High Volume Dust Sampling point (HVS2) is located to the south of Newstan Colliery near the Fassifern Railway Station. It was not possible to locate the southern high volume dust sampler at the Fassifern Public School as required by the Development Consent DA 73-11-98, due to the need to undertake extensive tree clearing at the school. The site chosen is located closer to the mine site.

High volume dust sampling is undertaken to monitor dust deposition rates and concentrations of Total Suspended Particulates (TSP) and Suspended Particles PM10 and PM2.5.

6.2.6. EIS Predictions

The EIS states that the annual average TSP levels are predicted to be approximately 10 µg/m3 at Wakefield and Fassifern. This is less than measured background levels indicating that other local dust sources may also be contributing to TSP levels in the area. Predictions for the expansion up to 3 mtpa using the front end loader method showed an annual average TSP concentrations at the nearest residence to the northwest of the existing emplacement area increase by 5 µg/m3 above those predictions made for the existing case. Emissions were not predicted to cause exceedances of the air quality goal of 90 µg/m3 (annual average for TSP). Assuming that approximately 50% of total TSP is PM10, the annual average goal of 50 µg/m3 is not predicted to exceed after the initial expansion for PM10.

The Main West Mining Project EA states that the results of dispersion modelling indicate no potential for exceedance of the annual average TSP and PM10 assessment criteria at the nearest non-project related receptors. The dispersion modelling predicted a likelihood of exceedances at the nearest sensitive receptor of regulatory guidelines for PM10 as a 24 hour average. Background concentrations of PM10 also contribute significantly to predicted likelihood of exceedances of 24 hour PM10.

6.2.7. Summary of Monitoring Results

Table 11 displays the annual average PM10 (ug/m3) at HVS1 and HVS2 for the previous 5 years from 2016 to 2020, while Table 12 shows the Annual Average TSP. The Newstan EPL 395 requires a sampling frequency for high volume air samplers to be every 6 days for TSP and PM10 at the two monitoring locations.

Figure 3 displays the rolling annual average and 24 hour results for high volume dust sampling results for PM10. Figure 4 displays the Rolling Annual average and the 24 hour results for TSP at the Hill Top Location (HVS1) and Water Tank Location (HVS2).

Table 11 – Annual Average PM10 (ug/m3) at HVS1 and HSV2

Annual Average PM10 (ug/m3)		
Year	**Hill Top (HVS1)**	**Water Tank (HVS2)**
2016	11.0	12.4
2017	11.5	14.6
2018	13.9	15.5
2019	17.6	18.8
2020	13.8	15.5
Newstan Development Consent Criteria (Annual Average)	30 µg/m^3	30 µg/m^3

Table 12 – Annual Average TSP (ug/m3) at HVS1 and HSV2

Annual Average TSP (ug/m3)		
Year	**Hill Top (HVS1)**	**Water Tank (HVS2)**
2016	18.0	20.3
2017	20.1	29.9
2018	23.1	31.1

Annual Average TSP (ug/m3)		
Year	**Hill Top (HVS1)**	**Water Tank (HVS2)**
2019	30.4	36.2
2020	23.5	30.0
Newstan Development Consent Criteria (Annual Average)	90 µg/m^3	90 µg/m^3

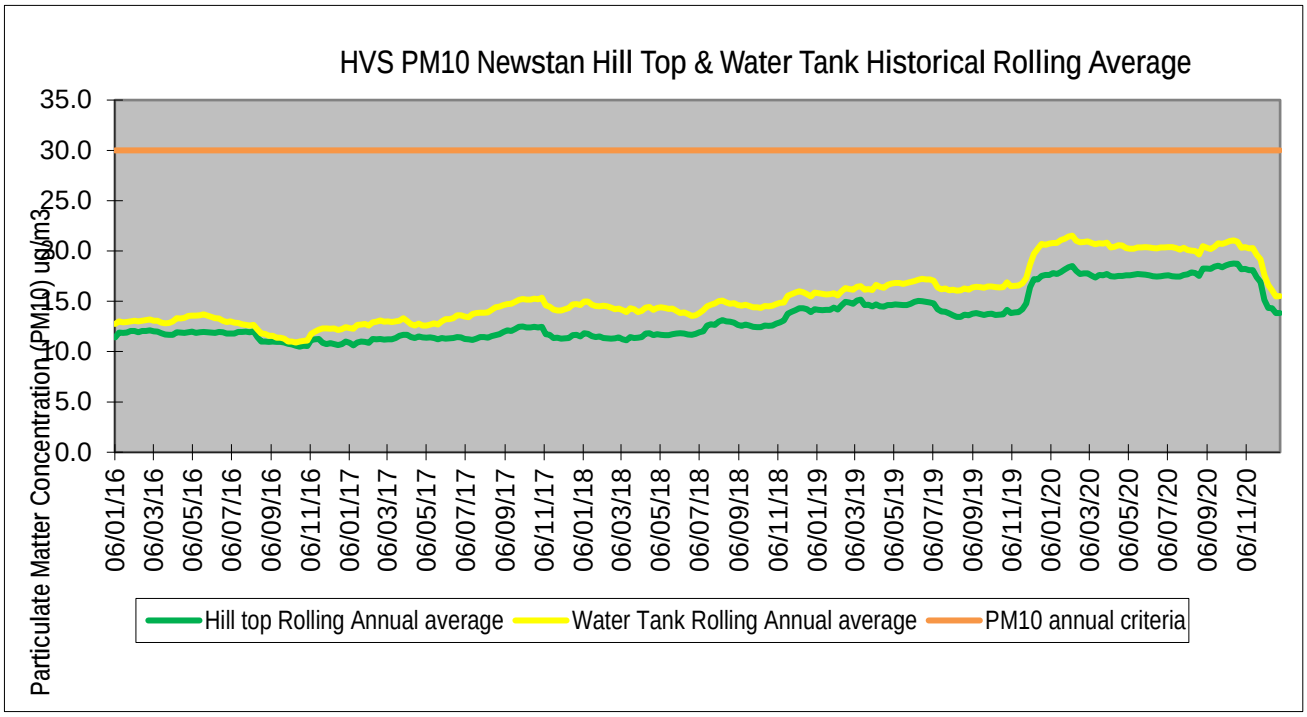


Figure 3 – Rolling Annual Average for High Volume Dust Sampling for PM10

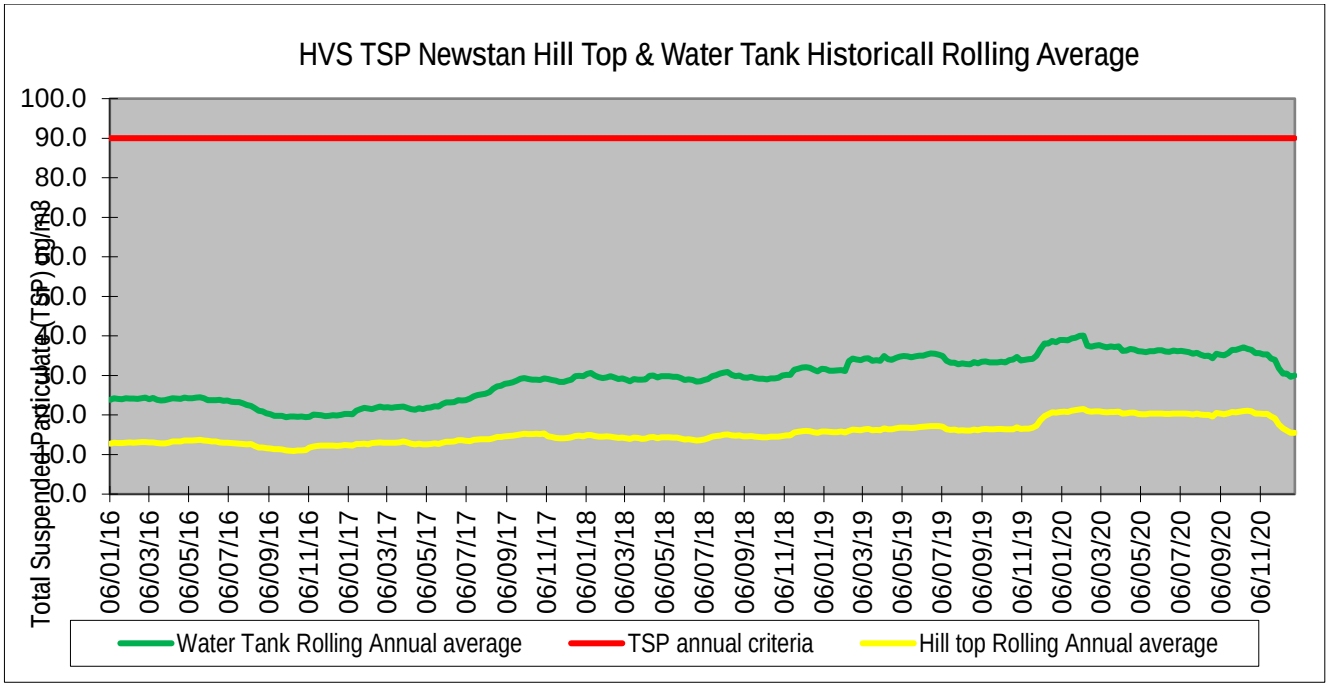


Figure 4 - Newstan Rolling Annual Average for High Volume Dust Sampling for TSP

Figure 5 displays the 24 hour results for high volume dust sampling results for PM2.5 during the reporting period. The annual average high volume dust for PM2.5 was 7.5 µg/m3 and 8.5µg/m3 for Hill Top and Water Tank respectively.

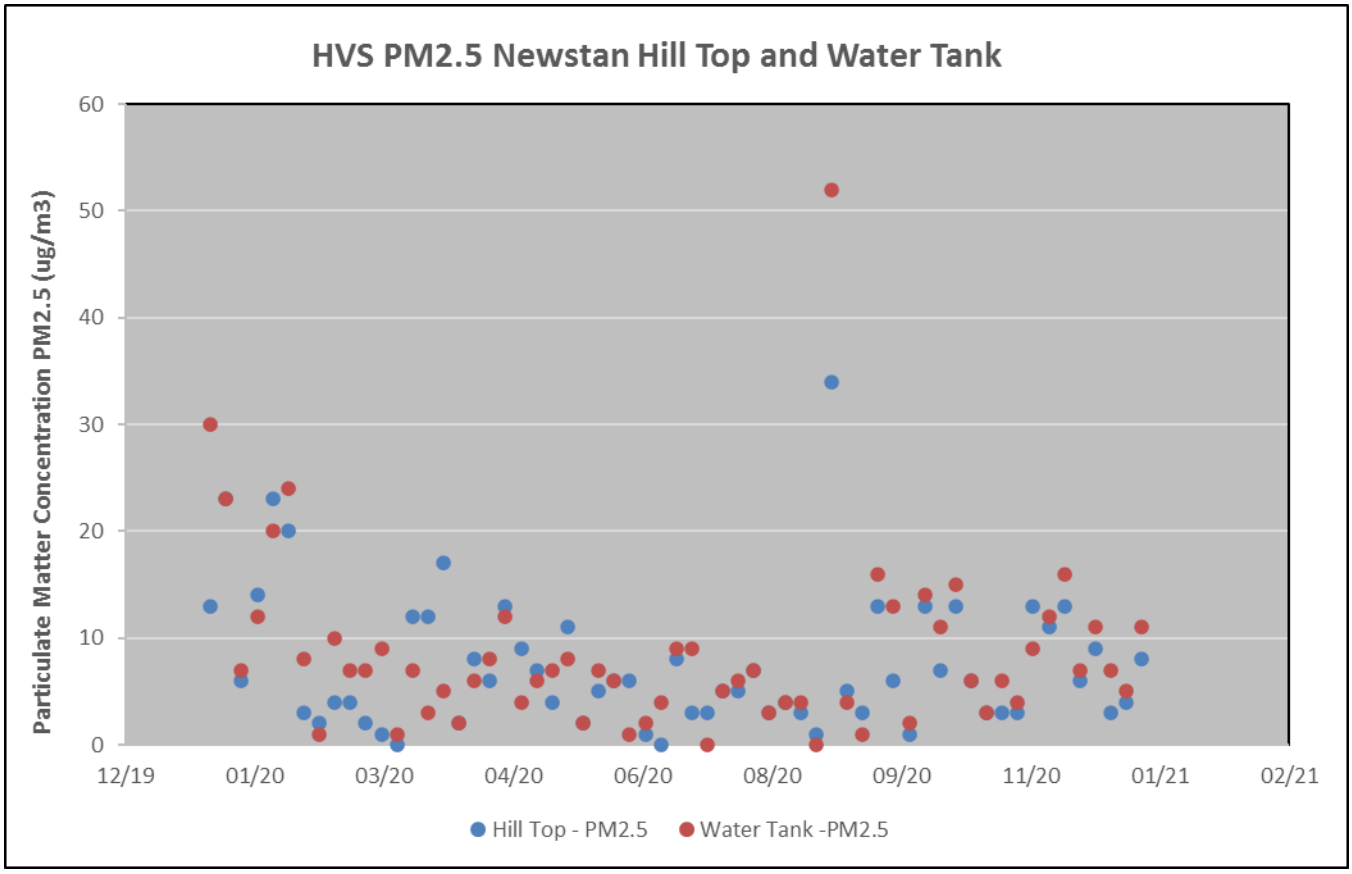


Figure 5 - Newstan High Volume Dust Sampling for PM2.5

6.3. Greenhouse Gas Monitoring

Table 13 provides a summary of Newstan's main Greenhouse Gas emissions for the 2020 Annual Review reporting period (Financial Year 2019-2020). The Post Mining Activities began being included for the first time in 2015.

Table 13 – Greenhouse Gas Emissions FY2016 - FY2020

	FY2016	FY2017	FY2018	FY2019	FY2020
Electricity	10,624	11,363	10,695	9,886.3	9,788
Diesel	889	1,740	1,681	2,023	2,145
Fugitives – CH4	100,000	70,739	44,900	37,288	42,252
Fugitives – CO2	1,020	929	761	8,725	1,390
Post Mining Activities*	0	0	0	0	0
Total of above GHG Emissions (tonnes)	**112,533**	**84,711**	**58,127**	**50,839**	**55,575**

* Note Emissions from Post Mining activities (e.g. surface stockpile), previously not included in the Annual Review. Actual values updated in 2020 Annual Review to be consistent with FY reporting.

6.4. SUBSIDENCE

Newstan Colliery did not mine coal in 2020. The mine has been on Care and Maintenance since August 2014. The 2019 monitoring surveys completed the requirement of subsidence monitoring for existing Newstan mine workings.

The Awaba Colliery Sinkhole Rehabilitation Plan covers sinkholes subsidence cracks identified are added to the rehabilitation program and they are rehabilitated in accordance to environmental and public safety risk. The 2020 sinkhole rehabilitation activities are reported within the Awaba Colliery Annual Review Appendix 1.

In 2020 a sinkhole was identified to the north east of the SREA from historical mining (pre-1950) and adjacent to the Haul Road. Rehabilitation works were undertaken on the sinkhole adjacent to the Haul Road. It is proposed to include Newstan Colliery in the Awaba Colliery Sinkhole Rehabilitation Plan in 2021.

6.5. BIODIVERSITY

The Northern Region Biodiversity Management Plan has been developed to guide the management of terrestrial and aquatic biodiversity at a regional scale and to comply with statutory approval conditions

Management measures for 2020 included the implementation of recommendations included in the 2019 Annual Monitoring report with on going weed management and the installation of an additional six nest boxes to promote fauna in the rehabilitated areas. The six nest boxes were installed at one control site and two rehabilitation sites for microbats, glider and small parrots.

This report can be found in Appendix 3.

6.5.1. ANNUAL FLORA AND FAUNA MONITORING

Condition 3.4 and 8.5 of Development Consent DA 73-11-98 require an Annual Ecological Monitoring Program at Newstan Colliery. Surveys conducted over the site targeted birds, microbats and invertebrates along with habitat. This report can be found in Appendix 3.

6.5.2. TETRATHECA JUNCEA

The Longwall TJ transect monitoring ceased in 2014. Annual *Tetratheca juncea* monitoring within the NREA and SREA ceased in 2017. These sites were reference sites for the construction of the SREA and monitoring was deemed no longer necessary to continue due to consistent monitoring results. The last monitoring report found that monitoring to date had shown considerable variation in clump counts between years for each REA quadrat. However, it is apparent that the presence of the reject emplacement areas has not had a negative impact on the viability of the associated *Tetratheca juncea* populations. There was no evidence that the overall habitat in the monitored areas had declined in quality between monitoring occasions.

6.6. HERITAGE

In 2012 Centennial Coal developed the Centennial's Northern Holdings Aboriginal Cultural Heritage Management Plan. This document aims to provide a consistent approach to consultation between Centennial and the Aboriginal community as well as identify standard Aboriginal cultural heritage monitoring and management requirements.

The LEA EIS identified rock shelters within sandstone outcrops on ML1452 to the east of current mining operations. It also suggested that there may be potential sites along Lords Creek that may be impacted by subsidence repair works in Lords Creek. Mining has not occurred in the eastern sections of ML1452 therefore there has been no potential for impact on the rock

shelters. LW24 and 25 were shortened such that no mining occurred under Lords Creek hence the need to undertake subsidence repair works in Lords Creek is negated.

The LW24 SEE identified a scar tree approximately 400m north-west of LW24. This scar tree has not been impacted by mining operations.

Due to Newstan Colliery being on care and maintenance during the reporting period, no pre and post mining monitoring was required to be conducted to assess any impacts on archaeological heritage as a result of mine subsidence.

The Northern Region Historic Heritage Management Plan was approved on 15 September 2016 for Mandalong Mine and Northern Coal Services. The Plan was reviewed in 2018 to incorporate Awaba, Newstan and Myuna. The revised Plan was approved on 13 July 2018.

6.7. WASTE

All opportunities for waste avoidance and minimisation are considered by all staff and contractors across all areas including; contracts, purchasing, equipment procurement and waste generation processes.

Waste oil and greases are stored in tanks and drums within bunded areas for removal by a licenced waste management contractor for recycling or disposal. Oil water separation is achieved using hydro-cyclone oil water separators at Newstan flows from vehicle work and storage areas and the wash down bays.

Hydrocarbon spill kits are inspected monthly by a licenced waste management contractor and re-stocked as required. Oily rag bins and oil filter bins are also serviced on a monthly basis.

Office paper and cardboard is collected and recycled by a licenced waste management contractor. Metals are collected and stored in steel bins onsite prior to removal. In 2020, a total of 53.34 tonnes of scrap steel was recycled. A reduction of scrap metal recycled has occurred year on year following previous scrap metal campaigns in 2018 (74.8 tonnes) and 2019 (53.34 tonnes).

General refuse and non-recyclable materials are sorted and stored in 15m steel bins. The material was collected by a licenced waste management contractor for disposal. In 2020, 39.6 tonnes of refuse material was taken off-site for disposal, less than the 2019 refuse material of 62 tonnes.

6.8. RAINFALL MONITORING RESULTS

The total monthly rainfall data is shown below in Table 14. A total of 1276.8 mm of rainfall was recorded at Newstan Colliery during the reporting period. The total annual rainfall for 2020 was less than the total rainfall recorded in 2018 (1066.47 mm) and 2019 (853.2 mm). The wettest period was in March 2020 recording 230.6 mm.

Table 14 – Rainfall at Newstan Colliery

2020 Month	Newstan Colliery Total Rainfall (mm)
January	29.6
February	183.8
March	230.6
April	45
May	55.6
June	64.4
July	218.8
August	34.8
September	30.2
October	125.6
November	48.2
December	210.2

6.9. WATER MANAGEMENT

6.9.1. SURFACE WATER MANAGEMENT

Water monitoring is undertaken in accordance with the Northern Coal Services Water Management Plan, the Mine Water Discharges Management Plan, Development Consent and Environment Protection Licence 395 requirements. Newstan Colliery's Environmental Protection Licence (EPL) was last varied on 17 November 2015.

The basis of the mine's water management is based on reuse of water on site including sediment laden runoff contained in sediment dams. Water runoff is concentrated via a network of kerb and guttering, collection sumps, pipes and drains, sediment sumps and pollution control dams. Water is then pumped to Connolly's Dam for reuse in the coal preparation plant.

An assessment of the potential impact on LT Creek and Lords Creek was undertaken for the Main West Project Approval. The Newstan Colliery pit top lies within the upper catchment of LT Creek. The creek consists of a North Arm and South Arm that combine within the residential/ commercial area of Fassifern before flowing into Fennell Bay on the western side of Lake Macquarie. LT Creek is originally an ephemeral system but discharges into LT creek have continued for over 35 years and the North Arm has been receiving water from the underground mine water storage since 2001 via LDP001; this has resulted in a continuous baseflow within LT Creek. The location of surface water monitoring poits is provided in NS3332.

The Newstan Colliery, Surface Water Quality Assessment examined the existing surface water quality in order to determine background and baseline values for the watercourses associated with discharge from Newstan Colliery's operations. The assessment found that downstream water quality in LT Creek has generally been slightly to moderately alkaline and brackish, and generally within the background trigger value limits for LT Creek (North Arm).

Underground mining in the Main West Area was within the catchment of Lords Creek. Lords Creek is a tributary of Jigadee Creek, Jigadee Creek drains to Dora Creek, which is a major tributary of Lake Macquarie. Surface impacts have been negligible and cannot be measured. The potential surface water impacts associated with Main West have been identified and assessed. It is concluded that surface impacts to Lords Creek are negligible.

The underground water management system at Newstan Colliery involves mine water injections into, and extractions out of, an underground mine water storage. The underground

storage is a combination of the goaf in the Great Northern and Fassifern seam workings at Newstan Colliery. The Water Management Plan reports that the existing outputs from the underground water system are:

- extraction of water from the underground storage via the Fassifern No. 1 borehole (up to 11.0 ML/day); and
- emergency discharge through the underground emergency discharge pipeline (known as the "Stony Creek pipeline" & EPL Point 17).

Water extracted from underground storage is transferred and discharged to the North arm of LT Creek via LDP001. Investigations by GHD have identified that underground water extraction (via the Fassifern No. 1 borehole) of 11 ML/day is required under operational conditions to maintain the underground water level at least 2 metres below the invert of the Stony Creek pipeline (EPL Point 17). Newstan Colliery received an EPL variation in October 2012 to increase the volume of water discharged through LDP001 from the current EPL limit of 7 ML/day to 11 ML/day. This variation also included discharge limits for a range of pollutants.

In 2014 Newstan commissioned the Clean Water Plant at Newstan Colliery. This allows Newstan to treat water from the surface and the Fassifern Seam, prior to discharging through LDP001. The CWP employs coagulation, flocculation, sedimentation, and filtration treatment to reduce the turbidity, concentration of total suspended solids (TSS) and as a by-product also reduce the total (unfiltered) metal concentrations before water is discharged to LT Creek via LDP001. Water that was previously transferred directly from the Fassifern Underground Storage to LDP001 is now directed to McKendry's Dam and treated by the CWP at a maximum rate of 14 ML/day. Water treated by the CWP may also be used to supply mining processes and the CPP at Newstan. The CWP does not remove all total metals and dissolved metals.

With the increase in LDP001 volume discharge and the installation of the CWP, Newstan Colliery has generally been able to maintain the Fassifern Storage at a low level. Figures 6, 7, 8 and 9 show the pH, total suspended solids (TSS), oil & grease & conductivity for discharge waters through LDP001 in 2019. Note: If results are less then the limit of reporting, a value of 0 is put in for the development of the below graphs.

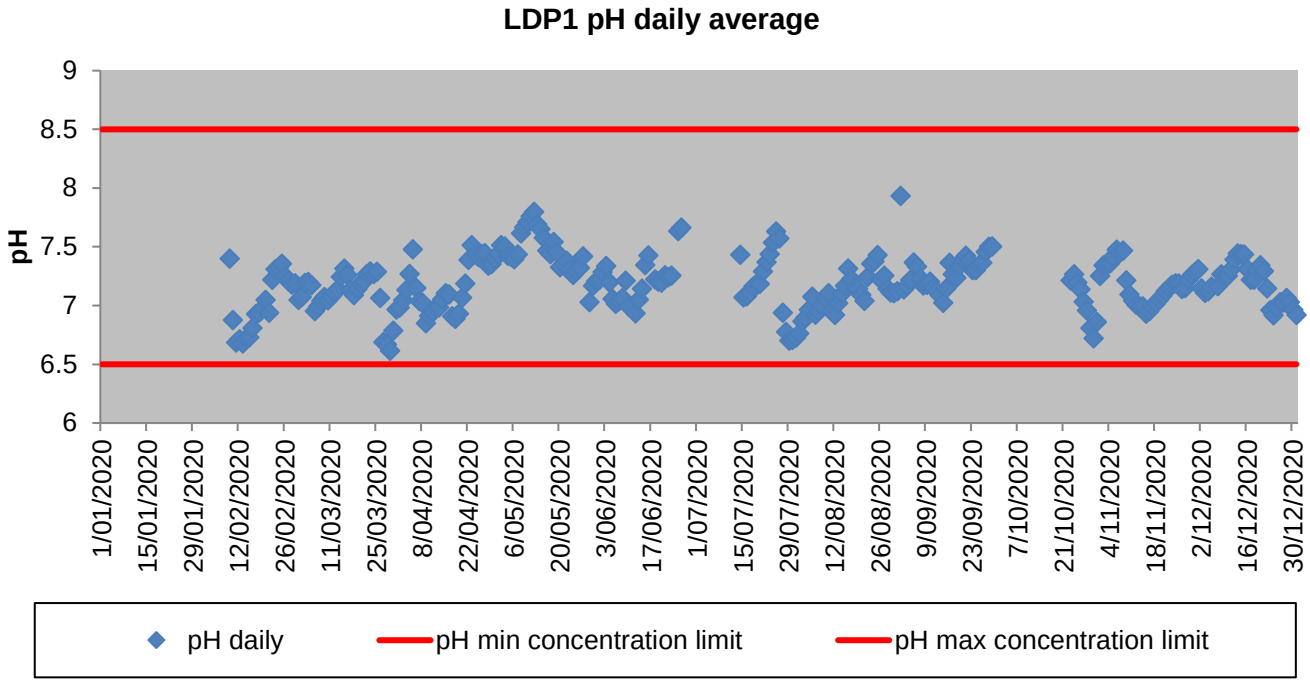


Figure 6 – LDP001 pH 2020

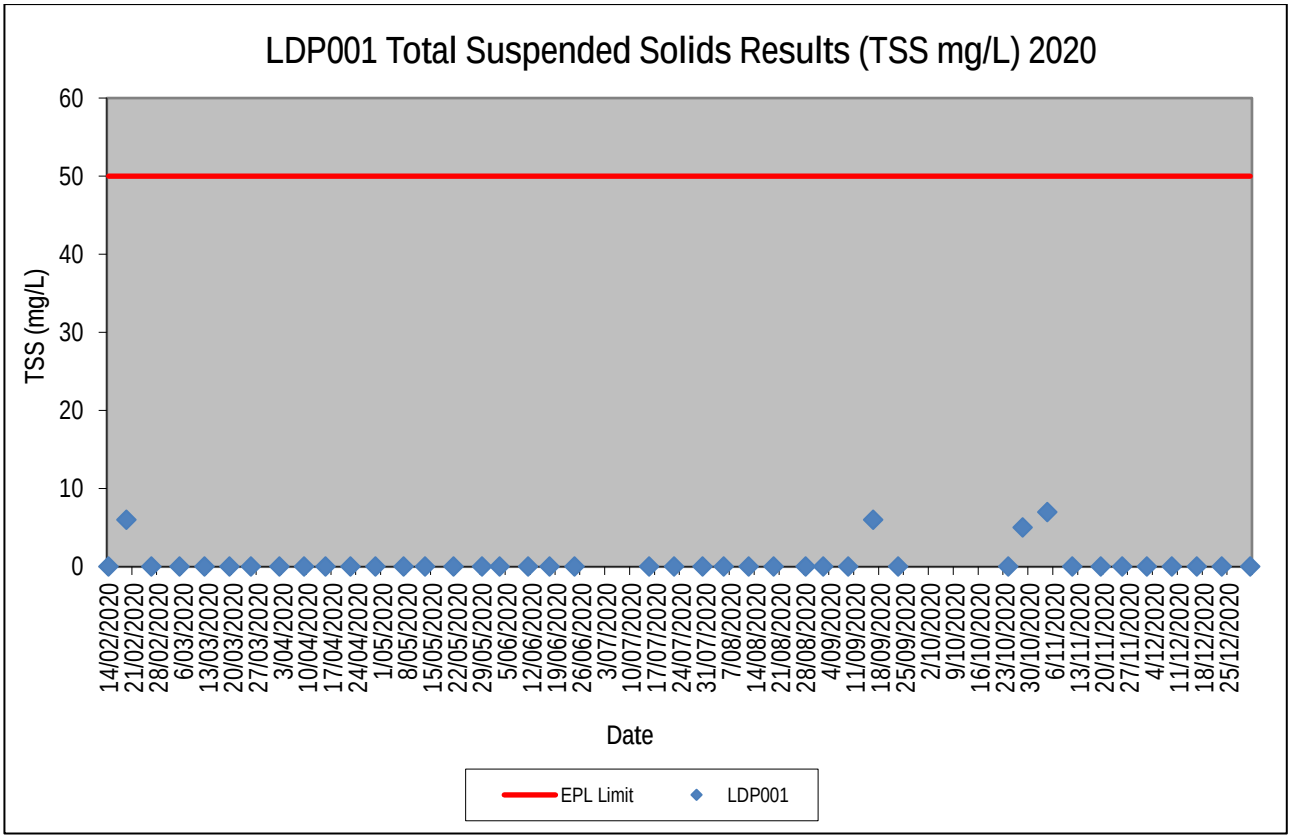


Figure 7 - LDP001 Total Suspended Solids 2020

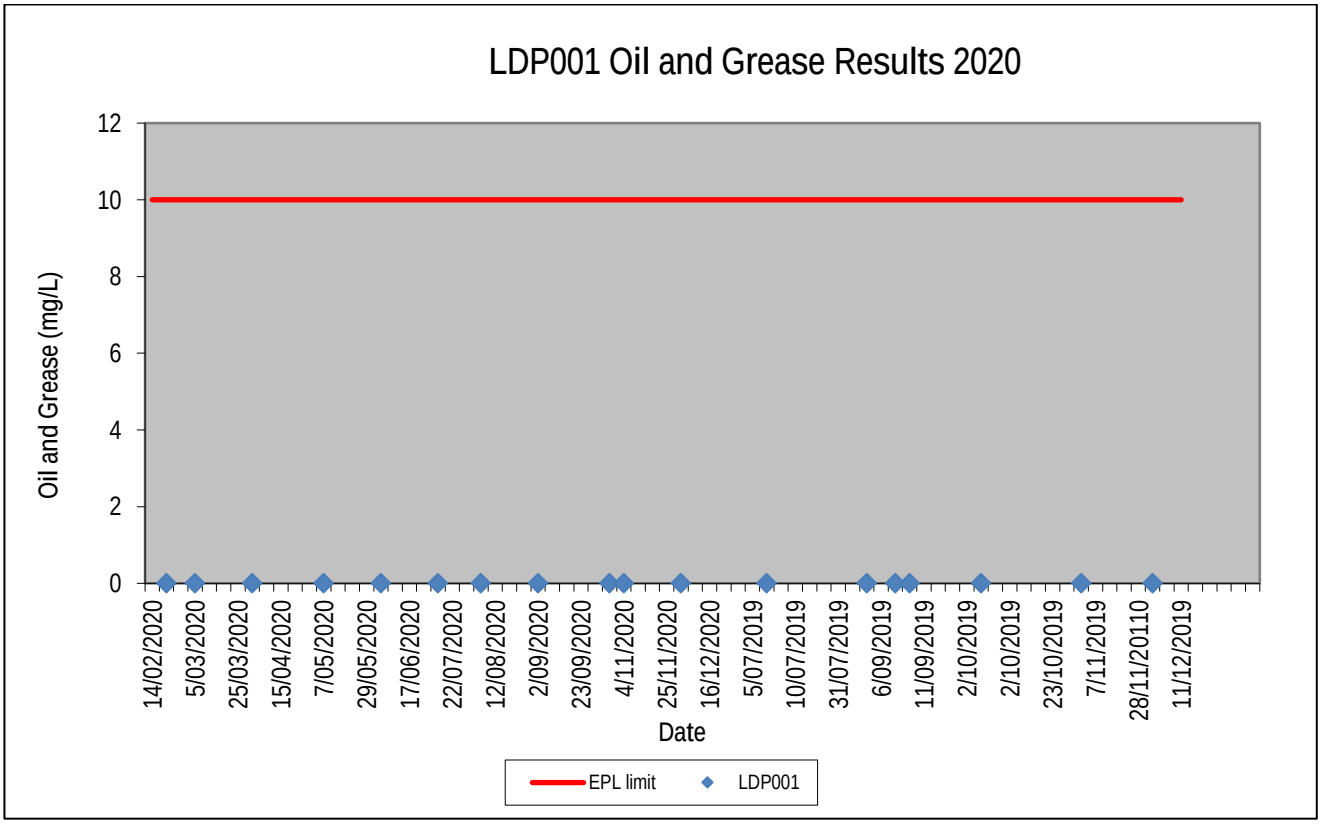


Figure 8 - LDP001 Oil and Grease 2020

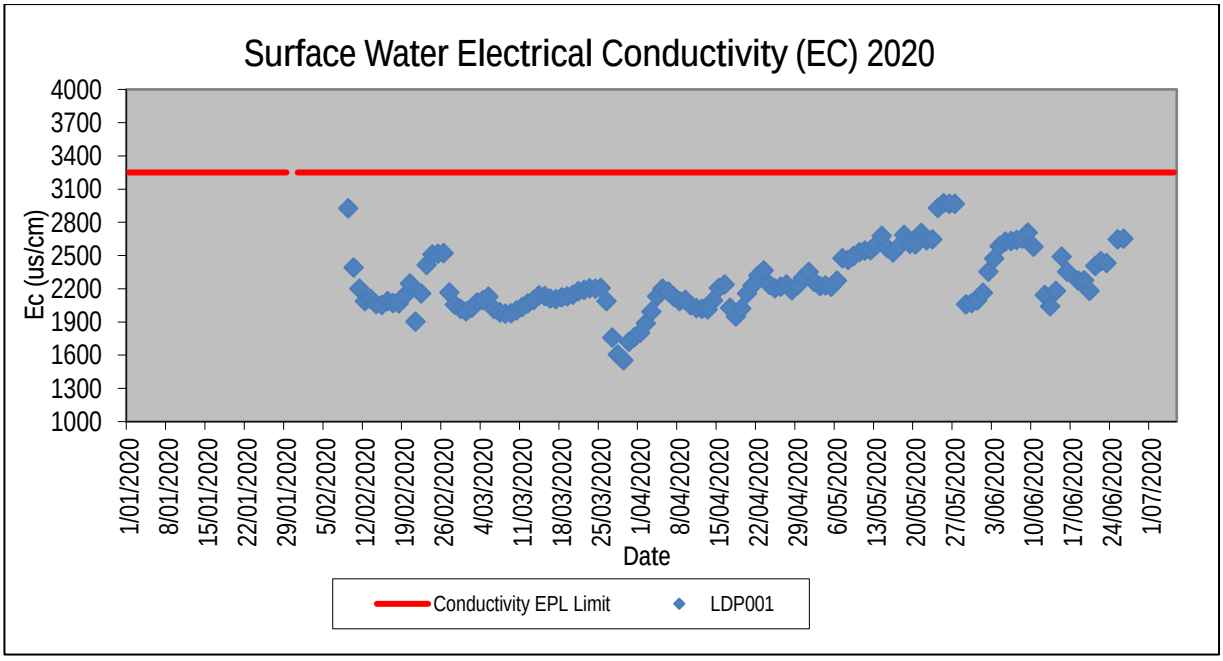


Figure 9 - LDP001 Electrical Conductivity 2020

An historical overview of monitoring results (including metals) is provided in the report in Appendix 2. Surface monitoring locations are provided in Plan– NS2541A.

A summary of the water volume and quality data of EPL monitoring points can be found in Table 15 and Table 16, all parameters were within EPL limits.

Table 15 – Licenced Discharge Points Volume

Frequency	Licenced discharge point	No. of measurements made	Lowest result (ML/day)	Mean result (ML/day)	Highest result (ML/day)
Daily during any discharge	LDP001	365	0	7.7	10.71
Daily during any discharge	LDP002	No discharge occurred during reporting period			
Daily during any discharge	LDP017	No discharge occurred during reporting period			

Table 16 – LDP001 Water Quality Summary

Pollutant	Unit of measure	No. of samples required by licence	No. of samples collected and analysed	Lowest sample value	Mean of sample	Highest sample value
Aluminium (dissolved)	milligrams per litre	12	27	LOR	0.0035	0.022
Arsenic (dissolved)	milligrams per litre	12	27	LOR	0.0002	0.0045
Barium (dissolved)	milligrams per litre	12	27	0.09 76	0.1459	0.246
Bicarbonate	milligrams	12	36	132	579.77	750

Pollutant	Unit of measure	No. of samples required by licence	No. of samples collected and analysed	Lowest sample value	Mean of sample	Highest sample value
alkalinity	per litre					
Boron (dissolved)	Milligrams per litre	12	27	0.14	0.2127	0.325
Cadmium (dissolved)	milligrams per litre	12	27	LOR	0.0000	0.0001
Calcium (dissolved)	milligrams per litre	12	27	21.4	30.12	41
Chloride (dissolved)	milligrams per litre	12	27	360	504.33	638
Chromium (total)	milligrams per litre	12	27	LOR	0.0001	0.0005
Cobalt (dissolved)	milligrams per litre	12	27	LOR	0.0002	0.0008
Conductivity	Microsiemens per centimetre	Continuous	Continuous	1332.81	2553	3067.02
Copper (dissolved)	milligrams per litre	12	15	LOR	0.0000	LOR
Iron (dissolved)	milligrams per litre	365	4	7.82	8.0975	8.3
Lead (dissolved)	milligrams per litre	52	18	2	5.0000	7
Lithium (dissolved)	milligrams per litre	12	17	LOR	0.0000	LOR
Magnesium	milligrams per litre	0	17	LOR	0.0006	0.01
Manganese (dissolved)	milligrams per litre	0	17	LOR	0.0000	0.0003
Mercury (dissolved)	milligrams per litre	12	17	LOR	0.00006	0.001
Molybdenum (dissolved)	milligrams per litre	0	17	LOR	0.0000	LOR
Nickel (dissolved)	milligrams per litre	12	17	0.049	0.0759	0.137
Nitrogen (total)	milligrams per litre	0	17	0.058	0.0799	0.143
Oil and Grease	milligrams per litre	0	17	LOR	0.00000	LOR
pH	pH	0	17	LOR	0.00000	LOR
Phosphorus (total)	milligrams per litre	12	52	276	517.9615	700
Potassium (dissolved)	milligrams per litre	12	17	0.12	0.1719	0.21

Pollutant	Unit of measure	No. of samples required by licence	No. of samples collected and analysed	Lowest sample value	Mean of sample	Highest sample value
Selenium (total)	milligrams per litre	0	17	0.13	0.180 6	0.22
Sodium	milligrams per litre	12	17	LOR	0.000 006	0.0001
Sulfate (dissolved)	milligrams per litre	0	17	LOR	0.000 0	LOR
TKN-N	milligrams per litre	12	17	24	31.79 41	39
Total sulfate	milligrams per litre	12	17	361	422.6 471	504
Total suspended solids	milligrams per litre	0	17	LOR	0.000 0	LOR
Turbidity	Nephelometric turbidity units	12	17	LOR	0.000 2	0.003
Zinc (dissolved)	milligrams per litre	12	17	LOR	0.0001	0.0005

6.9.2. GROUNDWATER MANAGEMENT

Newstan has eighteen groundwater monitoring bores that were installed to establish groundwater baseline conditions for the proposed Awaba Open Cut Mine. Even though the application for the Awaba Open Cut Mine was withdrawn, it was determined appropriate to continue monitoring the groundwater bores to determine the impact of longwall mining on the groundwater levels and quality. Biannual analyses monitoring and reporting of water level, pH and electrical conductivity (EC) is undertaken.

6.9.3. EIS Predictions

The EIS states that in the Eastern part of the Life Extension Area (LEA) where the depth of cover ranges up to 400 metres, the height of interconnected fracturing of 80 metres is considered to have very low to negligible probability of tapping into any surface alluvial aquifers. In the far western part of the LEA with the depth of cover reduced to as low as 50 metres in the vicinity of Palmers Creek, there is an increased potential for drainage of alluvium aquifers into the mine workings.

It was considered that the potential for significant mine water inflows from the surface alluvial deposits is minimal and the rate of water inflow into the mine in the proposed LEA should be similar to that experiences from the earlier workings in the existing Newstan Colliery.

The SEE subsidence predictions for LW24, and the general concept of strata disturbance above longwall mines, indicates that vertical fracturing may extend to a height of 100m above LW24. Therefore the shallow aquifers within the SEE boundary may potentially be impacted where the depth of cover between the longwall panel and base of alluvium is less than 100m. The cover thickness review indicated that the thickness is greater than 100m over the whole of LW24. It was considered that there is minimal risk of impacting the alluvium of Lords Creek.

In all subsided areas there may be shallow surface cracking. Where this occurs beneath saturated alluvium of regolith and does not provide hydraulic connection to the mine, there is

still potential for short-term loss of alluvium /regolith groundwater in this zone of increased permeability. This may lead to very temporary, minor lowering of groundwater levels that will only persist for as long as is required to fill the new void cracks.

Where the Main West Area underlies the Lords Creek alluvium (north-eastern section), the depth of cover is approximately 70 – 90 metres. At this depth of cover it is very unlikely that fractures would develop and that there would be loss of groundwater from the alluvium for the past bord and pillar mining.

Any reduction in groundwater levels within the Lords Creek alluvium is also unlikely, based on the predicted subsidence calculations. It is predicted that the vertical subsidence above the proposed Main West mine area will be less than 20 millimetres and that surface impacts will be negligible and cannot be measured.

Monitoring of groundwater levels within Lords Creek alluvium indicates that recent mining, using longwall mining methods, adjacent to the Main West Area has not resulted in a reduction in groundwater levels or a loss of groundwater from the alluvium.

Therefore it is unlikely that the bord and pillar workings within the Main West Area will impact the groundwater in the overlying Lords Creek alluvium. It is not anticipated that mining within the Western Zone will impact on alluvial groundwater or groundwater-dependent ecosystems.

The Modification to Development Consent (DA-73-11-95 Mod 4) in 2012 required the preparation of a Groundwater Monitoring Program for the Main West Mining Area. This management plan has been submitted for approval. This monitoring plan stipulates quarterly monitoring of MB10, MB11, MB12, MB13 & MB15 for depth to water, conductivity and pH which commenced in 2013.

The shallow bores are purged and sampled with foot valves and tubing dedicated to each bore, whereas the deeper bores (MB02-MB06, MB16 and MB18), monitoring the coal seam aquifers, are sampled with a Bennett Auto Sample Pump with tubing dedicated to each well.

Baseline water samples were collected from the installed bores during the first sampling round in October 2005. Subsequent monthly sampling to date has involved measurement of water level and field measurement of pH and EC.

Monitoring results for alluvial aquifers for 2020 are provided in Table 17. Graphs for water level, pH and EC are provided in Figures 10, 11 and 12 for the period 2016 to 2020.

Monitoring results for the coal seam bores are provided in Table 18. Graphs for water level, pH and EC are provided in Figures 13, 15 and 15 for the period 2016 to 2020. The water levels within the Coal Seam bores were generally stable in 2020. The pH trends shown on Figure 14 indicate that groundwater from the coal seams were quiet variable, ranging from 5.4 to 8.03 during 2020. Groundwater samples collected from the coal seam monitoring bores have a variable EC with the average conductivities ranging from 176μS/cm to a high of 1860μS/cm in 2020 as shown on Figure 15.

Table 17 – Alluvial Aquifer Results for 2020

Alluvial Aquifers									
Monitoring Bore		**MB9**	**MB10**	**MB11**	**MB12**	**MB13**	**MB14**	**MB15**	**MB17**
Groundwater Level (Baseline)	mbgs	0.96	3	2.52	5.33	4.88	3.73	5.88	2.63
Groundwater Level (Historical Average)	mbgs	1.51	2.67	2.62	4.86	4.84	3.58	3.89	2.83
Groundwater Level (2020)	mbgs	1.51	2.68	2.79	4.85	5.22	3.89	2.87	2.84
Chemical Parameters									
pH (Baseline)	pH unit	7.16	5.98	5.85	6.2	6.55	6.33	5.71	6.53
pH (Historical Average)	pH unit	5.76	6.21	6.18	6.61	6.61	6.46	6.08	6.22
pH (2020)	pH unit	5.47	6.92	8.15	7.20	6.89	6.69	6.59	6.77
Electrical Conductivity (Baseline)	uS/cm	300	1000	2400	1000	600	580	100	225
Electrical Conductivity (Historical Average)	uS/cm	260.37	1353.60	3559.44	1370.60	874.78	471.02	293.17	193.11
Electrical Conductivity (2020)	uS/cm	373.50	1024.00	3785.00	992.00	1306.67	460.00	277.67	191.75

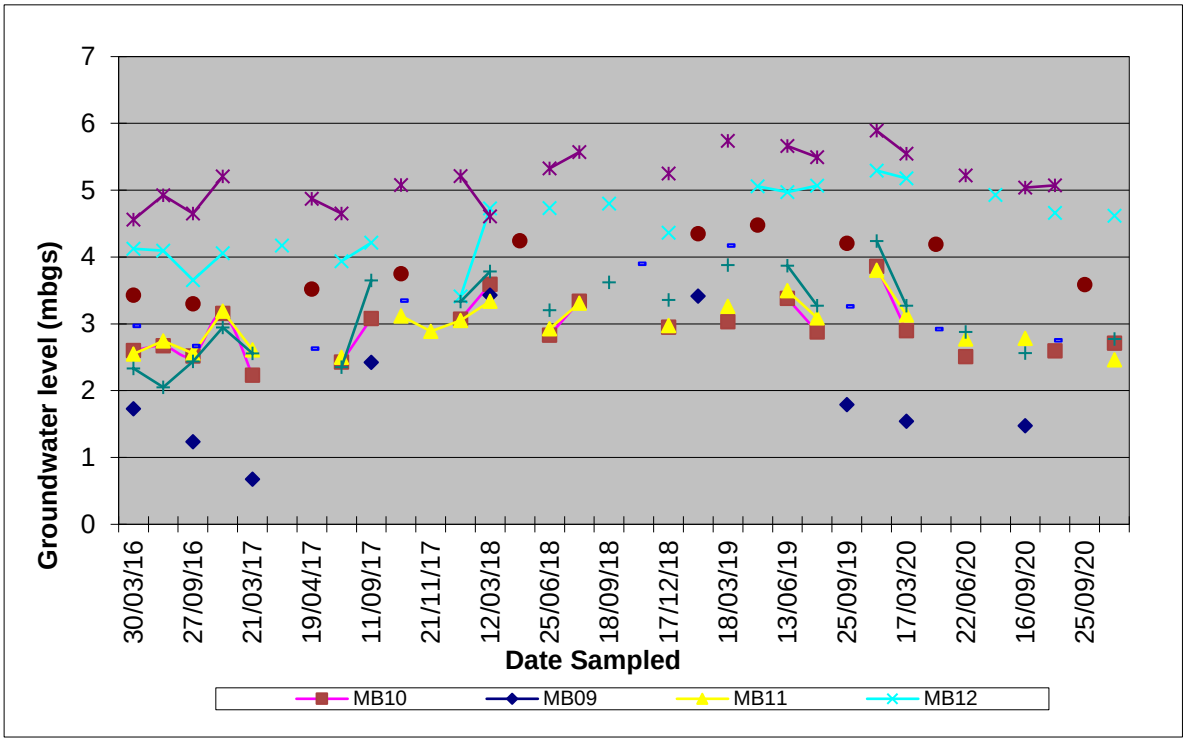


Figure 10 - Alluvial aquifer monitoring bores – level trends (2016 – 2020)

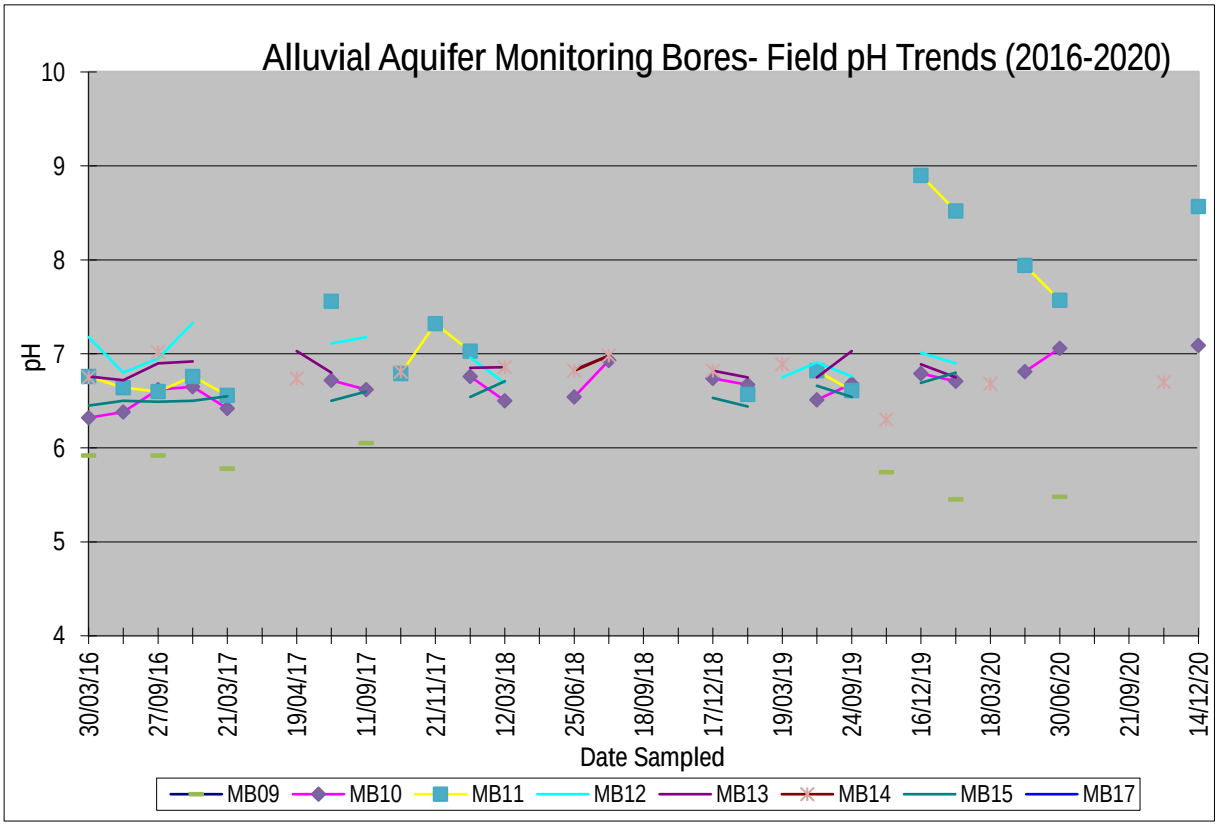


Figure 11 - Alluvial aquifer monitoring bores – pH trends (2016 – 2020)

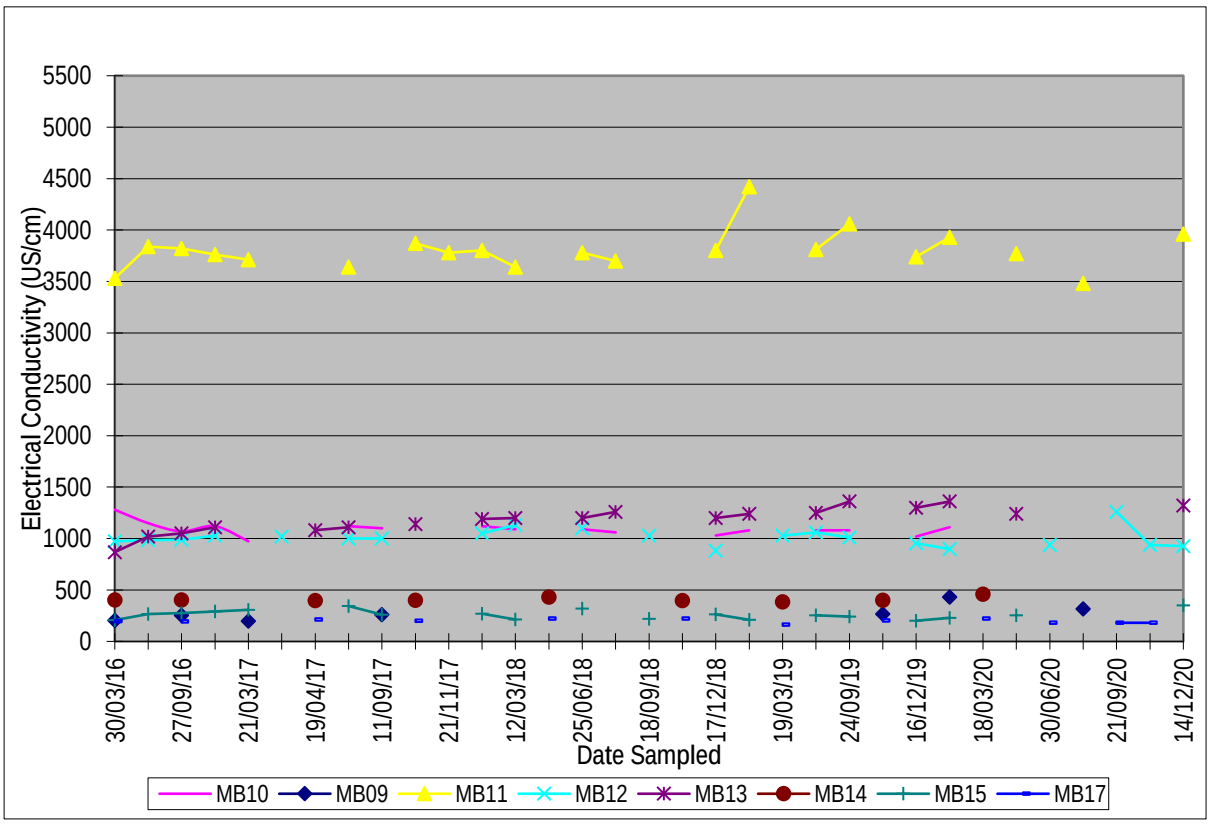


Figure 12 - Alluvial aquifer monitoring bores – EC trends (2016 – 2020)

Table 18 – Coal Seam Bedrock Aquifer Results for 2020

Coal Seam										
Monitoring Bore	**Unit**	**MB1**	**MB2**	**MB3**	**MB4**	**MB5**	**MB6**	**MB16**	**MB18**	**MB19**
Groundwater Level (Baseline)	mbgs	29.78	11.25	9.9	22.01	24.35	45.17	33.28	NA	NA
Groundwater Level (Historical Average)	mbgs	30.02	11.45	10.75	20.03	24.17	44.85	33.51	19.37	22.44
Groundwater Level (2020)	mbgs	NA	NA	19.39	23.97	23.97	46.35	34.25	NA	24.29
Chemical Parameters										
pH (Baseline)	pH unit	6.79	6.53	6.73	5.64	6.39	6.51	6.1	NA	NA
pH (Historical Average)	pH unit	6.88	6.01	7.24	5.32	6.27	6.64	6.03	7.11	6.78
pH (2020)	pH unit	NA	NA	7.18	5.47	6.37	7.41	6.62	N/A	6.82
Electrical Conductivity (Baseline)	uS/cm	3020	1620	652	291	1820	1440	780	NA	NA
Electrical Conductivity (Historical Average)	uS/cm	2820.00	1340.0	1261.98	226.57	1727.24	1295.0	614.49	2048.53	1732.93
Electrical Conductivity (2020)	uS/cm	NA	NA	1044.0	192.50	1840.0	1240.0	538.50	NA	512.50

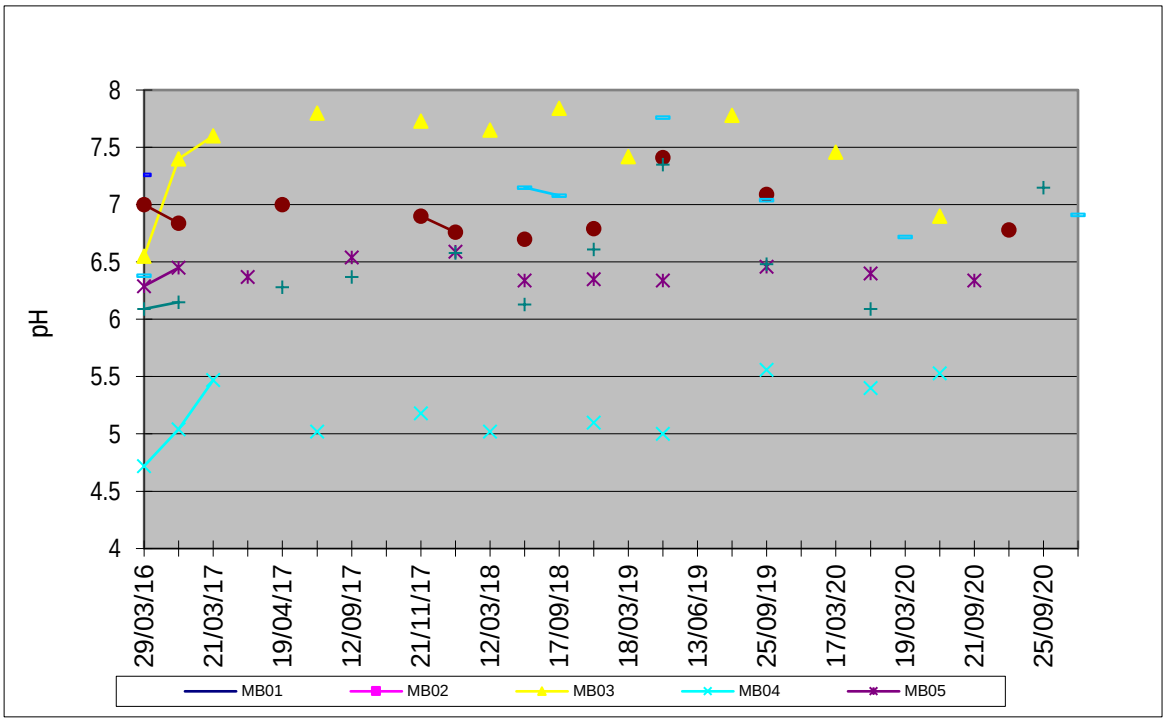


Figure 13 - Coal Seam monitoring bores – level trends (2016-2020)

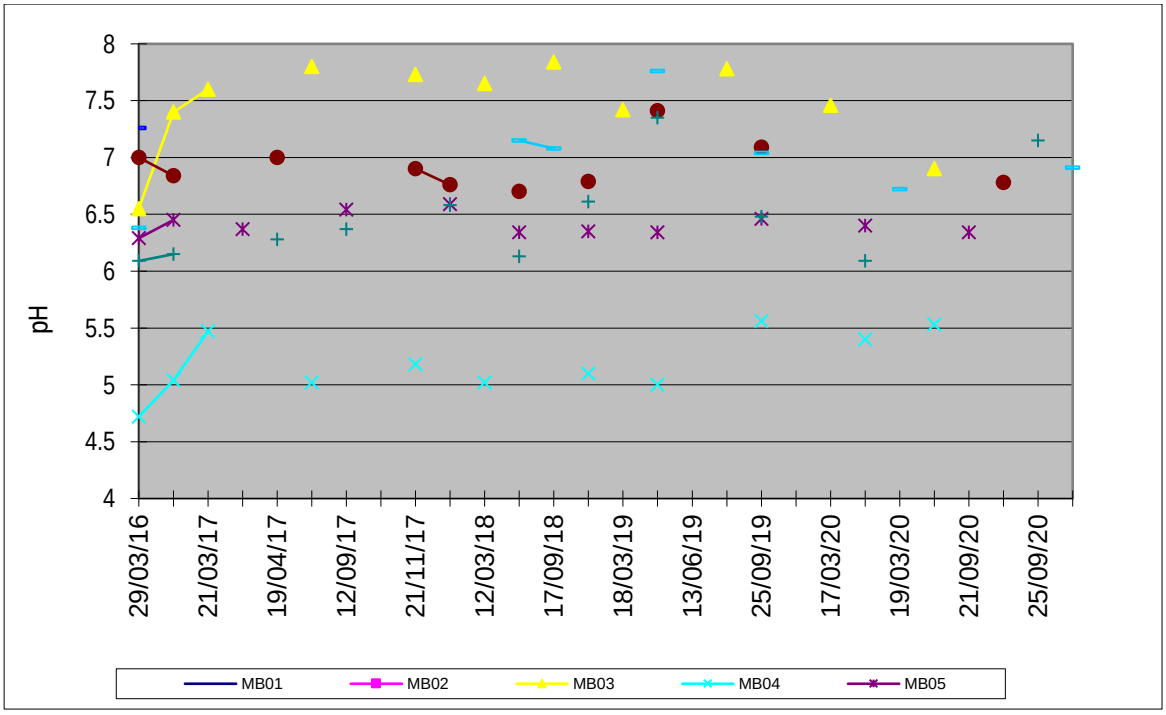


Figure 14 - Coal Seam monitoring bores – pH trends (2016-2020)

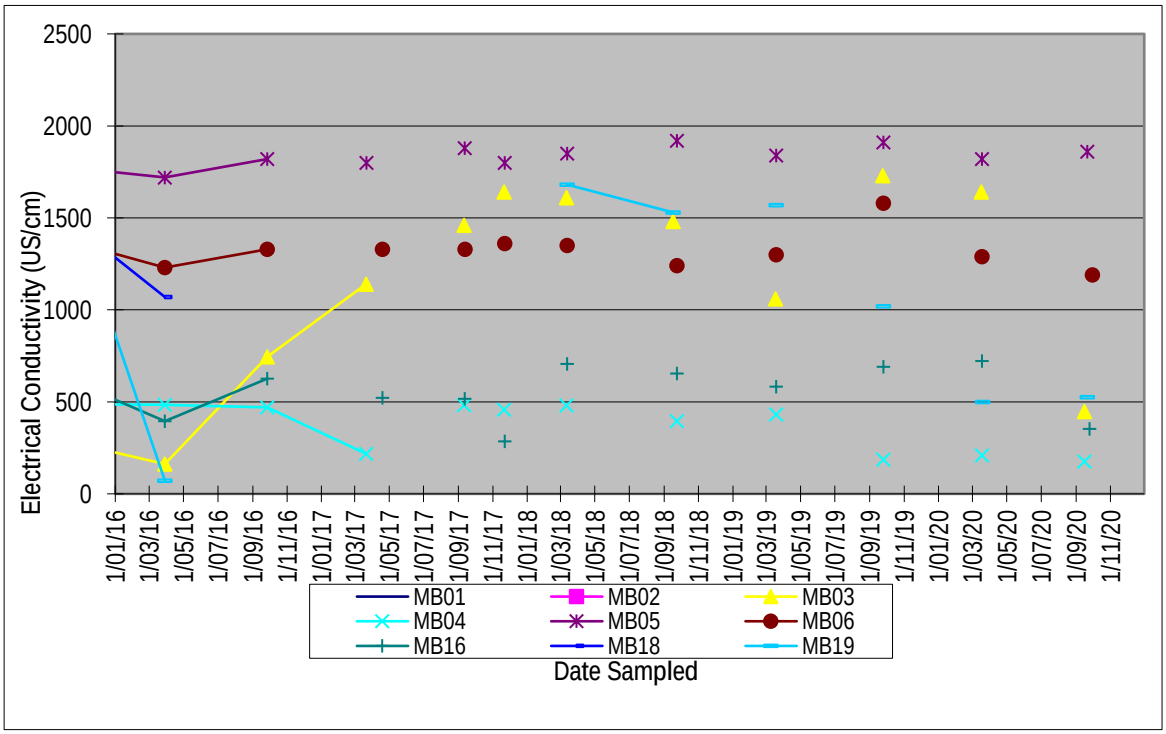


Figure 15 - Coal Seam monitoring bores – EC trends (2016-2020)

6.10. Water Budget

Newstan utilises potable and recycled water for surface operations and recycled water from dams and old workings for underground operations. Potable water is used in the bathhouse and amenity systems. All other operations utilise recycled water from the colliery dams, Fassifern No 1. Bore, and the Clean Water Plant. The Clean Water Plant at Newstan Colliery commenced operating in December 2013.

The average volume of water discharged from LDP001 during the reporting period was 7.7 ML per day with a total of 2164.98 ML being discharged for the year. Water from LDP001 discharges to the By-wash Dam where it is allowed to discharge to LT Creek. A summary of discharges recorded by Newstan Colliery is provided in Table 19.

Table 19 – Discharge Data Recorded by Newstan for 2020

Discharge Point	Total Annual Discharge (ML)
LDP001	2164.98
LDP002	0
EPL Point 17 Stony Creek Pipeline	0

7. REHABILITATION

7.1. Buildings

No additional buildings were undertaken during the report period at Newstan. No buildings were removed during the reporting period.

7.2. Rehabilitation of Disturbed Land

The NREA tailings dam is approximately 70% capped at the end of the reporting period, with minor works undertaken since the 2019 reporting period. These works are planned to continue in the 2020 reporting period when waste rock / chitter material becomes available.

Progressive stabilisation and rehabilitation of disturbed areas is undertaken with all land disturbance activities associated with the Newstan Colliery activities. Due to the limited site disturbance of the underground mine surface infrastructure and washery site, there were no other areas rehabilited during the period.

In accordance with the current approved MOP Rehabilitation inspections will be undertaken to check for:

- evidence of soil erosion;
- evidence of cap slumping / settlement;
- highwall instability (SREA);
- slope instability; and
- the presence of declared weeds.

Rehabilitation monitoring will include flora and fauna monitoring methodologies as per the Flora & Fauna Management Plan, as well as any observed occurrences of invertebrate recolonisation (ants, soil faunal communities establishing). This monitoring commenced annually in 2015 and will continue until completion criteria have been satisfied. Maintenance will be undertaken as required until the rehabilitation success criteria has been achieved and continued until lease surrender.

Table 20 displays a rehabilitation summary for the Newstan Colliery.

Table 20 – Newstan Awaba Rehabilitation Summary*

Mine Area Type	Previous Reporting Period (Actual)	This Reporting Period (Actual)	Next Reporting Period (Forecast)
	2019 (ha)	2020 (ha)	2021 (ha)
A. Total mine footprint[1]	3989.9	3989.9	3989.9
B. Total active disturbance[2]	25.4	25.4	25.4
C. Land being prepared for rehabilitation[3]	Nil	Nil	Nil
D. Land under active rehabilitation[4]	Nil	Nil	Nil
E. Completed rehabilitation[5]	Nil	34.6	34.6

Note A. Total Colliery Mining Lease Holding

7.3. Rehabilitation Trials and Research

No rehabilitation trials or research was undertaken at Newstan Colliery during the reporting period. Rehabilitation works undertaken to date on the NREA and SREA have proven successful therefore negating the need to undertake rehabilitation trials.

Analogue Rehabilitation areas were chosen in 2014 in accordance with the Flora & Fauna Management Plan to provide comparative data for the Rehabilitation of the Newstan Colliery lease area. Monitoring at these locations commenced in 2015. The areas chosen include historical rehabilitation site in the NREA, and the Fauna Corridor to the west of the Colliery. The Annual Monitoring Report can be found in Appendix 3.

8. COMMUNITY CONSULTATION

Newstan Colliery consults with the community through forums such as the Newstan Awaba Community Consultative Committee and community organised events.

A Community Consultative Committee (CCC) has been in place at Newstan since 1999. In 2011 Awaba Colliery was joined into the Newstan Colliery CCC. The Committee generally meets quarterly to review the environmental performance of the mine and other relevant matters. Minutes of the meeting are kept and distributed by the independent Chairman. The minutes are also available on the Centennial Newstan website. Meetings of the Newstan and Awaba Colliery CCC were held in March, August and November during the reporting period.

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

[2] **Total Active Disturbance:** includes all areas requiring rehabilitation

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

[4] **Land under active rehabilitation:** includes areas under rehabilitation and being managed to achieve relinquishment – includes 'ecosystem and land use establishment' and 'ecosystem and land use sustainability (as defined under the DRE MOP/RMP Guidelines)

[5] **Completed rehabilitation**: requires formal sign off from DRE that the area has successfully net the rehabilitation land use objectives or completion criteria

8.1. Community Sponsorship

Newstan Colliery continues to support the local community through various sponsorship avenues to the following community activities, groups and associations in 2020.

8.2. Community Complaints

There was one community complaint regarding Newstan Colliery operations during the 2020 reporting period shown in Table 21..

The Newstan community complaints and enquiries line is in place and contactable on 1800 247 662. Callers are directed to the Environment and Community Coordinator.

Table 21 – Newstan Complaints Summary

Record of Complaints	
Year	**Total**
2016	2
2017	1
2018	1
2019	0
2020	1

8.3. Investigation of Noise Complaint

A community complaint for noise was received on 6 August 2020 from a resident at Awaba.

Centennial installed metal sheeting across the compressor shed to reduce the contribution of the noise form the compressor. Following feedback form the resident the noise sheeting was unsuccessful, noise and vibration monitoring was undertaken on 16 November 2020 by Advitch Pty Limited. The source of the complaint was found to be a compressor supporting the Newstan Colliery underground mine.

Following the monitoring by Advitech, Centennial engaged the original manufacture of the compressor for the installation of ducting on the compressor that will directly reduce noise and vibration. This is to be undertaken in the next reporting period and is identified in Section 11.

9. INDEPENDENT AUDIT

The next Independent Environmental Audit will be undertaken in June 2021.

10. INCIDENTS AND NON-COMPLIANCES DURING THE REPORTING PERIOD

There were no non-compliances during the reporting period.

11. ACTIVITES TO BE COMPLETED IN THE NEXT REPORTING PERIOD

Planned activities for the next reporting year:

- installation on air compressor ducting from original equipment manufacturer;
- completion of Independent Environmental Audit; and

- inclusion of Newstan subsidence rehabilitation in the Awaba Colliery Sinkhole Rehabilitation Management Plan.

APPENDIX 1 – Newstan Colliery LDP001 Historical Data Review

CENTENNIAL

NEWSTAN COLLIERY HISTORICAL REVIEW FOR SURFACE WATER MONITORING

March 2021

Centennial Coal
Environment Matters

1. LDP001 ANALYTES

The discharge analytes for LDP001 have been included from 2010, as regular sampling of several analytes commenced at this time.

Where an outlier has caused the graph to become unreadable, a second graph has been added which excludes the outliers to provide more detail. All units in the graphs are in mg/L, with the exception of pH (pH units) and Conductivity (µS/cm).

The Environmental Protection Licence (EPL) 395 was modified in November 2015. These new limits have been included on the graphs. Where there is no longer a EPL limit the limit may be seen as 0. These metals are still required to be monitored as per EPL requirements. There are no discharge limits within the Newstan Development Consent (DA 73-11-98).

The majority of the water discharged through LDP001 was from an underground water storage called the Fassifern Seam. However if the rainfall exceeded the capacity of Graunch's Dam, this may also flow through LDP001. In 2013 a Clean Water Plant was commissioned at Newstan Colliery, and now the majority of the water discharged through LDP001 is treated through the CWP prior to discharge through LDP001.

While the limits only apply to either dissolved or total metals, both dissolved and total (where available and applicable) have been provided in the attached graphs to give an overall view of the water quality results from LDP001.

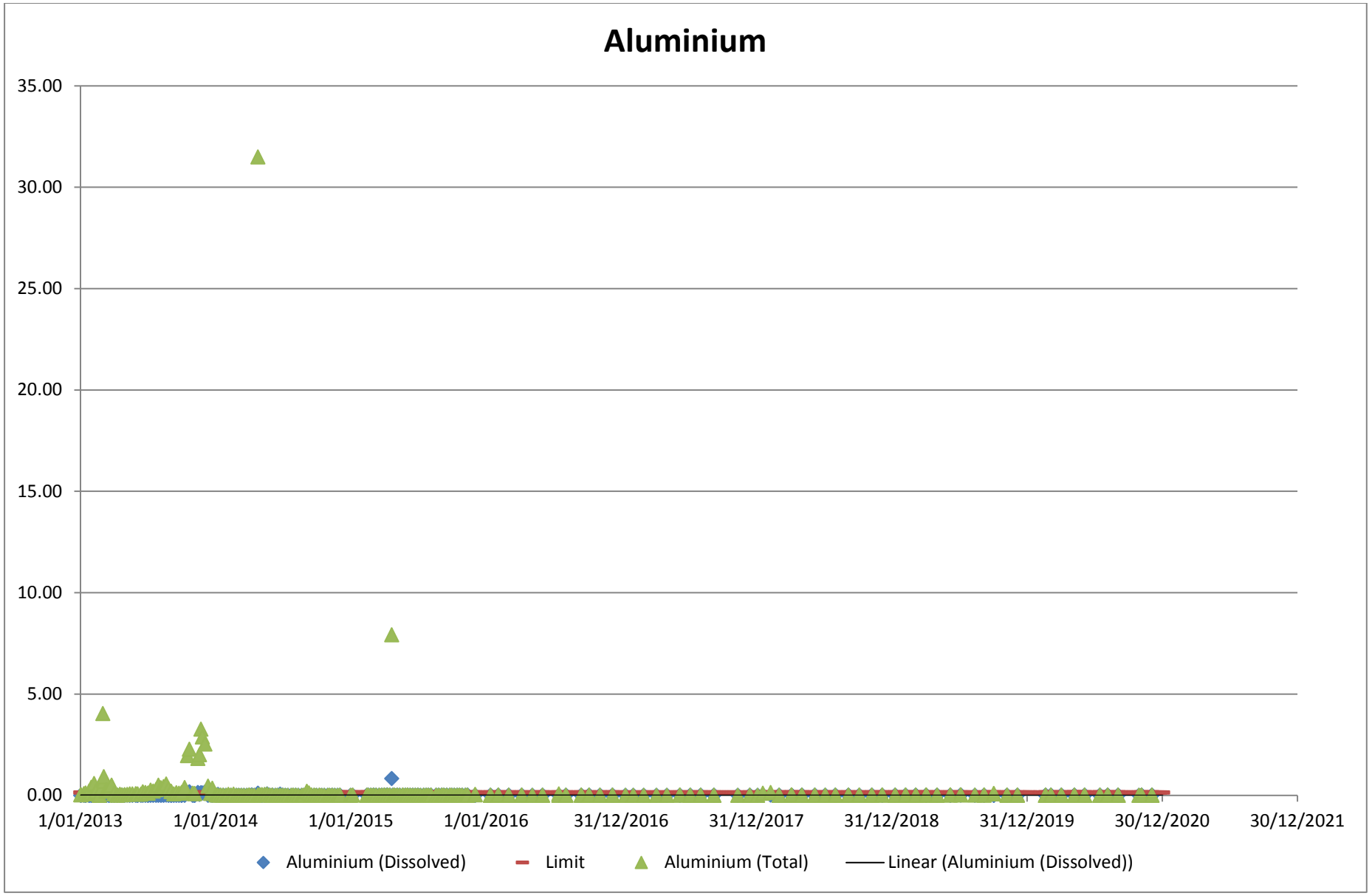
The following analytes are generally below the licence criteria, and have remained relatively stable since 2010: aluminium, barium, cadmium, copper, lead, manganese, mercury, nitrogen, oil & greases, phosphorus, selenium, TKN, and zinc.

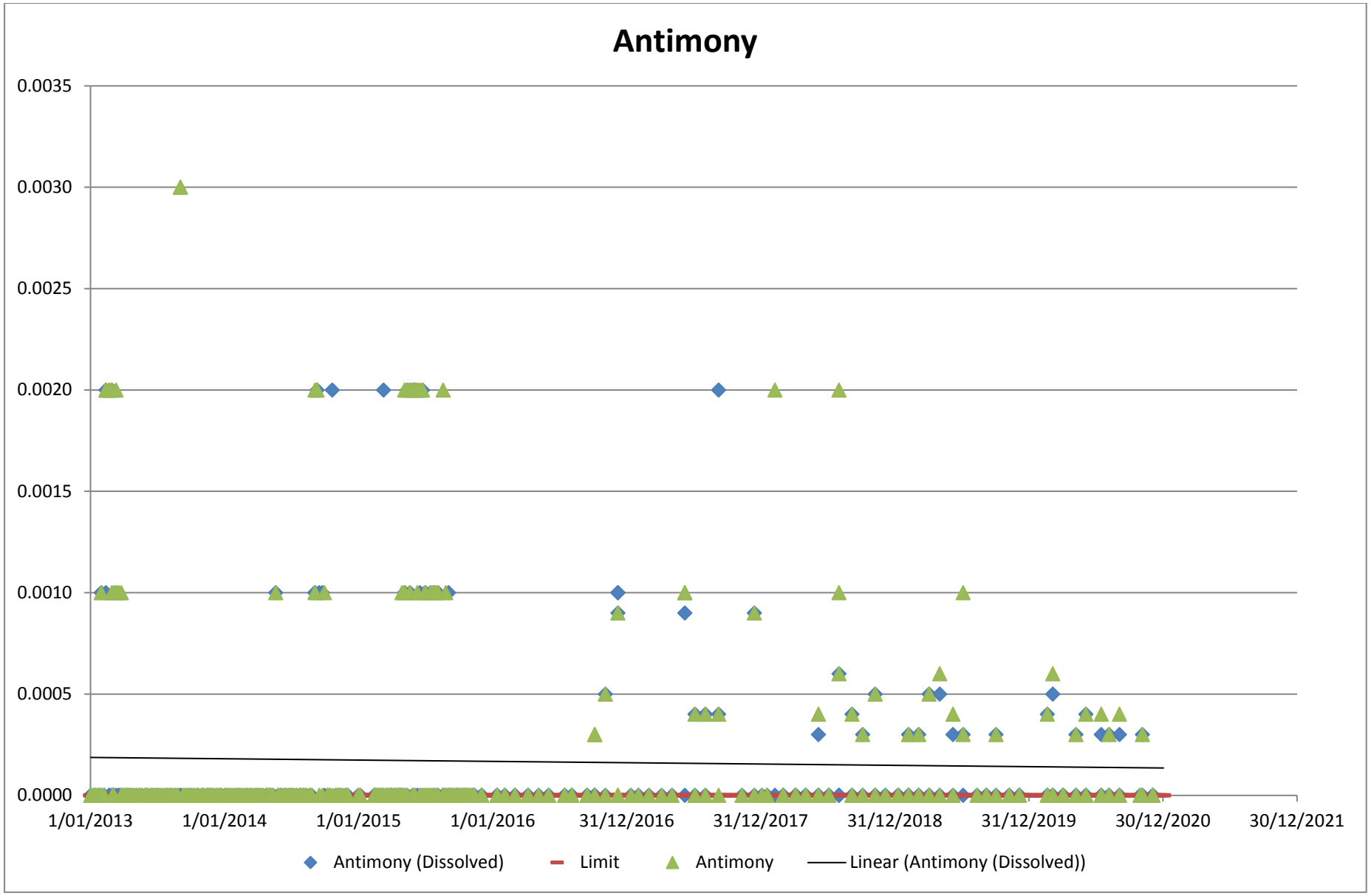
Note some lead results are above the limits, however this is due to contamination during the commissioning of the composite samplers, and are not licence exceedences. The results have been left in to provide a completed monitoring set.

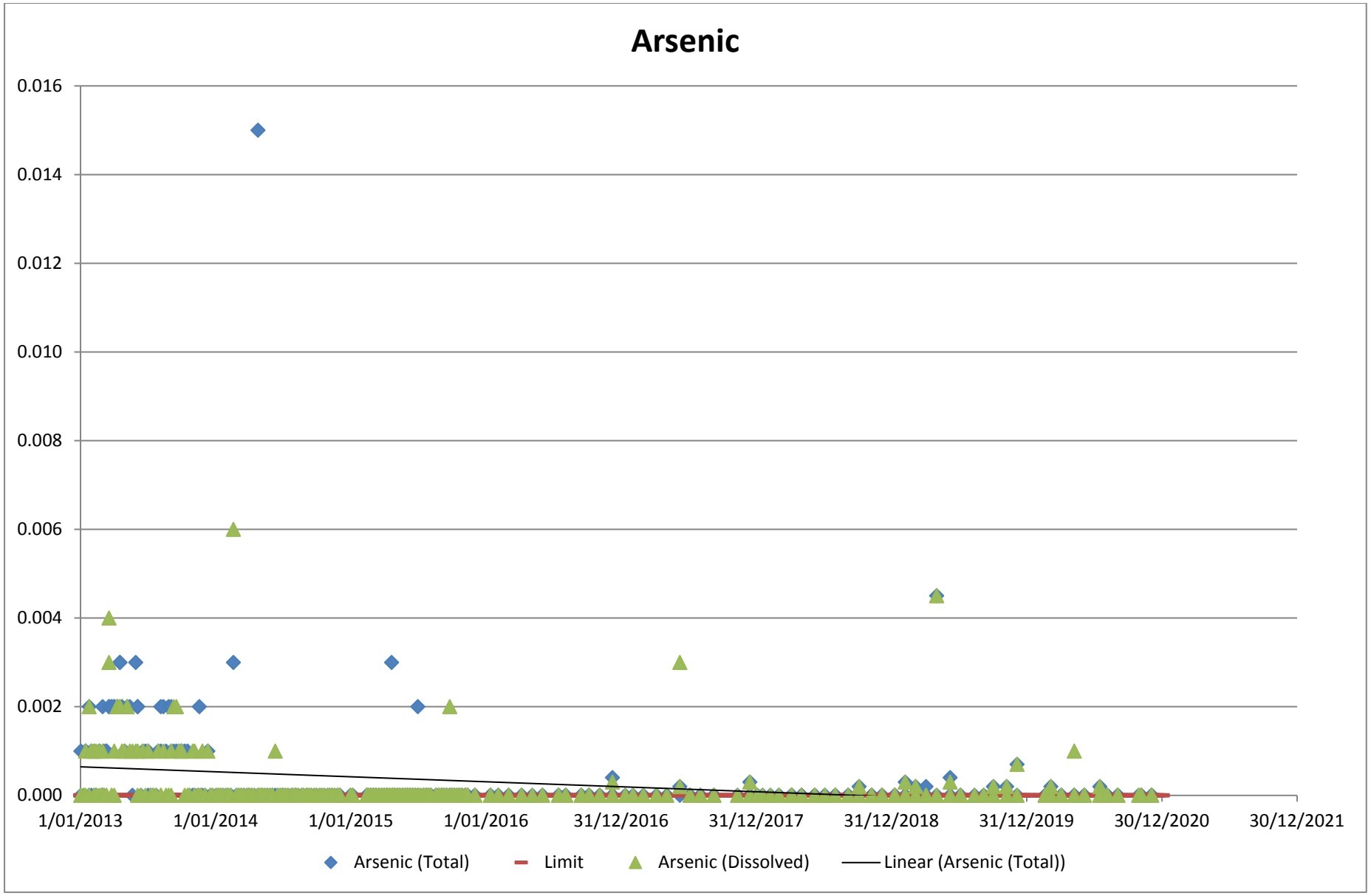
Bicarbonate alkalinity, boron, calcium, chromium, conductivity, molybdenum, nickel and silica are generally below the licence limits, and have a decreasing trend.

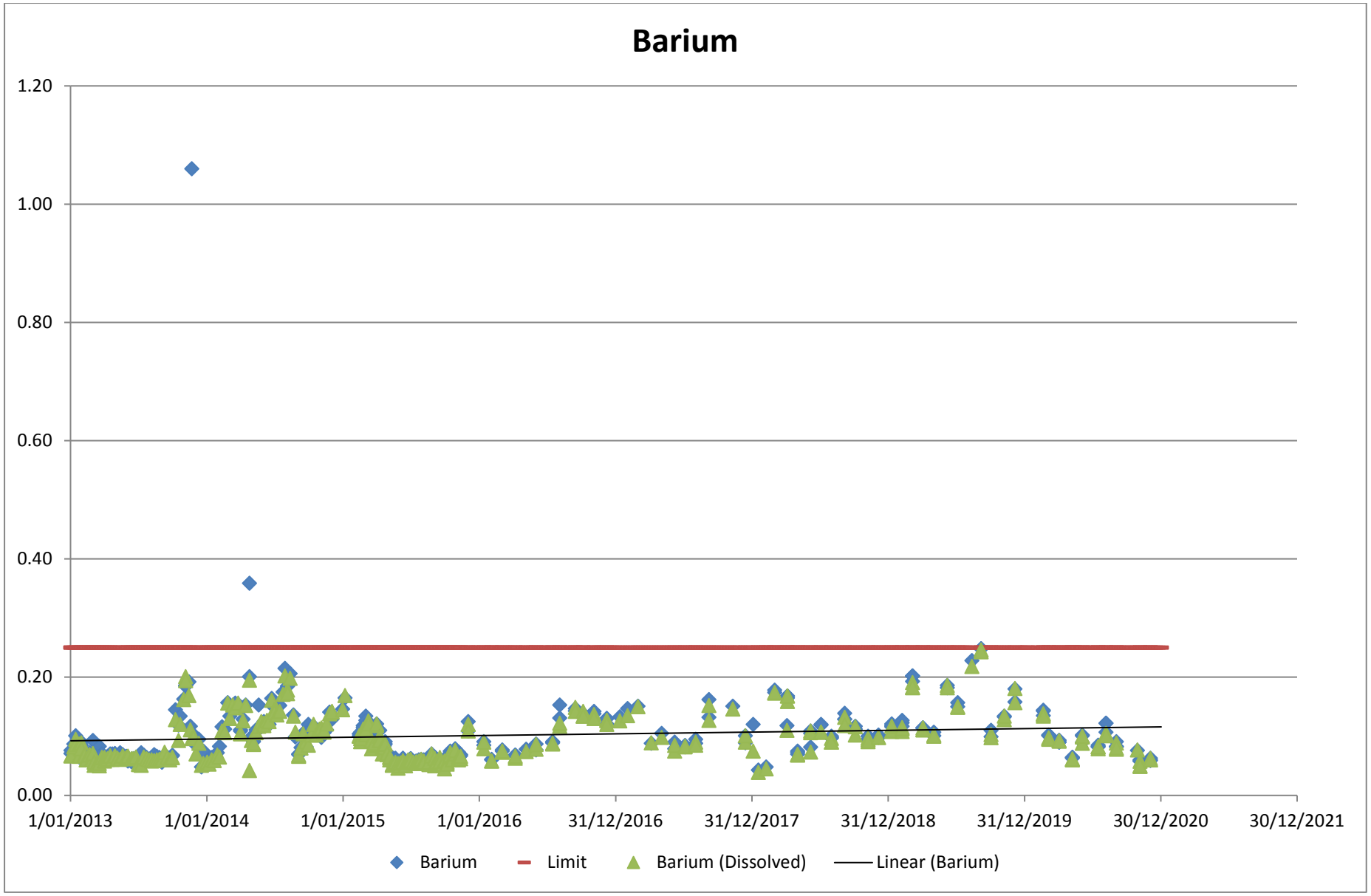
Sulphate exceeded the limits on several occasions in late 2012 and early 2013, however has been below the limit since mid 2013. The pH and chloride at LDP001 have been trending upwards over time, with lithium exceeding a few times in 2014.

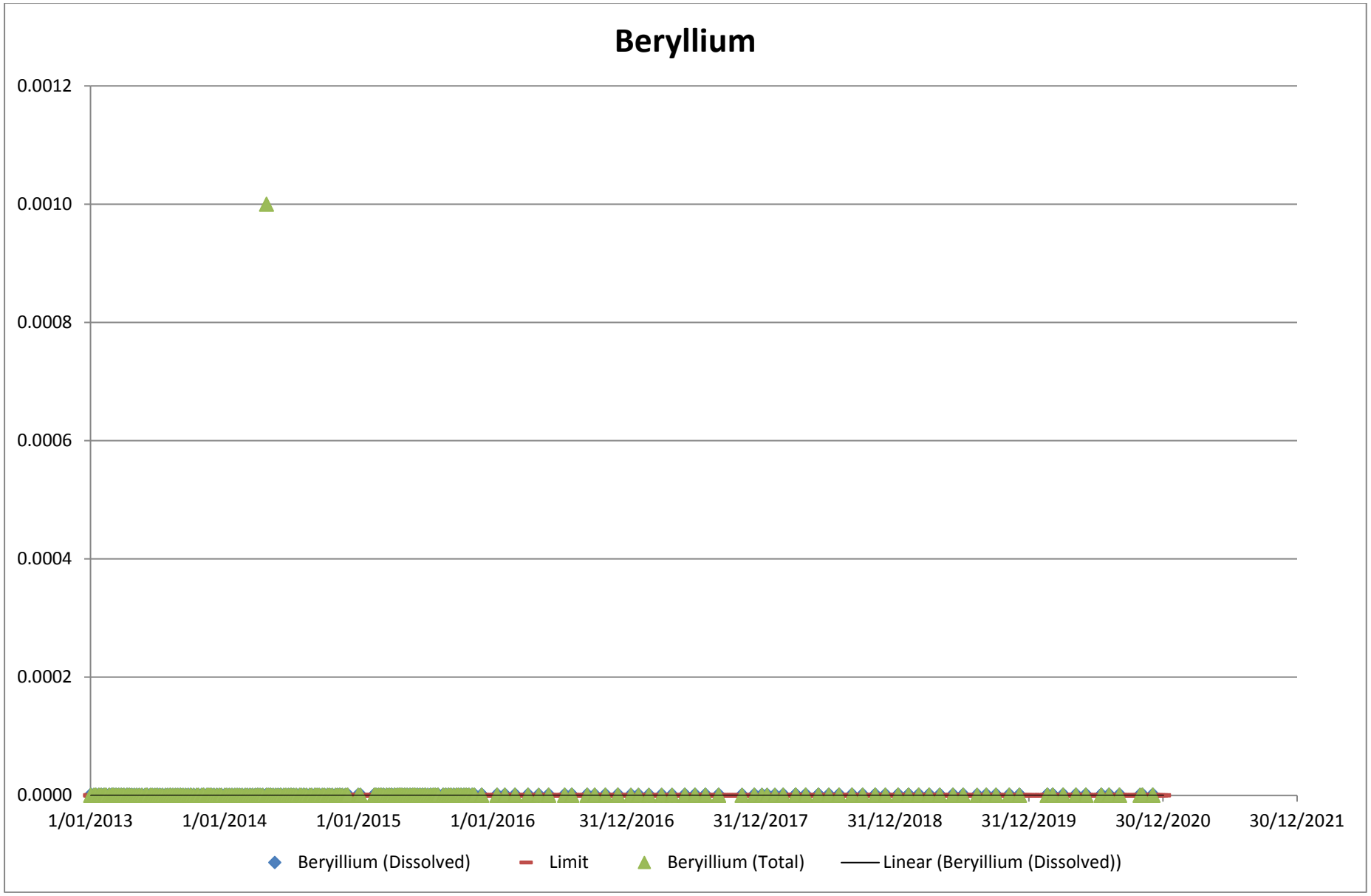
TSS may exceed the limits at times, but this generally aligns with overflows from Graunch's Dam through LDP001, rather then the water discharged from the underground Fassifern Seam.

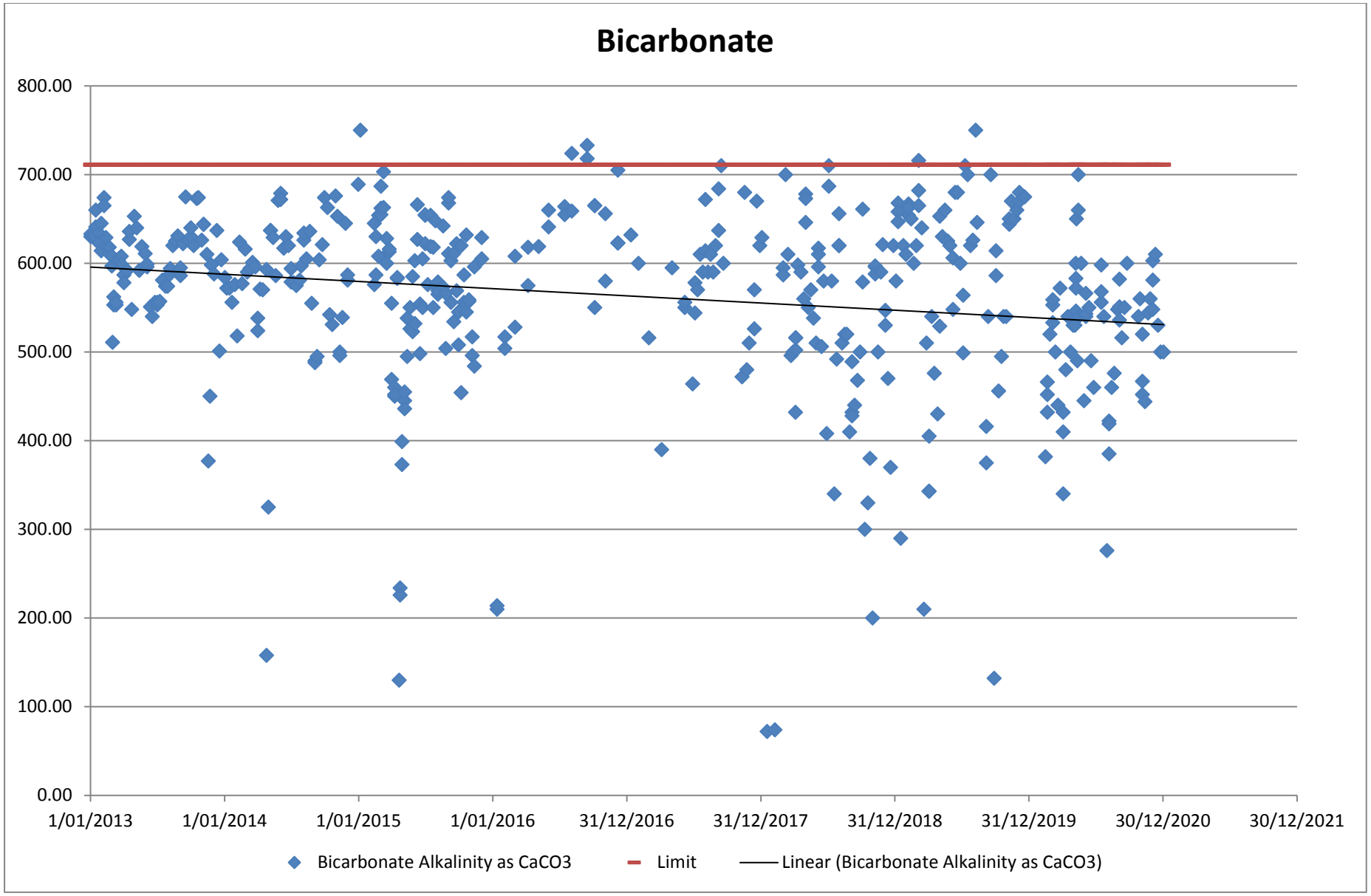

Aluminium
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
1/01/2013
1/01/2014
1/01/2015
1/01/2016
31/12/2016
31/12/2017
31/12/2018
31/12/2019
30/12/2020
30/12/2021
Aluminium (Dissolved)
Limit
Aluminium (Total)
Linear (Aluminium (Dissolved))

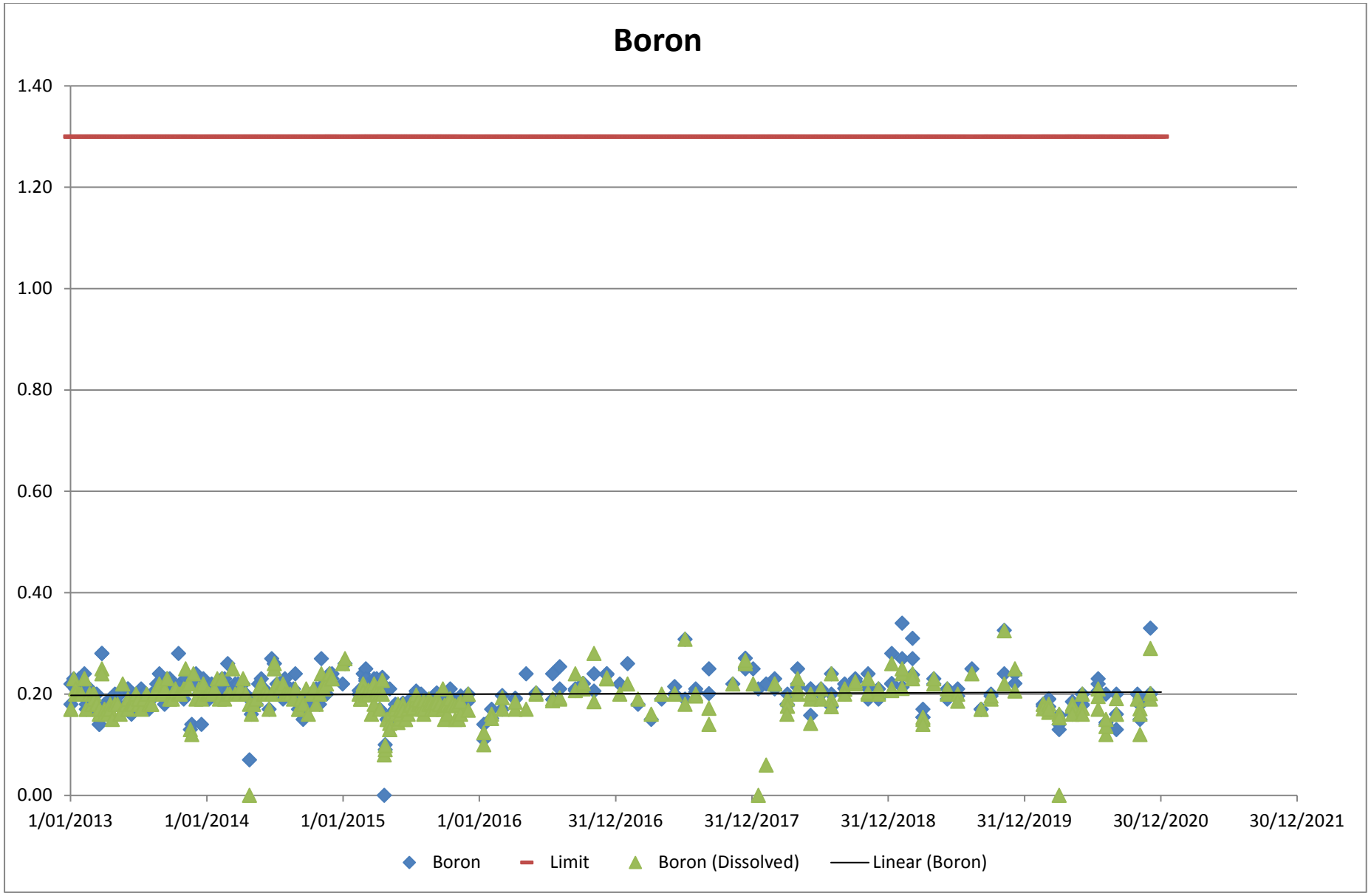

Antimony
0.0035
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
1/01/2013
1/01/2014
1/01/2015
1/01/2016
31/12/2016
31/12/2017
31/12/2018
31/12/2019
30/12/2020
30/12/2021
Antimony (Dissolved)
Limit
Antimony
Linear (Antimony (Dissolved))

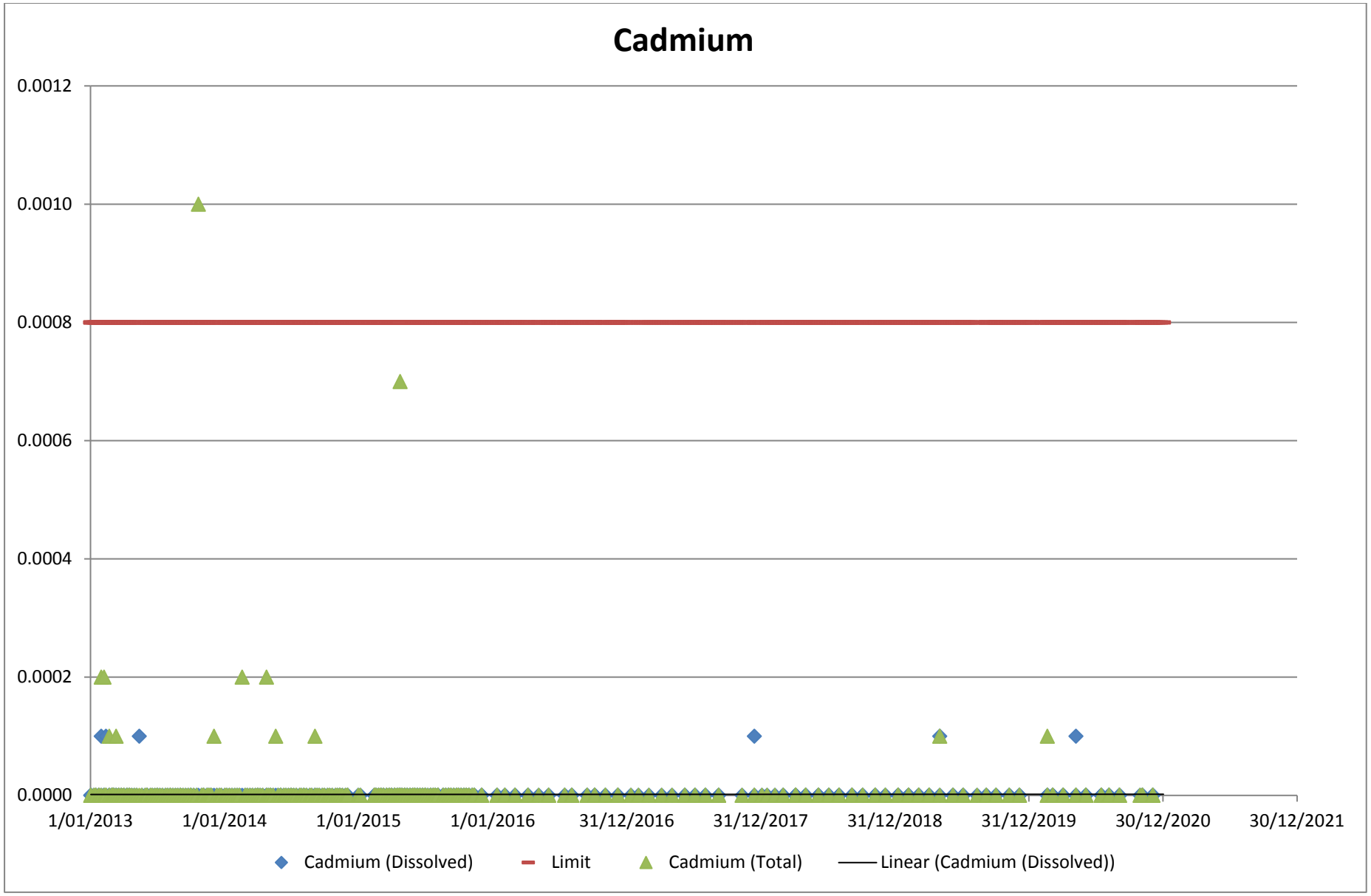

Arsenic
0.016
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000
1/01/2013
1/01/2014
1/01/2015
1/01/2016
31/12/2016
31/12/2017
31/12/2018
31/12/2019
30/12/2020
30/12/2021
Arsenic (Total)
Limit
Arsenic (Dissolved)
Linear (Arsenic (Total))

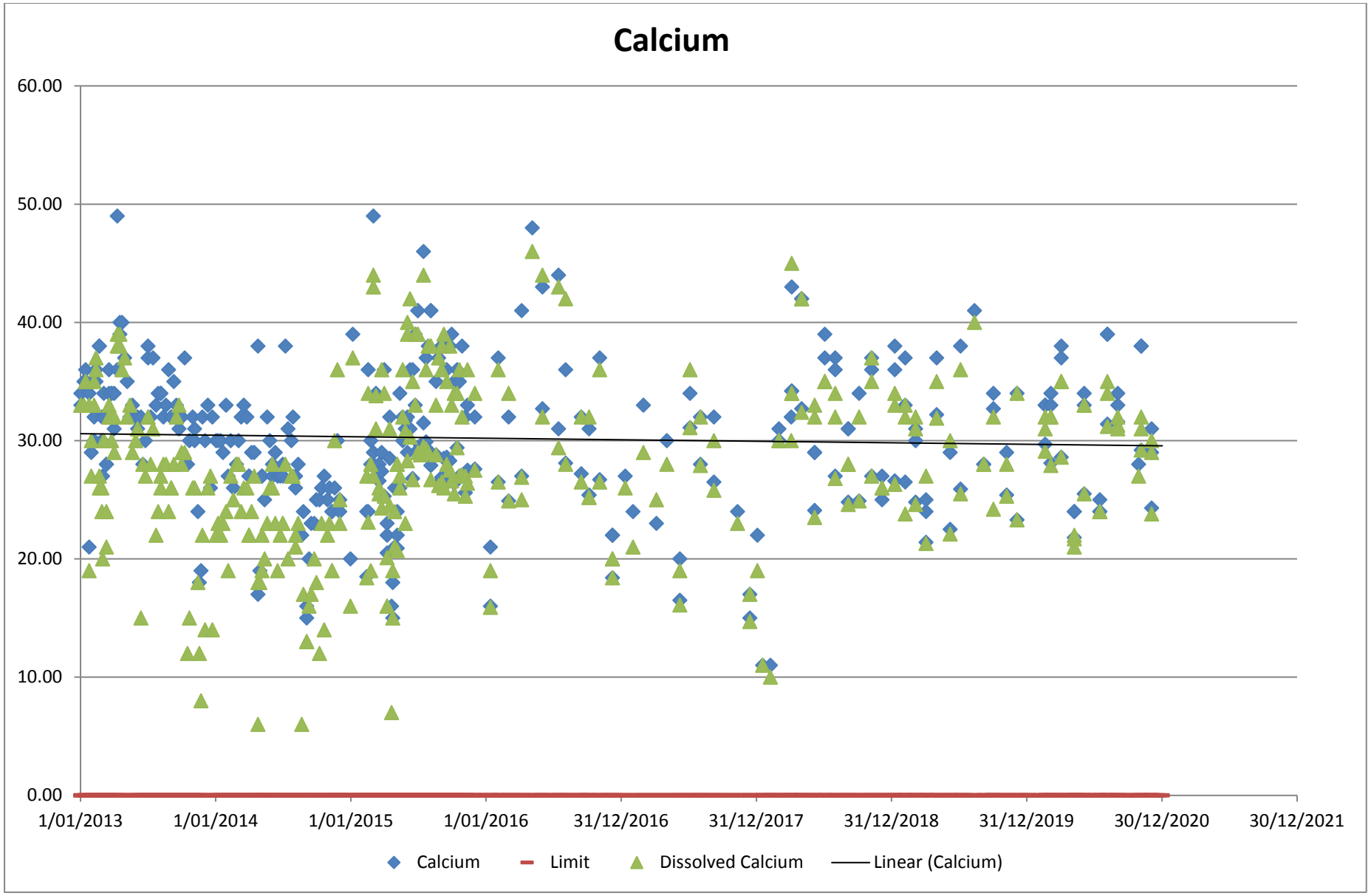

Barium
1.20
1.00
0.80
0.60
0.40
0.20
0.00
1/01/2013
1/01/2014
1/01/2015
1/01/2016
31/12/2016
31/12/2017
31/12/2018
31/12/2019
30/12/2020
30/12/2021
Barium
Limit
Barium (Dissolved)
Linear (Barium)

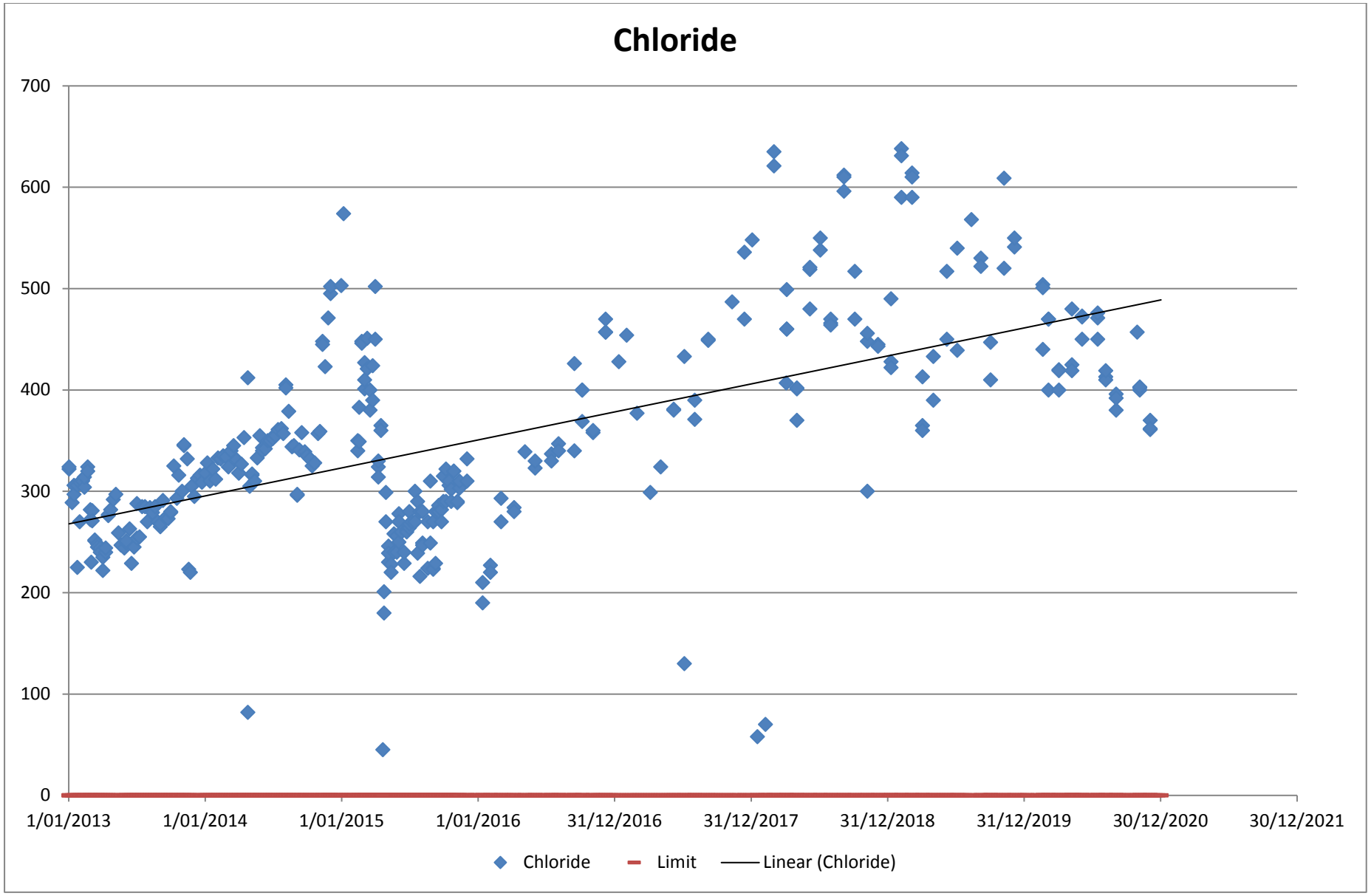

Beryllium
0.0012
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
1/01/2013
1/01/2014
1/01/2015
1/01/2016
31/12/2016
31/12/2017
31/12/2018
31/12/2019
30/12/2020
30/12/2021
Beryllium (Dissolved)
Limit
Beryillium (Total)
Linear (Beryillium (Dissolved))

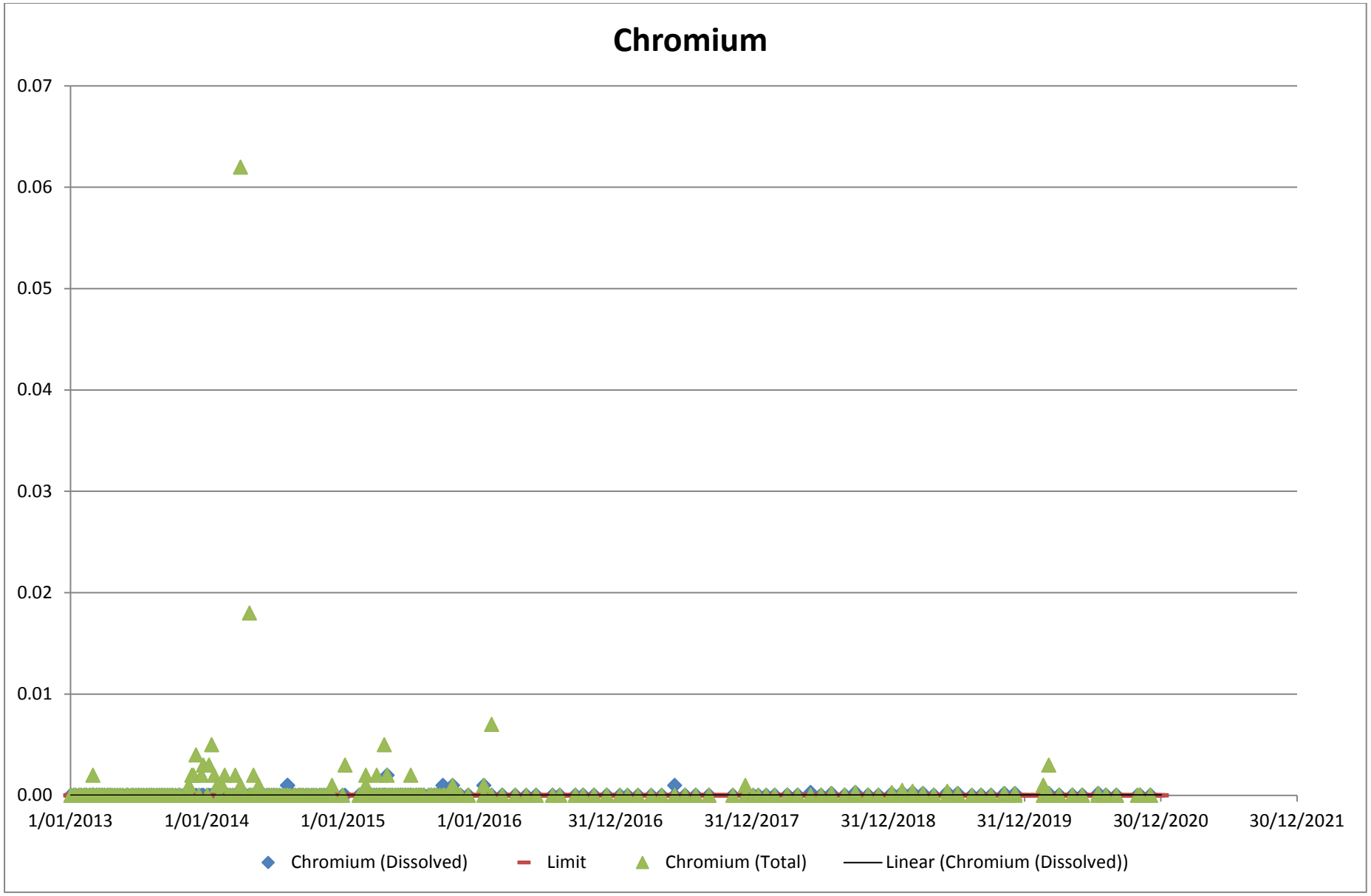

Bicarbonate
800.00
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
1/01/2013
1/01/2014
1/01/2015
1/01/2016
31/12/2016
31/12/2017
31/12/2018
31/12/2019
30/12/2020
30/12/2021
Bicarbonate Alkalinity as CaCO3
Limit
Linear (Bicarbonate Alkalinity as CaCO3)

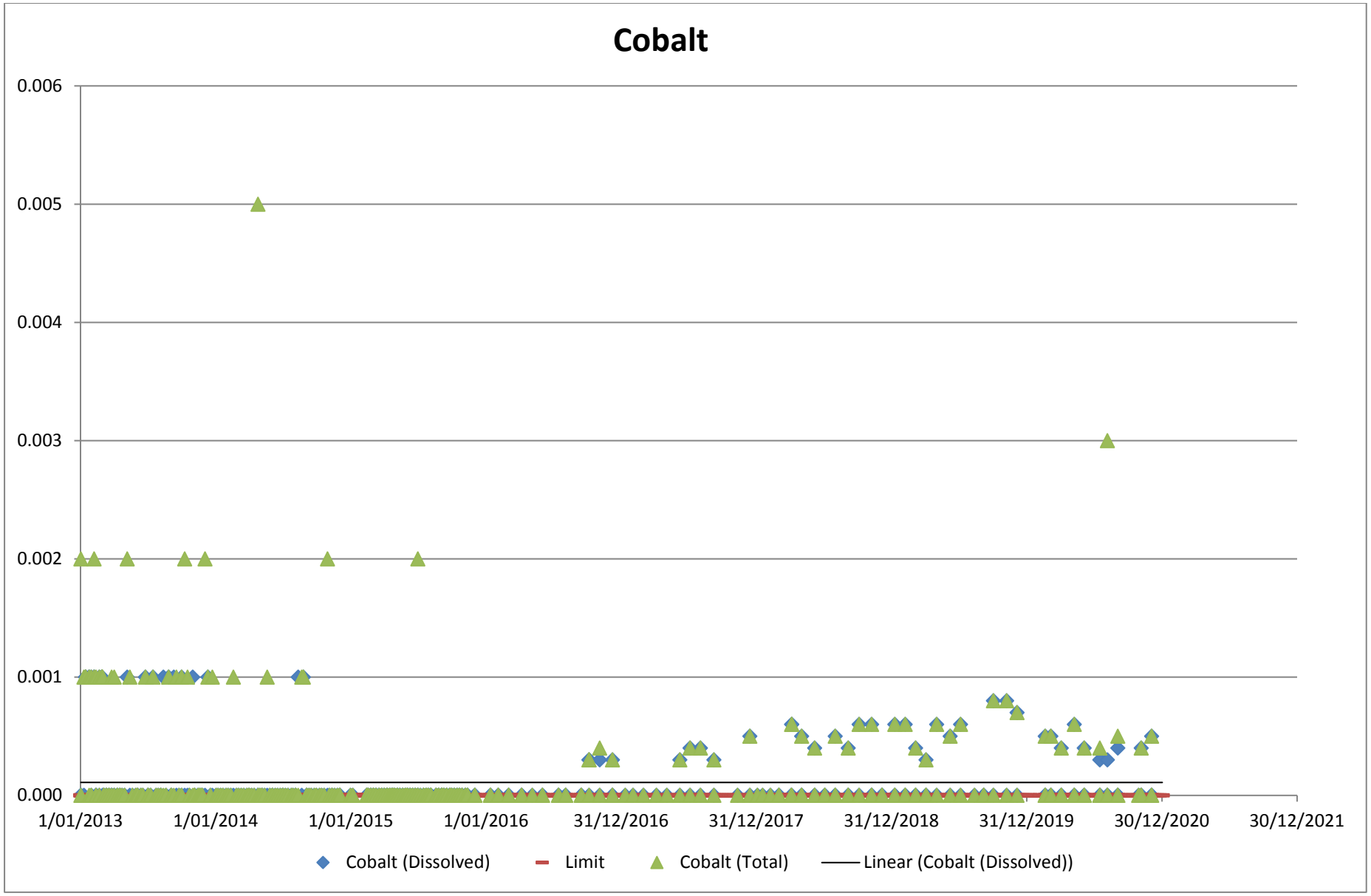

Boron
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
1/01/2013
1/01/2014
1/01/2015
1/01/2016
31/12/2016
31/12/2017
31/12/2018
31/12/2019
30/12/2020
30/12/2021
Boron
Limit
Boron (Dissolved)
Linear (Boron)

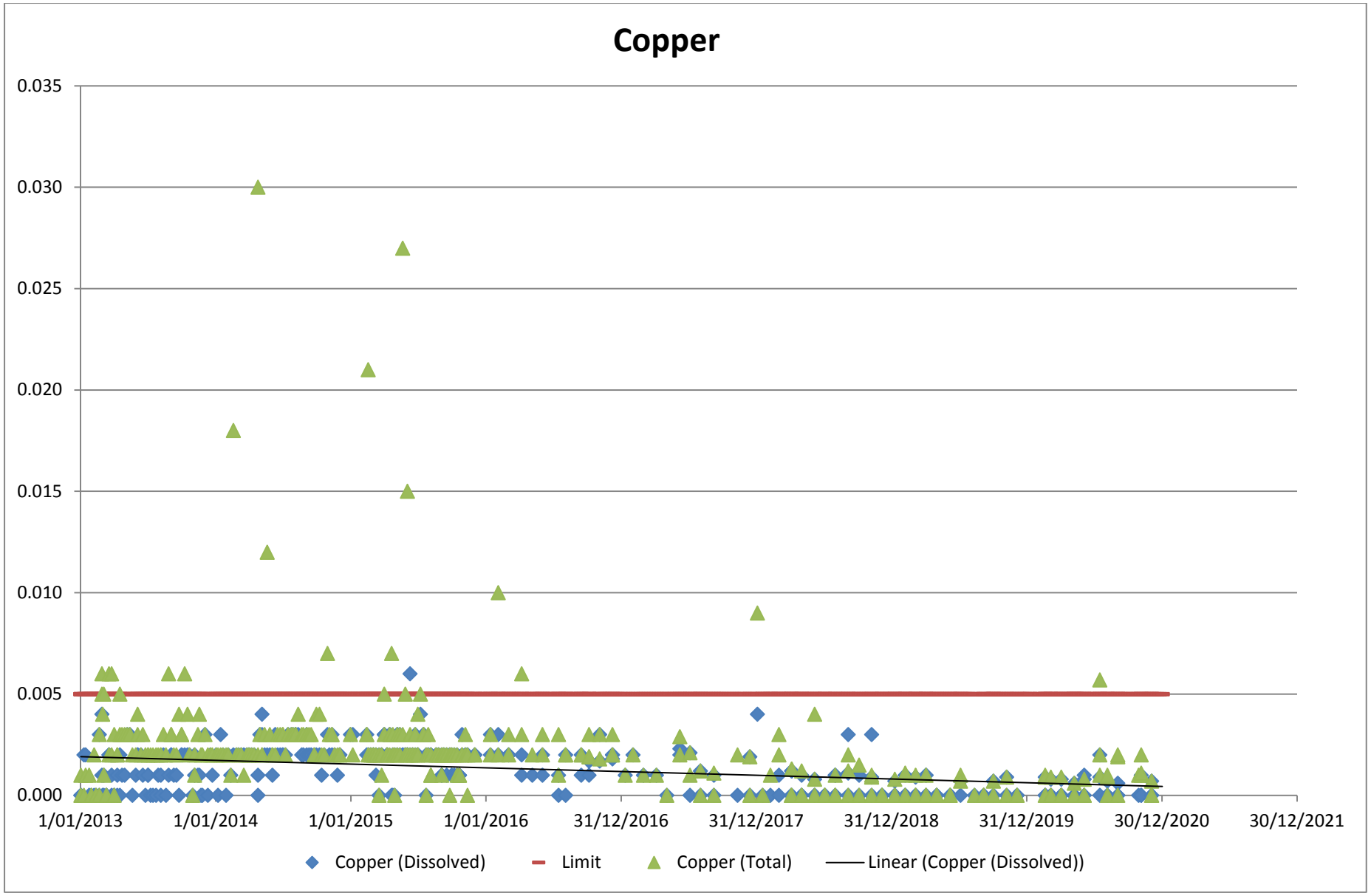

Cadmium
0.0012
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
1/01/2013
1/01/2014
1/01/2015
1/01/2016
31/12/2016
31/12/2017
31/12/2018
31/12/2019
30/12/2020
30/12/2021
Cadmium (Dissolved)
Limit
Cadmium (Total)
Linear (Cadmium (Dissolved))

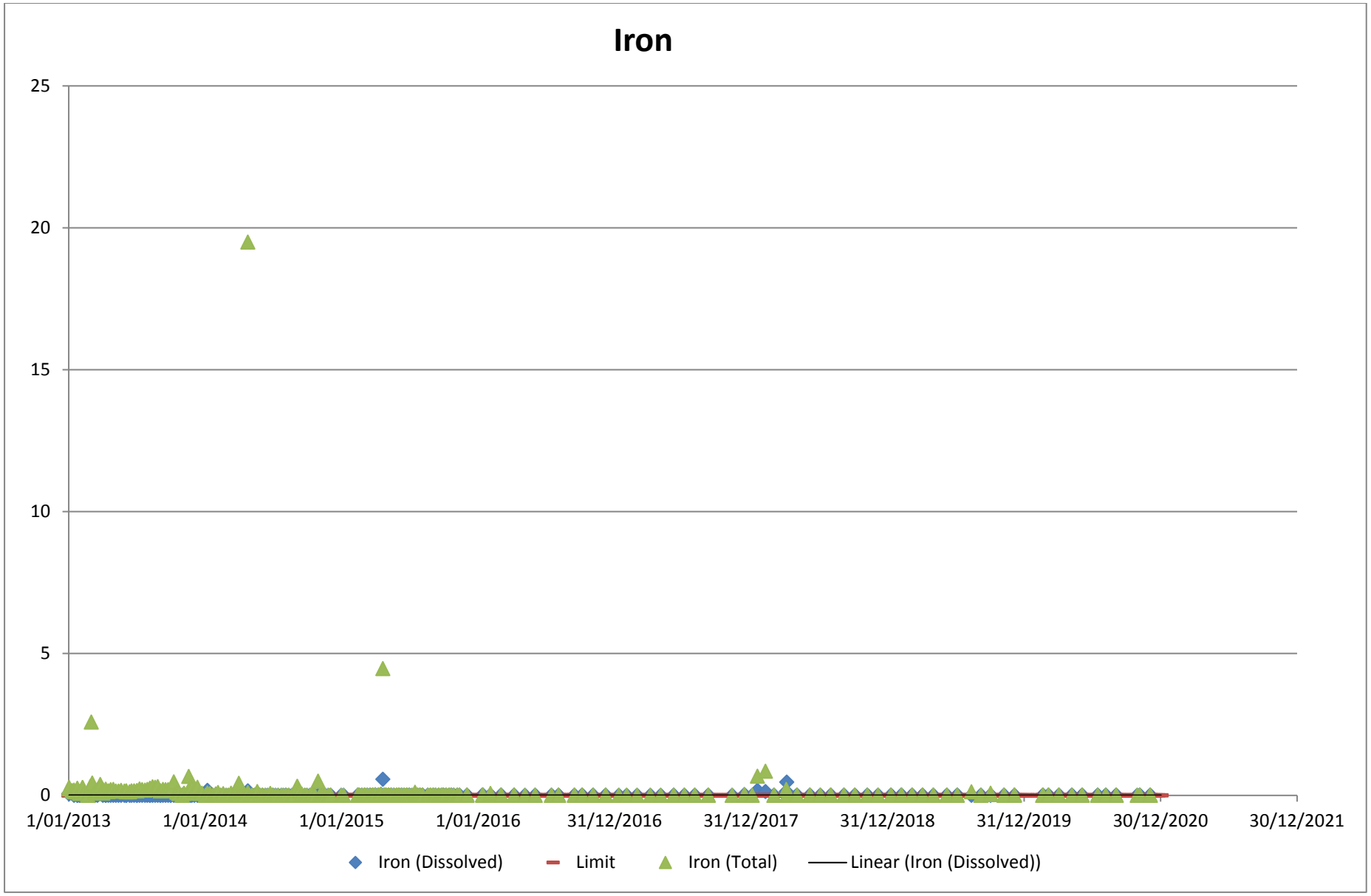

Calcium
60.00
50.00
40.00
30.00
20.00
10.00
0.00
1/01/2013
1/01/2014
1/01/2015
1/01/2016
31/12/2016
31/12/2017
31/12/2018
31/12/2019
30/12/2020
30/12/2021
Calcium
Limit
Dissolved Calcium
Linear (Calcium)

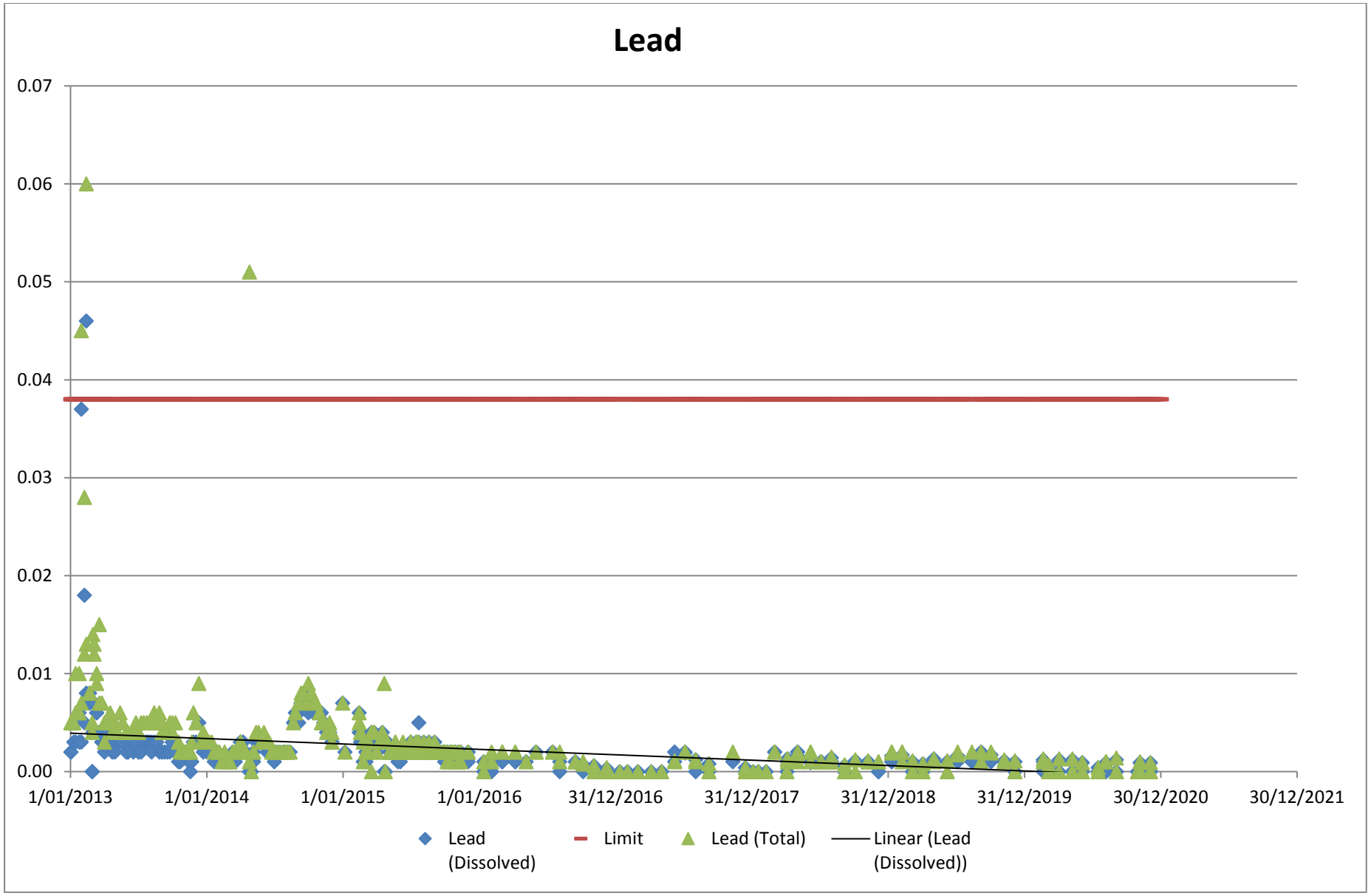

Chloride
700
600
500
400
300
200
100
0
1/01/2013
1/01/2014
1/01/2015
1/01/2016
31/12/2016
31/12/2017
31/12/2018
31/12/2019
30/12/2020
30/12/2021
Chloride
Limit
Linear (Chloride)

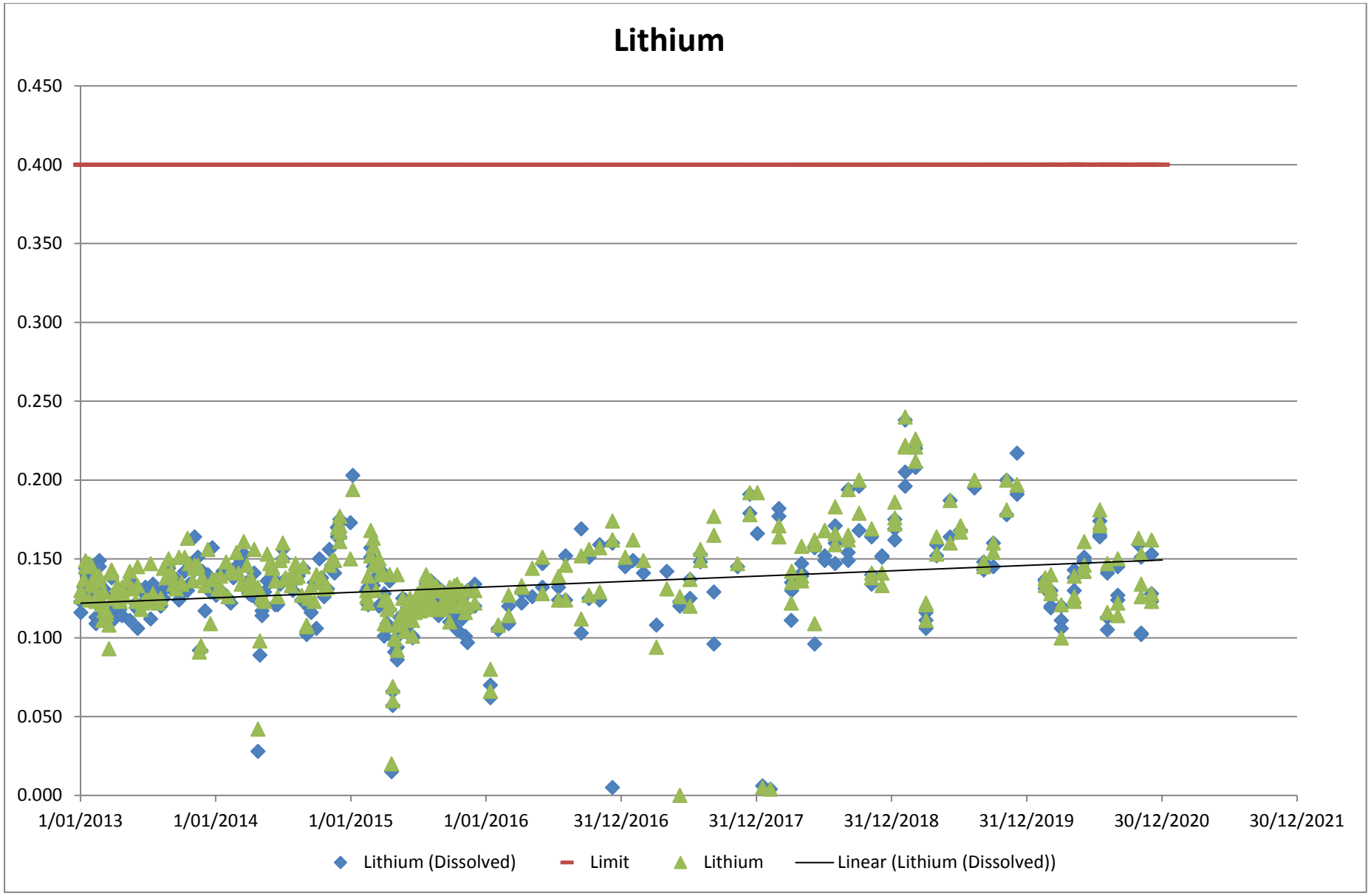

Chromium
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
1/01/2013
1/01/2014
1/01/2015
1/01/2016
31/12/2016
31/12/2017
31/12/2018
31/12/2019
30/12/2020
30/12/2021
Chromium (Dissolved)
Limit
Chromium (Total)
Linear (Chromium (Dissolved))

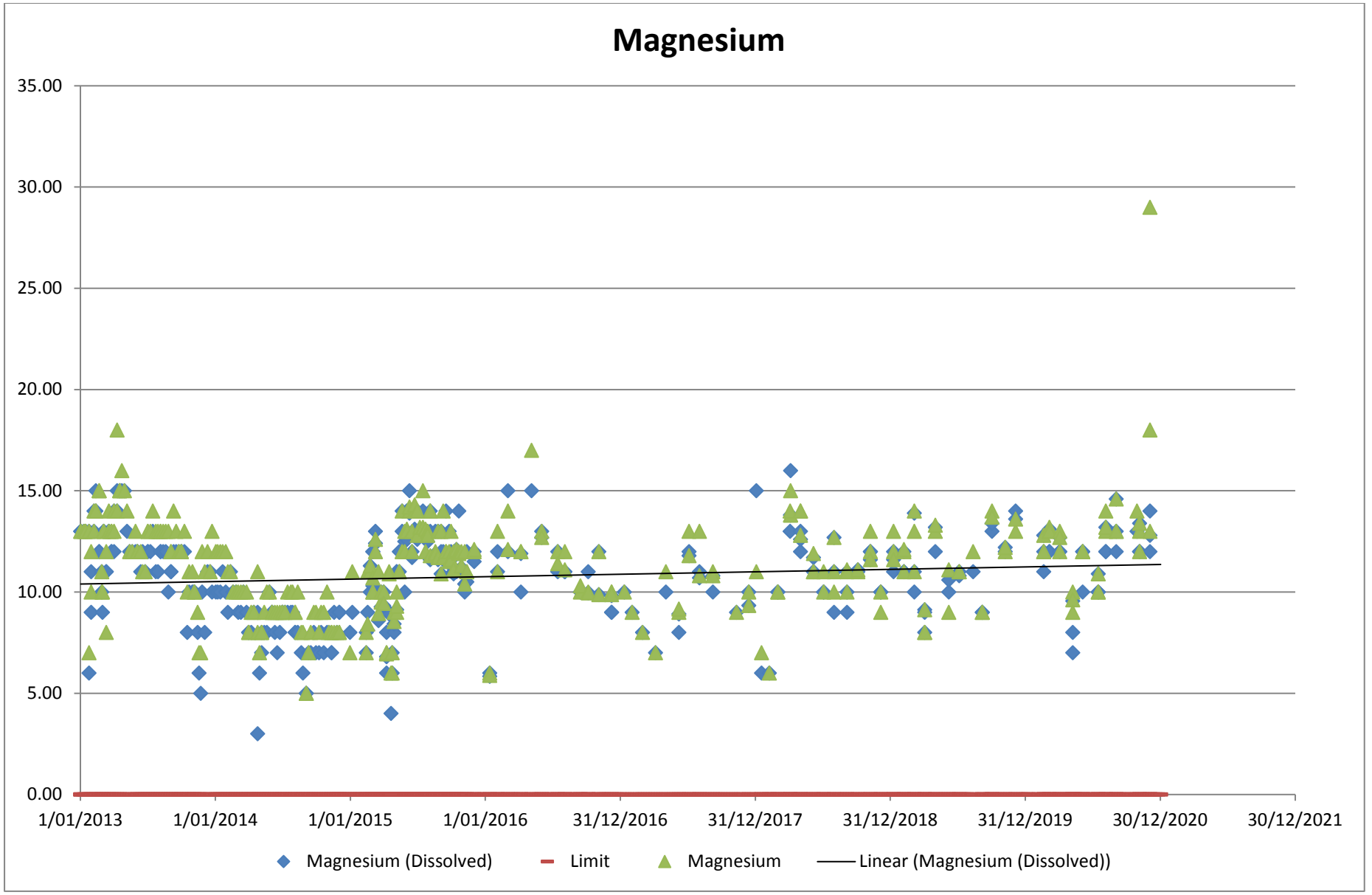

Cobalt
0.006
0.005
0.004
0.003
0.002
0.001
0.000
1/01/2013
1/01/2014
1/01/2015
1/01/2016
31/12/2016
31/12/2017
31/12/2018
31/12/2019
30/12/2020
30/12/2021
Cobalt (Dissolved)
Limit
Cobalt (Total)
Linear (Cobalt (Dissolved))

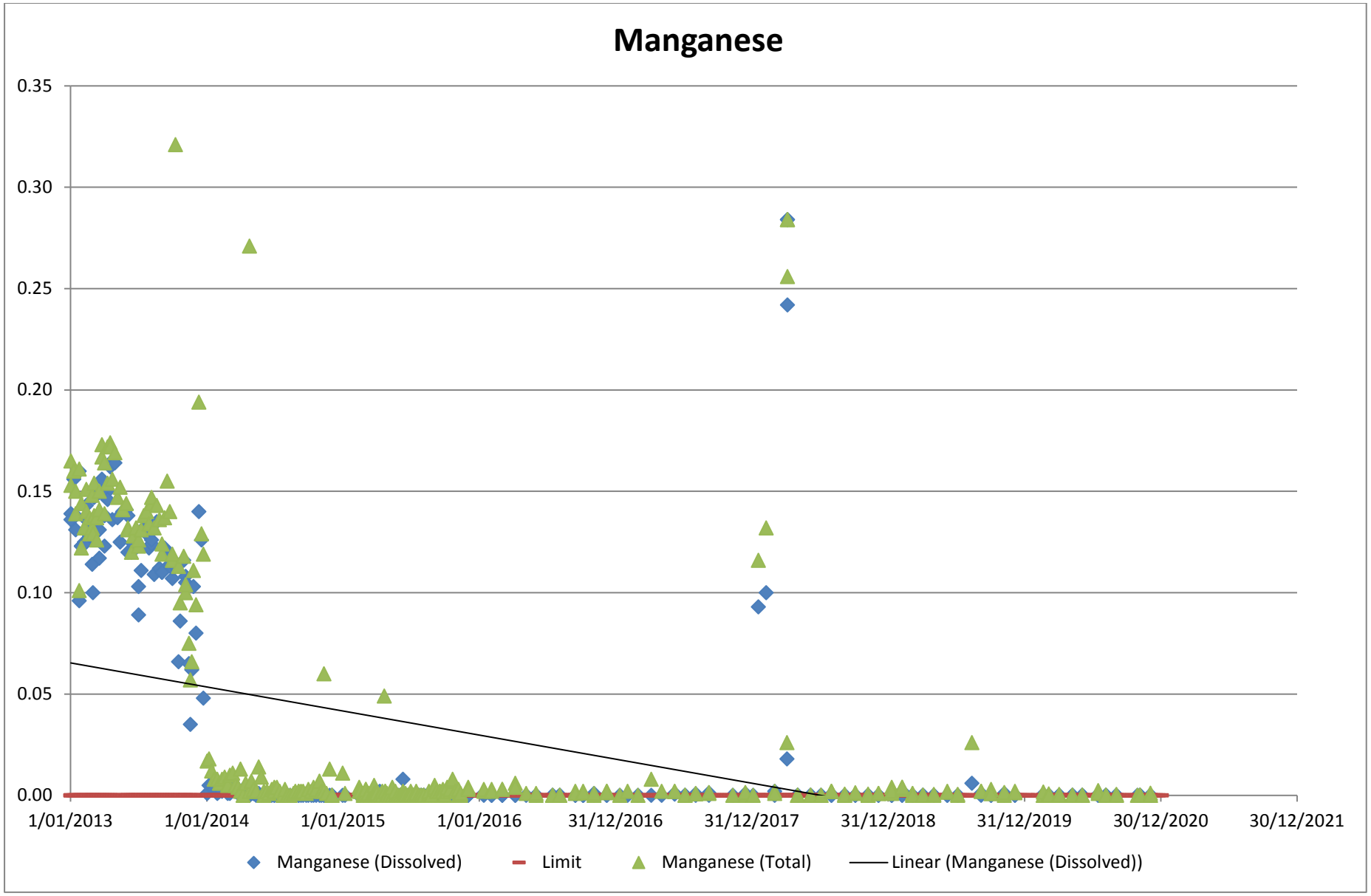

Copper
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
1/01/2013
1/01/2014
1/01/2015
1/01/2016
31/12/2016
31/12/2017
31/12/2018
31/12/2019
30/12/2020
30/12/2021
Copper (Dissolved)
Limit
Copper (Total)
Linear (Copper (Dissolved))

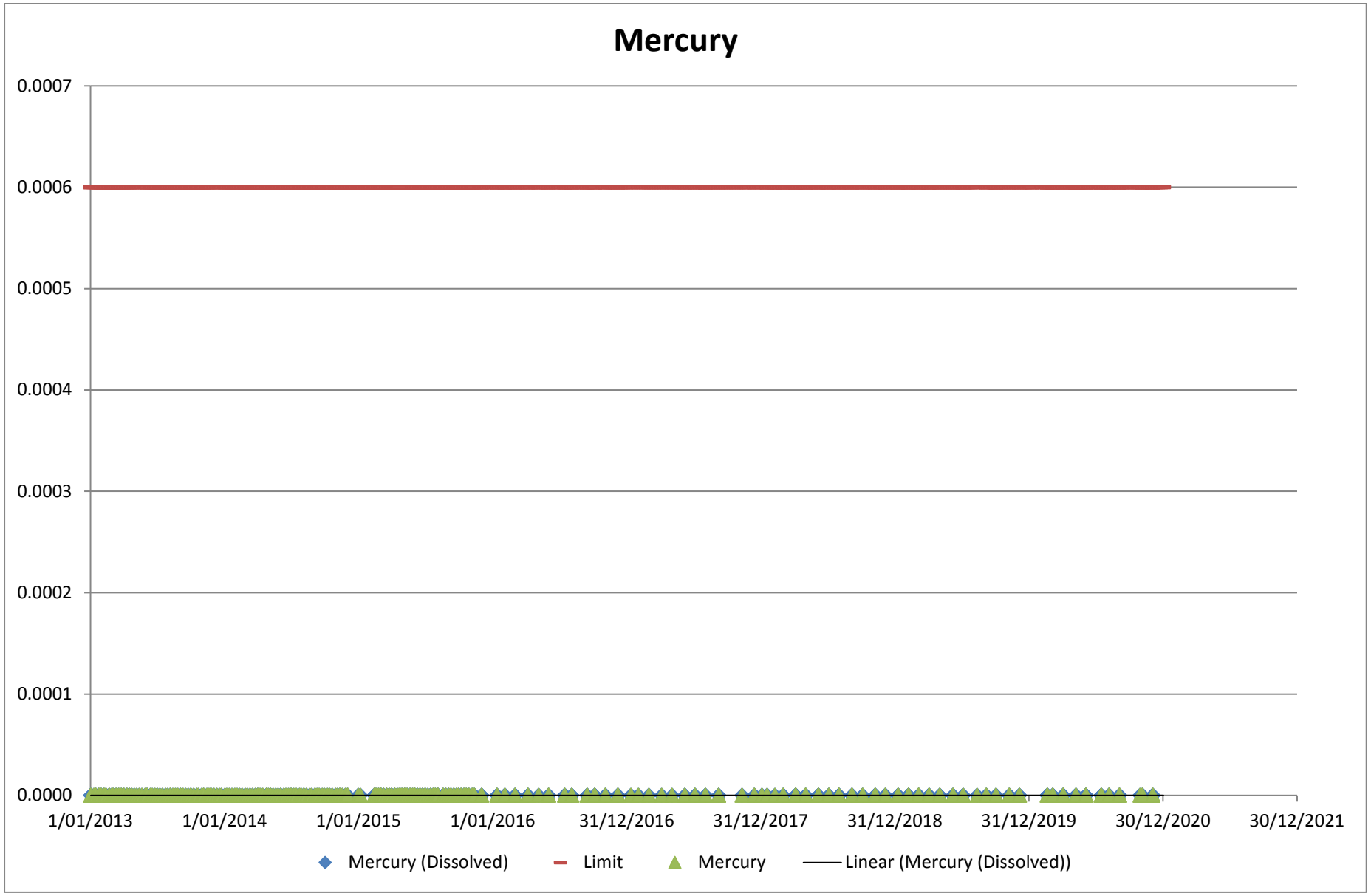

Iron
25
20
15
10
5
0
1/01/2013
1/01/2014
1/01/2015
1/01/2016
31/12/2016
31/12/2017
31/12/2018
31/12/2019
30/12/2020
30/12/2021
Iron (Dissolved)
Limit
Iron (Total)
Linear (Iron (Dissolved))

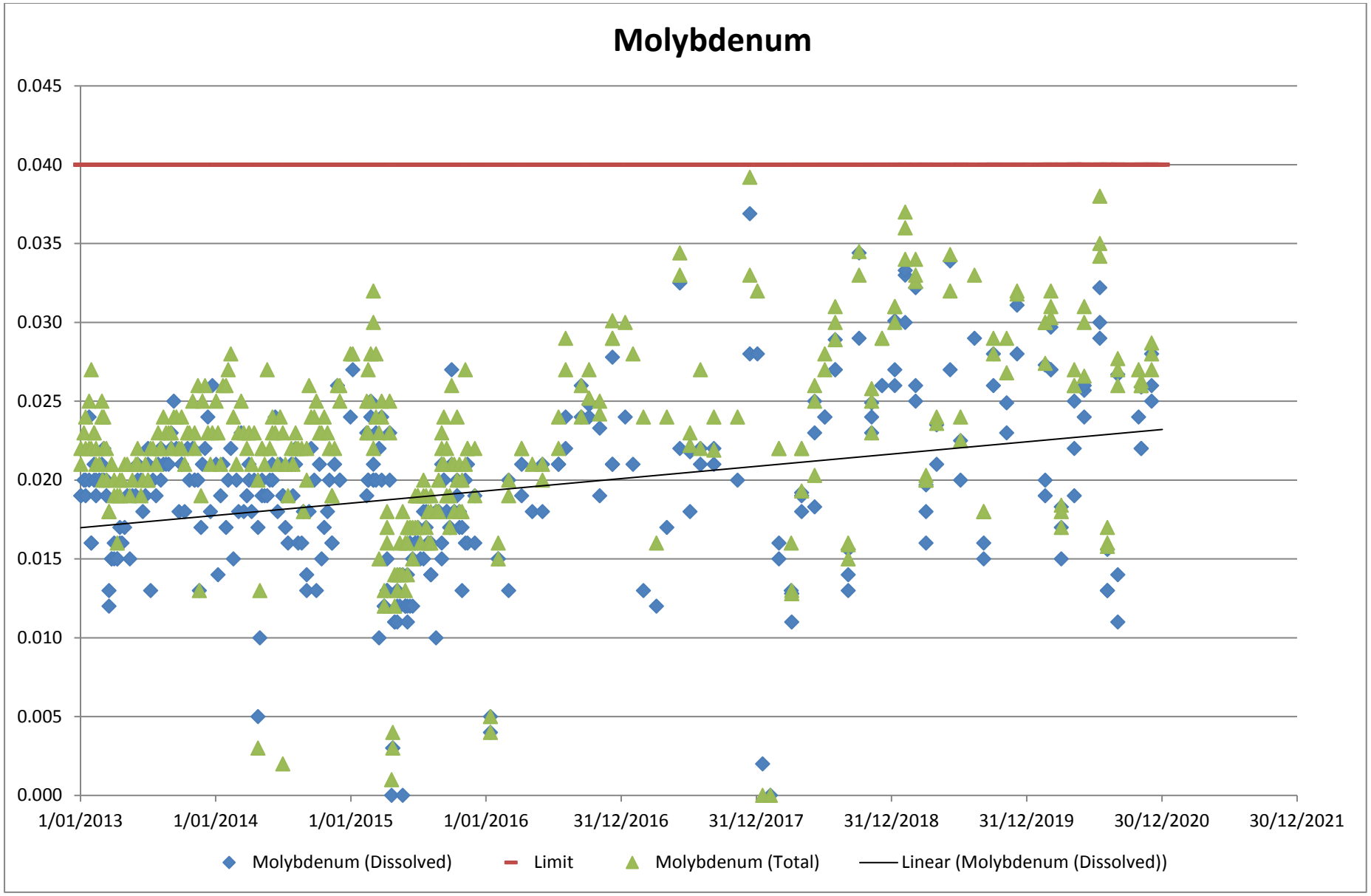

Lead
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
1/01/2013
1/01/2014
1/01/2015
1/01/2016
31/12/2016
31/12/2017
31/12/2018
31/12/2019
30/12/2020
30/12/2021
Lead (Dissolved)
Limit
Lead (Total)
Linear (Lead (Dissolved))

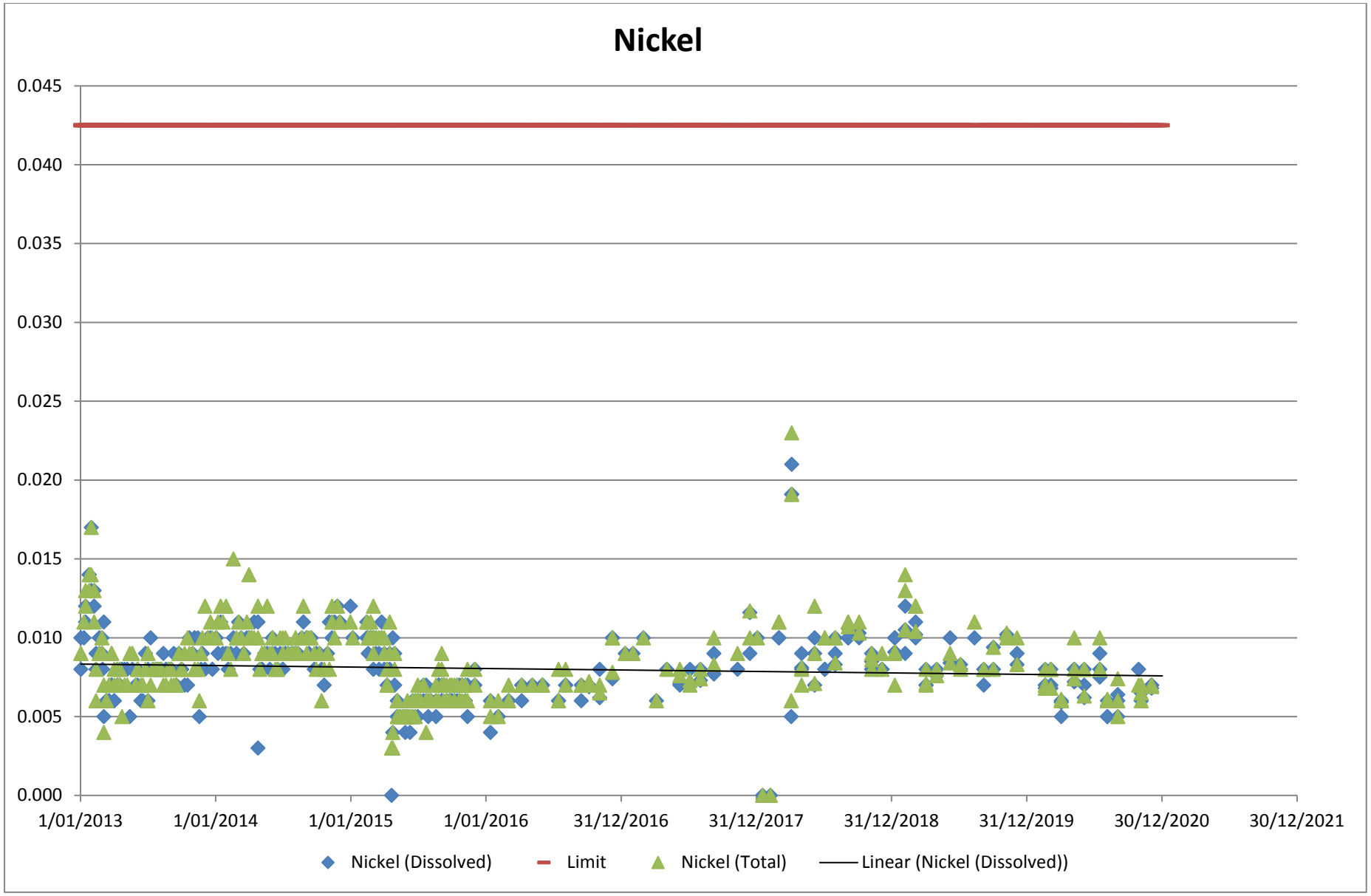

Lithium
0.450
0.400
0.350
0.300
0.250
0.200
0.150
0.100
0.050
0.000
1/01/2013
1/01/2014
1/01/2015
1/01/2016
31/12/2016
31/12/2017
31/12/2018
31/12/2019
30/12/2020
30/12/2021
Lithium (Dissolved)
Limit
Lithium
Linear (Lithium (Dissolved))

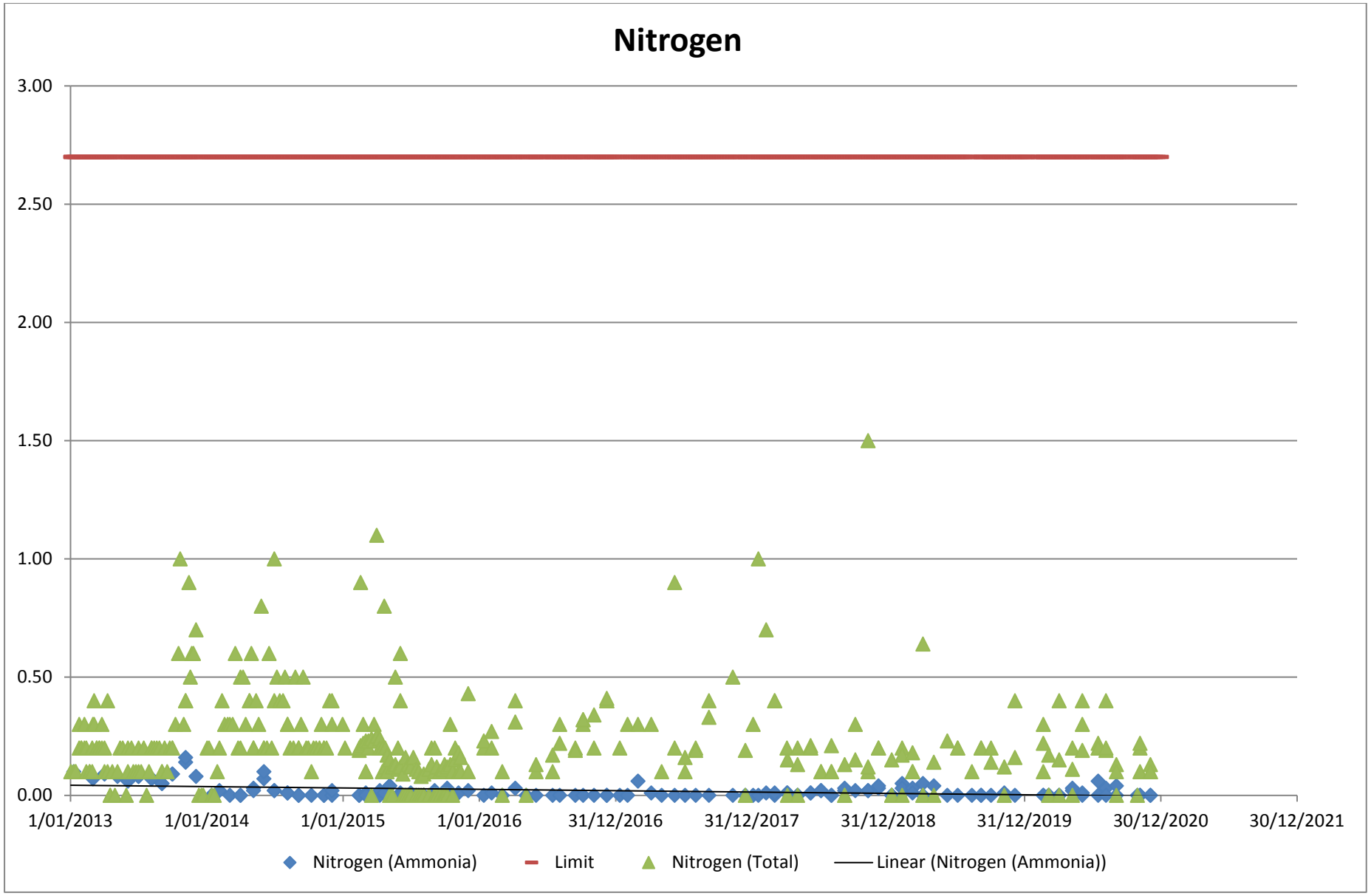

Magnesium
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
1/01/2013
1/01/2014
1/01/2015
1/01/2016
31/12/2016
31/12/2017
31/12/2018
31/12/2019
30/12/2020
30/12/2021
Magnesium (Dissolved)
Limit
Magnesium
Linear (Magnesium (Dissolved))

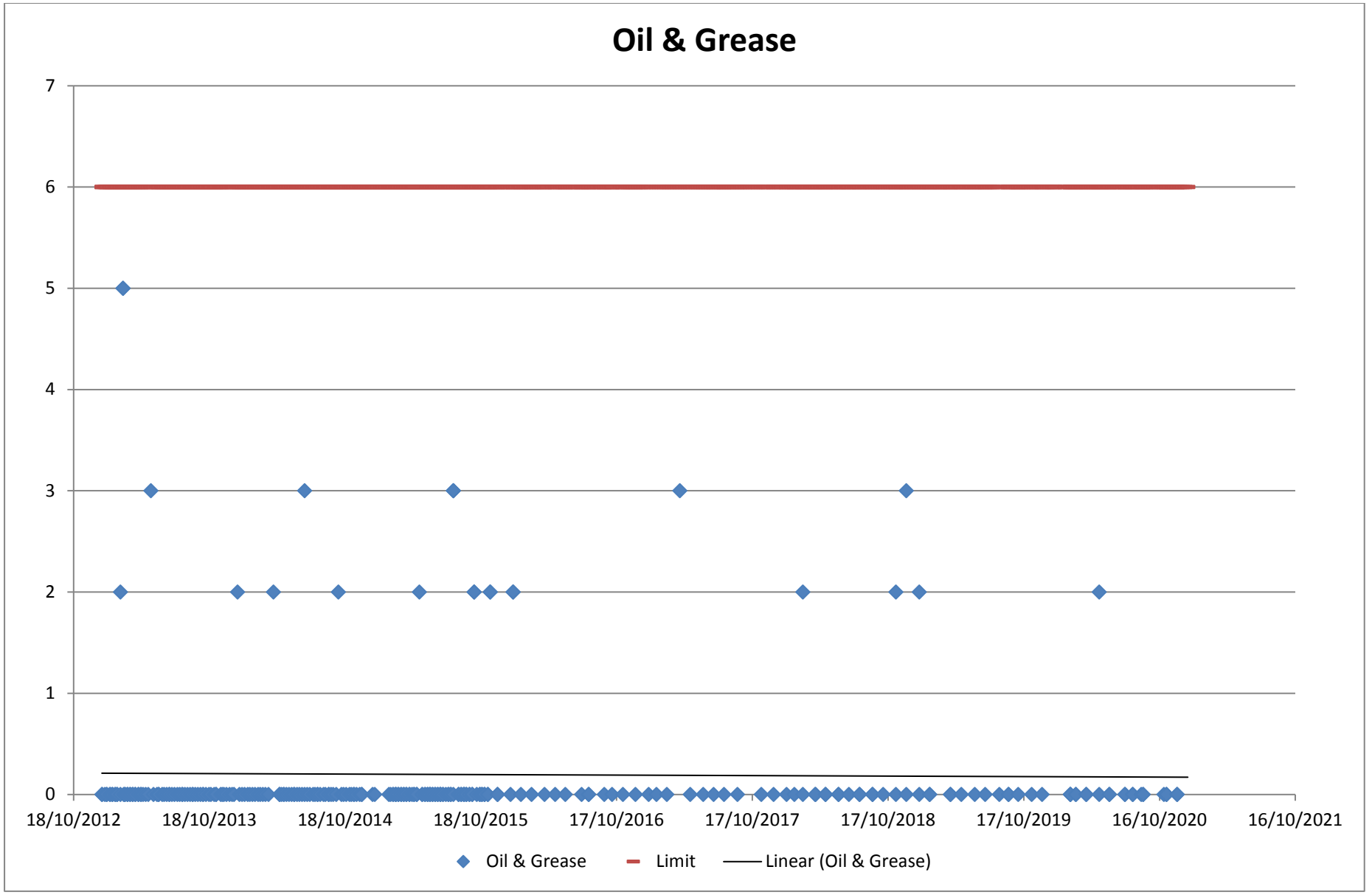

Manganese
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
1/01/2013
1/01/2014
1/01/2015
1/01/2016
31/12/2016
31/12/2017
31/12/2018
31/12/2019
30/12/2020
30/12/2021
Manganese (Dissolved)
Limit
Manganese (Total)
Linear (Manganese (Dissolved))

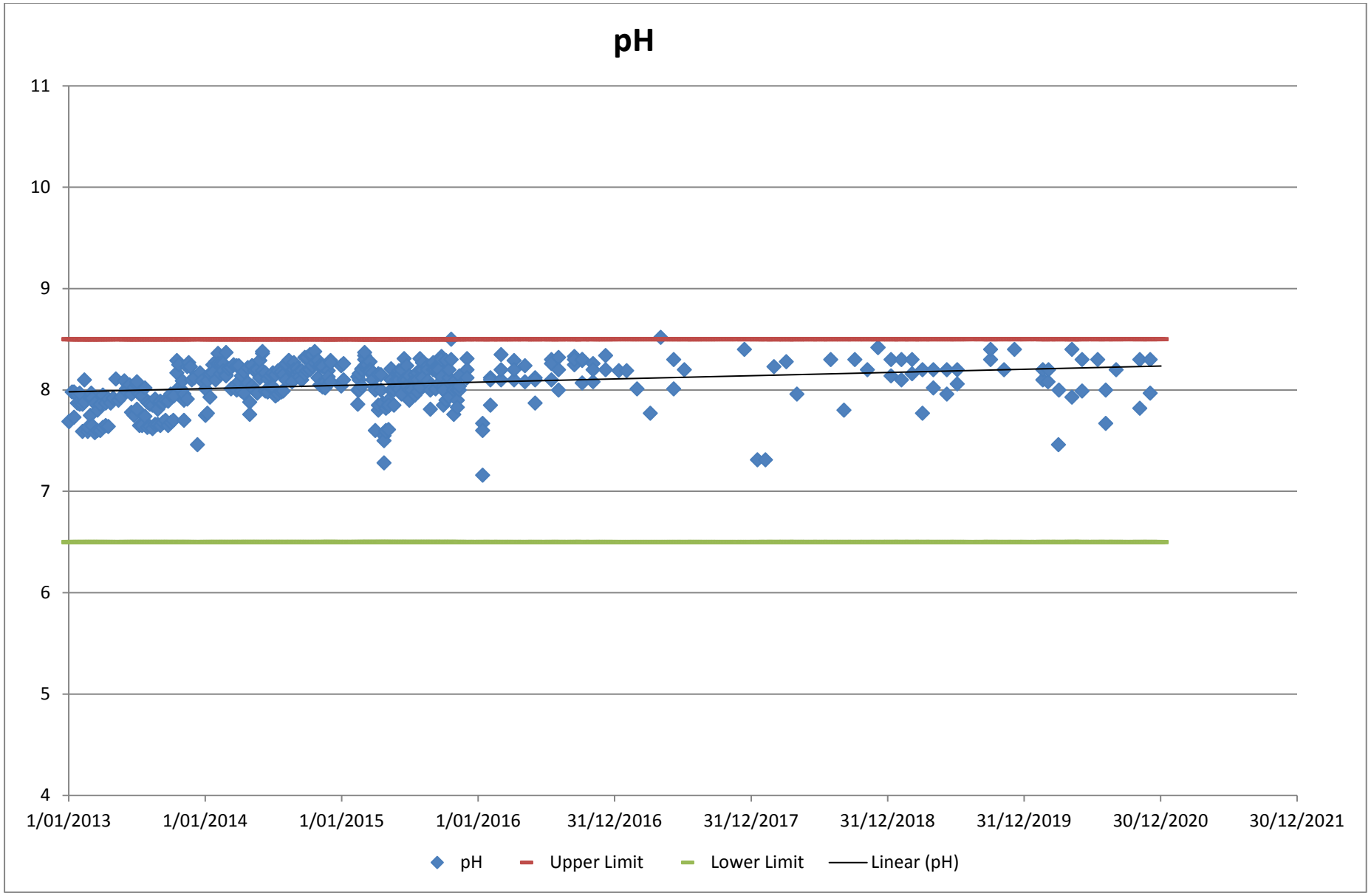

Mercury
0.0007
0.0006
0.0005
0.0004
0.0003
0.0002
0.0001
0.0000
1/01/2013
1/01/2014
1/01/2015
1/01/2016
31/12/2016
31/12/2017
31/12/2018
31/12/2019
30/12/2020
30/12/2021
Mercury (Dissolved)
Limit
Mercury
Linear (Mercury (Dissolved))

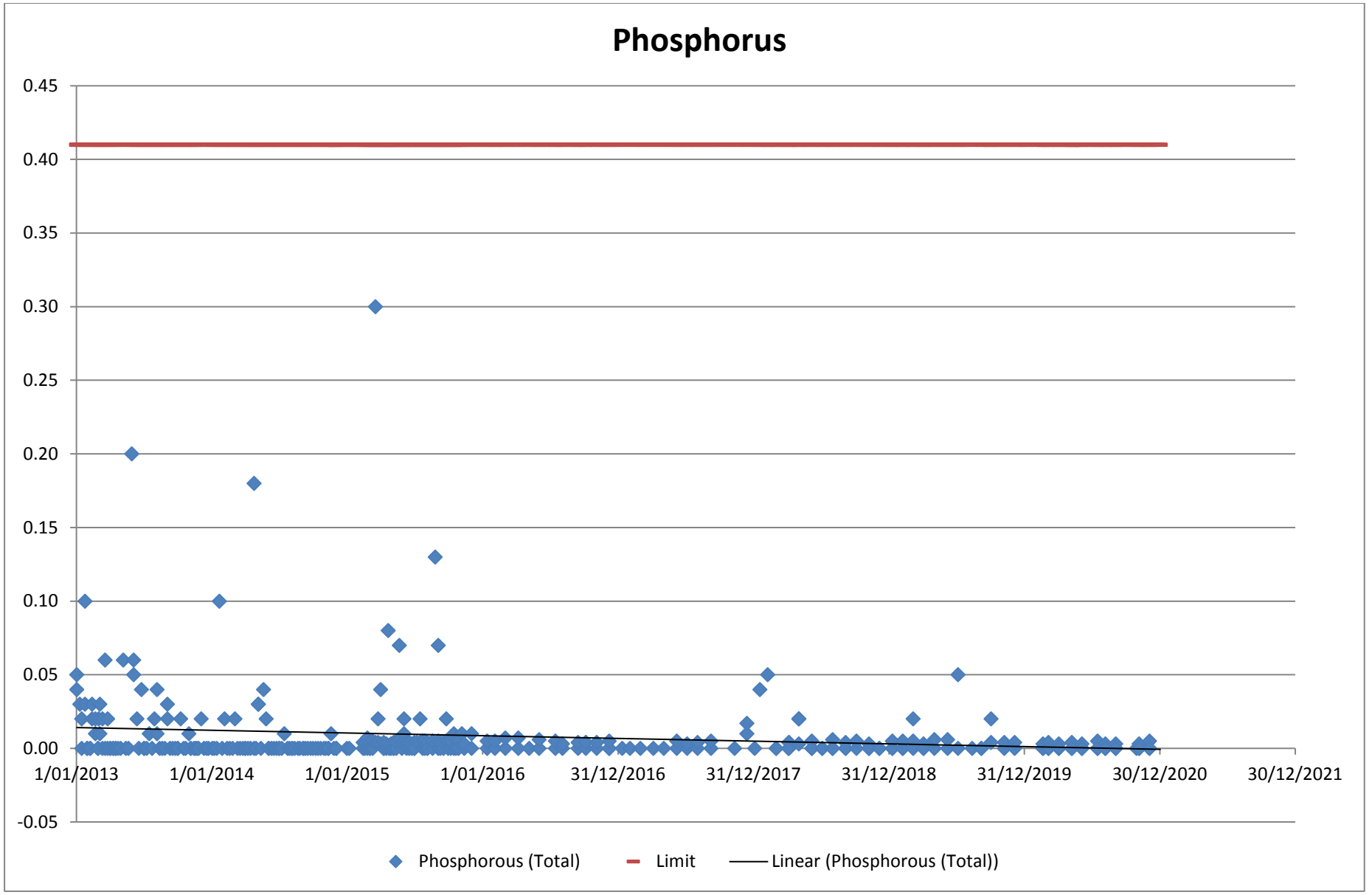

Molybdenum
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
1/01/2013
1/01/2014
1/01/2015
1/01/2016
31/12/2016
31/12/2017
31/12/2018
31/12/2019
30/12/2020
30/12/2021
Molybdenum (Dissolved)
Limit
Molybdenum (Total)
Linear (Molybdenum (Dissolved))

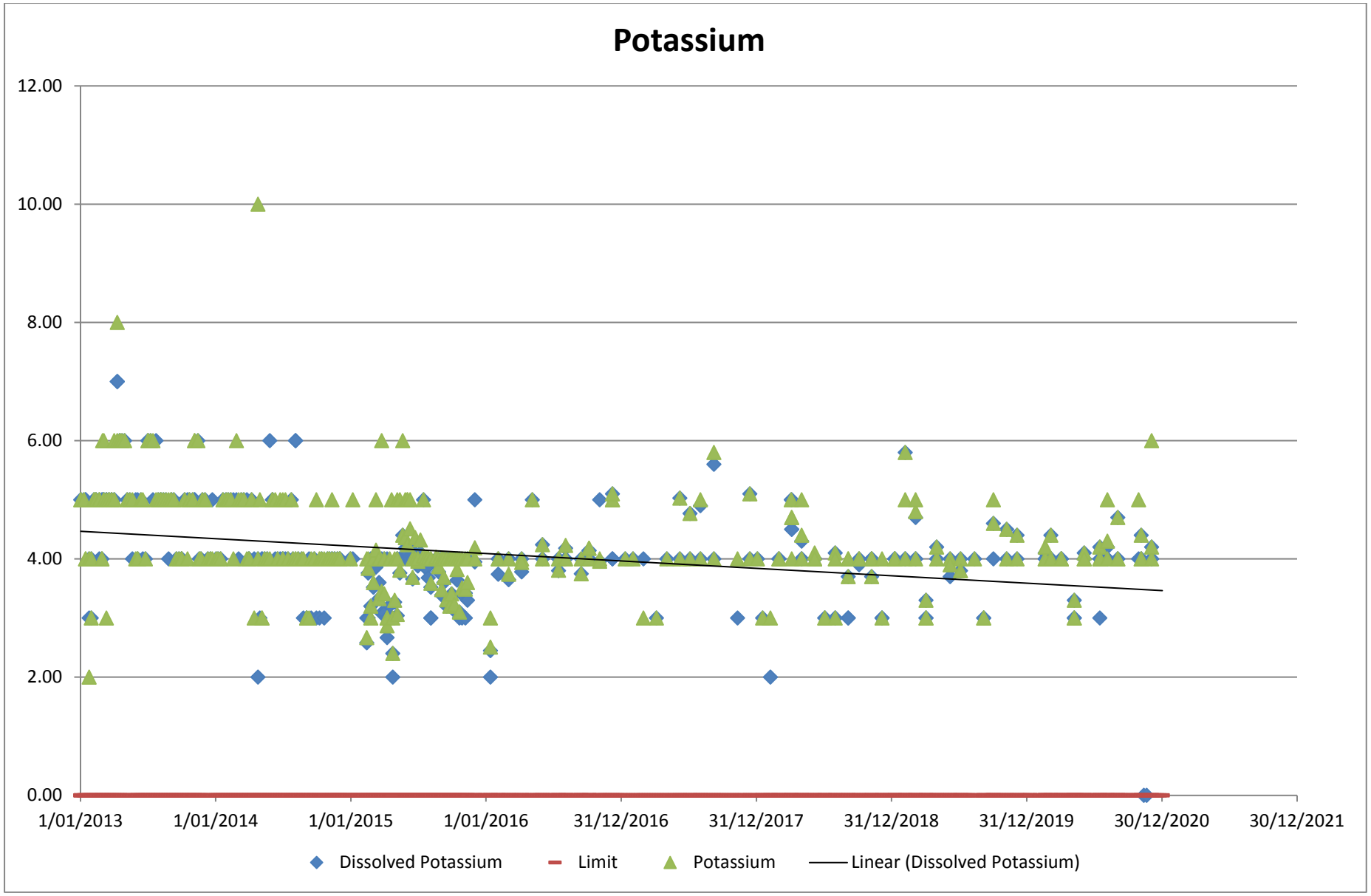

Nickel
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
1/01/2013
1/01/2014
1/01/2015
1/01/2016
31/12/2016
31/12/2017
31/12/2018
31/12/2019
30/12/2020
30/12/2021
Nickel (Dissolved)
Limit
Nickel (Total)
Linear (Nickel (Dissolved))

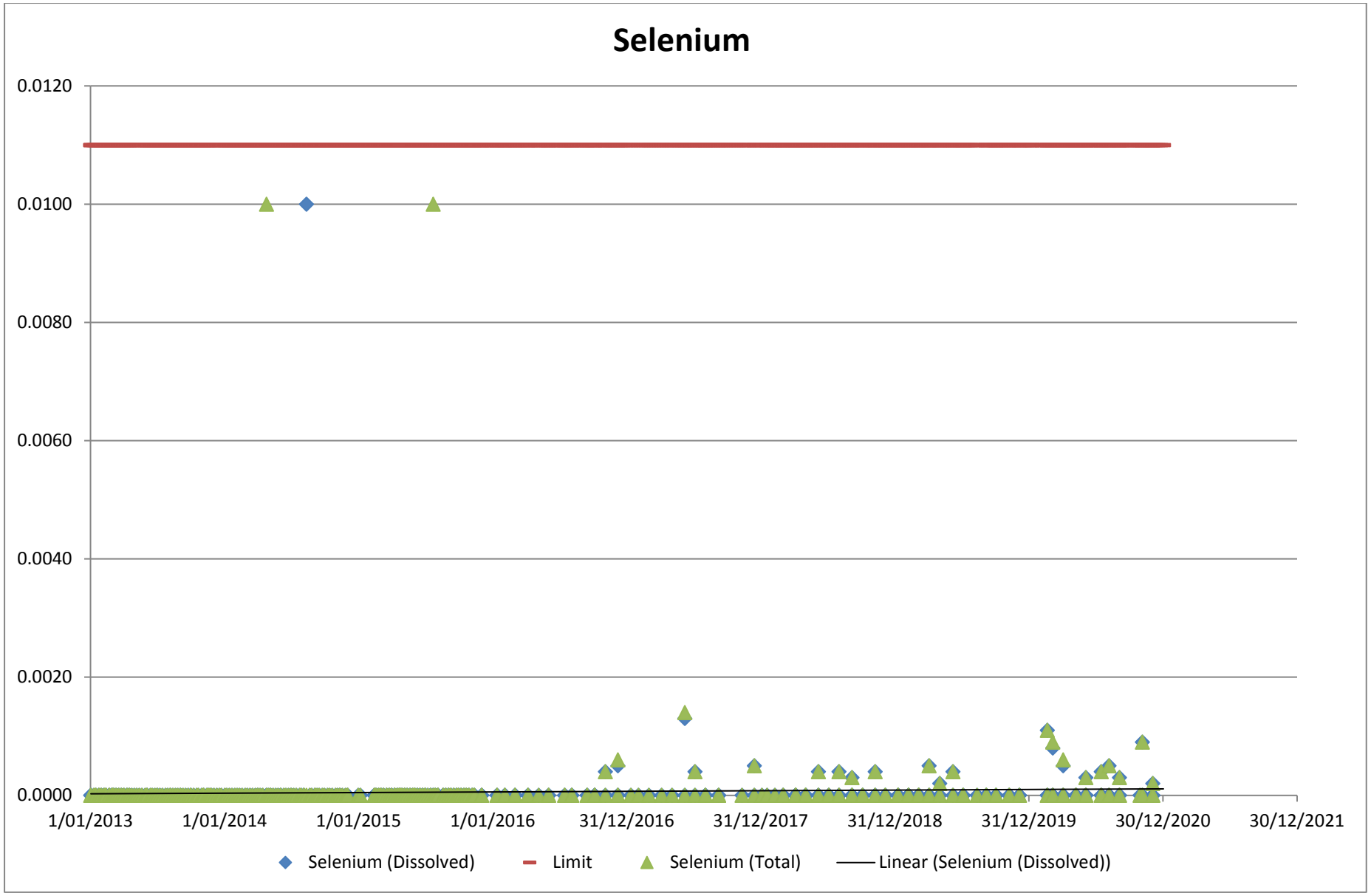

Nitrogen
3.00
2.50
2.00
1.50
1.00
0.50
0.00
1/01/2013
1/01/2014
1/01/2015
1/01/2016
31/12/2016
31/12/2017
31/12/2018
31/12/2019
30/12/2020
30/12/2021
Nitrogen (Ammonia)
Limit
Nitrogen (Total)
Linear (Nitrogen (Ammonia))

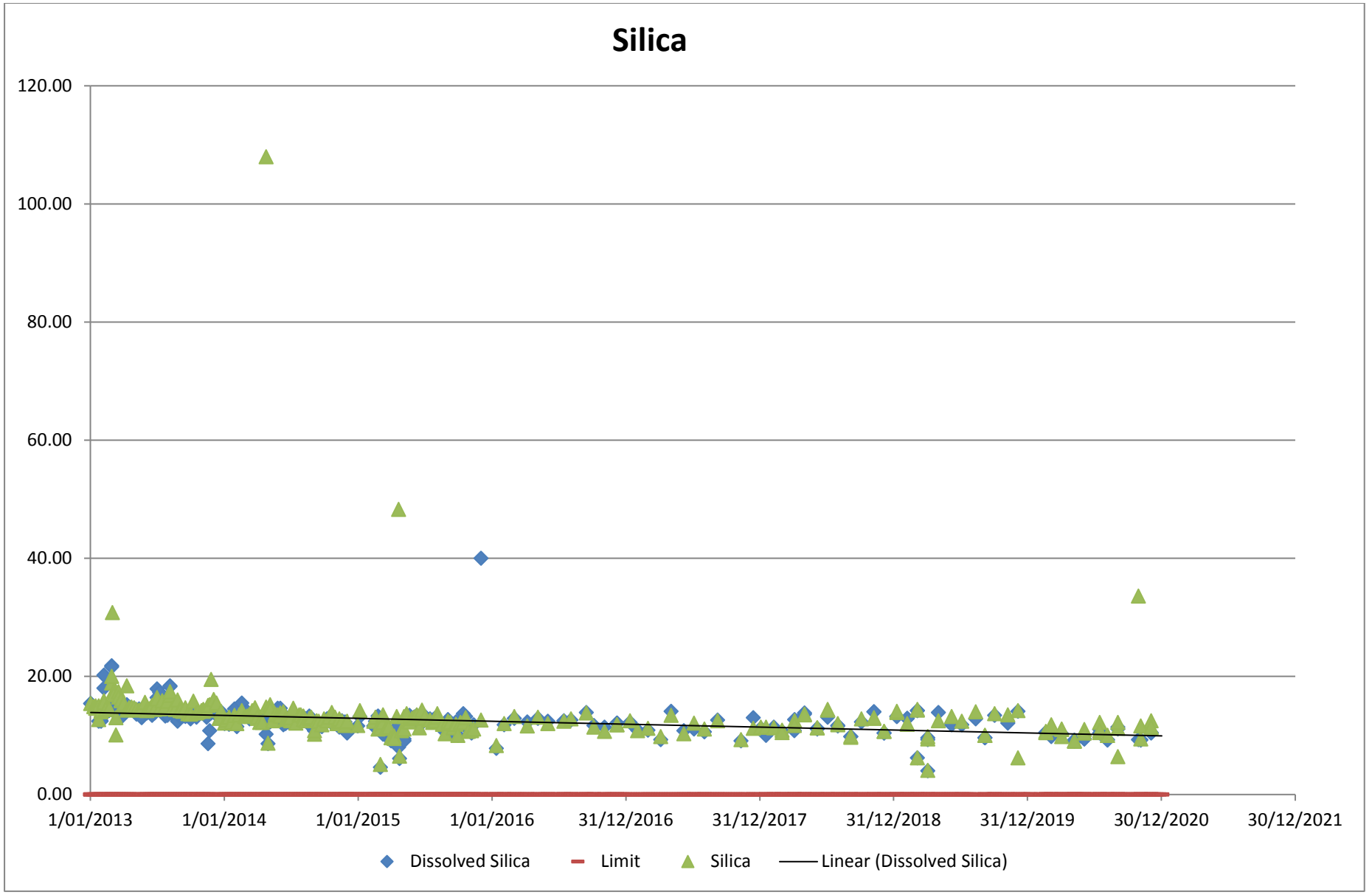

Oil & Grease
7
6
5
4
3
2
1
0
18/10/2012
18/10/2013
18/10/2014
18/10/2015
17/10/2016
17/10/2017
17/10/2018
17/10/2019
16/10/2020
16/10/2021
Oil & Grease
Limit
Linear (Oil & Grease)


pH
11
10
9
8
7
6
5
4
1/01/2013
1/01/2014
1/01/2015
1/01/2016
31/12/2016
31/12/2017
31/12/2018
31/12/2019
30/12/2020
30/12/2021
pH
Upper Limit
Lower Limit
Linear (pH)


Phosphorus
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
-0.05
1/01/2013
1/01/2014
1/01/2015
1/01/2016
31/12/2016
31/12/2017
31/12/2018
31/12/2019
30/12/2020
30/12/2021
Phosphorous (Total)
Limit
Linear (Phosphorous (Total))


Potassium
12.00
10.00
8.00
6.00
4.00
2.00
0.00
1/01/2013
1/01/2014
1/01/2015
1/01/2016
31/12/2016
31/12/2017
31/12/2018
31/12/2019
30/12/2020
30/12/2021
Dissolved Potassium
Limit
Potassium
Linear (Dissolved Potassium)


Selenium
0.0120
0.0100
0.0080
0.0060
0.0040
0.0020
0.0000
1/01/2013
1/01/2014
1/01/2015
1/01/2016
31/12/2016
31/12/2017
31/12/2018
31/12/2019
30/12/2020
30/12/2021
Selenium (Dissolved)
Limit
Selenium (Total)
Linear (Selenium (Dissolved))


Silica
120.00
100.00
80.00
60.00
40.00
20.00
0.00
1/01/2013
1/01/2014
1/01/2015
1/01/2016
31/12/2016
31/12/2017
31/12/2018
31/12/2019
30/12/2020
30/12/2021
Dissolved Silica
Limit
Silica
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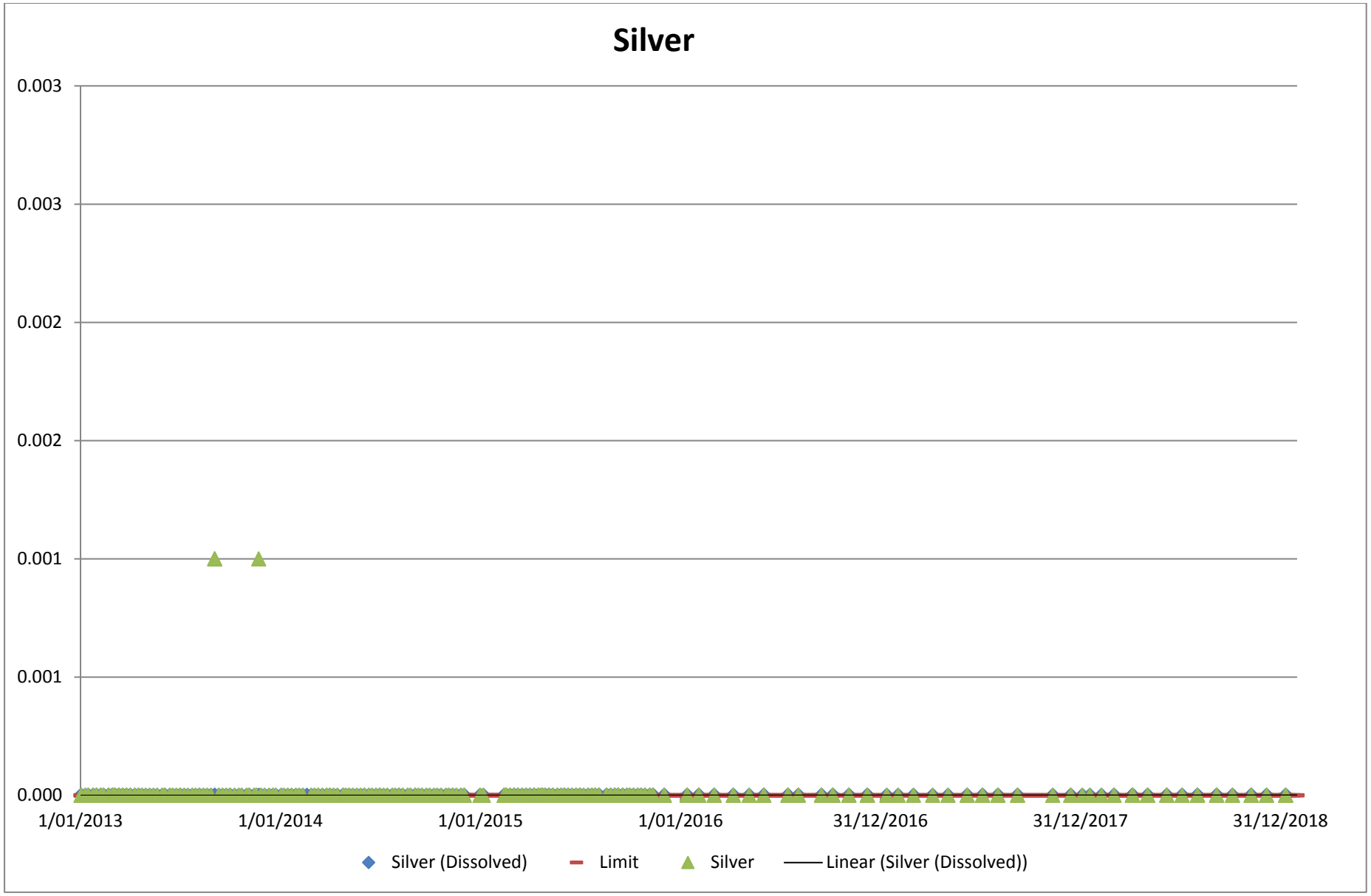
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0.002
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0.001
0.000
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1/01/2014
1/01/2015
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31/12/2016
31/12/2017
31/12/2018
Silver (Dissolved)
Limit
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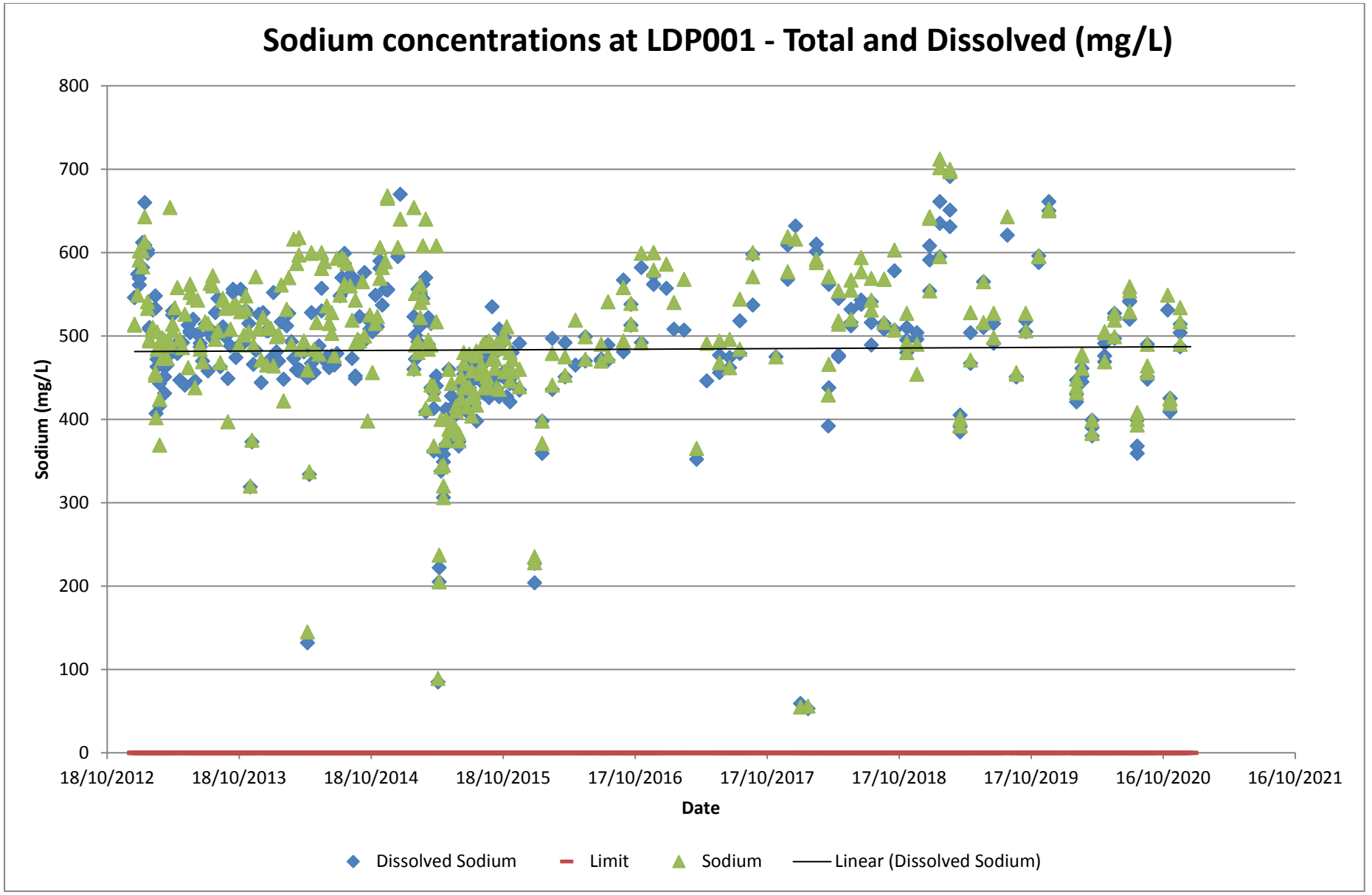
Linear (Silver (Dissolved))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Sodium (mg/L)
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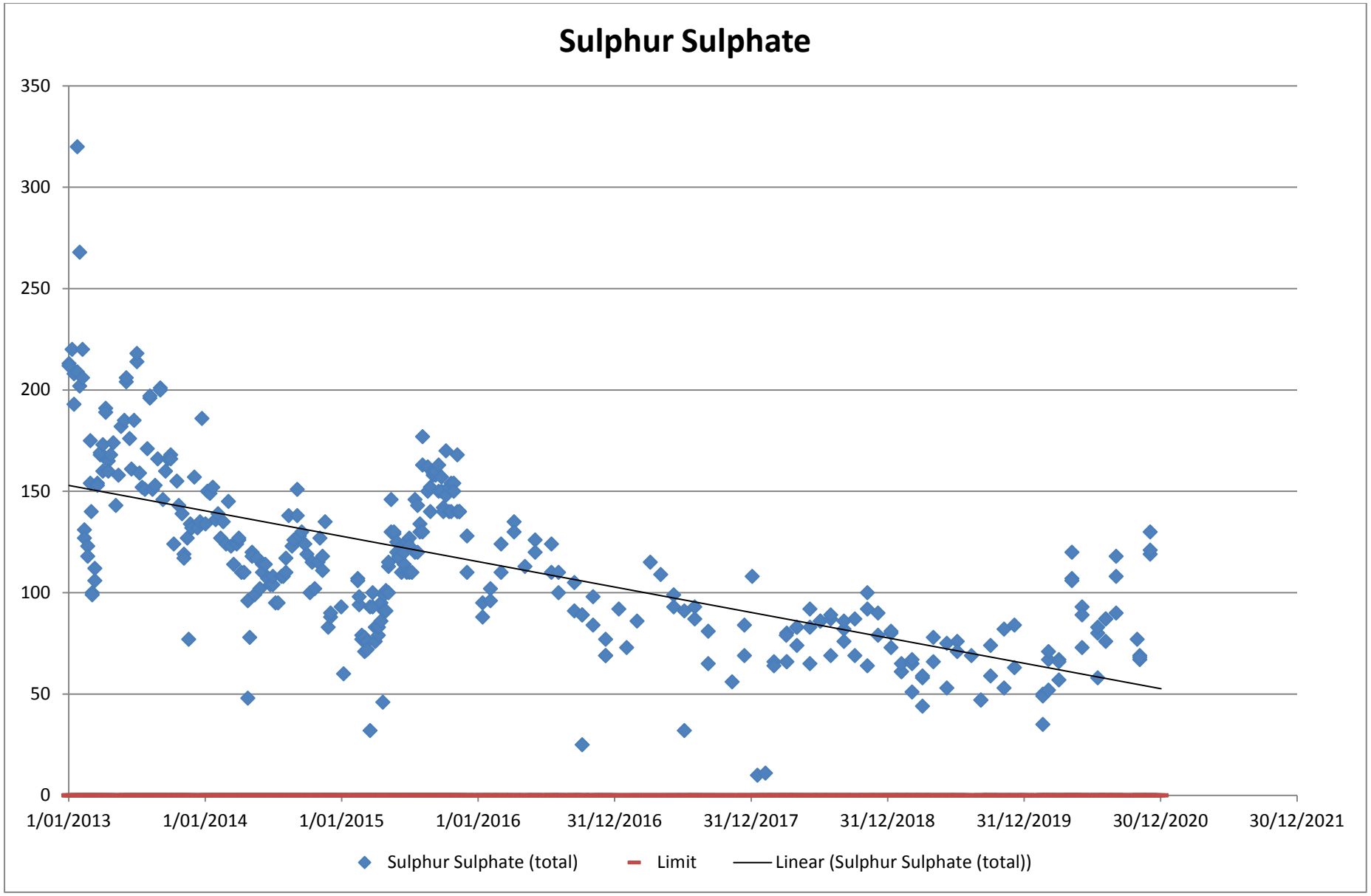
700
600
500
400
300
200
100
0
18/10/2012
18/10/2013
18/10/2014
18/10/2015
17/10/2016
17/10/2017
17/10/2018
17/10/2019
16/10/2020
16/10/2021
Date
Dissolved Sodium
Limit
Sodium
Linear (Dissolved Sodium)


Sulphur Sulphate
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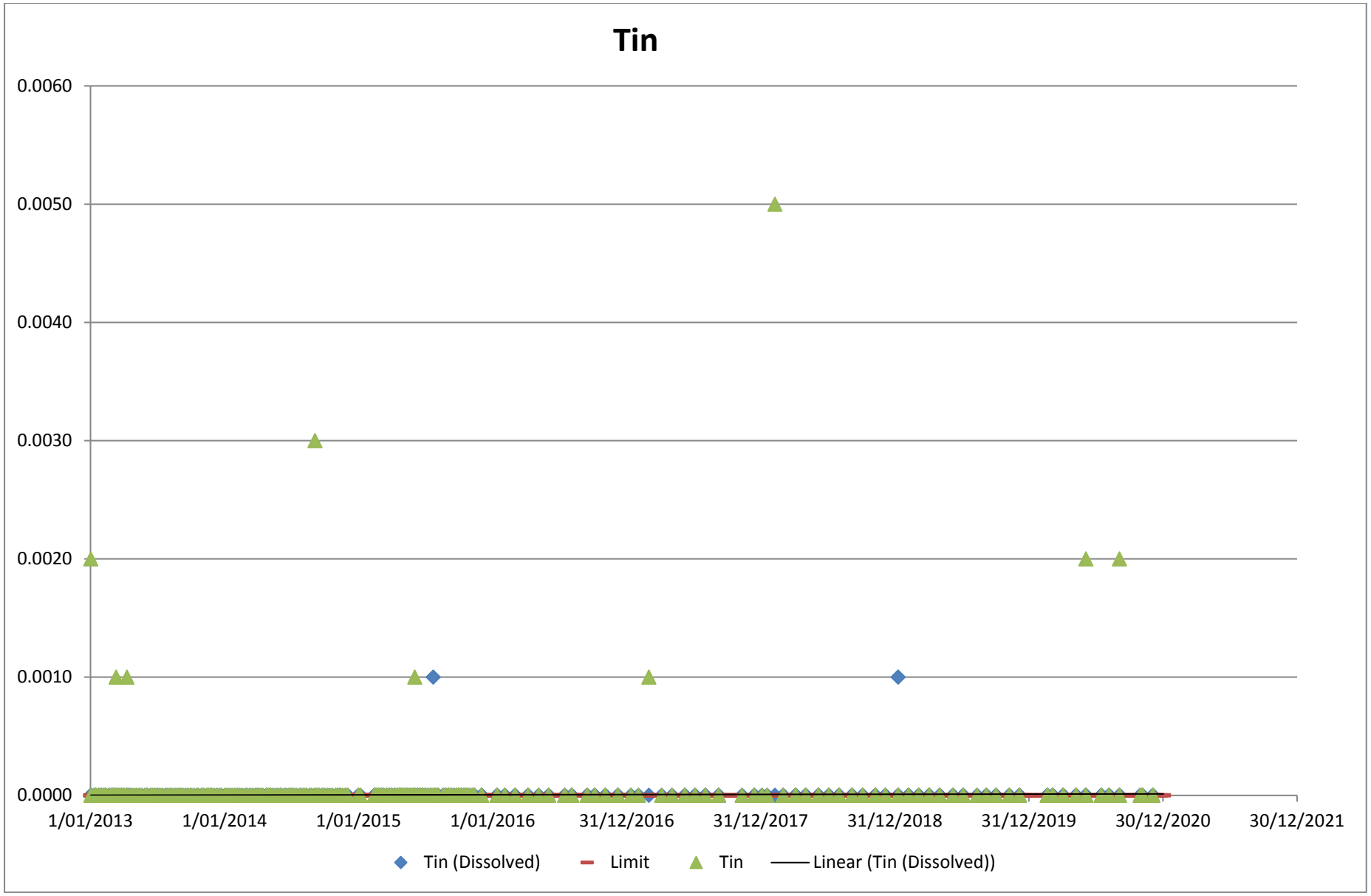
300
250
200
150
100
50
0
1/01/2013
1/01/2014
1/01/2015
1/01/2016
31/12/2016
31/12/2017
31/12/2018
31/12/2019
30/12/2020
30/12/2021
Sulphur Sulphate (total)
Limit
Linear (Sulphur Sulphate (total))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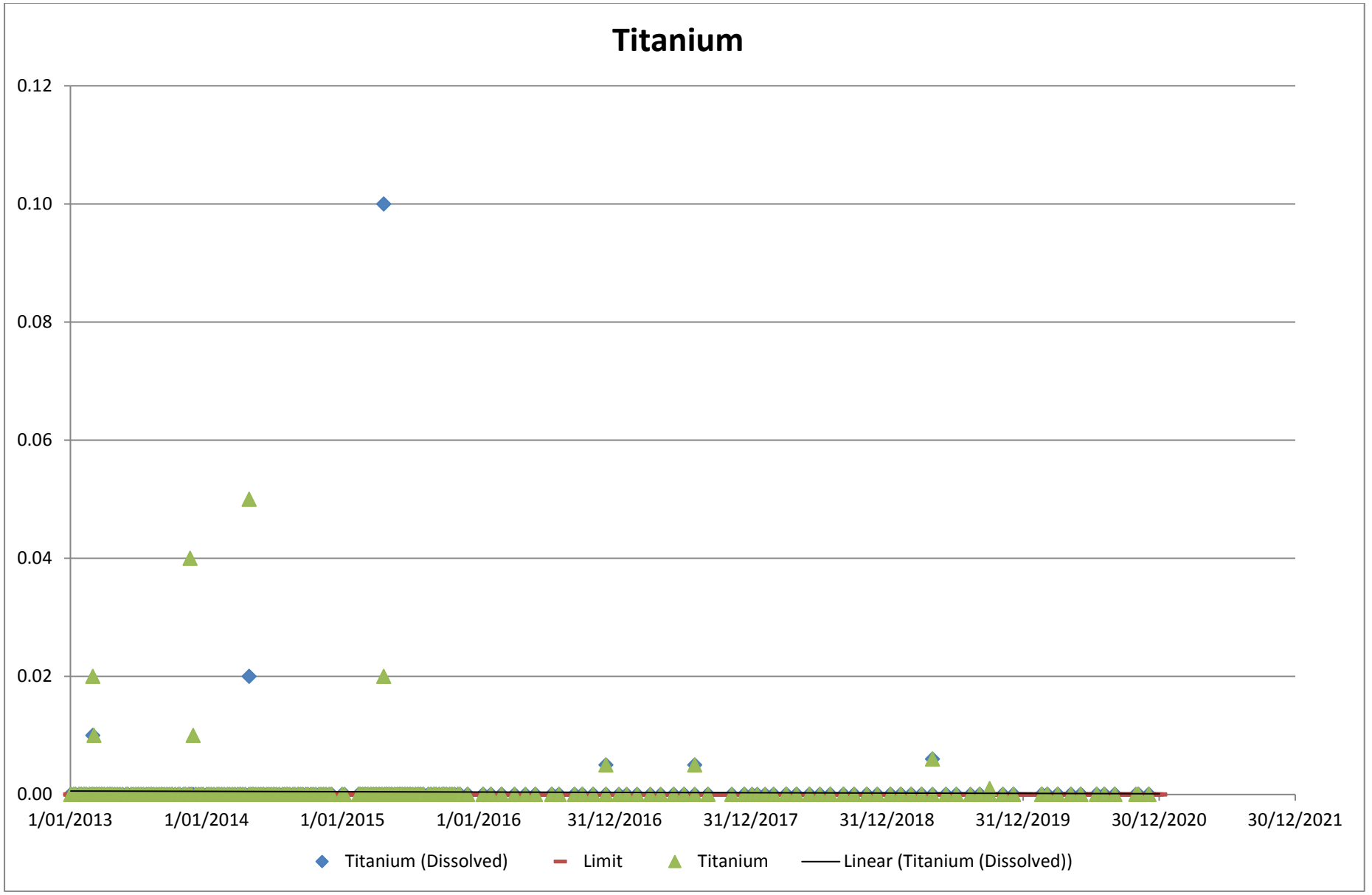
1/01/2016
31/12/2016
31/12/2017
31/12/2018
31/12/2019
30/12/2020
30/12/2021
Tin (Dissolved)
Limit
Tin
Linear (Tin (Dissolved))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1/01/2016
31/12/2016
31/12/2017
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31/12/2019
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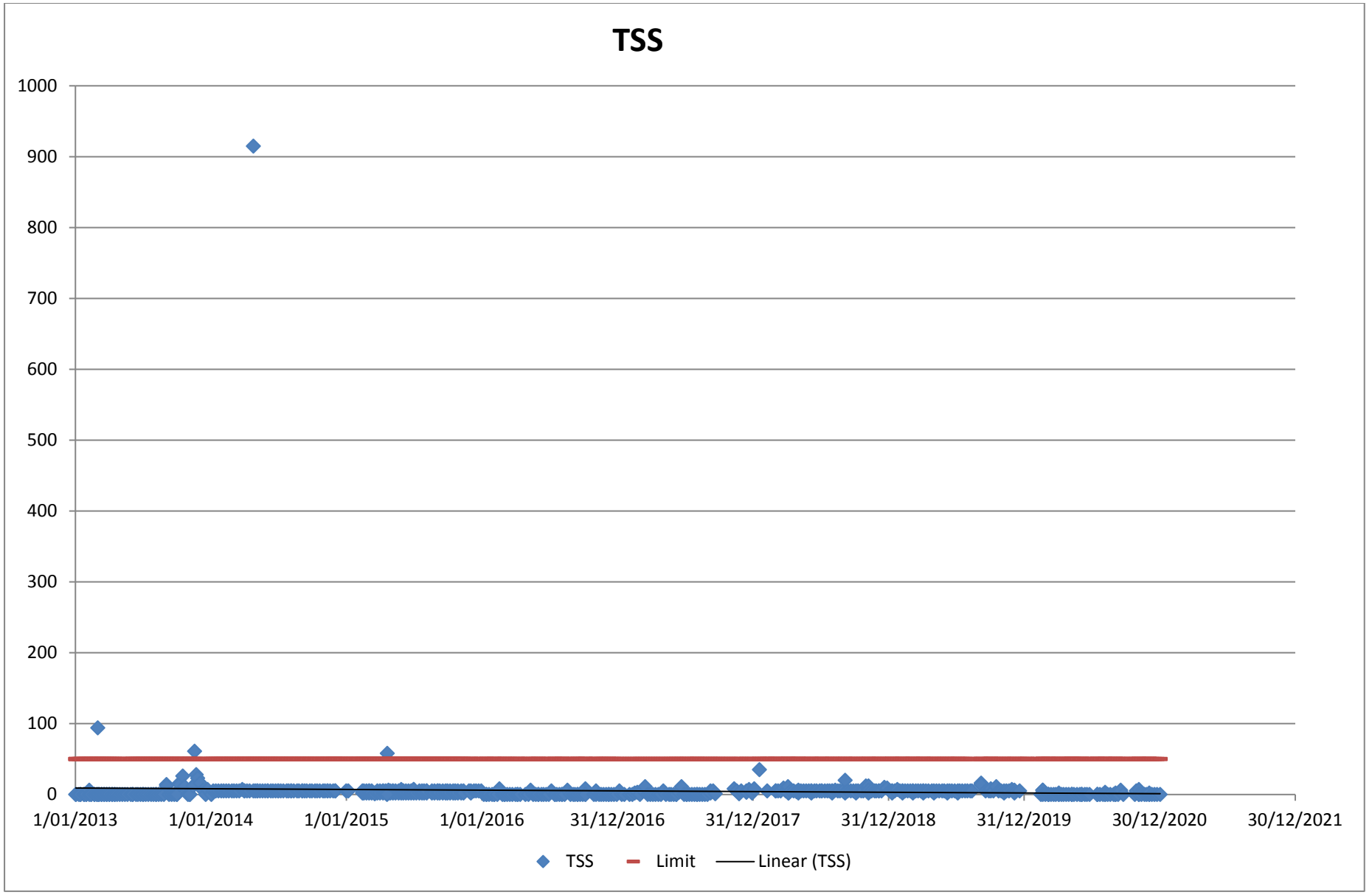
Limit
Titanium
Linear (Titanium (Dissolved))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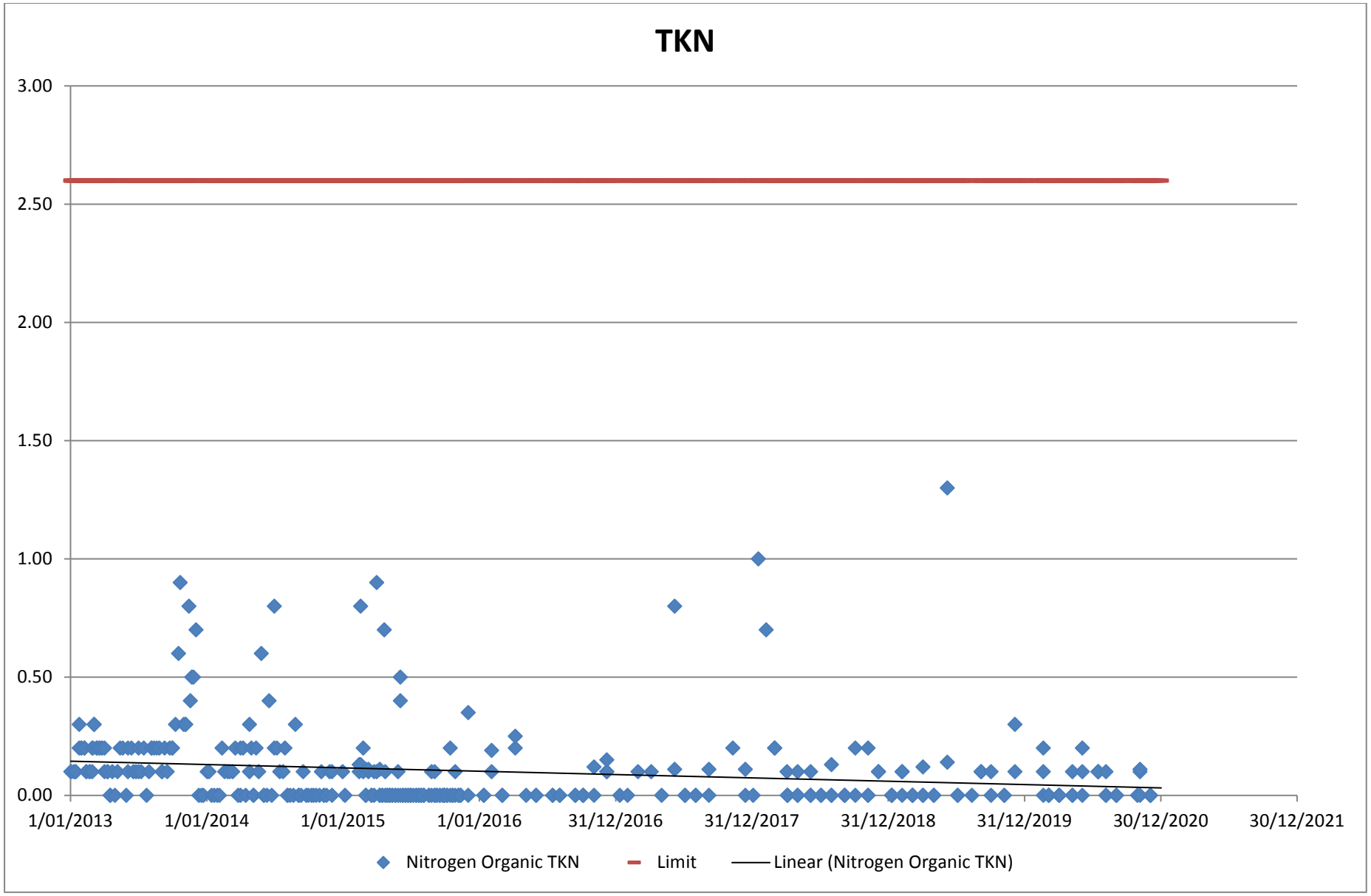
30/12/2020
30/12/2021
TSS
Limit
Linear (TSS)


TKN
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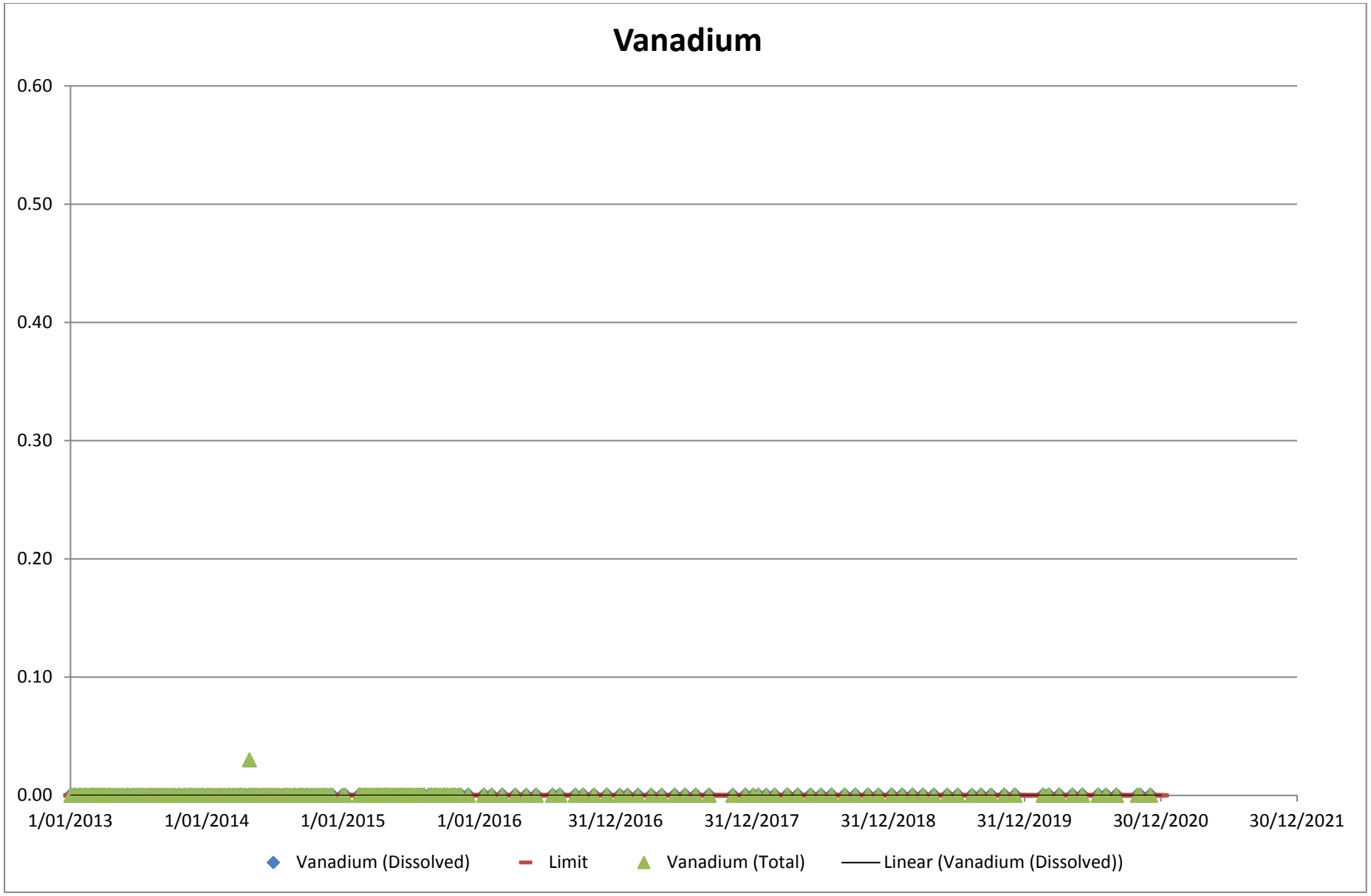
2.50
2.00
1.50
1.00
0.50
0.00
1/01/2013
1/01/2014
1/01/2015
1/01/2016
31/12/2016
31/12/2017
31/12/2018
31/12/2019
30/12/2020
30/12/2021
Nitrogen Organic TKN
Limit
Linear (Nitrogen Organic TKN)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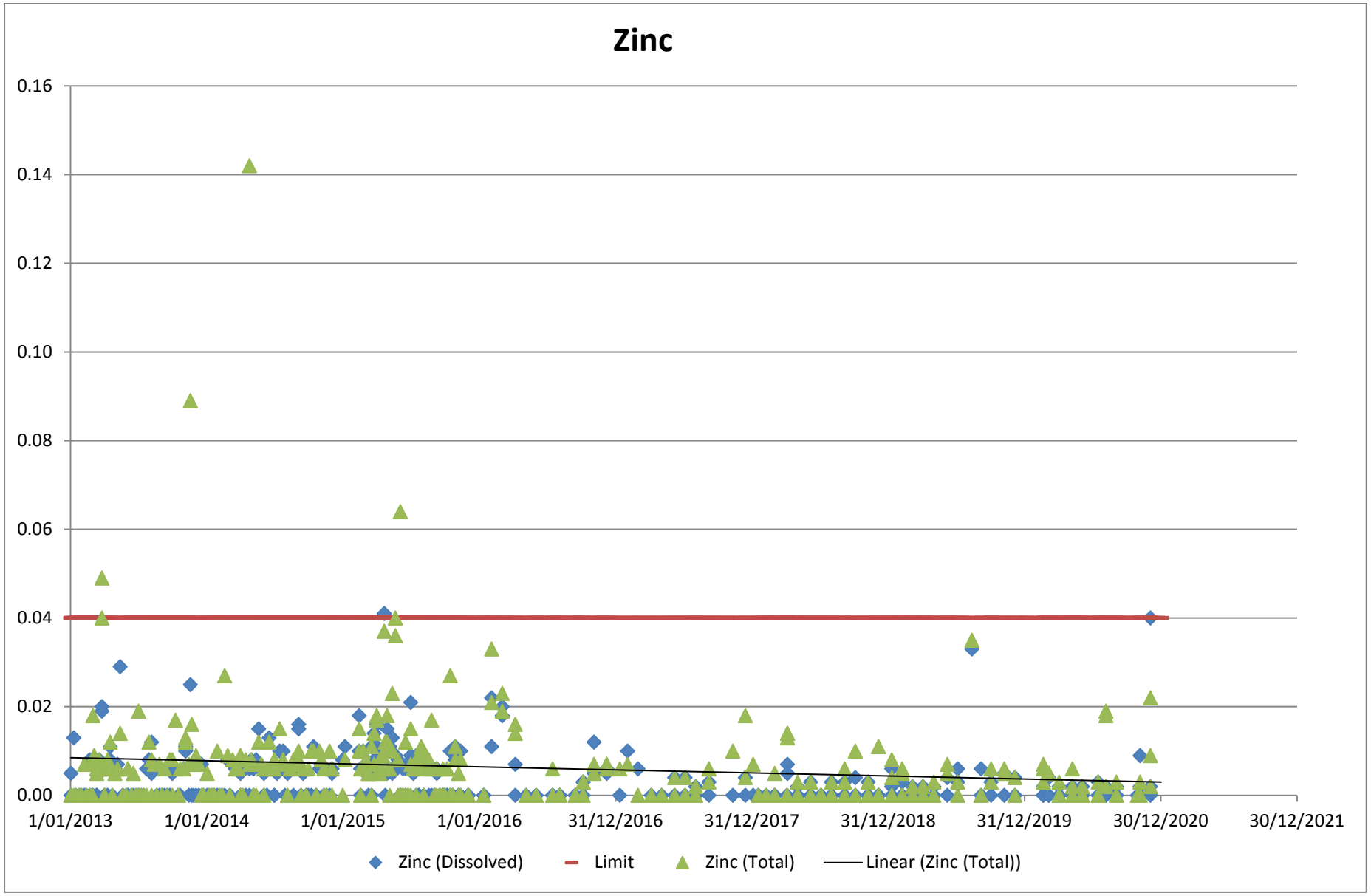
0.20
0.10
0.00
1/01/2013
1/01/2014
1/01/2015
1/01/2016
31/12/2016
31/12/2017
31/12/2018
31/12/2019
30/12/2020
30/12/2021
Vanadium (Dissolved)
Limit
Vanadium (Total)
Linear (Vanadium (Dissolved))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0.06
0.04
0.02
0.00
1/01/2013
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1/01/2015
1/01/2016
31/12/2016
31/12/2017
31/12/2018
31/12/2019
30/12/2020
30/12/2021
Zinc (Dissolved)
Limit
Zinc (Total)
Linear (Zinc (Total))

APPENDIX 2 – Newstan Colliery Annual Flora and Fauna Report

NEWSTAN COLLIERY ANNUAL MONITORING REPORT

2020 Annual Flora and Fauna Monitoring

146531
V1
05 March 2021

rpsgroup.com

Document status					
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Contents

SUMMARY **4**
Aims 4
Flora and Habitat 4
Diurnal Birds 4
Microchiropteran Bats 4
Invertebrates 4
Conclusions 5

1 INTRODUCTION **6**
1.1 Regulatory context 6
1.2 Objectives and scope of works 6
1.3 Site Particulars 6
1.4 Qualifications and licensing 6
1.4.1 Qualifications 6
1.4.2 Licensing 6

2 METHODOLOGY **9**
2.1 Overview 9
2.2 Weather conditions 10
2.2.1 Rainfall 10
2.2.2 Temperature 11

3 RESULTS **16**
3.1 Overview 16
3.2 Mine Rehabilitation Sites 16
3.2.1 Rehabilitation Site A 16
3.2.2 Rehabilitation Site B 19
3.2.3 Rehabilitation Site C 22

4 DISCUSSION AND ASSESSMENT OF REHABILITATION **40**
4.1 Flora Species Assemblages 40

Tables

Table 1 Survey method type per monitoring site 9
Table 2 Location of installed nest boxes 10
Table 3 Daily weather observations during the monitoring period 10

Plates

Plate 1 Acacias and non-native grasses at Rehabilitation A 18
Plate 2 Senescing Acacias and grasses at Rehabilitation Site B 20
Plate 3 Glider utilising Nest box 5 21
Plate 4 Vegetation at Rehabilitation C 23
Plate 5 Brushtail possum utilising nest box 4 24
Plate 6 Analogue Site 1 Vegetation 25
Plate 7 Glider utilising nest box 2 27
Plate 8 Analogue Site 2 Vegetation 28
Plate 9 Looking south into the EEC Site 30
Plate 10 Common Ringtail Possum (*Pseudocheirus peregrinus*) at the EEC site 31
Plate 11 Dominant Community site with MU 30 vegetation 33
Plate 12 Bush Rat (*Rattus fuscipes*) at Dominant Community site 34

Plate 13 Sugar Glider (*Petaurus breviceps*) at By-wash site 35
Plate 14 Swamp Wallaby (*Wallabia bicolour*) at WMP03....36
Plate 15 Eastern Whipbird (*Psophodes olivaceus*) at SP004 37
Plate 16 Brushtail Possum (*Trichosurus vulpecula*) at REA01 38

Figures

Figure 1 Newstan Colliery location....7
Figure 2 Monitoring Site Locations....8
Figure 3 Threatened species locations 17

Graphs

Graph 1 Precipitation recorded at Eraring from September 2019 to August 2020 (BoM 2020). 11
Graph 2 Mean monthly maximum temperatures for Cooranbong from September 2019 to August 2020 (BoM 2020). 11
Graph 3 Mean monthly minimum temperatures for Cooranbong from September 2019 to August 2020 (BoM 2020). 12
Graph 4 2020 native and exotic flora species richness for each site....40
Graph 5 Between years and sites comparison of species richness for each site (2015 – 2020) 40
Graph 6 Between years and sites comparison of bird species richness between all sites (2015 – 2020) 41
Graph 7 Between years and sites comparison of microbat species richness for all sites (2015 – 2020) 43
Graph 8 Comparison of invertebrate morphospecies diversity across all years and sample sites....44
Graph 9 Comparison of Invertebrate species abundance across all years and sample sites 44

Appendices

Appendix A Fauna Species List
Appendix B Anabat Report
Appendix C Invertebrate Results
Appendix D Flora Results

SUMMARY

RPS Australia East Pty Ltd (RPS) was commissioned by Centennial Coal Pty Ltd to undertake the Annual Ecological Monitoring Program for the Newstan Colliery complex, which is hereafter referred to as the "monitoring area". This Annual Monitoring Report (AMR) details the methods and results for the surveys of habitat, flora, diurnal birds, microchiropteran bats (microbats) and invertebrates for the 2020 monitoring period.

Aims

This monitoring program aims to confirm whether there have been any discernible impacts on the surrounding terrestrial habitats (outside of approved disturbance areas) as a result of mining operations and to monitor the efficacy of rehabilitation areas. In addition, specific recommendations have been provided with the management objective of enhancing the species richness and structural diversity of each site and the monitoring area as a whole.

Flora and Habitat

Habitat and flora assessments showed expected results, with reference sites having a higher inferred ecological condition than rehabilitation sites. Rehabilitation sites expressed high levels of exotic species cover, which has increased since 2019. Reference sites presented a broader and more diverse availability of resources including mature trees, foraging resources, ground habitat features, hollows and flora diversity. Management actions that aim to supplement absent habitat features, including ground refugia for small animals have previously been implemented in Rehabilitation sites A, B and C, and six nest boxes suited to a variety of fauna were installed in October 2020 at Analogue site 1, and Rehabilitation sites B and C. Additional installations to increase spatial coverage, especially at Rehabilitation site A and Analogue 2, would provide even further benefit to these sites. This is evidenced by full utilisation of existing glider and parrot boxes. Low weed presence was observed at reference sites, while weed establishment was evident at all rehabilitation sites and requires further management.

Diurnal Birds

The 2020 diurnal bird surveys recorded 45 different bird species across ten sites. One threatened species, the White-bellied Sea Eagle (*Haliaeetus leucogaster*) listed as Vulnerable under the Biodiversity Conservation Act 2016 (BC Act), was recorded while moving between sites.

Microchiropteran Bats

A total of eight microbat species were confidently detected (classified as either definite or probable), including two listed as Vulnerable under the BC Act, i.e. Little Bentwing Bat (*Miniopterus australis*) and Large-eared Pied Bat (*Chalinolobus dwyeri*), which is also listed as Vulnerable under the EPBC Act and was absent in 2019. Microbat species richness remained relatively stable, however, two threatened species were notably absent in 2020, i.e. Eastern Coastal Free-tailed Bat (*Micronomus norfolkensis*) and Large Bent-winged Bat (*Miniopterus orianae oceanensis*).

Invertebrates

A total of 94 invertebrate morphospecies were detected during the 2019 surveys. Due to the level of identification, it is not possible to determine whether all these species are native or exotic.

The highest species richness recorded was at Rehabilitation Site A and the highest abundance occurred at Rehabilitation Site C. Analogue Site 2 contained both the lowest diversity and abundance. The results of this survey are similar to 2019 in terms of species richness and abundance patterns, taking into account a shortened survey period.

Conclusions

Evidence of continued ecological succession is apparent in the rehabilitation areas; although some differences in the rate of improvement were detected. It is recommended that the future management focus be on the transformation of the groundcover stratum from predominantly exotic species coverage to more native species, as there is evidence the canopy is progressing unaided currently. Placement of more logs and nest boxes, in addition to the recent efforts, on the ground surface is also considered a positive management action that would assist in this objective as well as provide additional supplementary habitat for small fauna. Some successful weed management was previously noted in rehabilitation areas and is recommended for continuation to prevent proliferation and establishment of weeds in the area. With management and habitat enhancement, it is anticipated that further ecological benefit at a rate similar to that experienced in past years will become apparent in the rehabilitation areas in subsequent monitoring years.

1 INTRODUCTION

RPS was engaged by Centennial Coal Pty Ltd to undertake the 2020 Annual Ecological Monitoring Program at Newstan Colliery in Fassifern, NSW, approximately 19 km southwest of Newcastle (**Figure 1**). This is the sixth survey of the monitoring program, which continues on an annual basis until determined by the Director-General. Detailed in this Annual Monitoring Report (AMR) are the survey methods and results of the program, as well as an evaluation of the rehabilitation works against nominated success criteria.

1.1 Regulatory context

As per the conditions of consent for DA73-11-98, this monitoring program has been undertaken in accordance with the Flora and Fauna Management Plan, Newstan Colliery (RPS 2014), to satisfy Conditions 3.4 and 8.5. The monitoring methodologies include habitat assessments, avifauna, microbat and invertebrate surveys and flora quadrats at rehabilitation and control sites with additional use of infrared cameras to detect any local fauna.

1.2 Objectives and scope of works

The objective of this monitoring program is to confirm if there have been any discernible impacts on the surrounding terrestrial habitats as a result of mining operations and to monitor the efficacy of rehabilitation areas through indicator species and habitat assessments. In addition, specific recommendations have been provided with the management objective of enhancing species richness and structural diversity. The scope of works for the annual monitoring involves collecting and analysing data for diurnal birds, microbats and invertebrates, as well as specific habitat attributes and flora quadrats over 13 sites. The specific methodologies applied to each site vary, and are provided in Section 2.1.

1.3 Site Particulars

The 'monitoring area' is the area that encompasses all monitoring locations (as shown on **Figure 1**). Each monitoring location, consisting of both reference and impact sites, has been allocated a site name (as shown on **Figure 2**). There are 13 monitoring sites in total.

1.4 Qualifications and licensing

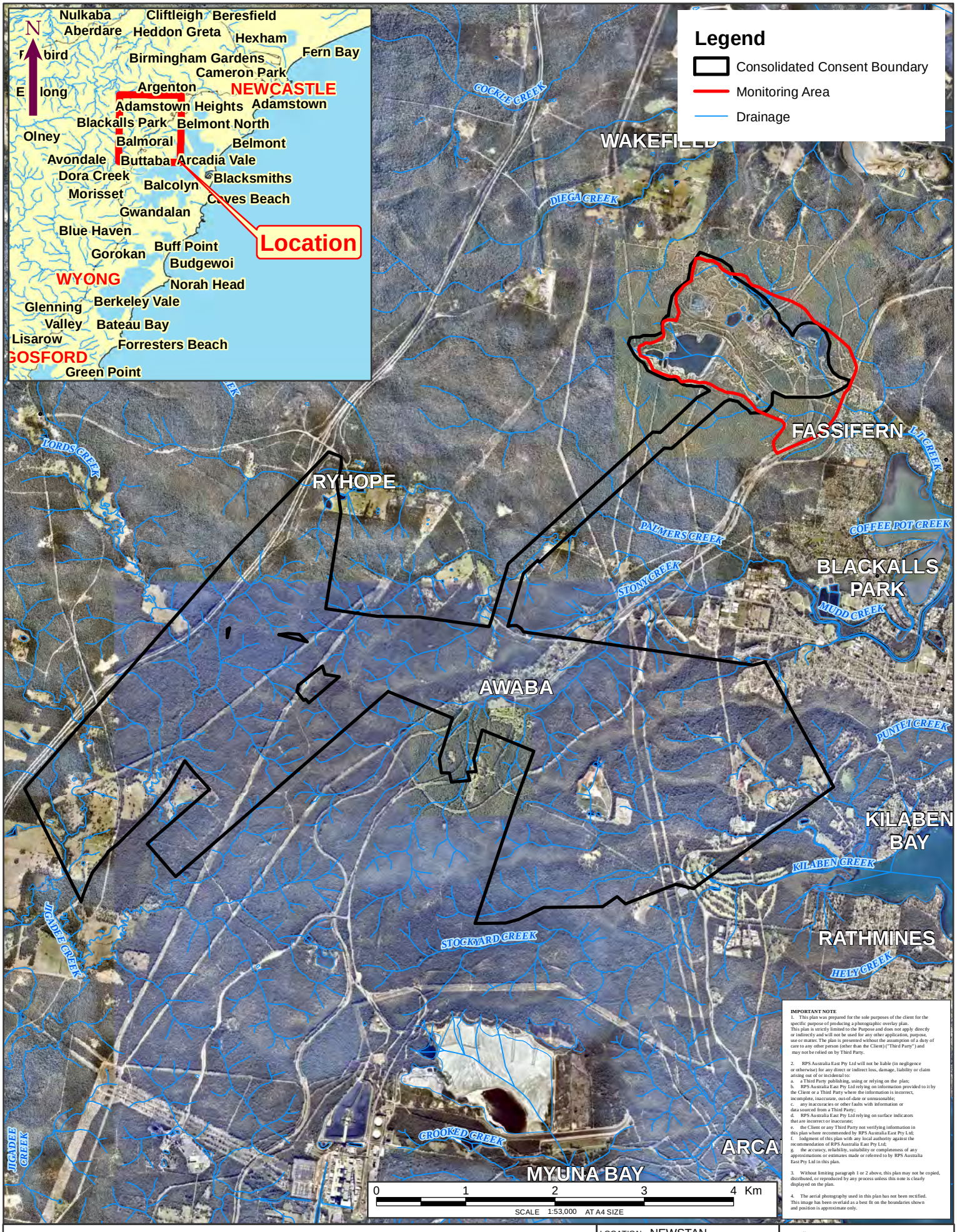
1.4.1 Qualifications

The principal author of this report is Shelomi Doyle B. Hort (Env), Grad. Dip. Sci (Biodiversity) and accredited BAM Assessor (Assessor #BAAS20032) of RPS. The report was reviewed by Arne Bishop B. Env. Sc. and accredited BAM Assessor (Assessor #BAAS17065) of RPS.

1.4.2 Licensing

Research was conducted under the following licences:

- NSW National Parks and Wildlife Service Scientific Investigation Licence S100536 (Valid 31 December 2020);
- Animal Research Authority (Trim File No: 16/361) issued by NSW Department of Primary Industries (Valid to 21 March 2022);
- Animal Care and Ethics Committee Certificate of Approval (Trim File No: 16/361) issued by NSW Department of Primary Industries (Valid 21 March 2022); and
- Certificate of Accreditation of a Corporation as an Animal Research Establishment (Trim File No: 01/1522 & Ref No: AW2001/014) issued by NSW Agriculture (Valid 22 May 2023).



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   c. any inaccuracies or other faults with information or data sourced from a Third Party;
   d. RPS Australia East Pty Ltd relying on surface indicators that are incorrect or inaccurate;
   e. the Client or any Third Party not verifying information in this plan where recommended by RPS Australia East Pty Ltd;
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   g. the accuracy, reliability, suitability or completeness of any approximations or estimates made or referred to by RPS Australia East Pty Ltd in this plan.

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4. The aerial photography used in this plan has not been rectified. This image has been overlaid as a best fit on the boundaries shown and position is approximate only.

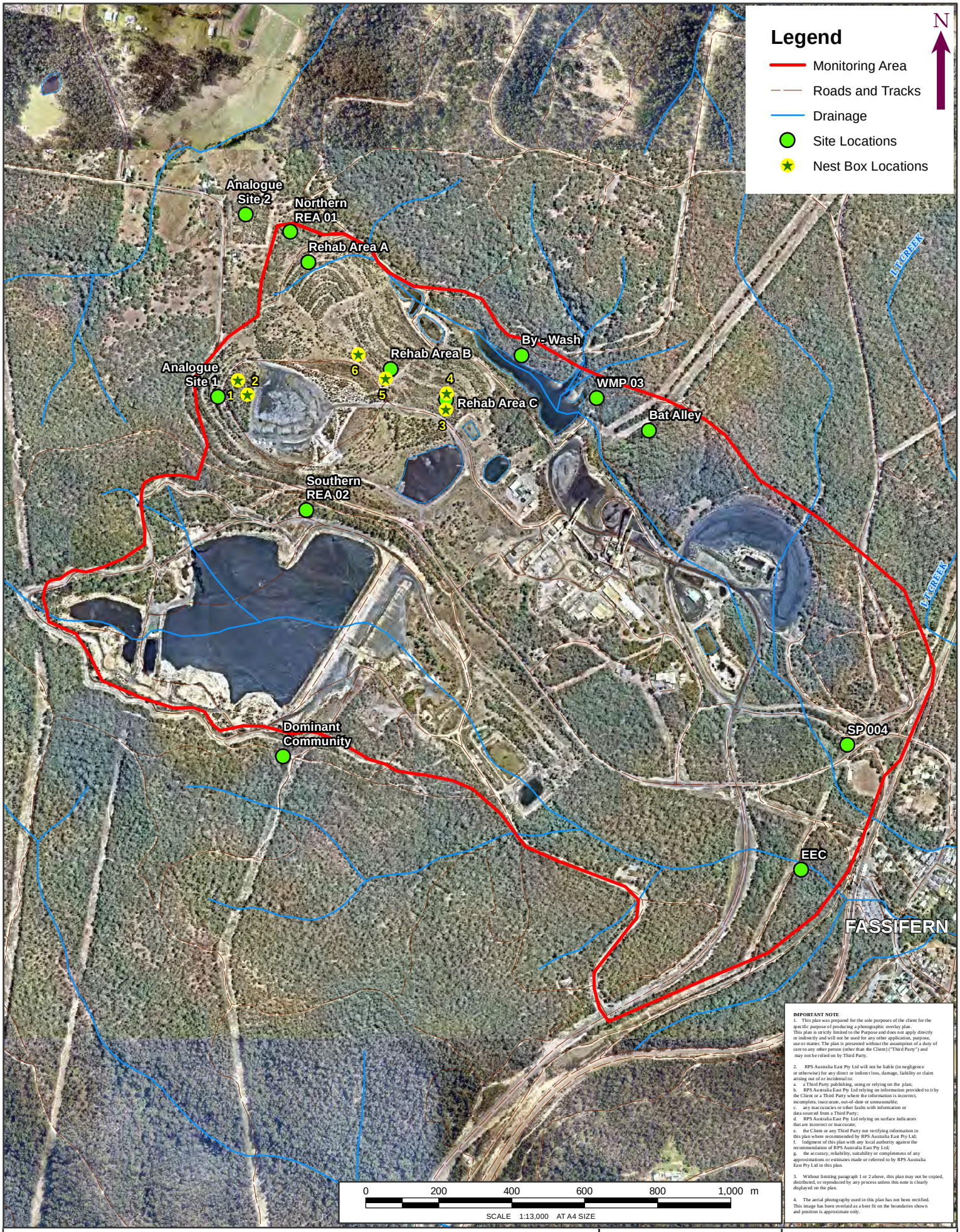
Figure 1: Newstan Colliery Location

LOCATION: NEWSTAN	Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994
JOB NO.: **PR146531** PURPOSE: ECOLOGY Technician: Natalie.Wood Date: 10/03/2021	Data Sources: RPS, Client Nearmap 21/01/2020

CLIENT: CENTENNIAL

RPS AUSTRALIA EAST PTY LTD (ABN 44 140 292 762)
Unit 2A, 45 Fitzroy Street, Carrington, NSW, Australia, 2294 PO Box 120, Carrington, NSW, 2294
T: 02 4940 4200 F: 02 4940 4299 www.rpsgroup.com.au

Path: S:\Centennial\All Jobs\146531 Newstan 2020 AMR\10 - Drafting\Arcgis Map Documents\Eco\146531 Figure 1 Newstan Colliery Location A A4 20210310.mxd



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2. RPS Australia East Pty Ltd will not be liable (in negligence or otherwise) for any direct or indirect loss, damage, liability or claim arising out of or incidental to:
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   d. RPS Australia East Pty Ltd relying on surface indicators that are incorrect or inaccurate;
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4. The aerial photography used in this plan has not been rectified. This image has been overlaid as a best fit on the boundaries shown and position is approximate only.

Figure 2: MONITORING LOCATIONS

LOCATION: NEWSTAN

Coordinate System: GDA 1994 MGA Zone 56
Datum: GDA 1994

JOB NO.: **PR146531**
PURPOSE: ECOLOGY
Technician: Natalie.Wood Date: 11/03/2021

Data Sources:
RPS, Client
Nearmap 21/01/2020

CLIENT: CENTENIAL

RPS AUSTRALIA EAST PTY LTD (ABN 44 140 292 762)
Unit 2A, 45 Fitzroy Street, Carrington, NSW, Australia, 2294 PO Box 120, Carrington, NSW, 2294
T: 02 4940 4200 F: 02 4940 4299 www.rpsgroup.com.au

Path: S:\Centennial\All Jobs\146531 Newstan 2020 AMR\10 - Drafting\Arcgis Map Documents\Eco\146531 Figure 2 Th species Locations A A4 20210310.mxd

2 METHODOLOGY

2.1 Overview

Monitoring performed within the monitoring area includes targeted surveys for birds, microbats and invertebrates. Birds and bats are considered to be one of the best bio-indicators of a habitat's health. They are known to respond to environmental changes over many spatial scales (Temple and Weins, 1989; handel Gaisler et al, 1998) and can yield results that are data rich and efficient to collect (Carignan and Villard 2002). They are also highly suited to monitoring (Furness et al. 1993; Read et al. 2000; Lantz and Martinez-Espineira 2008) because; they can be monitored efficiently over large spatial scales, are easy to accurately identify, have stable taxonomy, have relatively well known ecology and behaviour, are reasonably long-lived, and hold a high position in some food chains where they may integrate the effects of environmental stresses over time.

These surveys were also conducted in conjunction with habitat and/or flora assessments in order to ascertain whether there are any correlations with species diversity and habitat complexity both between sites and across years.

A total of 13 sites were originally chosen by Centennial Newstan in collaboration with RPS, consisting of a combination of rehabilitation and reference sites. **Table 1** below shows a breakdown of the survey effort between the sites. The field work for the Annual Ecological Monitoring Program was undertaken between 7 and 11 September 2020. The locations of the monitoring sites are listed in **Table 1**.

Table 1 Survey method type per monitoring site

Survey Site	Easting	Northing	Flora Quadrat	Bird Census	Invertebrate Survey	Infrared Camera	Anabat	Habitat Assessment
Rehabilitation Site A	365910.3	6351097.3	X	X	X		X	X
Rehabilitation Site B	366136.0	6350804.8	X	X	X		X	X
Rehabilitation Site C	366287.2	6350720.5	X	X	X		X	X
Analogue Site 1	365662.9	6350728.4	X	X	X		X	X
Analogue Site 2	365738.4	6351227.7	X	X	X		X	X
Bat Alley	366843.0	6350636.2					X	
EEC (Endangered Ecological Community)	367259.5	6349433.4	X	X		X	X	X
Dominant Community	365840.4	6349744.2	X	X	X	X	X	X
By-Wash	366494.0	6350841.5		X		X		
WMP03	366700.5	6350725.5		X		X		
SP004	367386.7	6349775.6		X		X		
REA Site 1	365860.7	6351181.0				X	X	
REA Site 2	365905.2	6350418.3				X	X	

In addition, the 2020 monitoring also included a survey of nest boxes installed within the last 12 months. The locations of nest boxes are listed in **Table 2.** This passive survey was non-invasive and utilised pole cameras to determine whether there were individuals present or signs of use.

Table 2 Location of installed nest boxes

Box number	Rehabilitation area	Easting	Northing	Type
1	Analogue site 1	365717	6350775	Microbat
2	Analogue site 1	365743	6350735	Small Parrot
3	Rehab Area C	366287	6350694	Glider
4	Rehab Area C	366289	6350739	Small Parrot
5	Rehab Area B	366121	6350779	Glider
6	Rehab Area B	366047	6350845	Microbat

2.2 Weather conditions

The closest Bureau of Meteorology weather station that provided daily rainfall was located at Eraring, approximately 10 km from the monitoring area (station number 061376). Temperature data was collected from Cooranbong approximately 15 km from the monitoring area (station number 061412). Daily temperatures and rainfall experienced during the survey period are provided in **Table 3** below.

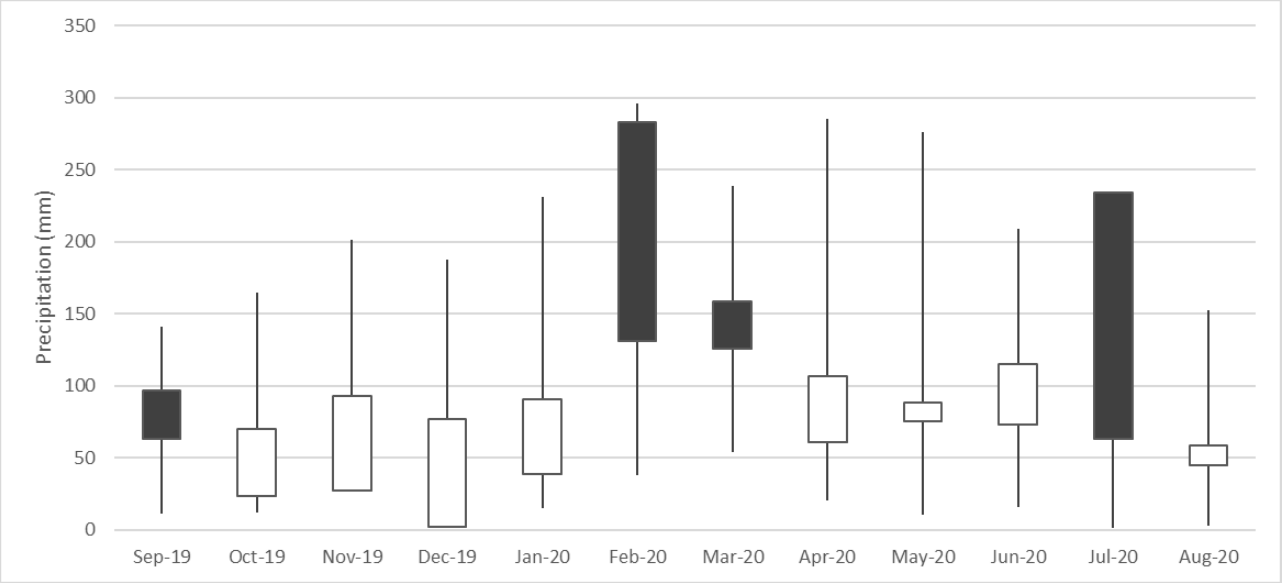
Table 3 Daily weather observations during the monitoring period

Date	Minimum temperature (°C)	Maximum temperature (°C)	Total rainfall (mm)
07/09/2020	5.3	22.1	0
08/09/2020	4.1	24.9	0
09/09/2020	9.0	17.6	0
10/09/2020	10.8	17.9	10.8
11/09/2020	7.8	19.6	1.6

2.2.1 Rainfall

Total annual precipitation recorded at the Eraring weather station for the preceding 12-month period (i.e. September 2019 – August 2020) was 1119.2 mm, which is above the historical annual mean (i.e. 1080.5 mm) as reported for the Eraring 061376 weather station. An increase in total annual precipitation could be primarily attributed to two above average rainfall events in February and July 2020 (283.2 mm and 234.2 mm respectively), which accounted for almost half of the annual rainfall total and exceeded the 95th percentile in July. Eight out of the twelve months experienced rainfall below the corresponding historic monthly means (**Graph 1**). Closed candles in the graphs below show recent mean maximum monthly temperature exceeding the long-term average. Bars show the 95th and 5th percentiles.

The rainfall total in the three-month period preceding this monitoring event (i.e. June 2020 to August 2020) totalled 352 mm, which is above the corresponding historical mean of 236.5 mm. Although mean monthly rainfall totals fell mostly below the historic monthly mean, the NSW Seasonal Update for August 2020 reported drought in NSW continuing to weaken (NSW DPI 2020).

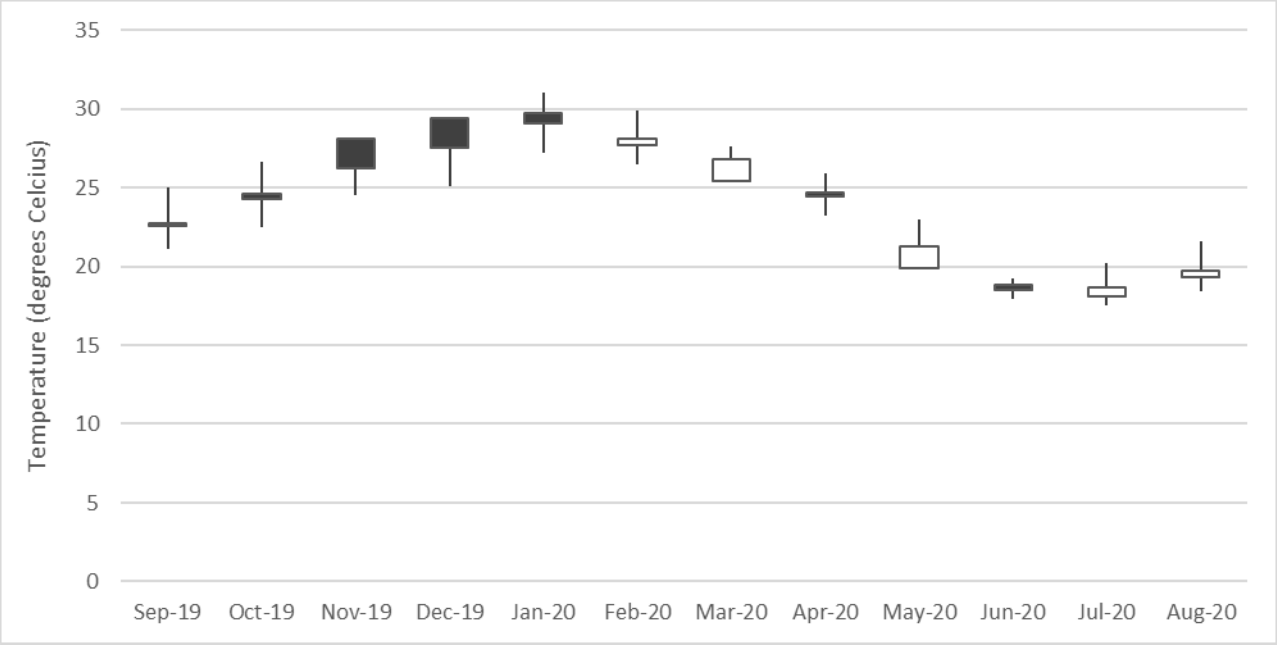


Graph 1 Precipitation recorded at Eraring from September 2019 to August 2020 (BoM 2020).

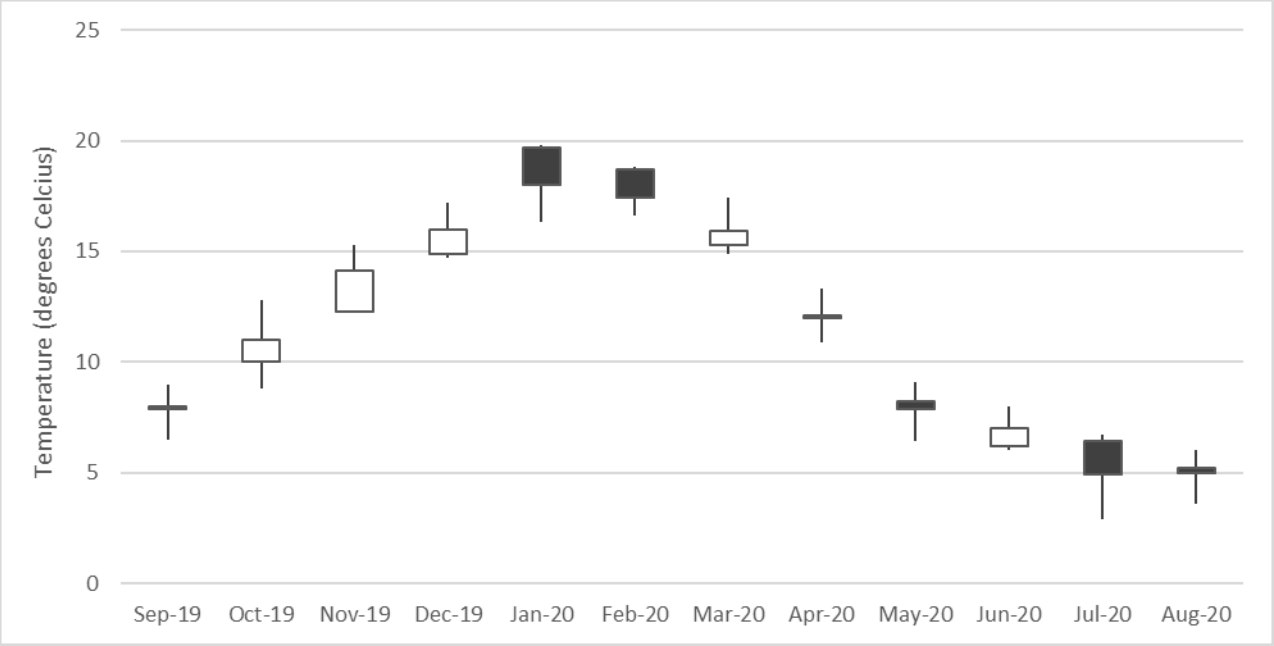
2.2.2 Temperature

The mean monthly maximum temperatures for seven of the twelve months preceding the spring 2020 monitoring event were higher than the historical mean (BoM 2020). November reached the 95th centile, and December was 0.1 degrees below it (**Graph 2**). The mean minimum monthly temperatures for the twelve months preceding the spring 2020 monitoring event were generally cooler than average, with seven months recording temperatures below the historical monthly means (**Graph 3**). Closed candles in the graphs below show recent mean maximum monthly temperature exceeding the long-term average. Bars show the 95th and 5th percentiles.

The mean maximum monthly temperatures at Cooranbong during the three months preceding this survey (i.e. June 2020- August 2020) were close to the historical average, with June recording below and July and August recording above historical mean maximum monthly temperatures (**Graph 2**). Mean minimum monthly temperatures for the same three-month period were opposite in direction, with June below the historical minimum monthly mean temperature, and July and August above (**Graph 3**).



Graph 2 Mean monthly maximum temperatures for Cooranbong from September 2019 to August 2020 (BoM 2020).



Graph 3 Mean monthly minimum temperatures for Cooranbong from September 2019 to August 2020 (BoM 2020).

2.3 Habitat Descriptions

Detailed habitat assessments for the 2019 monitoring period were undertaken at Rehabilitation Sites A, B and C, Analogue Sites 1 and 2, EEC (Endangered Ecological Community) and Dominant Community. The below data was chosen and collected by RPS, with consideration of the habitat analysis techniques described in Bayley and Brouwer (2004). Recorded habitat attributes include:

- Physical features including:
  - Topographic position;
  - Slope;
  - Aspect;
  - Structure;
  - Patch size;
  - Patch shape;
  - Width if linear;
  - Connectivity;
  - Linear type;
  - Geology;
  - Soil colour and texture; and
  - Surface water bodies within 100 m.
- Plant diversity and health including:
  - Exposed soil;
  - Lichen;
  - Litter;
  - Herbs/ forbs;

  - Grasses;
  - Grassland condition;
  - Grassland height;
  - Grassland species diversity;
  - Dieback;
  - Mistletoe;
  - Litter at tree base;
  - DBH ranges and percentage cover;
  - Shrub species;
  - Shrub layer species diversity;
  - Canopy species;
  - Canopy layer species diversity;
  - Canopy layer structural diversity;
  - Patch health;
  - Canopy description;
  - Understory description; and
  - Tree species percentage (%) of cover.
- Habitat value including:
  - Rock on rock;
  - Overhangs/caves;
  - Mistletoe;
  - Terrestrial and Arboreal termite mounds;
  - Hollow; structure, size classes, number, status and relative abundance;
  - Number of habitat trees;
  - Scratches on smooth tree trunks; and
  - Loose tree bark.
- Level of disturbance including:
  - Fire;
  - Number of cut stumps;
  - Presence of grazing and, if so, by what animal species;
  - Presence of erosion and, if so, what type;
  - Dumping;
  - Weed cover abundance; and
  - Dominant weed species.

The above variables have been analysed by using a habitat typology assessment developed by RPS.

Specimens of plant species that could not be identified in the field were collected and identified according to nomenclature in Harden (1992, 1993, 2000 and 2002).

2.4 Diurnal Bird Census

Birds were surveyed for 20 minutes at each monitoring site and were restricted to mornings during periods of nil or low rain, in order to record birds during peak activity periods. All birds observed or heard within or flying over the site were recorded. Birds that were detected outside the search area of a site were recorded separately as opportunistic. Where threatened bird species were detected, a hand-held Trimble differential global positioning system (D-GPS) with the ability to be accurate to less than one metre, was used to record the locations.

2.5 Invertebrate Survey

Invertebrate populations were traditionally sampled after a 4 night period, however the 2020 survey included only 2 nights to avoid heavy rainfall impacting the results.

There are a number of methods that can be employed to capture invertebrates; however, the chosen method was selected due to the wider coverage of insect diversity collection. The chosen method was the Yellow Pan Trap method outlined by Oliver et al. (1999).

Flying invertebrates are attracted to the colour of yellow and as such were sampled using yellow pans (plastic plates with a diameter of 230 mm and a depth of 25 mm) containing a soap solution (Oliver et al., 1999; Dahms, 1997). Each pan was pegged to the ground using two skewers, to hold the plates steady and level.

Each site had a transect consisting of three yellow pans set 5 m apart. A sieve was used to collect all insects, and as a result, invertebrates <0.5 mm were not included in the sampling process. The filtered material was placed in sampling jars containing methylated spirits and labelled appropriately. All pans and sieves were inspected thoroughly after each filtering process and washed out to ensure all invertebrates were removed.

2.5.1 Invertebrate Sorting and Identification

Invertebrates were sorted and identified to morphospecies or Recognisable Taxonomic Units (RTUs). This is a recognised methodology that has been utilised as a time and cost-efficient technique to sort and identify invertebrates for biological surveys (Beattie and Oliver, 1994). No classification reference material or technical training is required, and invertebrates are separated based on differentiating characteristics. Morphospecies can be used as surrogates for species provided that the correspondence between morphospecies and species is approximately one to one and that each morphospecies is unique (Beattie & Oliver, 1994).

Each sampling jar was individually sorted in a shallow tray containing a small amount of methylated spirits. Invertebrates were sorted into morphospecies using easily identifiable features that distinguished them from other sampled invertebrates.

2.5.2 Analysis

Raw data from invertebrate sorting and identification was tabulated in an excel spreadsheet and the following was calculated for each site:

- Total number of the type of invertebrate (diversity);
- Total number of individual invertebrates (abundance); and

Species unique to a specific site.

2.6 Microbat Monitoring

Microbat species were monitored using in situ echolocation call recorders (Anabats) which were set to record calls from 6pm to 6am each day. Microbat calls were recorded using the Anabat Express system (Titley Scientific) and recorded calls were analysed by a recognised expert in the field (Dr Anna McConville of Echo Ecology). No trapping of microbats was performed as part of the annual monitoring. The units were positioned to maximise calls recorded along potential microbat flyways.

2.7 Infrared Cameras

Remote sensor infrared cameras were used across seven of the sites to detect nocturnal and diurnal fauna. Each camera was tied to a tree at approximately 0.5 m from the ground and angled towards the ground. Tinned mackerel was used as bait and placed within the camera's centre focal point on the ground to attract fauna. A total of 28 camera trap nights were undertaken over the survey period.

2.8 Flora Quadrat

A total of seven floristic 20 x 20 m quadrats were undertaken within the monitoring sites. Each quadrat was undertaken with reference to current NSW mapping standards (Sivertsen, 2009) whereby floristic data was collected using a six-point Braun-Blanquet cover abundance scale. The applied Braun-Blanquet cover abundance scale assigns each species to one of these six cover abundance classes which are considered indicative of the dominance of these species within the quadrat. Where relevant, vegetation communities were described in accordance with the Lower Hunter and Central Coast Regional Environment Management Strategy (LHCCREMS; NPWS 2000) vegetation map units (MU). Additionally, structural features of the vegetation within the quadrat and other relevant habitat features (e.g. soil type; presence of rock and slope) were also recorded.

In 2019, two of the flora quadrats were moved by approximately 20 m at the request of Centennial Newstan, to avoid placement in drainage lines and to better represent the surrounding vegetation. These were the rehabilitation sites B and C. Care was taken to ensure that plots were close to their previous position and reflected the level of rehabilitation present in the general area. This move may influence ongoing results and comparative analysis.

2.9 Limitations

Not all flora species are detectable throughout all times of any given year and it is unlikely that all species would be detected during surveys undertaken once a year. For example, cryptic orchids flower within specific seasons and cannot be detected at other times of the year. Also, vegetation structure and cover abundance were estimated visually and, as a result, there is likely to be an element of observer bias. Where possible, this observer bias has been limited by using guides and charts for assisting to standardise measurements, such as those provided in the Australian Soil and Land Survey Field Handbook (National committee on Soil and Terrain, 2009).

The flowering and fruiting plant species that attract some nomadic or migratory threatened species often fruit or flower in cycles spanning a number of years. Furthermore, these resources might only be accessed in some areas during years when resources more accessible to threatened fauna species fail. Consequently, threatened species may be absent from some areas where potential habitat exists for extended periods.

Bird surveys were limited to a single sample for each site. Differences between sites could be reflection of a number of confounding factors (e.g. time of day, weather conditions and vagrancy), which could only be reduced through multiple / repeat subsampling to better understand variance.

Limitations on tools used during field work are also present, where malfunctions can occur with any mechanical device. If this occurs, data can be lost, and results cannot be recollected in this instance. All measures have been undertaken to ensure all tools used are in the best working condition for the surveys. Due to their high sensitivity, bat call detectors can be impacted by excessive site noise from insects or machinery, which has the potential to cause buffer overflow errors and data loss in some cases.

In 2019, Rehabilitation sites B and C were relocated by approximately 20 m which may influence results at these sites. Despite endeavours to situate the new sites in habitat representative of their existing conditions, the habitat in these new locations is not identical and may cause inconsistencies that normally would not have been identified had these sites remained at their original location.

3 RESULTS

3.1 Overview

A total of 62 vertebrate fauna species including 45 bird species, three reptiles, two amphibians, 12 mammals and eight confident microbat species were observed within Centennial Newstan during the 2020 survey period. Four fauna species listed as Vulnerable under the *Biodiversity Conservation Act 2016* (BC Act) were recorded as detailed below and displayed in **Figure 3**:

- Little Bentwing Bat (*Miniopterus australis*);
- Large-eared Pied Bat (*Chalinolobus dwyeri*);
- White-bellied Sea Eagle (*Haliaeetus leucogaster*); and
- Little lorikeet (*Glossopsitta pusilla*).

Large-eared Pied Bat (*Chalinolobus dwyeri*) is also listed as Vulnerable under the Commonwealth EPBC Act.

A total of 136 flora species were identified in all quadrats, of which 101 were native and 35 exotic. Two flora species listed as threatened under the *Biodiversity Conservation Act 2016* (BC Act) were recorded and are displayed in **Figure 3**:

- *Tetratheca juncea* (Black-eyed Susan) (Vulnerable);
- *Corybas dowlingii* (Red Helmet Orchid) (Endangered); and

Tetratheca juncea is also listed as Vulnerable under the Commonwealth EPBC Act.

Twelve species considered high threat weeds in NSW were recorded, including two species that are listed as Weeds of National Significance (WoNS), namely:

- *Lantana camara*; and
- *Senecio madagascariensis* (Fireweed).

Site by site monitoring results are provided in the following sections.

3.2 Mine Rehabilitation Sites

3.2.1 Rehabilitation Site A

Rehabilitation Site A is situated in an area that has been subject to vegetation rehabilitation through direct seeding. It is the most western site of the three rehabilitation sites and is displayed in **Plate 1**.

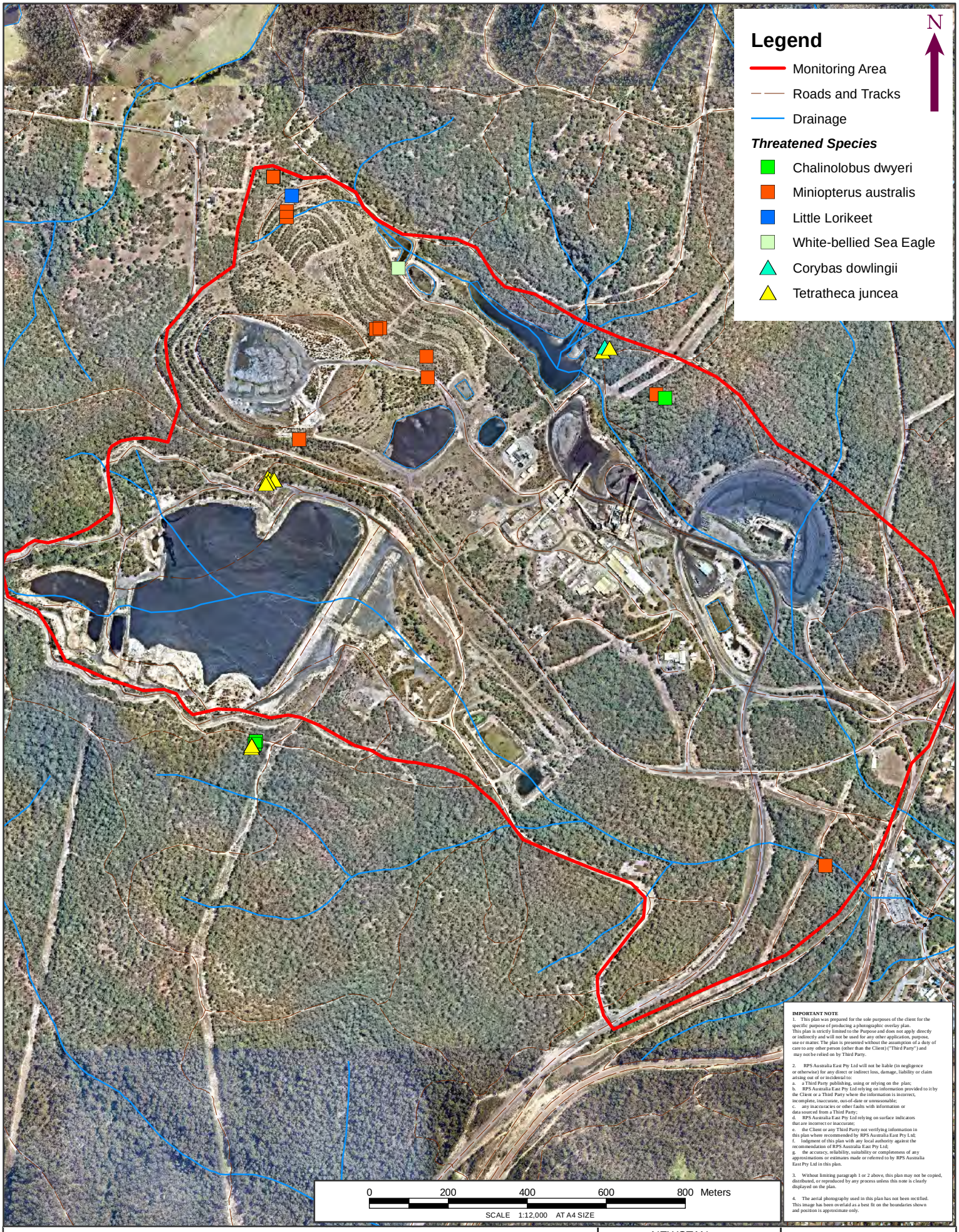


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Figure 3: Threatened Species Locations

LOCATION: NEWSTAN

JOB NO.: **PR146531**

PURPOSE: ECOLOGY

Technician: Natalie.Wood Date: 20/01/2021

Coordinate System: GDA 1994 MGA Zone 56
Datum: GDA 1994

Data Sources:
RPS, Client
Nearmap 21/01/2020

CLIENT: CENTENIAL

RPS AUSTRALIA EAST PTY LTD (ABN 44 140 292 762)
Unit 2A, 45 Fitzroy Street, Carrington, NSW, Australia, 2294 PO Box 120, Carrington, NSW, 2294
T: 02 4940 4200 F: 02 4940 4299 www.rpsgroup.com.au

Path: S:\Centennial\All Jobs\146531 Newstan 2020 AMR\10 - Drafting\Arcgis Map Documents\Eco\146531 Figure 3 Th species Locations A A4 20210119.mxd

Plate 1 Acacias and non-native grasses at Rehabilitation A

3.2.1.1 Flora Quadrat

A total of 17 flora species were recorded at Rehabilitation site A in 2020 including 6 native and 11 exotic species. This is a reduction from previous surveys, which recorded 25 total species in 2019, 17 in 2018, 21 in 2017, 29 in 2016 and 24 species in 2015. Vegetation within this site does not correspond to any MU within LHCCREMS vegetation mapping (NPWS 2000) as the species selected for rehabilitation were primarily chosen for quick re-establishment. No threatened flora species listed under the BC Act or *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act) were identified within the quadrat. Three species are considered high threat weeds in NSW, namely *Bidens pilosa* (Cobbler's Pegs), *Megathyrsus maximus* (Guinea Grass) and *Ricinus communis* (Castor Oil Plant).

3.2.1.2 Diurnal Bird Surveys

The 2020 survey identified 15 bird species, a reduction from 21 in 2019, and similar to the 2018 survey of 16 species, which is again substantially higher than nine recorded in 2017. Previously, this site had remained stable in its total number of bird species since 2015. Most recorded species are locally common, including the Grey Fantail (*Rhipidura albiscapa*), Rainbow Lorikeet (*Trichoglossus haematodus*) and Yellow-faced Honeyeater (*Lichenostomus chrysops*), with two unique species identified at the site, the Masked Lapwing (*Vanellus miles*) and Little Lorikeet (*Glossopsitta pusilla*). The Little Lorikeet is listed as vulnerable under the BC Act, and no species listed under the EPBC Act were recorded at this site during surveys. A list of all recorded bird species is provided in **Appendix A**.

3.2.1.3 Microbat Monitoring

The Anabat results for Rehabilitation Site A are provided in **Appendix B,** obtained from Anabat 10 from 09/09/20 and 10/09/20. Two microbat species were confidently identified at this site, including:

- Little Bentwing Bat (*Miniopterus australis*); and
- Horseshoe Bat (*Rhinolophus megaphyllus*).

Ride's Freetail Bat (*Ozimops ridei*) and Gould's Wattled Bat (*Chalinolobus gouldii*) were also recorded as probable calls at this site. Of these species, the Little Bentwing Bat is listed as Vulnerable under the BC Act.

3.2.1.4 Invertebrate Surveys

A total of 42 morphospecies among 105 individuals were detected at individuals were detected at Rehabilitation Site A, compared with 37 morphospecies in 2019, 41 in 2018, 12 in 2017, 35 in 2016 and 10 found at the same site in 2015. A list of all morphospecies per site is outlined in **Appendix C**.

3.2.1.5 Habitat Assessment

3.2.1.5.1 Physical Features

Rehabilitation Site A is a northwest facing site on a hill falling into the mid-slope. The site was characterised as regenerating woodland.

3.2.1.5.2 Plant Diversity

The vegetation was not representative of a naturally occurring vegetation community, rather, it was consistent with conditions normally observed in a rehabilitated zone (i.e. vegetation was reflective of selected flora species commonly used in rehabilitation works). The dominant species within the site was a combination of *Acacia implexa* with some Spotted Gums (*Corymbia maculata*) forming a tree canopy layer. The sparse shrub layer largely consisted of regenerating Acacia trees (100–200 mm Diameter at Breast Height (DBH)) and saplings. The ground cover was dominated by a dense coverage of exotic grasses and weeds.

3.2.1.5.3 Level of Disturbance

The site displayed a high level of historical disturbance as indicated by the low number of tree canopy species, high weed presence, few regenerating shrub species, low quality soil type (imported virgin excavated natural material (VENM)) and existing largely as a monoculture of *Acacia* species. Grazing pressure was light and vegetation ground cover was dense and approaching 100%.

3.2.1.5.4 Potential Habitat

At present, foraging resources are largely limited to the flowering of Acacia species and weed species. As a result, most fauna species are likely only using the area during transit or foraging expeditions, with little available refuge for larger animals, especially hollow dependent fauna. Exotic grass and weed species dominate the ground cover, restricting the presence of native grasses, herbs and forbs. It also limits the presence of small ground dwelling mammals and skinks that are unable to penetrate the thick grass. The site was accessible by macropods that would utilise the grassy areas to rest and forage. No logs, hollows, termite mounds or areas of rock were present within this site.

3.2.1.5.5 Overall Value

The habitat resources within Rehabilitation Site A were considered to be poor owing to a lack of diversity in vegetation structure and native plant species. As the site was regenerating, improvement in habitat condition was a possibility over time, particularly with the continued growth of juvenile eucalypt species and formation of a tree canopy resembling woodland structure. Dieback and senescence of *Acacia* individuals noted within the site allows for future growth and succession of the *Corymbia maculata*.

3.2.2 Rehabilitation Site B

Rehabilitation Site B is situated in an area that has been subject to vegetation rehabilitation through direct seeding. It is situated between Rehabilitation Site A and Rehabilitation Site C and is displayed in **Plate 2**.

Plate 2 Senescing Acacias and grasses at Rehabilitation Site B

3.2.2.1 Flora Quadrat

A total of 31 flora species were recorded in 2020, including 12 native and 19 exotic species. This is an increase from 24 species in 2019. Vegetation within the site does not correspond to any MU within LHCCREMS vegetation mapping (NPWS 2000) as the species selected for rehabilitation were primarily chosen for quick re-establishment. No threatened flora species listed under the BC Act or EPBC Act were identified within the quadrat. Seven species are considered high threat weeds in NSW, namely *Ageratina adenophora* (Crofton Weed), *Bidens pilosa* (Cobbler's Pegs), *Chloris gayana* (Rhodes Grass) *Hyparrhenia hirta* (Coolatai Grass), *Lantana camara* (Lantana), *Megathyrsus maximus* (Guinea Grass), and *Senecio madagascariensis* (Fireweed). In addition, *Lantana camara* and *Senecio madagascariensis* are listed as WoNS.

This plot was moved slightly in 2019 to better represent the surrounding vegetation, with no major changes to the species assemblage. However, for this reason it is not recommended to compare with previous seasons.

3.2.2.2 Diurnal Bird Surveys

The 2020 survey identified 11 bird species, compared to 14 in 2019, 13 in 2018, 17 in 2017, nine in 2016 and four in 2015. Most recorded species are locally common, including the Superb Fairy-wren (*Malurus cyaneus*) Rainbow Lorikeet (*Trichoglossus haematodus*) and Yellow-faced Honeyeater (*Lichenostomus chrysops*), with one unique species identified at the site, the Brown Thornbill (*Acanthiza pusilla*). No threatened species listed under the BC Act or EPBC Act were recorded at this site during the 2020 surveys. A list of all recorded bird species is provided in **Appendix A**.

3.2.2.3 Microbat Monitoring

The Anabat results for Rehabilitation Site B are provided in **Appendix B,** obtained from Anabat 1 from 07/09/20 to 08/09/20. Four microbat species were confidently identified at this site including:

- White-striped Freetail Bat (*Austronomus australis*);
- Little Bentwing Bat (*Miniopterus australis*);
- Horseshoe Bat (*Rhinolophus megaphyllus*); and

- Eastern Forest Bat (*Vespadelus pumilus*).

Gould's Wattled Bat (*Chalinolobus gouldii*) was also recorded as probable calls at this site. Of these species, the Little Bentwing Bat is listed as Vulnerable under the BC Act.

3.2.2.4 Invertebrate Surveys

A total of 29 invertebrate morphospecies among 127 individuals were detected at Rehabilitation Site B, compared with 43 morphospecies in 2019, 46 in 2018, 22 in 2017, 37 in 2016 and 25 at the same site in 2015. A list of all morphospecies per site is outlined in **Appendix C**.

3.2.2.5 Nest Box Monitoring

Next boxes 5 and 6 were located within the broader Rehabilitation Area B, and a survey recorded an unidentified glider occupying box number 5, and no obvious sign of use of box number 6, which was designed for microbat use. A photograph of the glider with wing membrane visible is shown in **Plate 3**. Identification to species level would require manual survey.

Plate 3 Glider utilising Nest box 5

3.2.2.6 Habitat Assessment

3.2.2.6.1 Physical Features

Rehabilitation Site B is a north-east facing site on a hill side. The site was characterised as regenerating open forest.

3.2.2.6.2 Plant Diversity

The vegetation was not representative of a naturally occurring vegetation community, rather, it was consistent with conditions normally observed in a rehabilitated zone (i.e. vegetation was reflective of selected flora species used in rehabilitation works). The dominant species within the site was a combination of *Acacia* species, with less dominant Spotted Gum (*Corymbia maculata*) occurring and becoming emergent. The canopy layer was developing in the form of the young emergent eucalyptus species. The ground cover was dominated by patchy coverage of native and exotic grasses. The shrub layer was largely absent, as short-lived *Acacia decurrens* individuals mature and continue to senesce. The declared weed *Hyparrhenia hirta* (Coolatai Grass) was again identified within the flora plot with an increased coverage, in addition to *Lantana camara*, *Megathyrsus maximus* (Guinea Grass) and *Senecio madagascariensis* (Fireweed) which are all considered high threat weeds in NSW.

3.2.2.6.3 Level of Disturbance

The site displayed a high level of historical disturbance as indicated by the abundance and cover of weed species and cover. Soil at this site was low quality, with a thick layer of crushed rock above the soil to prevent erosion; otherwise further inhibiting vegetation development.

3.2.2.6.4 Potential Habitat

At present, foraging resources are largely limited to the flowering of *Acacia* species and weed species. The site was similar to Rehabilitation Site A in this respect with habitat potential likely restricted to foraging for larger animals. Native and exotic grass species dominate the ground cover, restricting the presence of native grasses, herbs and forbs. The site was accessible by macropods that would utilise the grassy areas to rest and forage. No logs, hollows, termite mounds or areas of rock were present within this site.

3.2.2.6.5 Overall Value

Habitat resources within Rehabilitation Site B were considered to be poor, owing to the simplistic diversity in vegetation structure and native plant species. As the site was regenerating, improvement in habitat condition will occur, particularly with the continued growth of juvenile eucalypt species and colonisation of native groundcovers to compete with weed species.

3.2.3 Rehabilitation Site C

Rehabilitation Site C is situated in the mining rehabilitation area that has been subject to vegetation rehabilitation through direct seeding. It is situated to the east of Rehabilitation Site B and is displayed in **Plate 4**.

Plate 4 Vegetation at Rehabilitation C

3.2.3.1 Flora Quadrat

A total of 33 flora species were recorded in 2020, including 17 native and 16 exotic species. This is an increase on 30 species in 2019. Vegetation within this site does not correspond to any MU within LHCCREMS vegetation mapping (NPWS 2000), as the species selected for rehabilitation were primarily chosen for quick re-establishment. No threatened flora species listed under the BC Act or EPBC Act were identified within the quadrat. Eight species are considered high threat weeds in NSW, namely *Andropogon virginicus* (Whisky Grass), *Bidens pilosa* (Cobbler's Pegs), *Briza subaristata* (Chilean Quaking Grass), *Chloris gayana* (Rhodes Grass), *Lantana camara (Lantana)*, *Megathyrsus maximus* (Guinea Grass), *Paspalum dilatatum* (Paspalum) and *Senecio madagascariensis* (Fireweed). In addition, *Lantana camara* and *Senecio madagascariensis* are listed as WoNS.

This plot was moved slightly in 2019 to better represent the surrounding vegetation, with no major changes to the species assemblage. However, for this reason it is not recommended to compare with previous seasons.

3.2.3.2 Diurnal Bird Surveys

The 2020 surveys recorded 16 bird species, an increase from 13 bird species 2019, six species in 2018, 18 in 2017, 12 in 2016 and six in 2015. Most species were locally common, including the Scarlet Honeyeater (*Myzomela sanguinolenta*), Rainbow Lorikeet (*Trichoglossus haematodus*) and Yellow-faced Honeyeater (*Lichenostomus chrysops*), with one unique species identified at the site, namely Lewins Honeyeater (*Meliphaga lewinii*). No threatened species listed under the BC Act or EPBC Act were recorded at this site during surveys. A list of all recorded bird species is provided in **Appendix A**.

3.2.3.3 Microbat Monitoring

The Anabat results are provided in **Appendix B,** obtained from Anabat 2 from 07/09/20 and 08/09/20. Four microbat species were confidently identified at Rehabilitation Site C including:

- Ride's Free-tailed bat (*Ozimops ridei*);
- Horseshoe Bat (*Rhinolophus megaphyllus*);
- White-striped Freetail Bat (*Austronomous australis*); and

- Little Bentwing-bat (*Miniopterus australis*).

Eastern Forest Bat (*Vespadelus pumilus*) and Gould's Wattled Bat (*Chalinolobus gouldii*) were also recorded as probable calls at this site. Of these species, the Little Bentwing-bat is listed as Vulnerable under the BC Act.

3.2.3.4 Invertebrate Surveys

A total of 37 invertebrate morphospecies among 142 were detected at Rehabilitation Site C, compared with 29 morphospecies in 2019, 53 in 2018, 37 in 2017, 45 in 2016 and 19 in 2015. A list of all morphospecies per site is outlined in **Appendix C**.

3.2.3.5 Nest Box Monitoring

Next boxes 3 and 4 were located within the broader Rehabilitation Area C, and a survey recorded a brushtail possum (*Trichosurus vulpecula*) occupying box number 4, and a dome of eucalypt leaves indicating signs of glider use in box 3. A photograph of the possum is shown in **Plate 5**.

Plate 5 Brushtail possum utilising nest box 4

3.2.3.6 Habitat Assessment

3.2.3.6.1 Physical Features

Rehabilitation Site C is a north east facing site on a hilltop and upper slope. The site was characterised as regenerating open forest.

3.2.3.6.2 Plant Diversity

The vegetation was not representative of a naturally occurring vegetation community, rather, it was consistent with conditions normally observed in a rehabilitated zone (i.e. vegetation was reflective of selected flora species used in rehabilitation works). The dominant species within the site was a combination of *Eucalyptus* and *Corymbia* species, with a developing canopy layer. The shrub layer largely consisted of regenerating trees (100–200 mm DBH) and saplings. The ground cover was sparse with patchy coverage of native and exotic grasses and herbs.

3.2.3.6.3 Level of Disturbance

The site displayed a high level of historical disturbance as indicated by the high weed presence and relatively low diversity of shrub and canopy species.

3.2.3.6.4 Potential Habitat

Foraging resources are largely limited to the flowering of *Acacia* and weed species as the Eucalypts mature to flowering stage. The area may only provide foraging habitat and cover for movement for larger animals and usage of the area may be sporadic. Exotic grass species dominate the ground cover; however, some native ground covers were observed. Small mammals and reptiles may utilise the site for foraging and refuge. The site was accessible by macropods that may utilise the grassy areas to rest and forage. No logs, hollows, termite mounds or areas of rock were present within the survey area.

3.2.3.6.5 Overall Value

Habitat resources were considered to be low, owing to a lack in vegetation structure and native species richness. As the site was regenerating, improvement in habitat condition is a possibility over time, particularly with the continued growth of juvenile eucalypt species.

3.2.4 Analogue Site 1

Analogue Site 1 illustrates greater diversity in vegetation structure and species in comparison to the other rehabilitation areas within the monitoring area. It is situated on the western side of the monitoring area boundary in close proximity to Miller Road. **Plate 6** displays vegetation at Analogue Site 1.

Plate 6 Analogue Site 1 Vegetation

3.2.4.1 Flora Quadrat

A total of 27 flora species were recorded in 2020 including 13 native and 14 exotic species. This is a slight increase on 25 species in 2019 and 2018, 27 in 2017, 22 in 2016 and 19 in 2015. Vegetation within Analogue Site 1 appears to be approaching MU 30 Coastal Plains Smooth-barked Apple Woodland (NPWS 2000), which is consistent with the most dominant community in the Newstan Colliery Consolidated Consent Boundary (as shown on **Figure 1**). No threatened flora species listed under the BC Act or EPBC Act were identified within the quadrat. Five species are considered high threat weeds in NSW, namely *Andropogon virginicus* (Whisky Grass), *Bidens pilosa* (Cobbler's Pegs), *Chloris gayana* (Rhodes Grass), *Lantana camara*, and *Senecio madagascariensis* (Fireweed). In addition, *Lantana camara* and *Senecio madagascariensis* are listed as WoNS.

3.2.4.2 Diurnal Bird Surveys

The 2020 surveys at Analogue site 1 recorded 13 species in 2020, compared to 17 bird species in 2019, 10 in 2018, 18 in 2017, none in 2016 and 10 in 2015. Most species were locally common, including the Scarlet Honeyeater (Myzomela sanguinolenta) Rainbow Lorikeet (Trichoglossus haematodus) and Yellow-faced Honeyeater (*Lichenostomus chrysops*), in addition to less common species such as Red-browed finch (*Neochmia temporalis*) and Fan-tailed Cuckoo (*Cacomantis flabelliformis*). No threatened species listed under the BC Act or EPBC Act were recorded at this site during surveys. A list of all recorded bird species is provided in **Appendix A**.

3.2.4.3 Microbat Monitoring

The Anabat results for Analogue site 1 are provided in **Appendix B,** obtained from Anabat 1 from 09/09/20 and 10/09/20. Two microbat species were confidently identified at this site, including:

- Horseshoe Bat (*Rhinolophus megaphyllus*); and
- Little Bentwing-bat (*Miniopterus australis*).

Of these species, the Little Bentwing-bat is listed as Vulnerable under the BC Act.

3.2.4.4 Invertebrate Surveys

A total of 17 invertebrate morphospecies among 103 individuals were detected at Analogue Site 1, compared with 34 morphospecies in 2019, 51 in 2018, 32 in 2017, 26 in 2016 and 18 at the same site in 2015. A list of all morphospecies per site is outlined in **Appendix C**.

3.2.4.5 Nest Box Monitoring

Next boxes 1 and 2 were located within the broader Analogue Site 1, and a survey recorded an unidentified glider occupying box number 2, and no obvious sign of use of box number 1, which was designed for microbat use. A photograph of the glider with dome of eucalypt leaves and fur visible is shown in Plate 4. Identification to species level would require manual survey.

Plate 7 Glider utilising nest box 2

3.2.4.6 Habitat Assessment

3.2.4.6.1 Physical Features

Analogue Site 1 occurred on a mid-slope south-westerly aspect. The site was characterised as open forest (30-70% foliage cover), with canopy species starting to mature.

3.2.4.6.2 Plant Diversity

The vegetation within the site comprised a dry, open forest dominated by *Eucalyptus siderophloia* (Northern Grey Ironbark) and *Corymbia maculata* (Spotted Gum). The canopy largely consisted of maturing eucalypt trees (100–200 mm DBH) and saplings, with mature trees occurring sporadically across the site. The shrub layer was sparse, with exotic species including *Solanum nigrum* (Blackberry nightshade) and *Verbena bonariensis* (Purpletop) in addition to native species such *Acacia longifolia*. The ground cover was heavily dominated by exotic grasses and weeds, particularly *Chloris gayana* (Rhodes Grass).

3.2.4.6.3 Level of Disturbance

Given that the site is an existing rehabilitation area, signs of historical disturbance are apparent through the dense and diverse weed presence and lack of habitat resources. A track runs parallel to the site that encourages the continued spread of weeds, and easy access by exotic fauna species.

3.2.4.6.4 Potential Habitat

No tree hollows were observed within Analogue Site 1. Fallen logs were present within the site which will provide habitat value over time. The development of additional habitat values such as loose tree bark or termite mounds were not noted. Similar to the rehabilitation sites, the exotic species will provide foraging habitat for a range of species. Some of the eucalypt species were at flowering maturity and represent more diverse foraging sources for local fauna such as avifauna and invertebrates.

3.2.4.6.5 Overall Value

The patch was considered to be 'low' in regard to its health as the vegetation lacks diversity within canopy layer species and displays low structural diversity within all strata. However, this is expected to improve over time as vegetation structure becomes more complex.

3.2.5 Analogue Site 2

Analogue Site 2 is located outside the Newstan Colliery Consolidated Consent Boundary to the north eastern corner. It is largely a regenerating area aimed at representing MU 30; however, due to its' regenerating nature, it consists primarily of juvenile eucalypts and a layer of native and exotic herbs and grasses. **Plate 8** displays vegetation at Analogue Site 2.

Plate 8 Analogue Site 2 Vegetation

3.2.5.1 Flora Quadrat

A total of 30 flora species were recorded in 2020, including 14 native and 16 exotic species. This site is stable, with 30 species recorded in 2019, 29 in 2018, and 30 in both 2017 and 2016. Vegetation within the site does not correspond to any MU within LHCCREMS vegetation mapping (NPWS 2000), as the species selected for rehabilitation were primarily chosen for quick establishment. No threatened flora species listed under the BC Act or EPBC Act were identified within the quadrat. Eight species are considered high threat weeds in NSW, namely *Bidens pilosa* (Cobbler's Pegs), *Briza subaristata* (Chilean Quaking Grass), *Lantana camara* (Lantana), and *Senecio madagascariensis*(Fireweed). In addition, *Lantana camara* and *Senecio madagascariensis* are listed as WoNS.

3.2.5.2 Diurnal Bird Surveys

The 2020 surveys at analogue Site 2 recorded 15 bird species, compared to 20 bird species in 2019, 13 species in 2018, six in 2017, 16 in 2016 and 14 in 2015. Most recorded species are locally common species including the Yellow-faced honeyeater (*Lichenostomus chrysops*) and Black-faced Cuckoo-shrike (*Coracina novaehollandiae).* The Willie Wagtail (*Rhipidura leucophrys*), Red Junglefowl (*Gallus gallus*) and Magpie-lark (*Grallina cyanoleuca*) were unique to the site during this survey. No threatened species listed under the BC Act or EPBC Act were recorded at this site during surveys. A list of all recorded bird species is provided in **Appendix A**.

3.2.5.3 Microbat Monitoring

The Anabat results for Analogue Site 2 are provided in **Appendix B**, obtained from Anabat 9 on 09/09/20 and 10/09/20. Anabat surveys confidently identified two species, including:

- Ride's Freetail Bat (*Ozimops ridei*); and
- Horseshoe Bat (*Rhinolophus megaphyllus*).

Little Bentwing-bat (*Miniopterus australis*) and Gould's Wattled Bat (*Chalinolobus gouldii*) were also recorded as probable calls at this site. The Little Bentwing Bat is listed as Vulnerable under the BC Act.

3.2.5.4 Invertebrate Surveys

A total of 20 invertebrate morphospecies among 45 individuals were detected at Analogue Site 2, compared with 36 morphospecies in 2019, 54 in 2018, 32 in 2017, 42 in 2016 and 25 in 2015. A list of all morphospecies per site is outlined in **Appendix C**.

3.2.5.5 Habitat Assessment

3.2.5.5.1 Physical Features

Analogue Site 2 is a north-west facing upper slope. The site was characterised as regenerating shrubland with canopy species starting to emerge.

3.2.5.5.2 Plant Diversity

The site was determined to be relatively young in its development, with the canopy predominantly comprised young *Corymbia maculata* beginning to establish a larger and more long-term canopy area. The shrub layer consisted of a mixture of *Melaleuca armillaris* and *Babingtonia sp.* The grassy ground cover was predominantly exotic but included small areas of native grass, ferns and herbs.

3.2.5.5.3 Level of Disturbance

Given that the site is an existing rehabilitation area, signs of historical disturbance are apparent through the dense weed presence and lack of habitat resources. The site had high weed dispersal and no sign of erosion or dumping.

3.2.5.5.4 Potential Habitat

The site is limited in its non-foraging resource availability. No mature trees were observed, and no hollows were present. Exotic grass species dominate the ground cover; however, some native ground covers were observed. Small mammals and reptiles may utilise the site for foraging. The site was accessible by macropods that would utilise the grassy areas to rest and forage. No logs, hollows, termite mounds or areas of rock were present within this site.

3.2.5.5.5 Overall Value

The patch was considered to be 'low' condition owing to a lack in vegetation structure within all strata. However, this is expected to improve over time as the habitat matures.

3.3 Reference Sites

3.3.1 Bat Alley

Bat Alley is a disused mine shaft to the north east of Newstan Colliery that hosts known populations of threatened bat species. The area has been preserved for conservation purposes and has been afforded a 50 m buffer for protection and site preservation. Of the survey methodologies conducted under this program, only microbat species monitoring was conducted at this site. As per recommendations from 2019, the survey was extended at Bat Alley to four nights instead of 2 in 2020, to meet the guidelines for *Chalinolobus dwyeri.*

3.3.1.1 Microbat Monitoring

The Anabat results for Bat Alley are provided in **Appendix B**, obtained from Anabat 8 from 07/09/20 to 10/09/20. Anabat surveys confidently identified two species, including:

- Large-eared Pied Bat (*Chalinolobus dwyeri*);
- Little Bentwing-bat (*Miniopterus australis*); and
- Horseshoe Bat (*Rhinolophus megaphyllus*).

Ride's Freetail Bat (*Ozimops ridei*) was also recorded as a probable call at this site. Of these species, the Little Bentwing Bat and Large-eared Pied Bat are listed as Vulnerable under the BC Act. Large-eared Pied Bat is also listed as vulnerable under the EPBC Act.

3.3.2 EEC

The EEC site is located to the southeast of the mining area and contains riparian vegetation surrounding a permanently inundated area and creek. The broader area is dissected by multiple tracks and an electrical easement. **Plate 9** displays vegetation within the EEC site.

Plate 9 Looking south into the EEC Site

3.3.2.1 Flora Quadrat

A total of 42 flora species were recorded in 2020, including 40 native and two exotic species. 49 flora species were identified in 2019, compared to 48 species in 2018, 38 species in 2017, 29 in 2016 and 30 in 2015. Based on the floristic structure and diversity of vegetation within the EEC site, the vegetation community was delineated as MU 43 Wyong Paperbark Swamp Forest under LHCCREMS (NPWS 2000) which corresponds to the BC Act listed EEC Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions. One species is considered a high threat weed in NSW, namely *Lantana camara*. In addition, this species is also listed as a WoNS.

3.3.2.2 Diurnal Bird Surveys

During the 2020 surveys a total of 14 bird species were recorded, compared to 15 species in 2019, 14 in 2018, 10 in 2017, 21 in 2016 and 19 in 2015. Most recorded species were limited to locally common bird species including the Yellow-faced Honeyeater (*Lichenostomus chrysops*) and Black-faced Cuckoo-shrike (*Coracina novaehollandiae*). The Pacific Black Duck (*Anas superciliosa*) and Weebill (*Smicrornis brevirostris*) were unique to the site during this survey. No threatened species listed under the BC Act or EPBC Act were recorded during surveys. A list of all recorded bird species is provided in **Appendix A**.

3.3.2.3 Microbat Monitoring

The Anabat results for the EEC site are provided in **Appendix B**, obtained from Anabat 10 from 07/09/20 and 08/09/20. Anabat surveys confidently identified two species, including:

- Little Bentwing-bat (*Miniopterus australis*); and
- White-striped Freetail Bat (*Austronomous australis*).

Of these species, the Little Bentwing Bat is listed as Vulnerable under the BC Act.

3.3.2.4 Infrared Camera Surveys

Five species were identified at this site, including Pacific Black Duck (*Anas superciliosa*), White-cheeked Honeyeater (*Phylidonyris niger*), Common Ringtail possum (*Pseudocheirus peregrinus*), Swamp Rat (*Rattus lutreolus*) and Bush Rat (*Rattus fuscipes*). **Plate 10** shows a photograph of the Ringtail Possum.

Plate 10 Common Ringtail Possum (*Pseudocheirus peregrinus*) at the EEC site

3.3.2.5 Habitat Assessment

3.3.2.5.1 Physical Features

The EEC site occurred within drainage area to a creek line. The site was characterised as open forest (approx. 50% foliage cover).

3.3.2.5.2 Plant Diversity

The vegetation within the site comprised a wet, open forest dominated by various eucalypt species and *Melaleuca linariifolia* (Flax-leaved Paperbark) and *Melaleuca styphelioides* (Prickly-leaved Paperbark). The canopy consisted of middle-aged trees (200-400 mm DBH) and saplings, with few mature trees occurring across the site. The shrub layer was dominated by *Dodonaea triquetra* (Hop-bush) while the ground cover was dominated by *Imperata cylindrica* (Blady Grass) with other grasses interspersed with ferns and sedges. Leaf litter was dense in parts with moderate amount accumulating at the base of canopy trees.

3.3.2.5.3 Level of Disturbance

The vegetation observed within this site exhibited signs of recovery from fire. This was evident by the presence of a rejuvenating understory and fire scars on trees. Healthy regeneration was observed, with increases in exotic species now stabilising, with two species compared to five in 2019, eight in 2018 and one in 2017.

Excluding fire damage, the level of disturbance to the site was considered to be low. Two access tracks and an easement dissect the surrounding vegetation, which makes the site more accessible to exotic fauna species and weed encroachment.

3.3.2.5.4 Potential Habitat

A variety of canopy trees including *Melaleuca*, *Angophora* and *Corymbia* species offer flowers, nectar and pollen at different times of year for bird and arboreal mammal species, including migratory species. Only one small hollow was identified within the site, however, logs of differing sizes were prevalent offering denning habitat for small mammals and reptiles. No termite mounds were observed.

3.3.2.5.5 Overall Value

The site was considered to be in good condition, as it demonstrates diversity in vegetation structure and species with low levels of weeds or anthropogenic disturbance.

3.3.3 Dominant Community

This site is situated outside the monitoring area to the south west, in relatively undisturbed vegetation. Vegetation within the site represents the most dominant vegetation community within the Newstan Colliery Consolidated Consent Boundary, which is MU 30 Coastal Plains Smooth-barked Apple Woodland**. Plate 11** depicts the vegetation within this site.

Plate 11 Dominant Community site with MU 30 vegetation

3.3.3.1 Flora Quadrat

In 2020 a total of 32 flora species were recorded, all of which were native flora species. Compared to a total of 38 in 2019, and 27 flora species in 2018. *Tetratheca juncea* (Black-eyed Susan) was recorded in and adjacent to the quadrat. *Tetratheca juncea* is listed as Vulnerable under both the BC Act and EPBC Act. Based on the floristics determined by the flora quadrat, the vegetation on site was considered to be MU 30 Coastal Plains Smooth-barked Apple Woodland, which is not commensurate with any BC Act or EPBC Act.

3.3.3.2 Diurnal Bird Survey

During the 2020 surveys a total of 12 species were recorded, compared to 10 species in 2019, 13 in 2018, five in 2017, 10 in 2016 and 11 in 2015. Most recorded species were limited to locally common bird species including the Yellow-faced Honeyeater (*Lichenostomus chrysops*), Scarlet Honeyeater (*Myzomela sanguinolenta*) and Grey Fantail (*Rhipidura albiscapa*). The Yellow Thornbill (*Acanthiza nana)* was unique to this site during this survey. No species listed under the BC Act or the EPBC Act were recorded during surveys. A list of all recorded bird species is provided in **Appendix A**.

3.3.3.3 Microbat Monitoring

The Anabat results for the Dominant Community site are provided in **Appendix B**, obtained from Anabat 9 from 07/09/20 and 08/09/20. Anabat surveys confidently identified three species, including:

- Large-eared Pied Bat (*Chalinolobus dwyeri*);
- Little Bentwing-bat (*Miniopterus australis*); and
- Horseshoe Bat (*Rhinolophus megaphyllus*).

Gould's Wattled Bat (*Chalinolobus gouldii*) and Ride's Freetail Bat (*Ozimops ridei*) were also recorded as a probable call at this site. Of the above listed species, the Little Bentwing Bat and Large-eared Pied Bat are listed as Vulnerable under the BC Act. Large-eared Pied Bat is also listed as Vulnerable under the EPBC Act.

3.3.3.4 Infrared Camera Surveys

Infrared cameras detected Bush Rat (*Rattus fuscipes*) at this site, as shown in **Plate 12.**

Plate 12 Bush Rat (*Rattus fuscipes*) at Dominant Community site

3.3.3.5 Invertebrate Surveys

A total of 29 morphospecies among 84 individuals of invertebrates were recorded at the Dominant Community Site, compared with 27 morphospecies in 2019, 36 in 2018, 17 in 2017, 26 in 2016 and 14 at the same site in 2015. A list of all morphospecies per site is outlined in **Appendix C**.

3.3.3.6 Habitat Assessment

3.3.3.6.1 Physical Features

The Dominant Community site occurred on an upper ridge with a south-westerly aspect. The site was characterised as open forest (30-70% foliage cover) and is located approximately 150 m south of the reject emplacement area for Newstan Colliery.

3.3.3.6.2 Plant Diversity

The vegetation within the site comprised a dry, open forest dominated by *Angophora costata* (Smooth-barked Apple) and *Corymbia gummifera* (Red Bloodwood). The highly diverse shrub layer and ground cover exhibits moderate structural diversity.

3.3.3.6.3 Level of Disturbance

The level of disturbance within the site was considered to be low. No exotic flora species were detected within the quadrat, no erosion was observed, and only minor evidence of fire was observed.

3.3.3.6.4 Potential Habitat

Angophora costata trees are known for producing hollows, and the vegetation type at this site is dominated by this species. Various sized hollows were observed within the site and based on the vegetation type, many hollows are expected to exist within the surrounding area.

This vegetation community is also known habitat for the threatened *Tetratheca juncea* (Black-eyed Susan). One individual was detected within the plot during surveys, and also immediately adjacent to the surveyed area.

3.3.3.6.5 Overall Value

The site was considered to be in good condition as it demonstrates high vegetation structure and species diversity in combination with low levels of weeds and disturbance.

3.3.4 By-Wash

The By-Wash site is situated near the edge of the most northern dam within Newstan Colliery. The large volume of shrubs and canopy cover likely provide a large amount of structural complexity which can favour smaller birds and mammals by providing more refuge and protection.

3.3.4.1 Diurnal Bird Survey

A total of 15 bird species were recorded at the By-was site during the 2020 surveys, compared to 14 species in 2019, 14 in 2018, 15 in 2017 and 13 in 2015. Recorded species were limited to locally common bird species including the Yellow-faced Honeyeater (*Lichenostomus chrysops*), Scarlet Honeyeater (*Myzomela sanguinolenta*), and Black-faced Cuckoo-shrike (*Coracina novaehollandiae*). No threatened species listed under the BC Act or EPBC Act was recorded at this site during surveys. A list of all recorded bird species is provided in **Appendix A.**

3.3.4.2 Infrared Camera Surveys

Five species were detected using this method, including unidentified Antechinus (*Antechinus sp.),* Bush Rat (*Rattus fuscipes*), Black Rat (*Rattus rattus*), Sugar Glider (*Petaurus breviceps*) and White-browed Scrubwren (*Sericornis frontalis*). The Black Rat is an exotic invasive species. **Plate 13** shows a photograph of the Sugar Glider.

Plate 13 Sugar Glider (*Petaurus breviceps*) at By-wash site

3.3.5 WMP03

WMP03 is situated in close proximity to a dam weir at the north-eastern portion of the monitoring area. Two tracks were adjacent to the site, however the vegetation within the site was in relatively good condition.

3.3.5.1 Diurnal Bird Surveys

A total of 13 species were recorded at WMP03 in 2020. Compared to 23 species in 2019, 10 in 2018, 16 during 2017, nine in 2016 and nine in 2015. Many recorded species were locally common, including the Scarlet Honeyeater (*Myzomela sanguinolenta*) Rainbow Lorikeet (*Trichoglossus haematodus*) and Yellow-faced Honeyeater (*Lichenostomus chrysops*), however the Pied Currawong (*Strepera graculina*) was a unique species observation for this survey. No threatened species listed under the BC Act or EPBC Act was recorded at this site during surveys. A list of all recorded bird species is provided in **Appendix A**.

3.3.5.2 Infrared Camera Surveys

Two species were detected using this method, namely the Red Fox (*Vulpes vulpes*) and Swamp Wallaby (*Wallabia bicolour*). The Red fox is an exotic invasive species. **Plate 14** shows a photograph of the Swamp Wallaby.

Plate 14 Swamp Wallaby (*Wallabia bicolour*) at WMP03

3.3.6 SP004

SP004 is situated adjacent to a riparian zone which contains a permanent creek, to the far east of Newstan Colliery. Vegetation within the site contains a variety of ground cover, shrub and canopy species offering resources for a wide range of local bird species.

3.3.6.1 Infrared Camera Survey

Four species were detected using this method, namely the Red Fox (*Vulpes vulpes*), Bush Rat (*Rattus fuscipes),* Eastern Whipbird (*Psophodes olivaceus*) and unidentified skink (*Eulamprus sp*.). The Red fox is an exotic invasive species. **Plate 15** shows a photograph of the Eastern Whipbird.

Plate 15 Eastern Whipbird (*Psophodes olivaceus*) at SP004

3.3.6.2 Diurnal Bird Surveys

A total of 10 bird species were recorded at SP004 in 2020, compared to 25 species in 2019 surveys, 13 in 2018, 19 in 2017, 20 in 2016 and 17 in 2015. Many recorded species were locally common including the Scarlet Honeyeater (*Myzomela sanguinolenta*) Rainbow Lorikeet (*Trichoglossus haematodus*) and Yellow-faced Honeyeater (*Lichenostomus chrysops*). No threatened species listed under the BC Act or EPBC Act were recorded at this site during surveys. A list of all recorded bird species is provided in **Appendix A**.

3.3.7 Northern Fauna Monitoring Point (REA1)

Northern Fauna Monitoring Point (NFMP) is located within a relatively undisturbed area of MU30, situated in the north-western corner of the monitoring area.

3.3.7.1 Microbat Monitoring

The Anabat results for NFMP/REA01 are provided in **Appendix B,** obtained from Anabat 6 from 07/09/20 to 10/09/20. Anabat surveys confidently identified four species, including:

- White-striped Free-tailed Bat (*Austronomus australis*);
- Chocolate Wattled Bat (*Chalinolobus morio*);
- Little Bentwing-bat (*Miniopterus australis*); and
- Eastern Horseshoe Bat (*Rhinolophus megaphyllus*).

Of these species, the Little Bentwing-bat is listed as Vulnerable under the BC Act.

3.3.7.2 Infrared Camera Surveys

One fauna species was identified on remote cameras at this site in the 2020 survey, namely Brushtail Possum (*Trichosurus vulpecula*) as shown in **Plate 16**.

Plate 16 Brushtail Possum (*Trichosurus vulpecula*) at REA01

3.3.8 Southern Fauna Monitoring Point (REA02)

Southern Fauna Monitoring Point (SFMP) was situated to the north of the Newstan Reject Emplacement Area, to the south of Miller Road. The area was adjacent to a track and showed signs of disturbance.

3.3.8.1 Microbat Monitoring

An Anabat express unit was deployed for four nights, however there were no bat calls recorded for the REA02 site in 2020, possibly due to a malfunction within the unit (Anabat 7).

3.3.8.2 Infrared Camera Surveys

No fauna species were identified on remote cameras at this site in the 2020 survey. A hand-pass test confirmed this unit was functioning adequately.

3.3.9 Opportunistic sightings

During the survey period, fauna species were observed while moving between survey sites. Ten species were observed opportunistically that were not identified within survey sites, specifically one flora species, two amphibians, four bird species, two reptile species, and two mammals, including:

- *Corybas dowlingii* (Red Helmet Orchid);
- Common Eastern Froglet (*Crinia signifera*);
- Eastern Dwarf Tree Frog (*Litoria fallax*);
- Eastern Snake-necked Turtle (*Chelodina longicollis*);
- Eastern Blue-tongue (*Tiliqua skincoides*);
- Black Swan (*Cygnus atratus*);
- White-bellied Sea-Eagle (*Haliaeetus leucogaster*);
- Nankeen Kestrel (*Falco cenchroides*);
- Shining Bronze-Cuckoo (*Chalcites lucidus*);

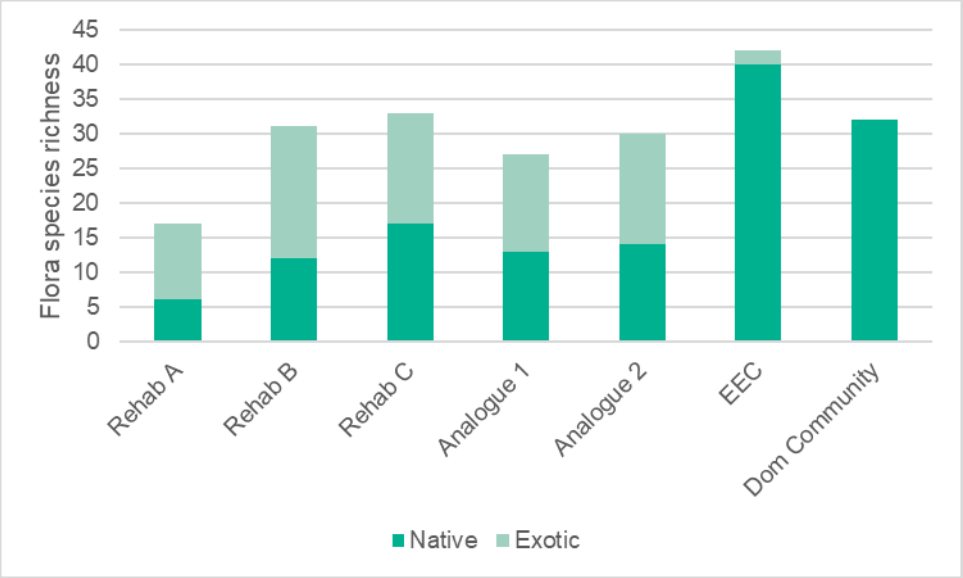
- Short-beaked Echidna (*Tachyglossus aculeatus*); and
- Goat (*Capra hircus**).

Of the above listed species *Corybas dowlingii* (Red Helmet Orchid) is listed as Endangered under the BC Act and the White-bellied Sea-Eagle (*Haliaeetus leucogaster*) is listed as Vulnerable under the BC Act.

4 DISCUSSION AND ASSESSMENT OF REHABILITATION

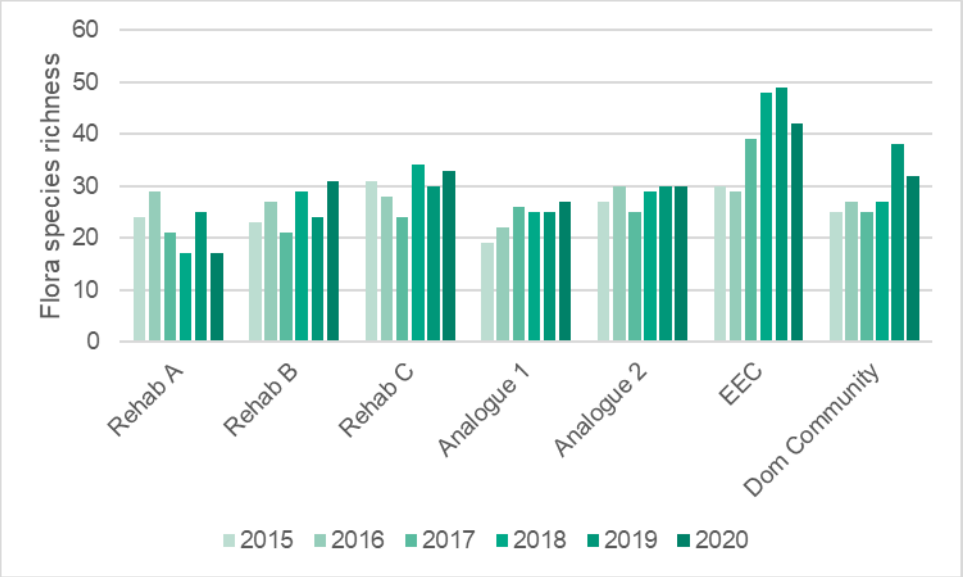
4.1 Flora Species Assemblages

A total of 136 flora species were detected from all flora quadrats. A full list of results can be found in **Appendix D**. **Graph 4** shows a breakdown of native and exotic flora species richness for this survey. As expected, the reference sites showed a higher proportion of native species, with Rehab A and Rehab B containing the highest proportion of exotic species.



Graph 4 2020 native and exotic flora species richness for each site

Most rehabilitation sites showed an increase in total species richness between 2019 and 2020 (**Graph 5**), whereas both reference sites showed a decrease in species richness compared to 2019 monitoring results. This result may be influenced by unfavourable weather potentially causing a decline in native species, allowing invasive species to colonise unoccupied areas.



Graph 5 Between years and sites comparison of species richness for each site (2015 – 2020)

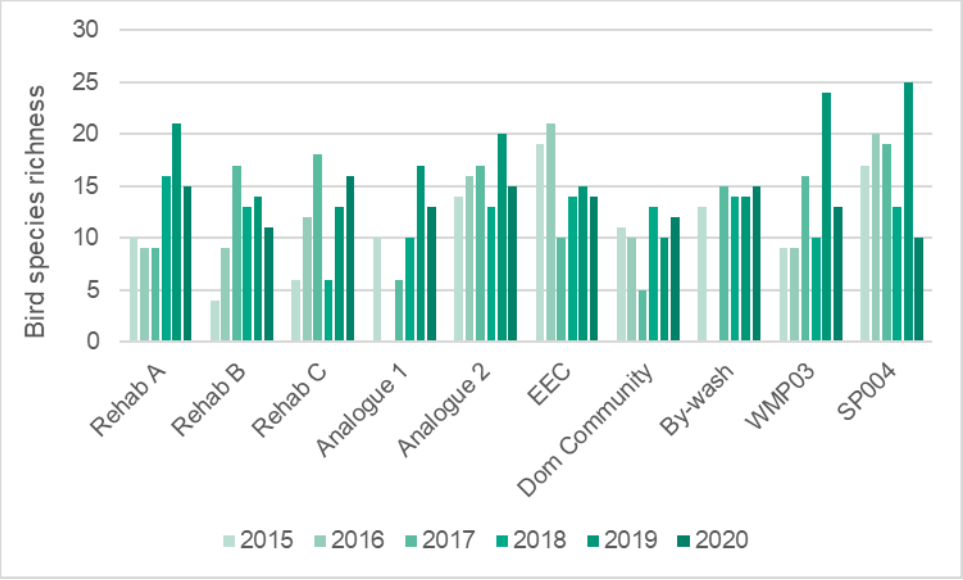
Notable results are provided below:

- The EEC and Dominant Community monitoring locations had a decrease of seven and six species respectively compared to the 2019 survey.
- Rehabilitation Site A decreased by eight plant species compared to 2019, which was a return to the previous low species richness of 2018.
- Rehabilitation Site B increased by seven species from 2019, a difference of two native and five exotic species.
- Analogue Site 1 has shown a steady increase in species richness year on year, however, the native species richness was relatively stable and increases are largely due to exotic species.

Reasons for fluctuation in species richness may include lack of detection due to seasonal influences, herbivory or competitive exclusion by other species in the area. Anecdotally some of the rehabilitation sites have extremely dense ground coverings of exotic grasses. These grasses have little or no cover under more established mature *Eucalyptus* and *Corymbia* species and may be increasing due to the senescence of older *Acacia* individuals opening up the canopy. A targeted weed management strategy with long term goals aligned with the likely time-frame for success in these areas may be the most cost effective way to assist the transition from rehabilitation to reflecting surrounding remnant vegetation but will require input from a suitably qualified and experienced vegetation management contractor. This season there was noted evidence of effective past weed control of *Lantana camara* on some sites, however, regrowth of this species and an increase in *Ricinus communis* (Castor Oil Plant) is of concern. Exotic grasses appear to be retained for the time being, as they may be of benefit in erosion and dust control. As canopy cover increases, it will be of higher benefit to control exotic groundcovers and transition to more native understorey.

4.2 Bird Species Assemblages and Response to Rehabilitation

A total of 45 bird species were detected during the monitoring period for 2020 across all sites, including 33 across rehabilitation sites and 29 across reference sites. Bird species richness across all sites was relatively uniform for rehabilitation and reference sites(**Graph 6**). These results likely reflect the high mobility of bird species, but also displays the utilisation of the rehabilitation sites, likely for foraging.



Graph 6 Between years and sites comparison of bird species richness between all sites (2015 – 2020)

Generally, bird species diversity has decreased in the rehabilitation sites between 2019 and 2020 monitoring, yet remains higher than initial surveys in 2015. Pied Butcherbirds were recorded in three rehabilitation sites and no reference sites, potentially indicating that the open nature of rehabilitated areas is preferred by predators due to a lack of mid storey shrubs to provide cover.

The most common species were the Yellow-faced Honeyeater, Rainbow Lorikeet and Scarlet Honeyeater occurring in ten, eight and eight sites respectively. These results are consistent with 2019 monitoring,

however with a decrease in numbers of Grey fantails from 9 to 6, and an increase in Scarlet Honeyeaters and Rainbow Lorikeets from 6 and 3 respectively. These species were well represented in both rehabilitation and remnant vegetation, are commonly found in forest vegetation types and are expected results as they are regionally common (Pizzey et al., 2012).

Ten species were detected more often than in 2019, and 16 species less often. Eleven species were recorded that were not detected in 2019, and 15 species were not detected in 2020 that had been recorded in 2019. These results should continue to be compared each monitoring period to determine if these results are reflective of a shift in habitat suitability and fauna composition at these sites or an uncharacteristic result.

Many sites displayed a decrease from 2019 species richness levels, which in most cases was a return to 2018 survey results. Previous monitoring has displayed general increases at Rehabilitation sites. These results may be related to the sporadic abundance of foraging resources in the area, large yearly changes in habitat suitability due to changes in stand structure that are less likely to occur in established habitats and/or temporal variation and low methodological repetition. Diversity at the EEC site was still lower than expected when considering 2015 and 2016 results and relatively high habitat quality of the site (RPS 2018). Despite this, there was an increase in cover of a number of key immature flora species that may not yet provide foraging habitat; rather an interim homogenisation of vegetation structure which can be a contraindicator of higher species richness due to increased competition (Staudacher et al., 2018). While reasons for this result remain unclear, it is considered that greater clarity may be obtained through repeat sampling that would otherwise overcome limitations in the interpretation of single sample data (i.e. better appreciation for the variance of species diversity in these sites).

4.3 Microbat Species Assemblages and Response to Rehabilitation

During the 2020 surveys, a total of eight species were confidently identified through definite and probable calls, with a top of six species confidently identified at each of Rehabilitation Site C (**Graph 7)**.

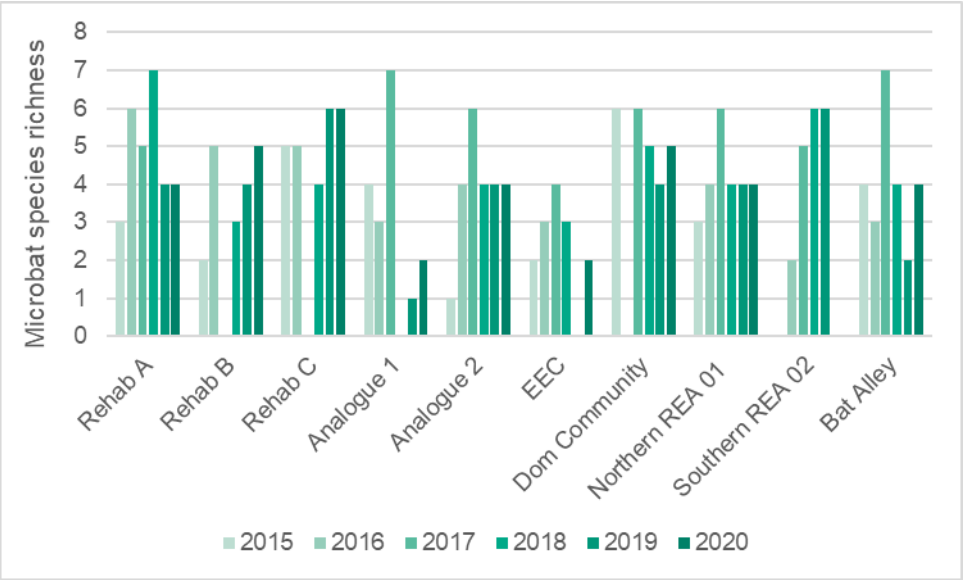
The Little Bentwing Bat (*Miniopterus australis*), listed as Vulnerable under the BC Act, and Large-eared Pied Bat (*Chalinolobus dwyeri*), listed as Vulnerable under the BC Act and EPBC Act were confidently detected during the monitoring period. The Large-eared Pied Bat had not been detected in 2019 or the two years prior, and success during this survey was partly due to an extended survey period of four nights rather than the two proposed at Bat Alley site.

Buffer overflow error messages were recorded by two of the units due to excessive noise, which can lead to data loss. This affected the units located at Southern REA02 and Bat Alley and may have limited the results.

The 2020 microbat monitoring survey showed a varying level of microbat species richness between sites despite the close proximity of these monitoring sites. However, over time, this variation appears to have stabilised at Analogue 2 and NREA01. Aside from the SREA02 site where the Anabat unit recorded no calls, the 2019 results were relatively consistent across the sites.

Notably the Eastern Freetail-bat (*Micronomus norfolkensis*), listed as Vulnerable under the BC Act, was not detected at any sites during this monitoring period, or in the 2019 and 2018 surveys. There is no obvious reason for this lack of detection in the most recent surveys. In addition, the Eastern Bentwing Bat (*Miniopterus orianae oceanensis*), listed as Vulnerable under the BC Act, was not recorded in this survey despite being recorded in 2019.

Results suggest stabilisation of species richness at around four species at each site, however, there is at least one high or low outlier per site, and no clear distinction can be made between rehabilitation and reference sites. These results suggest at the least that the rehabilitation areas are not a barrier to dispersal and may provide valuable foraging resources for the insectivorous bats. The invertebrate sampling results reflect this as presumably prey abundance is relatively uniform across all sites given the high abundances; however, it is also important to note that the sampling technique is biased towards ground dwelling invertebrates which contribute largely to abundances.



Graph 7 Between years and sites comparison of microbat species richness for all sites (2015 – 2020)

Bat Alley, which has been known to host two threatened species, namely the Little Bentwing Bat (*Miniopterus australis*) and Large-eared Pied Bat (*Chalinolobus dwyeri*) (RPS 2014), has shown decreased numbers of Little Bentwing Bat since surveys began, with results from 2019 (n=16) compared to 2018 (n = 15), 2017 (n = 20) and 2015 (n = 56). This survey recorded 28 definite calls, however this was over an extended period of four nights instead of the previous two. Two calls of the Large-eared Pied Bats were recorded during the 2020 surveys, after recording none for the for the previous three years in a row. In 2018 a high number of White-striped Freetail-bat (*Austronomous australis*; n = 270) calls were also detected at Bat Alley, with no calls recorded in 2020 or 2019 at this site. This may suggest changes to the co-habitation assemblage within the shaft, with a large number of Eastern Horseshoe Bat (*Rhinolophus megaphyllus*) calls recorded during this survey (n=489).

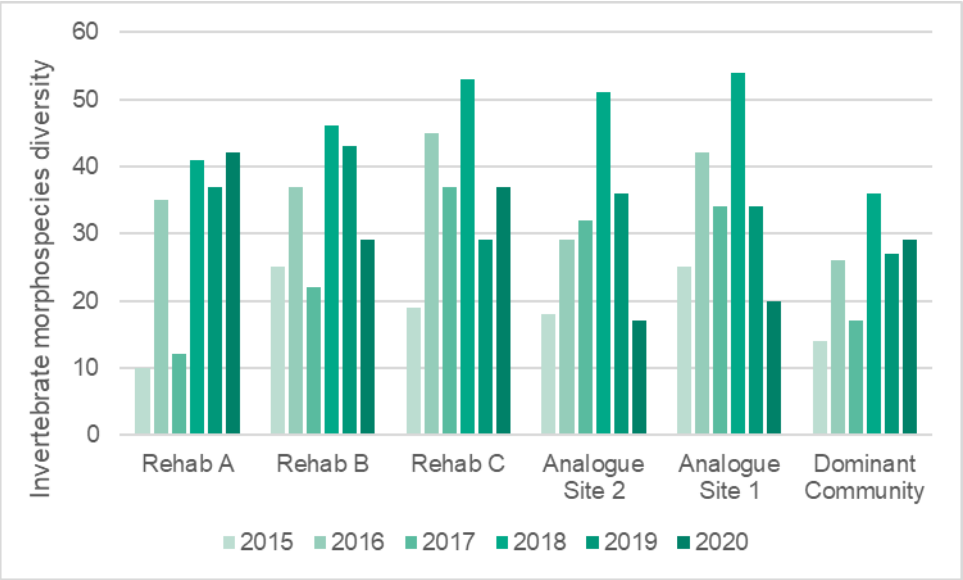
The threatened Little Bentwing Bat (*M. australis*) was detected at nine sites, compared with seven previously. It has been recorded consistently in all reference sites and sporadically through the rehabilitation sites, further supporting the use of rehabilitation sites suitability as foraging habitat. Although the number of calls cannot be divided into number of individuals, this result is nonetheless promising for this threatened species in the local area. This result is potentially related to the close proximity of all sites to Bat Alley (a known roosting site).

The continued presence of the eight species of Microbats is promising, however, the absence of two Vulnerable species may require further investigations. Over time, the results have shown that the microbats are utilising the rehabilitation sites as much as the reference sites. Whilst the provision of roosting habitat is not available in these sites, it is evident that foraging habitat is. The installed nest boxes that were designed to be suitable for microbats showed no obvious signs of use, possibly indicating that sufficient or better suited habitat exists nearby. Future results will help provide information on trends at each of the sites at Newstan Colliery.

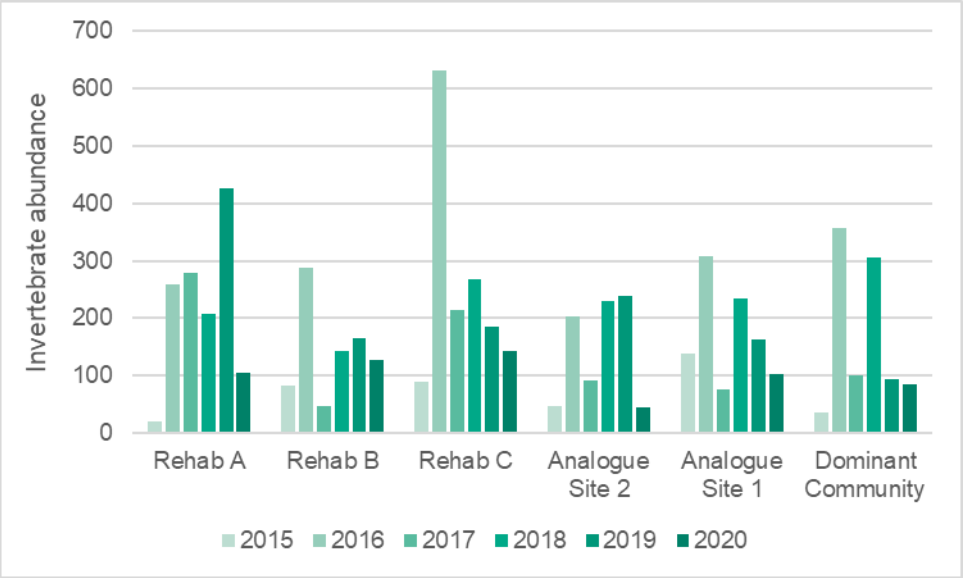
4.4 Invertebrate Species Assemblages and Response to Rehabilitation

Morphospecies diversity was mixed in the 2020 survey, with increases at the Rehab A, Rehab C and Dominant Community sites, and decreases at Rehab B and Analogues Sites 1 and 2. Abundances were relatively uniform and high across all sites, except that the lowest diversity and abundance both occurred within Analogue Site 2. These results may have been impacted slightly by the shorter survey period of 2 nights instead of 4, with traps collected early to avoid heavy rainfall, particularly abundance figures.

Diversity and abundance of morphospecies between sites is compared in **Graph 8** and **Graph 9**. **Appendix C** contains a full invertebrate list for each site. These results are likely due to natural variation, and the sample sizes conducted here do not allow formal statistical analysis.



Graph 8 Comparison of invertebrate morphospecies diversity across all years and sample sites



Graph 9 Comparison of Invertebrate species abundance across all years and sample sites

Lower abundances were recorded for all sites, likely attributable to a shorter survey period. In previous years, high abundances were typically driven by extreme abundances of individual morphospecies (e.g. in 2019 “meat ant” accounted for 239 individuals within the rehabilitation site A), or through a mixture of dipteran and hymenopteran morphospecies occurring in low to mid-level abundances. Generalist ant species can typically be divided into two categories, small ants with high populations that exploit large stochastic resources through rapid worker recruitment and large ants that use size and aggression to exclude competitors. The small ant species may drive up abundances during surveys when a nest is nearby, and large numbers of workers are able to randomly stumble into the traps.

The limited data set does not provide adequate sample size to provide conclusive outcomes; however, climatic variables are likely to have contributed to yearly variation. Continued monitoring will allow for further understanding of differences (if they exist) between rehabilitation and reference sites, however, at this stage the main differences appear to be spatial and unrelated to the rehabilitation status of the sites. Further investigation into individual species identifications may highlight a specialisation or species presence that differentiates sites and can be used in the future as an indicator to streamline monitoring efforts.

In 2019, Rehabilitation Site A was the only site to contain meat ants (probably *Iridiomyrmex purpureus*), and in larger numbers than 2018. These were not recorded at any site in 2020. Ants from the genus Iridiomyrmex are among the most commonly encountered in Australia and can be very bold and aggressively defend territory (Australian Museum, 2010). Presence of meat ants should be paid attention in future monitoring events to see if they re-establish at other sites, as their absence from Rehab A may be a reason for the increase in diversity recorded in this survey.

Soil condition, microclimate and plant biomass can all influence invertebrate species assemblages (Kruess & Tscaharntke, 2002; Bergstrom, 2005) but are beyond the scope of this program.

4.5 Limitations to Habitat Potential

4.5.1 Structural Diversity and Foraging Resources

Limiting factors to habitat potential were common throughout all rehabilitated sites surveyed in 2020 but varied in their intensity. The majority of sites consisted of varying amounts of regrowth, and canopy layer density at sites is being developed, with the eucalypt species at some sites beginning to emerge. The continued emergence of the *Corymbia maculata* at the Rehabilitation sites A, B and C was a positive sign that a more mature canopy was beginning to establish, which can facilitate the regrowth of a more diverse understorey. A more diverse understorey and established overstorey will likely provide a more stable foraging resource for local fauna as currently a large portion of the species are immature or exclusively spring – summer flowering. The establishment of consistent and reliable foraging habitat is crucial for establishing and maintaining woodland bird diversity in small remnant woodland patches (Watson et al., 2001).

Additional management will be required to encourage the development of a diverse native understorey. The proximity of the rehabilitation to remnant native vegetation and the utilisation of the area by native avifauna may further facilitate dispersal of native species and restoration in the rehabilitation areas (Wunderle Jr, 1997). Conversely the exotic plant species may also be distributed into native remnant vegetation by the fauna species they occupy both areas and the dichotomy remains an issue in conservation science where case by case assessments of the cost-benefit ratio of management should be applied (McConkey et al., 2011).

4.5.2 Refuge for Ground Fauna

Although the monitoring sites do not require specific surveys for ground fauna, opportunistic observations are always noted, and cameras are used to capture any fauna occupying the ground stratum. There was a notable difference in ground refuge such as rocks, logs and tree roots for ground dwelling fauna between sites, with the undisturbed sites displaying a higher amount of these resources. The rehabilitated sites (particularly Rehabilitation Sites A, B and C) had ground refuge established as a management action based on recommendations from RPS (2018). Opportunities to establish more ground refuge for small mammals throughout the rehabilitation areas will provide a more connected habitat for ground dwelling fauna, further increasing the suitability of the habitat. Locally sourced hollow logs that can be reasonably transported into the area, yet sufficiently large that predators will be unable to shift them, should be targeted.

4.5.3 Hollow-bearing Trees

A paucity of roosting habitat in the form of tree hollows, combined with a lack of foraging resources within the canopy or shrub layer, substantially limits the potential occurrence of fauna reliant on this habitat feature such as arboreal mammals (particularly gliders). Growth and progress of the rehabilitation sites will eventually provide hollows; however, this is a lengthy process and is not likely to develop in the short to medium term.

4.5.4 Connectivity

The monitoring area is located within a fragmented mosaic of remnant and/or regrowth vegetation interspersed with areas of mine infrastructure, powerline easements and road networks. The sites vary dramatically in their connectivity with surrounding vegetation, from the isolated SFMP to those with links to large surrounding patches of bushland at EEC, Dominant Community and WMP03. Many of these areas are also influenced by fencing (partial barrier for some species), with the removal or modification of this partial

barrier potentially representing an opportunity to improve local connectivity. Given that many of these fences appear to be necessary barriers to vehicles or human activity, modifications to be considered may include replacement of barbed wire to avoid entanglement, removal of wires to form a 50cm gap between rails/strands and the ground, small gateways at ground level, installation of poles between two trees on either side of the fence, or construction of pole bridges as pictured in **Plate 17**. Increased connectivity may also increase movement of feral animals within the site, so control of species such as the foxes and goats sighted in this survey is also recommended.

Plate 17: Fauna fencing 'bridge'

4.5.5 Weed Species

The infestation of weed species continues to be a concern for many sites, with the presence of *Lantana camara, Senecio madagascariensis, Ricinus communis* and various exotic grasses occurring at multiple sites. All rehabilitated sites display a high presence of weed species, particularly in the understorey where exotic grasses dominate and restrict the establishment of native groundcovers. *Chloris gayana* was the main concern at Analogue Site 1, with *Bidens pilosa* and *Lysimachia arvensis* at Analogue Site 2. Rehab A showed the highest percent coverage of weeds, including *Bidens pilosa*, *Megathyrsus maximus* and *Ricinus communis*. Rehab B contains an increased coverage of *Hyparrhenia hirta*. Classic methods for control may be unsuitable for these species in the area as the complete removal may result in very low levels of ground cover, unless followed by direct seeding of native ground covers that occur in commensurate communities (e.g. *Rytidosperma pallidum, Aristida vagans* etc).

5 CONCLUSIONS AND RECOMMENDATIONS

The rehabilitation strategy for Newstan Colliery includes a monitoring program, which has the purpose of evaluating the progress of rehabilitation initiatives linked to the wider management of the Newstan site. This monitoring program included floristics, vertebrate and invertebrate fauna species across multiple reference and rehabilitation sites throughout the project area. This monitoring survey represents the fifth monitoring event since the program's inception in 2015, which is to continue on an annual basis until a nominated end date is prescribed by the Director General.

Bird surveys recorded 45 species for 2020, which is a similar result to previous years. Increases in bird diversity were evident at Rehabilitation C, Dominant Community and By-wash sites, however results were generally lower than in 2019. The lowest record was 10 species at the SP004 site, Dominant Community site, and the highest was 16 species at Rehab C. The White-bellied Sea Eagle was the only threatened bird species detected during 2020 surveys. Over time there has been no substantial change in bird diversity across the monitoring area, but as habitat improves it is likely to change positively.

Of the eight species of microbats confidently detected throughout various sites, two are listed as Vulnerable under the BC Act, and one of these is also listed as Vulnerable under the EPBC Act. Of these threatened species, the Little Bentwing Bat (*Miniopterus australis*) was recorded at nine of the ten sites surveyed for microbats. It was expected that reference sites would display a higher diversity of microbat presence; however, Rehabilitation Site C had the highest number of species compared to the other sites, with no consistent pattern for preference between reference and rehabilitation sites.

Invertebrate communities appear to be fluctuating substantially year to year across all sites. A mixture of ground-dwelling and aerial insects were present within all rehabilitation sites and it does appear that some functional indicator groups are present. The rehabilitation sites are progressing towards achieving the success criteria and the overall objective of returning the areas to resemble an un-disturbed environment. Some ecosystem service function experiments, such as seed removal experiments (myrmecochory), could assist in further assessing the role of the invertebrate communities in vital ecosystem functions (Handel, 1976).

Recommendations for the ongoing management of monitoring sites have been developed to address those factors that limit the habitat potential at each site. Natural regeneration is generally slow and active management practices are encouraged to significantly improve the quality of potential habitat located at each site.

The following recommendations have been made to supplement the natural regeneration of habitat at each monitoring site:

- The current weed control program targeting declared weeds as per the order of priority of significant weed infestations should be continued, as there was evidence of its previous success in the rehabilitation sites in 2019, but does not appear to have been effective in 2020. Rehabilitation Sites A, B, C and Analogue Sites 1 and 2 will continue to be monitored for their weed cover with a mid to long-term management goal aiming to re-establish a native understorey at each site.
- The nest boxes installed in 2019 have been successful in providing habitat for hollow dwelling animals. As the boxes designed for small parrots and gliders are fully utilised, it is recommended to expand this program across all sites, but particularly within Rehab A and Analogue 2, where no boxes were installed.
- Further improvement of connectivity may be achieved through modification of existing fences by removal of wires or construction of fauna bridges.
- Control of feral pest animals such as goats and foxes should be considered, in areas such as WMP03 and SP004 for foxes, and Southern REA 02 in the case of goats.

Continued monitoring of the sites as described within Section 2 of this report will complement the current data sets. Monitoring will also provide valuable information regarding the effectiveness of any management actions implemented as a result of the recommendations provided within this report. Additional monitoring that may be beneficial include the following activities, which may then be included in future monitoring events:

- Pilot seed removal experiments to provide further information on invertebrate ecosystem services, i.e. myrmecochory).
- Manual survey of nest boxes by hand to ascertain species of glider present, whether they are Sugar Gliders (*Petaurus breviceps*) or Squirrel Gliders (*Petaurus norfolcensis)*; which are listed as Vulnerable under the BC Act.

The above survey recommendations come at a relatively low cost and could provide valuable information for future management targets and outcomes.

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Appendix A

Fauna Species List

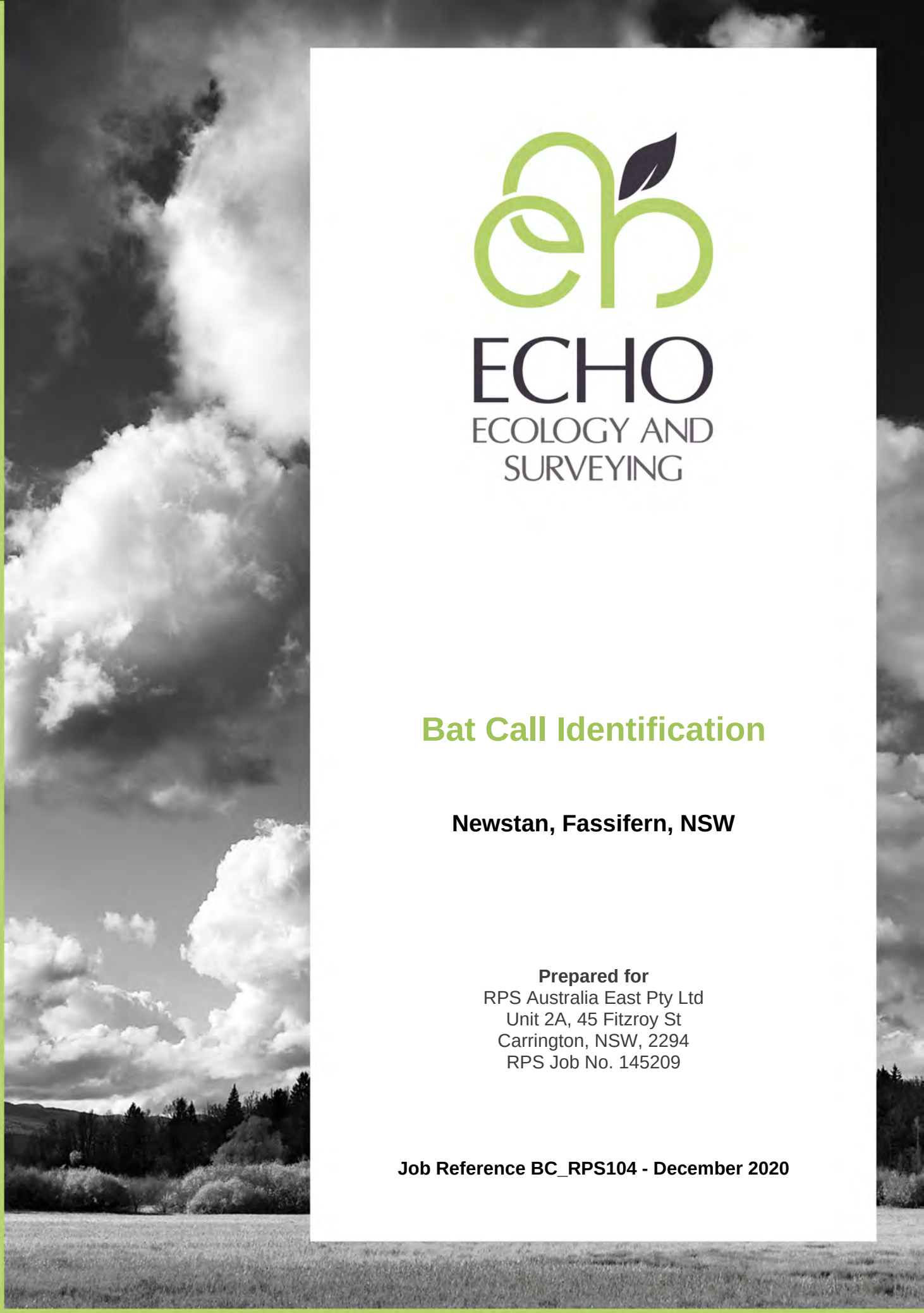
Common Name	Scientific Name	NSW Status	Comm Status	Opportunistic Sighting	Rehab A	Rehab B	Rehab C	Analogue 1	Analogue 2	Dominant Community	EEC	Bywash	WMP03	SP004	NFMP REA1	SFMP REA2	Bat Alley
Common Eastern Froglet	*Crinia signifera*	P		x													
Eastern Dwarf Tree Frog	*Litoria fallax*	P		x													
Eastern Snake-necked Turtle	*Chelodina longicollis*	P		x													
Unidentified Eulamprus	*Eulamprus sp.*	P												x			
Eastern Blue-tongue	*Tiliqua scincoides*	P		x													
Red Junglefowl	*Gallus gallus**								x								
Pacific Black Duck	*Anas superciliosa*	P									x						
Black Swan	*Cygnus atratus*	P		x													
Bar-shouldered Dove	*Geopelia humeralis*	P			x							x	x	x			
Wonga Pigeon	*Leucosarcia picata*	P			x				x								
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	V		x													
Nankeen Kestrel	*Falco cenchroides*	P		x													
Purple Swamphen	*Porphyrio porphyrio*	P				x						x	x				
Masked Lapwing	*Vanellus miles*	P			x												
Sulphur-crested Cockatoo	*Cacatua galerita*	P			x	x	x		x				x				
Little Lorikeet	*Glossopsitta pusilla*	V,P			x												
Eastern Rosella	*Platycercus eximius*	P			x							x					
Rainbow Lorikeet	*Trichoglossus haematodus*	P			x	x	x	x	x		x		x	x			
Fan-tailed Cuckoo	*Cacomantis flabelliformis*	P						x		x							
Shining Bronze-Cuckoo	*Chalcites lucidus*	P		x													
Laughing Kookaburra	*Dacelo novaeguineae*	P			x		x										
White-throated Treecreeper	*Cormobates leucophaea*	P					x	x		x	x	x		x			
Superb Fairy-wren	*Malurus cyaneus*	P			x	x	x	x			x						
Variegated Fairy-wren	*Malurus lamberti*	P										x	x				
Striated Thornbill	*Acanthiza lineata*	P			x		x	x	x	x				x			
Yellow Thornbill	*Acanthiza nana*	P								x							
Brown Thornbill	*Acanthiza pusilla*	P				x											
White-browed Scrubwren	*Sericornis frontalis*	P								x		x					
Weebill	*Smicrornis brevirostris*	P									x						
Spotted Pardalote	*Pardalotus punctatus*	P						x		x			x				
Eastern Spinebill	*Acanthorhynchus tenuirostris*	P			x								x				
Yellow-faced Honeyeater	*Lichenostomus chrysops*	P			x	x	x	x	x	x	x	x	x	x			
Bell Miner	*Manorina melanophrys*	P					x		x		x	x	x	x			
Lewin's Honeyeater	*Meliphaga lewinii*	P					x										

Common Name	Scientific Name	NSW Status	Comm Status	Opportunistic Sighting	Rehab A	Rehab B	Rehab C	Analogue 1	Analogue 2	Dominant Community	EEC	Bywash	WMP03	SP004	NFMP REA1	SFMP REA2	Bat Alley
Scarlet Honeyeater	*Myzomela sanguinolenta*	P				x	x	x		x	x	x	x	x			
White-cheeked Honeyeater	*Phylidonyris niger*	P									x	x					
Eastern Whipbird	*Psophodes olivaceus*	P							x		x			x			
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	P				x	x	x	x	x	x	x					
Grey Shrike-thrush	*Colluricincla harmonica*	P				x	x										
Golden Whistler	*Pachycephala pectoralis*	P			x	x		x		x	x			x			
Pied Butcherbird	*Cracticus nigrogularis*	P			x		x		x								
Australian Magpie	*Cracticus tibicen*	P					x	x	x	x	x						
Pied Currawong	*Strepera graculina*	P											x				
Grey Fantail	*Rhipidura albiscapa*	P			x			x	x	x	x	x					
Willie Wagtail	*Rhipidura leucophrys*	P							x								
Australian Raven	*Corvus coronoides*	P					x		x			x		x			
Magpie-lark	*Grallina cyanoleuca*	P							x								
Australian Reed-Warbler	*Acrocephalus australis*	P										x	x				
Welcome Swallow	*Hirundo neoxena*	P					x					x	x				
Red-browed Finch	*Neochmia temporalis*	P				x		x									
Short-beaked Echidna	*Tachyglossus aculeatus*	P		x													
Unidentified Antechinus	*Antechinus sp.*	P										x					
Sugar Glider	*Petaurus breviceps*	P										x					
unidentified glider	*Petaurus/Petauroides sp.*	P				x		x									
Common Ringtail Possum	*Pseudocheirus peregrinus*	P									x						
Common Brushtail Possum	*Trichosurus vulpecula*	P					x								x		
Swamp Wallaby	*Wallabia bicolor*	P											x				
Eastern Horseshoe-bat	*Rhinolophus megaphyllus*	P			x	x	x	x	x	x					x		x
Ride's Freetail Bat	*Mormopterus ridei*				x		x		x	x							x
White-striped Freetail-bat	*Tadarida australis*	P				x	x				x				x		
Large-eared Pied Bat	*Chalinolobus dwyeri*	V,P	V							x							x
Gould's Wattled Bat	*Chalinolobus gouldii*	P			x	x	x		x	x							
Chocolate Wattled Bat	*Chalinolobus morio*	P													x		
Little Bentwing-bat	*Miniopterus australis*	V,P			x	x	x	x	x	x	x				x		x
Eastern Forest Bat	*Vespadelus pumilus*	P				x	x										
Bush Rat	*Rattus fuscipes*	P								x	x	x		x			
Swamp Rat	*Rattus lutreolus*	P									x						
Black Rat	*Rattus rattus**											x					
Fox	*Vulpes vulpes**												x	x			

Common Name	Scientific Name	NSW Status	Comm Status	Opportunistic Sighting	Rehab A	Rehab B	Rehab C	Analogue 1	Analogue 2	Dominant Community	EEC	Bywash	WMP03	SP004	NFMP REA1	SFMP REA2	Bat Alley
Goat	*Capra hircus**			x													

Appendix B

Anabat Report



ECHO
ECOLOGY AND
SURVEYING

Bat Call Identification

Newstan, Fassifern, NSW

Prepared for
RPS Australia East Pty Ltd
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Carrington, NSW, 2294
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This report has been prepared to document the analysis of digital ultrasonic bat echolocation calls received from a third party. The data was not collected by the author and as such no responsibility is taken for the quality of data collection or for the suitability of its subsequent use.

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Contents

1.0 Introduction 1

2.0 Methods 1

2.1 Call Identification 1

2.2 Log file review 2

2.3 Limitations 2

3.0 Results 3

3.1 Log file review 4

4.0 Sample Calls 7

5.0 References 9

Appendix A Species Identification Confidence and Characteristics – Sydney Basin

Appendix B Log File Review

List of Tables

Table 3-1: Results of bat call analysis (number of passes per site per night) 5

List of Figures

Figure 4-1: *Austronomus australis* definite call 7

Figure 4-2: *Chalinolobus dwyeri* definite call 7

Figure 4-3: *Chalinolobus gouldii* probable call 7

Figure 4-4: *Chalinolobus morio* definite call 8

Figure 4-5: *Miniopterus australis* definite call 8

Figure 4-6: *Ozimops ridei* definite call 8

Figure 4-7: *Rhinolophus megaphyllus* definite call 9

Figure 4-8: *Vespadelus pumilus* definite call 9

1.0 INTRODUCTION

This report has been commissioned by RPS Australia East Pty Ltd to analyse bat echolocation call data collected from Newstan, NSW. Data was provided electronically to the author. This report documents the methods involved in analysing bat call data and the results obtained only.

2.0 METHODS

2.1 Call Identification

The identification of bat echolocation calls recorded during surveys was undertaken using Anabat Insight (Titley Electronics, Version 1.9.6) software. Files from Anabat Express units (.zca) were first converted to .zc and a noise filter was applied (EE_Allbats.als). The identification of calls was undertaken with reference to Pennay et al. (2004) and through the comparison of recorded reference calls from the Sydney Basin. Reference calls were obtained from the NSW database and from the authors personal collection.

A list of potentially occurring echolocating bat species for the region (approximately 50 – 100 km radius) was obtained from the NSW Office of Environment and Heritage's Bionet Atlas, which holds data from a number of custodians (http://www.bionet.nsw.gov.au) and was used to constrain the identification of bat calls.

Each call sequence ('pass') was assigned to one of five categories, according to the confidence with which an identification could be made, being:

- Definite - Pass identified to species level and could not be confused with another species
- Probable - Pass identified to species level and there is a low chance of confusion with another species
- Possible - Pass identified to species level but short duration or poor quality of the pass increases the chance of confusion with another species
- Species group - Pass could not be identified to species level and could belong to one of two or more species. Occurs more frequently when passes are short or of poor quality

- Unknown - Either background ‘noise’ files or passes by bats which are too short and/or of poor quality to confidently identify.

Call sequences that were less than three pulses in length were not analysed and were assigned to ‘Unknown’ and only search phase calls were analysed. Furthermore, some species are difficult to differentiate using bat call analysis due to overlapping call frequencies and similar shape of plotted calls and in these cases calls were assigned to species groups.

The total number of passes (call sequences) per unit per night was tallied to give an index of activity.

Nomenclature follows the Australian Faunal Directory (https://biodiversity.org.au/afd; downloaded 15 June 2020).

The echolocation call characteristics used to differentiate species for the region and the identification potential for each species are described in Appendix A.

2.2 Log file review

We reviewed the log files for each night of recording and have summarised the detector settings, recording duration and any errors. This may be used to confirm survey effort, the use of correct detector settings and may help diagnose missing data.

2.3 Limitations

The identification of bat species from echolocation calls in many Australian regions is not straightforward. Our reference call libraries tend to be relatively small, some species vary their call frequency with region and bat behaviour may also influence call shapes and frequencies. Additional factors may add to the level of uncertainty of species identification from echolocation calls such as short call sequences, high levels of noise and missing echolocation pulses. Some species share overlapping echolocation call characteristics and some overlap so much that we are unable to differentiate between species with our current knowledge.

To assist with the interpretation of our results within this context of uncertainty, we provide a qualitative indication of the confidence of bat call identification by assigning confidence levels (Definite, Probable, Possible and Species Groups). We have also provided a list of the general identification potential for each species potentially occurring within your sample region (Appendix A). For a more complete species inventory, bat call recording should be combined with other survey methods such as trapping.

It should be noted that the activity levels recorded at different sites may not be readily able to be compared. Activity levels should not be compared among species as different species have different detectability due to factors such as call loudness, foraging strategy and call identifying features. Activity comparisons among sites are dependent on many variables which need to be carefully controlled during data collection and statistically analysed. Influential variables include wind, rain, temperature, duration of recording, season, detector and microphone sensitivity, detector placement, weather protection devices etc.

The bat call identification results presented in this report should be interpreted with these limitations in mind and in many cases trapping and habitat assessment should also be undertaken in conjunction with bat call recording.

3.0 RESULTS

Calls were recorded in full spectrum format using Anabat Express bat detectors (Titley Scientific).

A total of 7,342 call sequences were recorded, of which 1,087 call sequences were able to be analysed (ie were not 'noise' files or bat calls of short length). Of the bat calls, 688 call sequences (63 %) were able to be confidently identified (those classified as either definite or probable identifications) to species level (Table 3-1). Species recorded confidently within the site include:

- *Austronomus australis* (White-striped Free-tailed Bat)
- *Chalinolobus dwyeri* (Large-eared Pied Bat)
- *Chalinolobus gouldii* (Gould's Wattled Bat)
- *Chalinolobus morio* (Chocolate Wattled Bat)
- *Miniopterus australis* (Little Bent-winged Bat)
- *Ozimops ridei* (Ride's Free-tailed Bat)
- *Rhinolophus megaphyllus* (Eastern Horseshoe Bat)
- *Vespadelus pumilus* (Eastern Forest Bat)

Additionally, the following bat species potentially occurred within the site, but could not be confidently identified (those calls classified as possible or as a species group):

- *Falsistrellus tasmaniensis* (Eastern Falsistrelle)
- *Micronomus norfolkensis* (Eastern coastal Free-tailed Bat)
- *Miniopterus orianae oceanensis* (Eastern Bent-winged Bat)
- *Myotis macropus* (Large-footed Myotis)
- *Nyctophilus geoffroyi* (Lesser long-eared bat)
- *Nyctophilus gouldi* (Gould's long-eared bat)
- *Scotorepens orion* (Eastern Broad-nosed Bat)

- *Vespadelus darlingtoni* (Large Forest Bat)
- *Vespadelus regulus* (Southern Forest Bat)
- *Vespadelus troughtoni* (Eastern cave bat)
- *Vespadelus vulturnus* (Little Forest Bat)

It should be noted that additional bat species may be present within the site but were not recorded by the detectors (or are difficult to identify by bat call) and habitat assessment should be used in conjunction with these results to determine the likelihood of occurrence of other bat species.

Table 3-1 below summarises the results of the bat call analysis.

3.1 Log file review

The log file review indicated that detectors were set for entire nights and functioning correctly. However, there were some nights with buffer overflow warning messages and some data may have been lost for these nights. Full details are provided in Appendix B.

Table 3-1: Results of bat call analysis (number of passes per site per night)

CONFIDENCE	IDENTIFICATION	Anabat 1 7/09/2020	Anabat 1 8/09/2020	Anabat 1 9/09/2020	Anabat 1 10/09/2020	Anabat 2 7/09/2020	Anabat 2 8/09/2020	Anabat 6 7/09/2020	Anabat 6 8/09/2020	Anabat 6 9/09/2020	Anabat 6 10/09/2020	Anabat 7 8/09/2020	Anabat 7 9/09/2020	Anabat 7 10/09/2020	Anabat 8 7/09/2020	Anabat 8 8/09/2020	Anabat 8 9/09/2020	Anabat 8 10/09/2020	Anabat 9 6/09/2020	Anabat 9 7/09/2020	Anabat 9 8/09/2020	Anabat 9 9/09/2020	Anabat 9 10/09/2020	Anabat 10 7/09/2020	Anabat 10 8/09/2020	Anabat 10 9/09/2020	Anabat 10 10/09/2020
DEFINITE	*Austronomus australis*	-	1	-	-	13	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	3	-	-
	Chalinolobus dwyeri	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	1	2	-	-	-	-	-	-
	Chalinolobus morio	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Miniopterus australis	1	-	-	1	1	6	12	16	1	11	-	-	-	7	14	-	7	-	2	-	-	-	-	1	1	2
	Ozimops ridei	-	-	-	-	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
	Rhinolophus megaphyllus	2	3	-	1	2	2	-	3	-	2	-	-	-	124	139	113	113	-	3	5	1	8	-	-	3	8
	Vespadelus pumilus	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PROBABLE	*Chalinolobus dwyeri*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
	Chalinolobus gouldii	-	1	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	1	2	-	1	-	-	-	1
	Chalinolobus morio	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Miniopterus australis	-	1	-	-	-	-	1	-	-	1	-	-	-	-	1	-	3	-	1	-	-	1	-	-	-	-
	Ozimops ridei	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	-	1	2	-	2	-	-	-	1
	Rhinolophus megaphyllus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
	Vespadelus pumilus	2	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
POSSIBLE	*Chalinolobus dwyeri*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-
	Chalinolobus gouldii	-	-	-	-	5	1	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	1	-	-	-
	Ozimops ridei	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	1	-	-
SPECIES GROUPS	*Chalinolobus gouldii / Micronomus norfolkensis / Ozimops ridei*	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	2	3	-	-	-	-	-	-
	Chalinolobus gouldii / Ozimops ridei	2	2	-	-	2	1	1	-	-	-	-	-	-	-	-	-	-	-	3	3	-	1	-	4	-	2
	Chalinolobus gouldii / Scoteanax rueppellii	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Chalinolobus morio / Vespadelus pumilus / Vespadelus vulturnus / Vespadelus troughtoni	-	-	-	-	-	-	1	9	-	-	-	-	-	2	15	-	1	-	1	2	-	-	2	-	-	-

CONFIDENCE	IDENTIFICATION	Anabat 1 7/09/2020	Anabat 1 8/09/2020	Anabat 1 9/09/2020	Anabat 1 10/09/2020	Anabat 2 7/09/2020	Anabat 2 8/09/2020	Anabat 6 7/09/2020	Anabat 6 8/09/2020	Anabat 6 9/09/2020	Anabat 6 10/09/2020	Anabat 7 8/09/2020	Anabat 7 9/09/2020	Anabat 7 10/09/2020	Anabat 8 7/09/2020	Anabat 8 8/09/2020	Anabat 8 9/09/2020	Anabat 8 10/09/2020	Anabat 9 6/09/2020	Anabat 9 7/09/2020	Anabat 9 8/09/2020	Anabat 9 9/09/2020	Anabat 9 10/09/2020	Anabat 10 7/09/2020	Anabat 10 8/09/2020	Anabat 10 9/09/2020	Anabat 10 10/09/2020
	Falsistrellus tasmaniensis / Scotorepens orion / Scoteanax rueppellii	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
	Micronomus norfolkensis / Ozimops ridei	1	-	-	-	1	1	-	1	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-
	Miniopterus australis / Vespadelus pumilus	5	6	-	4	-	-	4	4	-	6	-	-	-	1	3	-	9	-	-	3	-	-	2	-	-	3
	Miniopterus orianae oceanensis / Vespadelus darlingtoni / Vespadelus regulus	-	-	-	-	3	5	-	4	-	-	-	-	-	27	77	4	5	-	4	4	1	4	-	5	1	22
	Myotis macropus / Nyctophilus geoffroyi / Nyctophilus gouldi	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-
	Vespadelus darlingtoni / Vespadelus regulus	-	-	-	-	-	-	-	1	-	-	-	-	-	2	5	3	4	-	-	-	-	1	-	-	-	-
	Vespadelus pumilus / Vespadelus vulturnus / Vespadelus troughtoni	-	-	-	-	6	9	3	6	-	3	-	-	-	11	15	-	11	-	3	3	-	1	-	-	-	-
UNKNOWN	Unknown	34	24	3	6	12	12	21	19	-	14	-	1	1	6	19	2	15	-	18	20	-	17	14	8	11	30
	'Noise' files	101	57	173	6	85	88	23	38	1	54	5	1593	1020	60	70	1300	245	2	72	110	23	83	252	209	193	85
TOTAL		**149**	**98**	**176**	**18**	**132**	**136**	**67**	**110**	**2**	**91**	**5**	**1594**	**1021**	**240**	**359**	**1422**	**422**	**2**	**117**	**167**	**25**	**120**	**275**	**231**	**209**	**154**

4.0 SAMPLE CALLS

A sample of the calls actually identified from the site for each species is given below.

Figure 4-1: *Austronomus australis* definite call

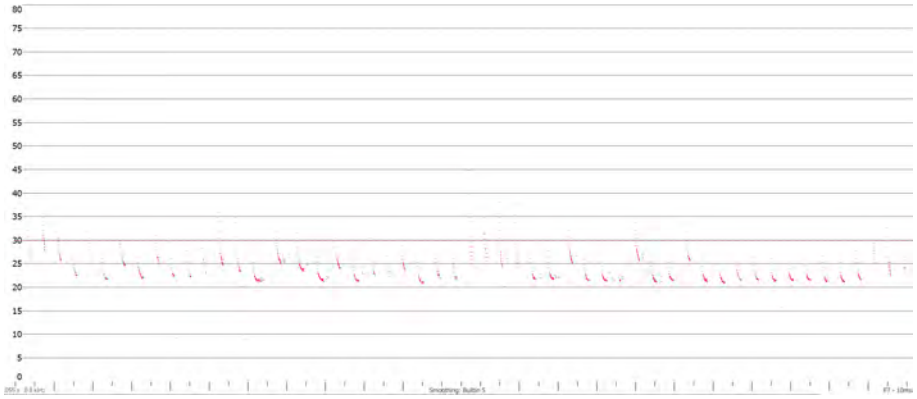

Figure 4-2: *Chalinolobus dwyeri* definite call

Figure 4-3: *Chalinolobus gouldii* probable call

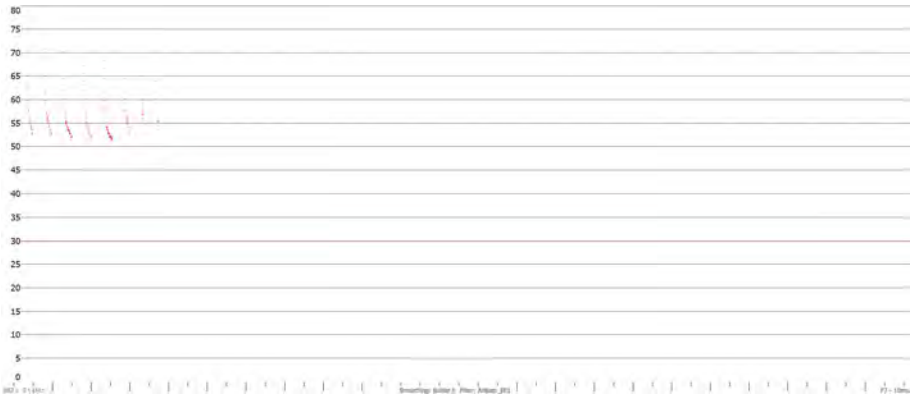

Figure 4-4: *Chalinolobus morio* definite call

Figure 4-5: *Miniopterus australis* definite call

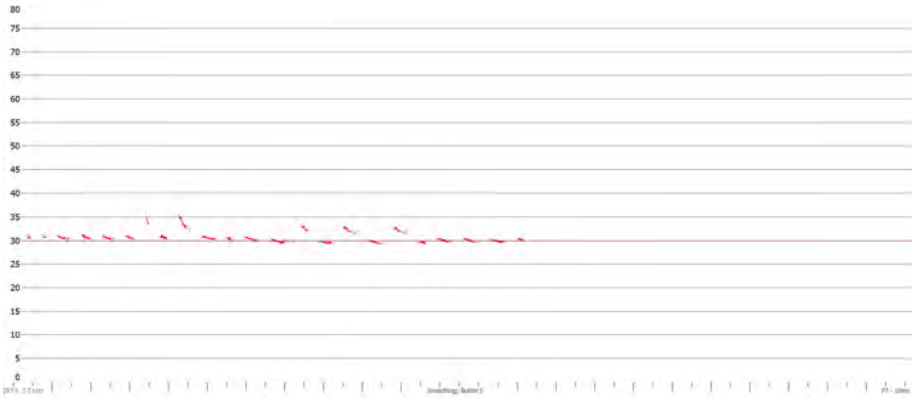

Figure 4-6: *Ozimops ridei* definite call

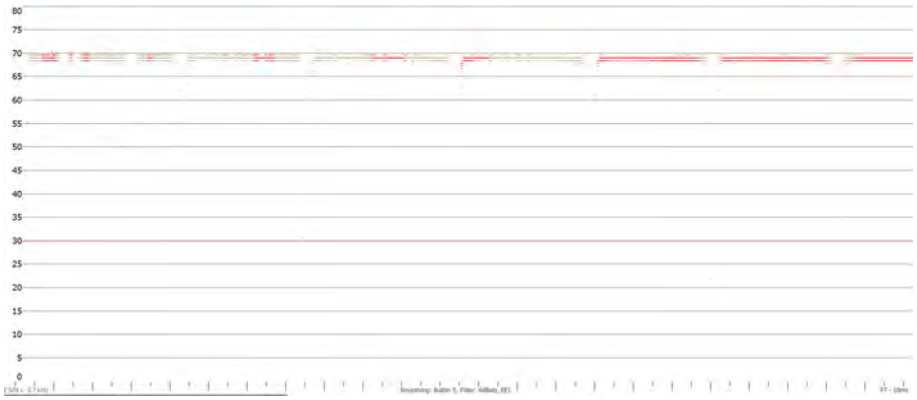

Figure 4-7: *Rhinolophus megaphyllus* definite call

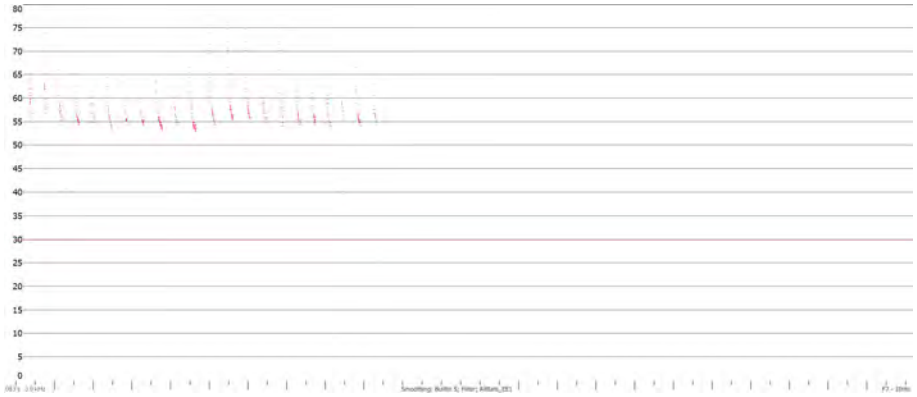

Figure 4-8: *Vespadelus pumilus* definite call

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APPENDIX A SPECIES IDENTIFICATION CONFIDENCE AND CHARACTERISTICS – SYDNEY BASIN

Table A1: Identification confidence and characteristics of bat echolocation calls from the Sydney basin region

Scientific Name	Common Name	Identification Potential	Identification characteristics
Austronomus australis	White-striped Free-tailed Bat	High	Good quality calls unlikely to be confused. However, partial calls may be confused with social calls of other bat species and insects.
Chalinolobus dwyeri	Large-eared Pied Bat	High	Calls may overlap with *Saccolaimus flaviventris*. However, good quality call sequences are unlikely to be confused due to small pulse shape and alternating pulses in *Chalinolobus dwyeri*.
Chalinolobus gouldii	Gould's Wattled Bat	Mod - High	Overlaps with *Micronomus norfolkensis*, *Ozimops ridei* and *Scoteanax rueppellii*. In good quality recordings, differentiated from *Mormopterus* spp. by curved pulses and from *Scoteanax rueppellii* by alternating pulse frequencies.
Chalinolobus morio	Chocolate Wattled Bat	Mod - High	Overlaps with *Vespadelus vulturnus, Vespadelus pumilus, Vespadelus troughtoni* and possibly with *Miniopterus orianae oceanensis* in some areas. Differentiated from *Vespadelus* spp. by the presence of down-sweeping tails on pulses and generally little doppler effect that is typically displayed by *Vespadelus* spp. Not differentiated from *Miniopterus orianae oceanensis* where they overlap in characteristic frequency.
Falsistrellus tasmaniensis	Eastern Falsistrelle	Low	Overlaps in characteristic frequency with *Scotorepens orion* and *Scoteanax rueppellii*. *Falsistrellus tasmaniensis* is most frequently recorded from more elevated locations in the region. However, some records exist from coastal lowlands and so included it in our species groups in coastal areas as a precautionary measure. We do not distinguish *Falsistrellus tasmaniensis* from *Scotorepens orion* where they overlap in frequency due to overlapping call characteristics.

Scientific Name	Common Name	Identification Potential	Identification characteristics
Micronomus norfolkensis	Eastern coastal Free-tailed Bat	Mod	Overlaps in characteristic frequency with *Ozimops ridei*, *Chalinolobus gouldii* and *Scoteanax rueppellii*. Differentiated from *Chalinolobus gouldii* and *Scoteanax rueppellii* by long call sequences with mostly flat pulse shapes. Differentiated from *Ozimops ridei* in long call sequences where pulses alternated, often with a downward sloping tail.
Miniopterus australis	Little Bent-winged Bat	Mod – High	Overlaps in characteristic frequency with *Vespadelus pumilus*. Differentiated from *Vespadelus pumilus* by the presence of down-sweeping tails on pulses, the lack of doppler effect that is typically displayed by *Vespadelus* spp. and/or by characteristic one-phase 'stepped' feeding buzz, if present.
Miniopterus orianae oceanensis	Eastern Bent-winged Bat	Low – Mod	Overlaps in characteristic frequency with *Vespadelus darlingtoni, Vespadelus regulus, Vespadelus vulturnus* and possibly with *Chalinolobus morio*. Differentiated from *Vespadelus* spp. by characteristic one-phase 'stepped' feeding buzz (if present) and generally little doppler effect (that is typically displayed by *Vespadelus* spp.). Not differentiated from *Chalinolobus morio* where they overlap in characteristic frequency.
Myotis macropus	Large-footed Myotis	Low - Mod	Overlaps in call features with *Nyctophilus* spp. Differentiated from *Nyctophilus* spp. in good quality call sequences with pulse intervals < 75 ms, initial slope > 400 OPS and often with a central kink and varying slopes among pulses.
Nyctophilus geoffroyi	Lesser long-eared bat	Low	Overlaps in call features with *Nyctophilus gouldi* and *Myotis macropus*. Differentiated from *Myotis macropus* by pulse intervals > 95 ms and an initial slope of < 300 OPS. However, *Nyctophilus geoffroyi* and *Nyctophilus gouldi* are unable to be differentiated from each other.
Nyctophilus gouldi	Gould's long-eared bat	Low	Overlaps in call features with *Nyctophilus geoffroyi* and *Myotis macropus*. Differentiated from *Myotis macropus* by pulse intervals > 95 ms and an initial slope of < 300 OPS. However, *Nyctophilus geoffroyi* and *Nyctophilus gouldi* are unable to be differentiated from each other.

Scientific Name	Common Name	Identification Potential	Identification characteristics
Ozimops ridei	Ride's Free-tailed Bat	Mod	Overlaps in characteristic frequency with *Micronomus norfolkensis* and *Chalinolobus gouldii*. Differentiated from *Chalinolobus gouldii* in long call sequences with mostly flat pulse shapes. Differentiated from *Micronomus norfolkensis* in long call sequences with little pulse alternation.
Phoniscus papuensis	Golden-tipped Bat	Low	Has a very quiet call that is not often recorded by bat detectors.
Rhinolophus megaphyllus	Eastern Horseshoe Bat	High	Long duration, flat calls at characteristic frequency of 66 – 70kHz, unlikely to be confused with any other species.
Saccolaimus flaviventris	Yellow-bellied Sheath-tailed Bat	Mod - High	Calls may overlap with *Chalinolobus dwyeri*. However, good quality call sequences are unlikely to be confused due to *Chalinolobus dwyeri* having small pulse shape and alternating pulses. The harmonics of *Saccolaimus flaviventris* assist identification in full spectrum (.WAV) recordings. The characteristic frequency of the fundamental (first harmonic) is 10-12 kHz, the second (loudest harmonic) is 20-25kHz and the third harmonic 30-35kHz.
Scoteanax rueppellii	Greater Broad-nosed Bat	Low – Mod	Overlaps in characteristic frequency with *Chalinolobus gouldii*, *Micronomus norfolkensis*, *Scotorepens orion* and *Falsistrellus tasmaniensis*. Differentiated from *Micronomus norfolkensis* in long call sequences with mostly curved pulse shapes. Differentiated from *Chalinolobus gouldii* only in long call sequences with no alternating pulse frequencies. Differentiated from *Scotorepens orion* and *Falsistrellus tasmaniensis* by long pre-characteristic sections. Usually only identified at a probable confidence level.
Scotorepens orion	Eastern Broad-nosed Bat	Low	Overlaps in characteristic frequency with *Falsistrellus tasmaniensis* and *Scoteanax rueppellii*. *Falsistrellus tasmaniensis* is most frequently recorded from more elevated locations in the region. However, some records exist from coastal lowlands and so included it in our species groups in coastal areas as a precautionary measure. We do not distinguish *Falsistrellus tasmaniensis* from *Scotorepens orion* where they overlap in frequency due to overlapping call characteristics.

Scientific Name	Common Name	Identification Potential	Identification characteristics
Vespadelus darlingtoni	Large Forest Bat	Low	Overlaps in characteristic frequency with *Miniopterus orianae oceanensis* and *Vespadelus regulus*. Differentiated from *Miniopterus orianae oceanensis* by a two-phase feeding buzz (where present) or by substantial doppler effect (typically displayed by *Vespadelus* spp.). Usually unable to be differentiated from *Vespadelus regulus*.
Vespadelus pumilus	Eastern Forest Bat	Mod	Overlaps in characteristic frequency with *Chalinolobus morio, Vespadelus vulturnus, Vespadelus troughtoni* and *Miniopterus australis*. Differentiated from *Chalinolobus morio* and *Miniopterus australis* at lower and higher characteristic frequencies respectively by the absence of down-sweeping tails on pulses and the presence of doppler effect that is typically displayed by *Vespadelus* spp.. Unable to be differentiated from *Vespadelus vulturnus* and *Vespadelus troughtoni* where they overlap in characteristic frequency.
Vespadelus regulus	Southern Forest Bat	Low	Overlaps in characteristic frequency with *Vespadelus darlingtoni, Vespadelus vulturnus* and *Miniopterus orianae oceanensis*. Differentiated from *Miniopterus orianae oceanensis* by a two-phase feeding buzz (where present) or by substantial doppler effect (typically displayed by *Vespadelus* spp.). Usually unable to be differentiated from *Vespadelus darlingtoni* and *Vespadelus vulturnus* in this region where they overlap in frequency.
Vespadelus troughtoni	Eastern cave bat	Low	Overlaps in characteristic frequency with *Chalinolobus morio, Vespadelus vulturnus* and *Vespadelus pumilus*. Differentiated from *Chalinolobus morio* in long call sequences with few down-sweeping tails on pulses and by the doppler effect that is typically displayed by *Vespadelus* spp. However, unable to be differentiated from *Vespadelus vulturnus* and *Vespadelus pumilus* in this region.
Vespadelus vulturnus	Little Forest Bat	Low	Overlaps in characteristic frequency with *Chalinolobus morio, Vespadelus troughtoni* and *Vespadelus pumilus*. Differentiated from *Chalinolobus morio* in long call sequences with few down-sweeping tails on pulses and by the doppler effect that is typically displayed by *Vespadelus* spp. Only differentiated from *Vespadelus troughtoni* and *Vespadelus pumilus* in calls with a characteristic frequency 47-48kHz.

APPENDIX B LOG FILE REVIEW

Table B1: Log file review results

Folder	Log file name	Unit Type	Set to Record?	Setting Mode	Data Division	Sensitivity	Firmware	GPS	Entire Night?	Errors?	Comments
Anabat 1\	SN395661 2020-09-07 log.csv	Anabat Express	Yes	Night	8	115	V5507J	-32.97301 151.56756	Yes	None	
Anabat 1\	SN395661 2020-09-08 log.csv	Anabat Express	Yes	Night	8	115	V5507J	-32.97303 151.56746	Yes	None	
Anabat 1\	SN395661 2020-09-09 log.csv	Anabat Express	Yes	Night	8	115	V5507J	-32.97344 151.56267	Yes	None	
Anabat 1\	SN395661 2020-09-10 log.csv	Anabat Express	Yes	Night	8	115	V5507J		Yes	None	
Anabat 2\	SN409322 2020-09-07 log.csv	Anabat Express	Yes	Night	8	115	V5507J	-32.97416 151.56884	Yes	None	
Anabat 2\	SN409322 2020-09-08 log.csv	Anabat Express	Yes	Night	8	115	V5507J	-32.97416 151.56884	Yes	None	

Folder	Log file name	Unit Type	Set to Record?	Setting Mode	Data Division	Sensitivity	Firmware	GPS	Entire Night?	Errors?	Comments
Anabat 6\	SN507272 2020-09-07 log.csv	Anabat Express	Yes	Night	8	115	V5507J	-32.96953 151.56473	Yes	None	
Anabat 6\	SN507272 2020-09-08 log.csv	Anabat Express	Yes	Night	8	115	V5507J	-32.96953 151.56473	Yes	None	
Anabat 6\	SN507272 2020-09-09 log.csv	Anabat Express	Yes	Night	8	115	V5507J	-32.96953 151.56473	Yes	None	
Anabat 6\	SN507272 2020-09-10 log.csv	Anabat Express	Yes	Night	8	115	V5507J	-32.96953 151.56473	Yes	None	
Anabat 7\	SN507250 2020-09-07 log.csv	Anabat Express	Yes	Night	8	115	V5507J	-32.97637 151.56444	Yes	None	
Anabat 7\	SN507250 2020-09-08 log.csv	Anabat Express	Yes	Night	8	115	V5507J	-32.97636 151.56442	Yes	None	
Anabat 7\	SN507250 2020-09-09 log.csv	Anabat Express	Yes	Night	8	115	V5507J	-32.97637 151.56447	Yes	Buffer Overflow	Multiple buffer overflow messages throughout the night. Usually occurs due to excessive noise where the unit cannot record fast enough to the SD card and some data is likely to be lost.

Folder	Log file name	Unit Type	Set to Record?	Setting Mode	Data Division	Sensitivity	Firmware	GPS	Entire Night?	Errors?	Comments
Anabat 7\	SN507250 2020-09-10 log.csv	Anabat Express	Yes	Night	8	115	V5507J	-32.97635 151.56448	Yes	Buffer Overflow	Multiple buffer overflow messages throughout the night. Usually occurs due to excessive noise where the unit cannot record fast enough to the SD card and some data is likely to be lost.
Anabat 8\	SN507239 2020-09-07 log.csv	Anabat Express	Yes	Night	8	115	V5507J	-32.97553 151.57533	Yes	Buffer Overflow	Multiple buffer overflow messages throughout the night. Usually occurs due to excessive noise where the unit cannot record fast enough to the SD card and some data is likely to be lost.
Anabat 8\	SN507239 2020-09-08 log.csv	Anabat Express	Yes	Night	8	115	V5507J	-32.97461 151.57503	Yes	None	
Anabat 8\	SN507239 2020-09-09 log.csv	Anabat Express	Yes	Night	8	115	V5507J	-32.9747 151.57529	Yes	None	
Anabat 8\	SN507239 2020-09-10 log.csv	Anabat Express	Yes	Night	8	115	V5507J	-32.9747 151.57529	Yes	None	
Anabat 9\	SN507284 2020-09-06 log.csv	Anabat Express	No	Night	8	115	V5507J		Yes	None	

Folder	Log file name	Unit Type	Set to Record?	Setting Mode	Data Division	Sensitivity	Firmware	GPS	Entire Night?	Errors?	Comments
Anabat 9\	SN507284 2020-09-07 log.csv	Anabat Express	Yes	Night	8	115	V5507J	-32.98247 151.56402	Yes	None	
Anabat 9\	SN507284 2020-09-08 log.csv	Anabat Express	Yes	Night	8	115	V5507J	-32.9824 151.56405	Yes	None	
Anabat 9\	SN507284 2020-09-09 log.csv	Anabat Express	Yes	Night	8	115	V5507J	-32.96911 151.56317	Yes	None	
Anabat 9\	SN507284 2020-09-10 log.csv	Anabat Express	Yes	Night	8	115	V5507J	-32.96907 151.56326	Yes	None	
Anabat 10\	SN507191 2020-09-07 log.csv	Anabat Express	Yes	Night	8	115	V5507J	-32.98549 151.57933	Yes	None	
Anabat 10\	SN507191 2020-09-08 log.csv	Anabat Express	Yes	Night	8	115	V5507J	-32.98542 151.57943	Yes	None	
Anabat 10\	SN507191 2020-09-09 log.csv	Anabat Express	Yes	Night	8	115	V5507J	-32.97032 151.56508	Yes	None	
Anabat 10\	SN507191 2020-09-10 log.csv	Anabat Express	Yes	Night	8	115	V5507J	-32.97045 151.56507	Yes	None	

Appendix C

Invertebrate Results

Morphospecies Label	Rehab A	Rehab B	Rehab C	Analogue Site 2	Analogue Site 1	Dominant Community
Amphipod sp.	3		2			17
Arachnid sp. 1		1				
Arachnid sp. 2		1				
Arachnid sp. 3						1
Arachnid sp. 4						
Arachnid sp. 5			1			
Arachnid sp. 6			2			
Arachnid sp. 7	1					
Archaeognatha sp. 1			1			
Archaeognatha sp. 2			1			
Asilidae sp.						3
Chrysididae sp.				1		
Coleoptera sp. 1	1					
Coleoptera sp. 2						1
Coleoptera sp. 3		1				
Coleoptera sp. 4	1					
Coleoptera sp. 5				1		
Coleoptera sp. 6				1		
Coleoptera sp. 7				1		
Coleoptera sp. 8					1	
Coleoptera sp. 9		1				
Collembola sp. 1						
Collembola sp. 2	2					
Orthoptera 1		1				
Orthoptera 2						1
Orthoptera 3				1		
Culicoidea sp. 1			1			
Culicoidea sp. 2			1			
Culicoidea sp. 3	2					
Culicoidea sp. 4	1	1				
Culicoidea sp. 5		4	1			
Culicoidea sp. 6	1		1			6
Culicoidea sp. 7	1					
Culicoidea sp. 8			1			
Culicoidea sp. 9			1			
Culicoidea sp. 10	2	1	1	1	1	1
Culicoidea sp. 11	4					
Culicoidea sp. 12	5		3			
Culicoidea sp. 13	6					
Culicoidea sp. 14			1			
Culicoidea sp. 15	2			3	11	4
Culicoidea sp. 16	2					
Culicoidea sp. 17			2			
Diplura sp. 1		1				
Diplura sp. 2	5	3	1			1

Morphospecies Label	Rehab A	Rehab B	Rehab C	Analogue Site 2	Analogue Site 1	Dominant Community
Diplura sp. 3					3	
Diplura sp. 4	1					
Diptera sp. 1	1					1
Diptera sp. 2						7
Diptera sp. 3	2	8	41	7	8	3
Diptera sp. 4		12				
Diptera sp. 5	1					
Diptera sp. 6	1					
Diptera sp. 7	1					
Diptera sp. 8	2					2
Diptera sp. 9	2					
Diptera sp. 10	2					
Diptera sp. 11	2					
Diptera sp. 12						1
Diptera sp. 13				5		
Diptera sp. 14				5		
Diptera sp. 15				2		
Diptera sp. 16			3			
Diptera sp. 17			1			
Diptera sp. 18					2	
Diptera sp. 19						1
Diptera sp. 20			1			
Diptera sp. 21			1			
Diptera sp. 22			12		2	
Diptera sp. 23			2			
Diptera sp. 24						1
Diptera sp. 25	4	2				
Diptera sp. 26		2				
Diptera sp. 27			3		1	
Diptera sp. 28	3					
Diptera sp. 29	3					
Formicidae sp. 1		1				
Formicidae sp. 2			1			
Formicidae sp. 3	1					
Formicidae sp. 4	1					
Formicidae sp. 5		1				
Formicidae sp. 6		3				
Formicidae sp. 7		6				
Formicidae sp. 8		12				
Formicidae sp. 9						
Formicidae sp. 10					3	
Formicidae sp. 11					1	
Formicidae sp. 12			1			
Formicidae sp. 13			3			
Formicidae sp. 14						

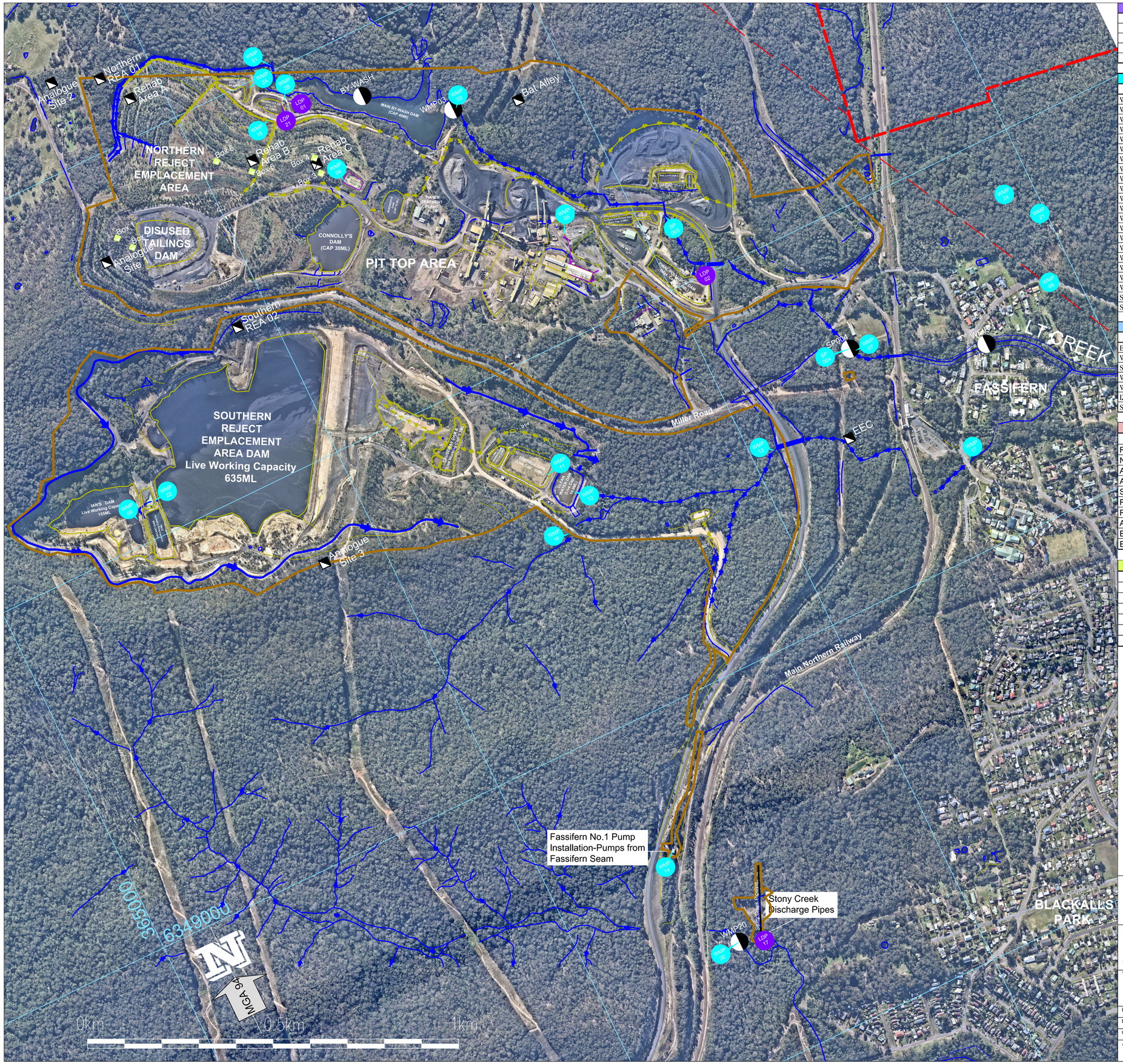
Morphospecies Label	Rehab A	Rehab B	Rehab C	Analogue Site 2	Analogue Site 1	Dominant Community
Hemiptera sp. 1			1			
Hemiptera sp. 2				1		
Hemiptera sp. 3			4			
Hemiptera sp. 4	1					
Hemiptera sp. 5			1			
Hemiptera sp. 6	1					
Hymenoptera sp. 1				1		
Hymenoptera sp. 2		1				
Hymenoptera sp. 3						1
Hymenoptera sp. 4					5	
Hymenoptera sp. 5						1
Hymenoptera sp. 6						2
Hymenoptera sp. 7						1
Hymenoptera sp. 8	1					
Hymenoptera sp. 9		1				
Hymenoptera sp. 10	2					
Isopoda sp. 1		2				
Larval sample			5			
Leaf hopper sp.			1			
Lepidoptera sp. 1				1		
Lepidoptera sp. 2		2				
Lepisma saccharinum						1
Salticidae sp. 1						1
Salticidae sp. 2	1					
Hemiptera sp.				1		
Unidentified insect morphotype					1	
Unidentified insect morphotype		2				
Unidentified insect morphotype	1					
Unidentified insect morphotype				1		
Unidentified insect morphotype					1	
Wasp sp. 1				3	25	
Wasp sp. 2						1
Wasp sp. 3			1			
Wasp sp. 4			2			
Wasp sp. 5						1
Wasp sp. 6						1
Wasp sp. 7				2	10	1
Wasp sp. 8		1				
Wasp sp. 9		2				
Wasp sp. 10		2				
Wasp sp. 11	14	11	19	6	27	9

Morphospecies Label	Rehab A	Rehab B	Rehab C	Analogue Site 2	Analogue Site 1	Dominant Community
Wasp sp. 12	13	41				10
Wasp sp. 13	1					3
Wasp sp. 14				1	1	
Wasp sp. 15			1			
Wasp sp. 16	2					
Wasp sp. 17	2		17			

Appendix D

Flora Results

Scientific Name	Common Name	NSW status	Comm. status	EEC	Dominant Community	Analogue 1	Analogue 2	Rehab A	Rehab B	Rehab C
Acacia saligna	Golden Wreath Wattle								3	
Ageratina adenophora	Crofton Weed								1	
Ambrosia artemisiifolia	Annual Ragweed							5		
Andropogon virginicus	Whisky Grass					2				2
Artemisia verlotiorum	Chinese Wormwood							2		
Bidens pilosa	Cobbler's Pegs					5	30	60	7	1
Briza spp.						1				
Briza subaristata	Chilean Quaking Grass						5			1
Chloris gayana	Rhodes Grass					50			2	5
Cirsium vulgare	Spear Thistle					1	1	3	1	1
Commelina africana							2			
Conyza bonariensis	Flaxleaf Fleabane					1				
Conyza spp.	A Fleabane						1		2	1
Facelis retusa							1			
Gamochaeta calviceps	Cudweed						1			
Hydrocotyle bonariensis								1		
Hyparrhenia hirta	Coolatai Grass								15	
Hypochaeris radicata	Catsear					1			1	1
Lantana camara	Lantana			1		1	5		2	2
Lysimachia arvensis	Scarlet Pimpernel						15			1
Megathyrsus maximus								40	10	2
Melinis repens	Red Natal Grass					1			1	
Modiola caroliniana	Red-flowered Mallow						1		1	
Paspalum dilatatum	Paspalum									1
Plantago lanceolata	Lamb's Tongues					1	2		3	1
Ricinus communis	Castor Oil Plant							20		
Senecio madagascariensis	Fireweed					1	2		1	1
Senna pendula var. glabrata				1						
Setaria parviflora									1	
Sida rhombifolia	Paddy's Lucerne						2		2	
Solanum nigrum	Black-berry Nightshade					1	2		1	2
Verbena bonariensis	Purpletop					1	1		1	1
Vicia sativa	Common vetch							3		1



NEWSTAN COLLIERY LICENCED DISCHARGE POINTS

Name	Easting	Northing	Description
LDP001	366292	6350908	Below Graunch's Dam - Also known as WMP02
LDP002	367072	6350010	Below Final Pollution Control Dam - Also known as WMP06
LDP017	366464	6348332	Stony Creek Pipeline - Also known as WMP19
LDP021	366271	6350911	Graunch's Dam Overflow Weir

SURFACE WATER MONITORING POINTS

Name	Easting	Northing	Description
WMP01	366287	6351020	Upstream of LDP001
WMP2A	366211	6350984	Graunch's Dam Cell 1
WMP2B	366282	6350913	Graunch's Dam Cell 2
WMP03	366691	6350695	EPL Point 19 - Bywash Dam Weir - Downstream of LDP001
WMP04	366335	6350646	Sewage Maturation Pond
WMP05	366806	6350261	Waste Water Treatment Plant
WMP07	367377	6349639	LT Creek downstream of Colliery U/S of Railway, D/S of Miller Rd
WMP08	367927	6349578	Seepage from the GNS into tributary of LT Creek sampled South of Macquarie St
WMP09	365438	6350067	Upstream of the SREA
WMP11	366483	6349698	SREA Seepage Dam
WMP12	366526	6349628	SREA Clean Water Dam (proposed LDP003)
WMP13	367063	6349491	EPL Point 6 - Southern branch LT Creek U/S of Eraring Haul Road
WMP14	366282	6350913	Pump line from Fassifern Seam No.1 Bore
WMP15	366225	6350887	NREA seepage pipe
WMP16	366470	6349529	EPL Point 5 - SREA LT Creek Side catchment
WMP17	367525	6349240	Southern Branch LT Creek below Railway Station
WMP20	366404	6348341	EPL Point 18 - Located in a tributary of Stony Creek, upstream of WMP19
WMP21	367970	6349726	Located within the Wetland system, upstream of WMP8
WMP22	365501	6350094	The decant from Stage 2-4 dam into the Fassi seam
WMP24	367920	6349844	Seepage from the GNS into tributary of LT Creek sampled North of Macquarie St
SP003	367071	6350187	EPL Point 3 - Upstream LDP002
SP004	367366	6349650	EPL Point 4 - Downstream LDP002

NEWSTAN COLLIERY AQUATIC MONITORING POINTS

Name	Easting	Northing	Description
BY-WASH	366477	6350833	By-Wash Dam
WMP03	366689	6350706	EPL Point 19 - Bywash Dam Weir - Downstream of LDP001
SP004	367343	6349726	LT Creek Downstream at Archery Range
WEIR	367702	6349502	LT Creek Downstream at Macquarie Road
WMP20	366404	6348341	Located in a tributary of Stony Creek, upstream of Stony Creek Pipeleline
IZ	368507	6348781	Intertidal Zone - Upstream of the discharge of LT Creek to Lake Macquarie
SCCIZ	368384	6347184	Upstream of confluence of Stony Creek and Fennell Bay

NEWSTAN COLLIERY TERRESTRIAL MONITORING POINTS

Name	Easting	Northing	Description
Rehab Area A	365910	6351097	Annual Flora and Fauna Monitoring Point
Northern REA 01	365861	6351181	Annual Flora and Fauna Monitoring Point
Analogue Site 2	365738	6351228	Annual Flora and Fauna Monitoring Point
Analogue Site 1	365663	6350728	Annual Flora and Fauna Monitoring Point
Southern REA 02	365905	6350418	Annual Flora and Fauna Monitoring Point
Rehab Area B	366136	6350805	Annual Flora and Fauna Monitoring Point
Rehab Area C	366287	6350720	Annual Flora and Fauna Monitoring Point
Analogue Site 3	365840	6349744	Annual Flora and Fauna Monitoring Point
Bat Alley	366852	6350641	Annual Flora and Fauna Monitoring Point
EEC	367260	6349433	Annual Flora and Fauna Monitoring Point

NEWSTAN COLLIERY TERRESTRIAL NEST BOX LOCATIONS

Box ID	Easting	Northing	Description
1	365717	6350775	Analogue Site 1 - for Microbat - in Ironbark sp.
2	365743	6350735	Analogue Site 2 - for Small Parrot - in Corymbia maculata
3	366287	6350694	Rehab Area C - for Glider - in Corymbia maculata
4	366289	6350739	Rehab Area C - for Small Parrot - in Corymbia maculata
5	366121	6350779	Rehab Area B - for Glider - in Corymbia maculata
6	366047	6350845	Rehab Area B - for Microbat - in Corymbia maculata

LEGEND

- U/G EPL Boundary / Extent of Mining Tenure
- Surface EPL Boundary
- LDP 1 — Water Monitoring Point; & Licenced Discharge Point
- WMP 8 — Water Monitoring Point
- SP004 — Aquatic Sampling Point
- REHAB AREA — Terrestrial Ecology Location
- Nesting Box Location
- Watercourse
- Clean Water Runoff
- Dirty Water Runoff

ENDORSEMENTS

- *Aerial image referenced from Nearmap dated 30th June 2020.*
- *The co-ordinate system for all data shown on this plan is Map Grid of Australia 1994 (MGA94).*
- *To read in conjunction with NS2541B*

nearmap.com

Centennial Newstan Pty Ltd (ACN 101 508 865)

NEWSTAN COLLIERY
Surface Plan

CENTENNIAL NEWSTAN

TITLE:

LOCATION OF TERRESTRIAL & WATER MONITORING POINTS (NORTH)

REVISED: C.Cluderay	DRAWN: A.Field	All Distances are in metres unless otherwise shown.	A1
DATE: 22/09/2020	Plot File: N:\Shared\Plots\Newstan\PDF\Enviro\Monitoring\NS2541A_2020-0922.pdf		
CHECKED: A.Ryan	SCALE: 1 :5000 (At A1 Size)		NS2541A
APPROVED: T. O'Brien			

EPL 395 UNDERGROUND PREMISES BOUNDARY					
CNR	EASTING	NORTHING	CNR	EASTING	NORTHING
1	366597.7	6346681.8	91	367858.0	6351595.0
2	366609.4	6346664.2	92	367624.9	6350144.3
3	367363.7	6345281.0	93	367993.8	6350088.3
4	365791.0	6344143.7	94	367999.1	6350120.9
5	365740.2	6343808.6	95	368419.3	6350055.6
6	365515.8	6343842.5	96	368291.8	6349202.4
7	365512.5	6343820.6	97	368286.8	6349174.3
8	365446.0	6343406.7	98	368270.3	6349191.5
9	365673.3	6343370.9	99	368247.5	6349206.0
10	365621.3	6343027.4	100	368229.2	6349213.8
11	365348.9	6343068.9	101	368216.0	6349217.3
12	365247.6	6342419.6	102	368200.4	6349219.5
13	365196.9	6342067.0	103	368169.8	6349215.2
14	364762.6	6342132.4	104	368137.4	6349218.9
15	364717.2	6341833.9	105	368102.9	6349224.7
16	364680.7	6341593.9	106	368099.4	6349225.0
17	364357.7	6341642.5	107	368406.3	6348624.3
18	363963.7	6341702.0	108	368616.5	6347994.5
19	363840.5	6340883.5	109	368845.7	6348011.8
20	363833.6	6340886.4	110	368854.6	6348000.0
21	363827.2	6340888.9	111	368838.2	6347972.6
22	363818.0	6340892.2	112	368845.1	6347940.2
23	363803.9	6340896.1	113	368861.9	6347925.3
24	363787.6	6340901.6	114	368885.9	6347916.8
25	363771.7	6340909.1	115	368901.6	6347918.7
26	363763.1	6340914.7	116	368895.0	6347874.6
27	363756.1	6340913.0	117	368984.0	6347861.9
28	363751.7	6340908.3	118	368963.1	6347825.2
29	363749.2	6340898.7	119	368952.6	6347785.0
30	363744.7	6340888.6	120	368965.9	6347726.7
31	363743.5	6340877.2	121	368977.2	6347673.6
32	363747.6	6340867.4	122	368998.1	6347605.4
33	363752.8	6340859.0	123	369010.7	6347571.6
34	363760.9	6340851.5	124	369030.9	6347511.9
35	363770.5	6340844.1	125	369069.8	6347452.5
36	363772.0	6340836.8	126	369103.9	6347417.6
37	363770.8	6340830.3	127	369135.1	6347391.7
38	363763.7	6340820.4	128	369159.7	6347357.2
39	363754.3	6340809.8	129	369187.5	6347311.4
40	363745.3	6340796.7	130	369192.0	6347296.6
41	363740.4	6340784.1	131	369182.5	6347284.7
42	363741.6	6340770.7	132	369168.1	6347264.9
43	363746.5	6340765.2	133	369116.7	6347221.2
44	363753.9	6340760.2	134	369079.5	6347189.2
45	363558.0	6340779.7	135	369037.6	6347153.2
46	360966.8	6341191.2	136	368985.6	6347091.0
47	360111.3	6341701.6	137	368961.0	6347068.6
48	359207.1	6343947.3	138	368927.0	6347023.7
49	358929.4	6343991.9	139	368911.4	6347001.6
50	358299.5	6345261.3	140	368913.8	6346956.6
51	360614.8	6347899.6	141	368915.5	6346928.9
52	361703.6	6349030.6	142	368910.8	6346899.4
53	361819.7	6348990.3	143	368900.0	6346873.1
54	361847.6	6348973.7	144	368873.0	6346829.2
55	361916.2	6348962.7	145	368851.8	6346794.1
56	362280.1	6348959.7	146	368832.3	6346745.5
57	362288.8	6348939.5	147	368823.1	6346696.9
58	362370.2	6348918.7	148	368844.2	6346635.3
59	362621.1	6348854.3	149	368875.5	6346588.7
60	362811.5	6348954.9	150	368891.8	6346564.8
61	362975.1	6349041.3	151	368941.7	6346516.2
62	363379.8	6349255.1	152	368995.3	6346471.5
63	363580.0	6349360.9	153	369008.6	6346431.7
64	363805.8	6349480.2	154	369025.4	6346389.5
65	363774.8	6349539.1	155	369046.9	6346338.3
66	364052.1	6349792.7	156	369067.6	6346311.6
67	364305.1	6350024.2	157	369068.9	6346298.6
68	364456.3	6350162.6	158	369014.1	6346315.0
69	364524.4	6350600.0	159	368750.9	6346353.4
70	364549.3	6350587.8	160	368757.0	6346393.1
71	364552.6	6350608.7	161	368739.6	6346395.8
72	364613.6	6351010.0	162	368733.2	6346355.7
73	364628.7	6351007.7	163	368287.0	6346423.5
74	364710.6	6351543.8	164	367954.4	6346473.2
75	364981.8	6351502.7	165	367951.0	6346454.3
76	365002.3	6351499.6	166	367926.3	6346458.0
77	365119.4	6352238.3	167	367532.2	6346518.0
78	365558.6	6352169.2	168	367540.5	6346573.0
79	365617.5	6352509.6	169	367125.6	6346639.2
80	365670.4	6352612.0	170	367103.9	6346520.8
81	365697.7	6352729.7	171	366746.3	6346577.0
82	365733.4	6352947.9	172	364072.0	6350279.1
83	365765.0	6353044.8	173	363818.9	6350047.7
84	365753.4	6353061.3	174	358914.1	6343975.7
85	365806.6	6353101.3	175	358972.3	6343756.2
86	365908.1	6353120.8	176	358960.1	6343553.4
87	366133.4	6353210.4	177	358867.6	6343307.5
88	366988.3	6351505.3	178	358520.1	6343377.3
89	367024.8	6351722.1			
90	367263.9	6351688.1			

All Coordinates are subject to Survey

WAKEFIELD ROAD
SYDNEY - NEWCASTLE M1 MOTORWAY
WAKEFIELD
RYHOPE
FASSIFERN
Coal Mined by Newstan (not in Holding)
NEWSTAN PIT TOP
MILLER Road
Lower Seams Subleased to MCJV
PALMERS ROAD
OLSTAN COLLIERY
CESSNOCK ROAD
AWABA ROAD
AWABA
CCL 727 ML 1052
ML 1462 CCL 746
VENTILATION SHAFT
AWABA PIT TOP
WILTON ROAD
WANGI ROAD
TORONTO
LAKE MACQUARIE
AWABA COLLIERY
DORRINGTON ROAD
FREEMANS DRIVE
MAIN NORTHERN RAILWAY
ERARING ASH DAM
RATHMINES
MGA94
0 1 2 3km

LEGEND

- Great Northern Seam Workings
- Fassifern Seam Workings
- Borehole Seam Workings
- Young Wallsend / West Borehole Workings (Workings at 22/08/2014)
- Colliery Holding Boundary (Underground Premises Boundary)
- Lease Boundaries
- EPL 395 Surface Premises

ENDORSEMENTS

- *Aerial image referenced from NearMap on the 19th October 2014.*
- *For details regarding Consolidated Coal Leases held by Centennial Newstan refer to plans PC1, PC6, PC7 & PC8.*
- *Colliery Holding Co-ordinates supplied by P.Duncan - Registered Mining Surveyor Centennial Property, Titles and Survey.*
- *The co-ordinate system for all data shown on this plan is Map Grid of Australia 1994 (MGA94).*
- *Plan prepared by C.Cluderay - Registered Mining Surveyor*

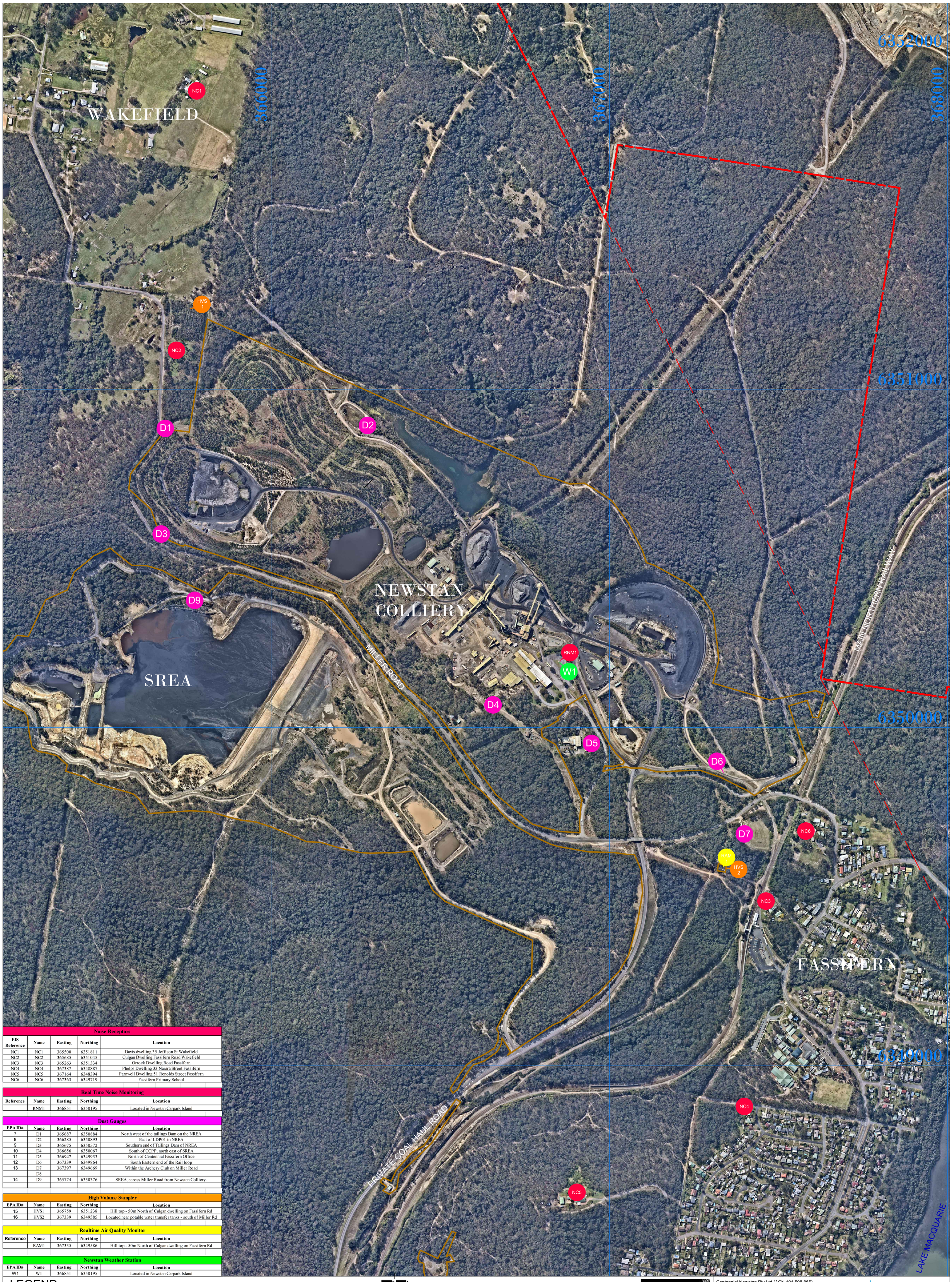
NOTE: This Plan to be Viewed in Conjunction with NS3302 (Plan of Premises - Surface Areas)

Centennial Newstan Pty Ltd (ACN 101 508 865)

NEWSTAN COLLIERY
West Borehole & Young Wallsend Seams

TITLE: Plan of Premises - Underground Workings Newstan EPL 395

DRAWN: C.Cluderay	REV:	All Distances are in metres unless otherwise shown.	A0
DATE: 18/11/2014	FILE: N:\SHARED\PLOTS\NEWSTAN\NS3301.pdf		
CHECKED: V.Howat	SCALE: 1 : 15000		NS 3301
APPROVED: P.Williams			



Noise Receptors

EIS Reference	Name	Easting	Northing	Location
NC1	NC1	365500	6351811	Davis dwelling 35 Jeffison St Wakefield
NC2	NC2	365685	6351045	Culgan Dwelling Fassifern Road Wakefield
NC3	NC3	365263	6351334	Orrock Dwelling Road Fassifern
NC4	NC4	367387	6348887	Phelps Dwelling 33 Narara Street Fassifern
NC5	NC5	367164	6348394	Parnwell Dwelling 51 Renolds Street Fassifern
NC6	NC6	367363	6349719	Fassifern Primary School

Real Time Noise Monitoring

Reference	Name	Easting	Northing	Location
	RNM1	366851	6350195	Located in Newstan Carpark Island

Dust Gauges

EPA ID#	Name	Easting	Northing	Location
7	D1	365687	6350884	North west of the tailings Dam on the NREA
8	D2	366285	6350893	East of LDP01 in NREA
9	D3	365675	6350572	Southern end of Tailings Dam of NREA
10	D4	366656	6350067	South of CCPP, north east of SREA
11	D5	366947	6349953	North of Centennial Fassifern Office
12	D6	367339	6349864	South Eastern end of the Rail loop
13	D7	367397	6349669	Within the Archery Club on Miller Road
	D8			
14	D9	365774	6350376	SREA, across Miller Road from Newstan Colliery.

High Volume Sampler

EPA ID#	Name	Easting	Northing	Location
15	HVS1	365759	6351238	Hill top - 50m North of Culgan dwelling on Fassifern Rd
16	HVS2	367339	6349585	Located near potable water transfer tanks - south of Miller Rd

Realtime Air Quality Monitor

Reference	Name	Easting	Northing	Location
	RAM1	367335	6349586	Hill top - 50m North of Culgan dwelling on Fassifern Rd

Newstan Weather Station

EPA ID#	Name	Easting	Northing	Location
W1	W1	366851	6350195	Located in Newstan Carpark Island

LEGEND

- D7 — Dust Gauge
- HVS 2 — High Volume Sampler
- RAM 1 — Realtime Air Quality Monitor
- NC1 — Noise Monitoring
- RNM1 — Real Time Noise Monitoring
- W1 — Weather Monitoring Station
- U/G EPL Boundary / Extent of Mining Tenure
- Surface EPL Boundary

MGA-94

0km 0.5km 1km

ENDORSEMENTS

- *Aerial image referenced from Nearmap dated 2nd September 2020.*
- *The co-ordinate system for all data shown on this plan is Map Grid of Australia 1994 (MGA94).*

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Centennial Newstan Pty Ltd (ACN 101 508 865)

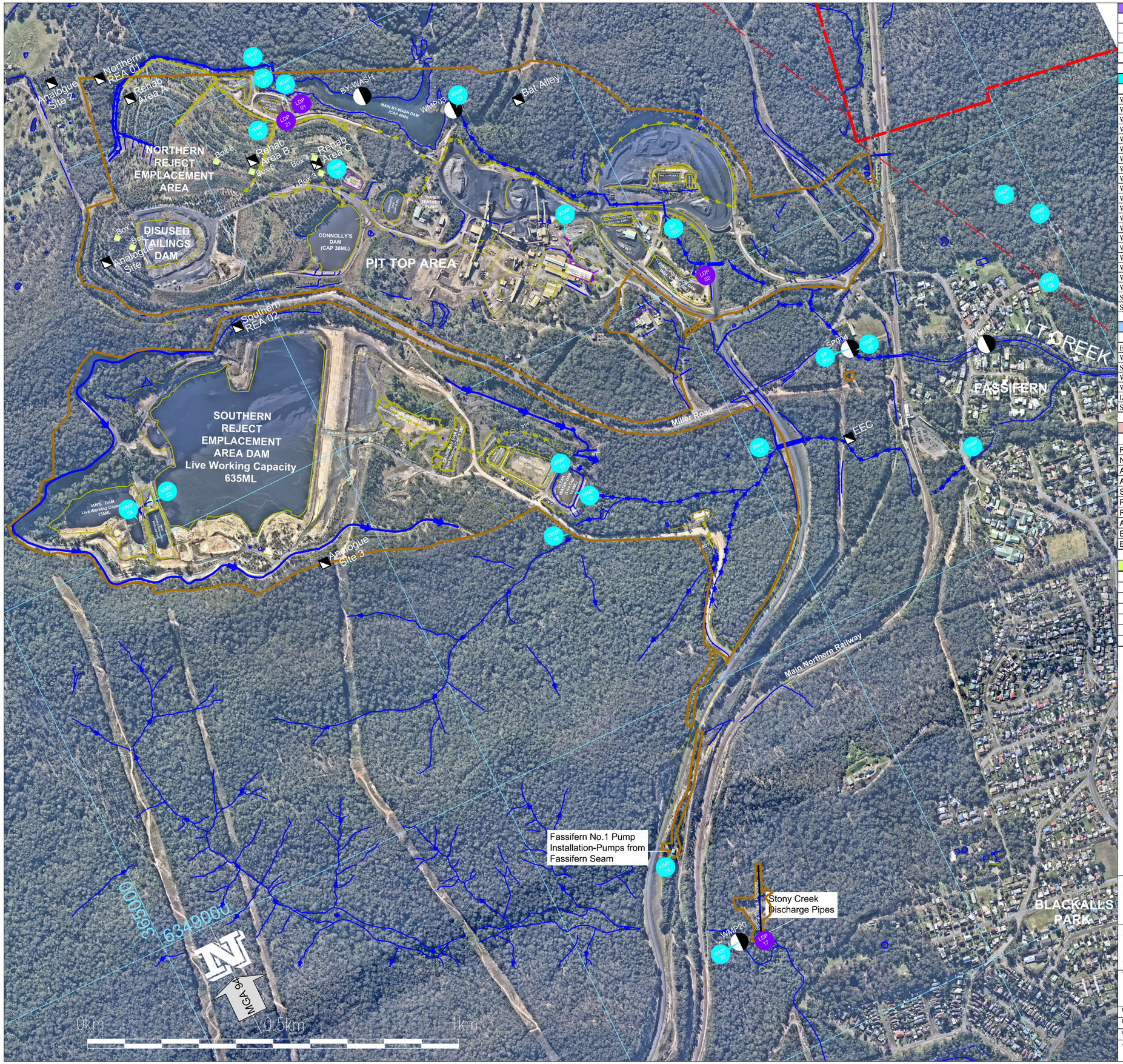
NEWSTAN COLLIERY
Surface

CENTENNIAL NEWSTAN

TITLE:

Location of Air, Noise & Weather Monitoring Points

REVISION:	C.Cluderay	Original Drawn: C.Cluderay 04/03/2016	All Distances are in metres unless otherwise shown. A0
DATE:	22/09/2020	PLOT FILE: N:\Shared\Plots\Newstan\PDF\Enviro\Monitoring\NS3332_2020-0922.pdf	
CHECKED:	A.Ryan	SCALE: 1 : 3500	NS3332
APPROVED:	T.O'Brien		



NEWSTAN COLLIERY LICENCED DISCHARGE POINTS

Name	Easting	Northing	Description
LDP001	366292	6350908	Below Graunch's Dam - Also known as WMP02
LDP002	367072	6350010	Below Final Pollution Control Dam - Also known as WMP06
LDP017	366464	6348332	Stony Creek Pipeline - Also known as WMP19
LDP021	366271	6350911	Graunch's Dam Overflow Weir

SURFACE WATER MONITORING POINTS

Name	Easting	Northing	Description
WMP01	366287	6351020	Upstream of LDP001
WMP2A	366211	6350984	Graunch's Dam Cell 1
WMP2B	366282	6350913	Graunch's Dam Cell 2
WMP03	366691	6350695	EPL Point 19 - Bywash Dam Weir - Downstream of LDP001
WMP04	366335	6350646	Sewage Maturation Pond
WMP05	366806	6350261	Waste Water Treatment Plant
WMP07	367377	6349639	LT Creek downstream of Colliery U/S of Railway, D/S of Miller Rd
WMP08	367927	6349578	Seepage from the GNS into tributary of LT Creek sampled South of Macquarie St
WMP09	365438	6350067	Upstream of the SREA
WMP11	366483	6349698	SREA Seepage Dam
WMP12	366526	6349628	SREA Clean Water Dam (proposed LDP003)
WMP13	367063	6349491	EPL Point 6 - Southern branch LT Creek U/S of Eraring Haul Road
WMP14	366282	6350913	Pump line from Fassifern Seam No.1 Bore
WMP15	366225	6350887	NREA seepage pipe
WMP16	366470	6349529	EPL Point 5 - SREA LT Creek Side catchment
WMP17	367525	6349240	Southern Branch LT Creek below Railway Station
WMP20	366404	6348341	EPL Point 18 - Located in a tributary of Stony Creek, upstream of WMP19
WMP21	367970	6349726	Located within the Wetland system, upstream of WMP8
WMP22	365501	6350094	The decant from Stage 2-4 dam into the Fassi seam
WMP24	367920	6349844	Seepage from the GNS into tributary of LT Creek sampled North of Macquarie St
SP003	367071	6350187	EPL Point 3 - Upstream LDP002
SP004	367366	6349650	EPL Point 4 - Downstream LDP002

NEWSTAN COLLIERY AQUATIC MONITORING POINTS

Name	Easting	Northing	Description
BY-WASH	366477	6350833	By-Wash Dam
WMP03	366689	6350706	EPL Point 19 - Bywash Dam Weir - Downstream of LDP001
SP004	367343	6349726	LT Creek Downstream at Archery Range
WEIR	367702	6349502	LT Creek Downstream at Macquarie Road
WMP20	366404	6348341	Located in a tributary of Stony Creek, upstream of Stony Creek Pipeleline
IZ	368507	6348781	Intertidal Zone - Upstream of the discharge of LT Creek to Lake Macquarie
SCCIZ	368384	6347184	Upstream of confluence of Stony Creek and Fennell Bay

NEWSTAN COLLIERY TERRESTRIAL MONITORING POINTS

Name	Easting	Northing	Description
Rehab Area A	365910	6351097	Annual Flora and Fauna Monitoring Point
Northern REA 01	365861	6351181	Annual Flora and Fauna Monitoring Point
Analogue Site 2	365738	6351228	Annual Flora and Fauna Monitoring Point
Analogue Site 1	365663	6350728	Annual Flora and Fauna Monitoring Point
Southern REA 02	365905	6350418	Annual Flora and Fauna Monitoring Point
Rehab Area B	366136	6350805	Annual Flora and Fauna Monitoring Point
Rehab Area C	366287	6350720	Annual Flora and Fauna Monitoring Point
Analogue Site 3	365840	6349744	Annual Flora and Fauna Monitoring Point
Bat Alley	366852	6350641	Annual Flora and Fauna Monitoring Point
EEC	367260	6349433	Annual Flora and Fauna Monitoring Point

NEWSTAN COLLIERY TERRESTRIAL NEST BOX LOCATIONS

Box ID	Easting	Northing	Description
1	365717	6350775	Analogue Site 1 - for Microbat - in Ironbark sp.
2	365743	6350735	Analogue Site 2 - for Small Parrot - in Corymbia maculata
3	366287	6350694	Rehab Area C - for Glider - in Corymbia maculata
4	366289	6350739	Rehab Area C - for Small Parrot - in Corymbia maculata
5	366121	6350779	Rehab Area B - for Glider - in Corymbia maculata
6	366047	6350845	Rehab Area B - for Microbat - in Corymbia maculata

LEGEND

- U/G EPL Boundary / Extent of Mining Tenure
- Surface EPL Boundary
- LDP 1 — Water Monitoring Point; & Licenced Discharge Point
- WMP 8 — Water Monitoring Point
- SP004 — Aquatic Sampling Point
- REHAB AREA — Terrestrial Ecology Location
- Nesting Box Location
- Watercourse
- Clean Water Runoff
- Dirty Water Runoff

ENDORSEMENTS

- *Aerial image referenced from Nearmap dated 30th June 2020.*
- *The co-ordinate system for all data shown on this plan is Map Grid of Australia 1994 (MGA94).*
- *To read in conjunction with NS2541B*

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Centennial Newstan Pty Ltd (ACN 101 508 865)

NEWSTAN COLLIERY
Surface Plan

CENTENNIAL NEWSTAN

TITLE:

LOCATION OF TERRESTRIAL & WATER MONITORING POINTS (NORTH)

REVISED: C.Cluderay	DRAWN: A.Field	All Distances are in metres unless otherwise shown.	A1
DATE: 22/09/2020	Plot File: N:\Shared\Plots\Newstan\PDF\Enviro\Monitoring\NS2541A_2020-0922.pdf		
CHECKED: A.Ryan	SCALE: 1 :5000 (At A1 Size)		NS2541A
APPROVED: T. O'Brien			

Legend

- Domain E - Rehabilitation Area - Woodland
- Ecosystem and Landuse Establishment

ENDORSEMENTS

- *Aerial image referenced from NearMap dated 28th November 2020.*

nearmap

MGA-56

0 50m 100m 150m 200m

Centennial Newstan Pty Ltd (ACN 101 508 865)

NEWSTAN COLLIERY
Surface

CENTENNIAL NEWSTAN

TITLE:

NREA Rehabilitation Areas

REVISION:	C.CLUDERAY	DRAWN:	C.CLUDERAY	All Distances are in metres unless otherwise shown.	A3
DATE:	10-02-2021	DATE:	05-10-2018		
CHECKED:	A.Ryan	PLOT FILE:	N:\Shared\Plots\Newstan\PDF\Enviro\AEMR\2020\Newstan\NS3394_R1.pdf		
APPROVED:		SCALE:	1:4000		NS3394

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Sydney NSW 2000