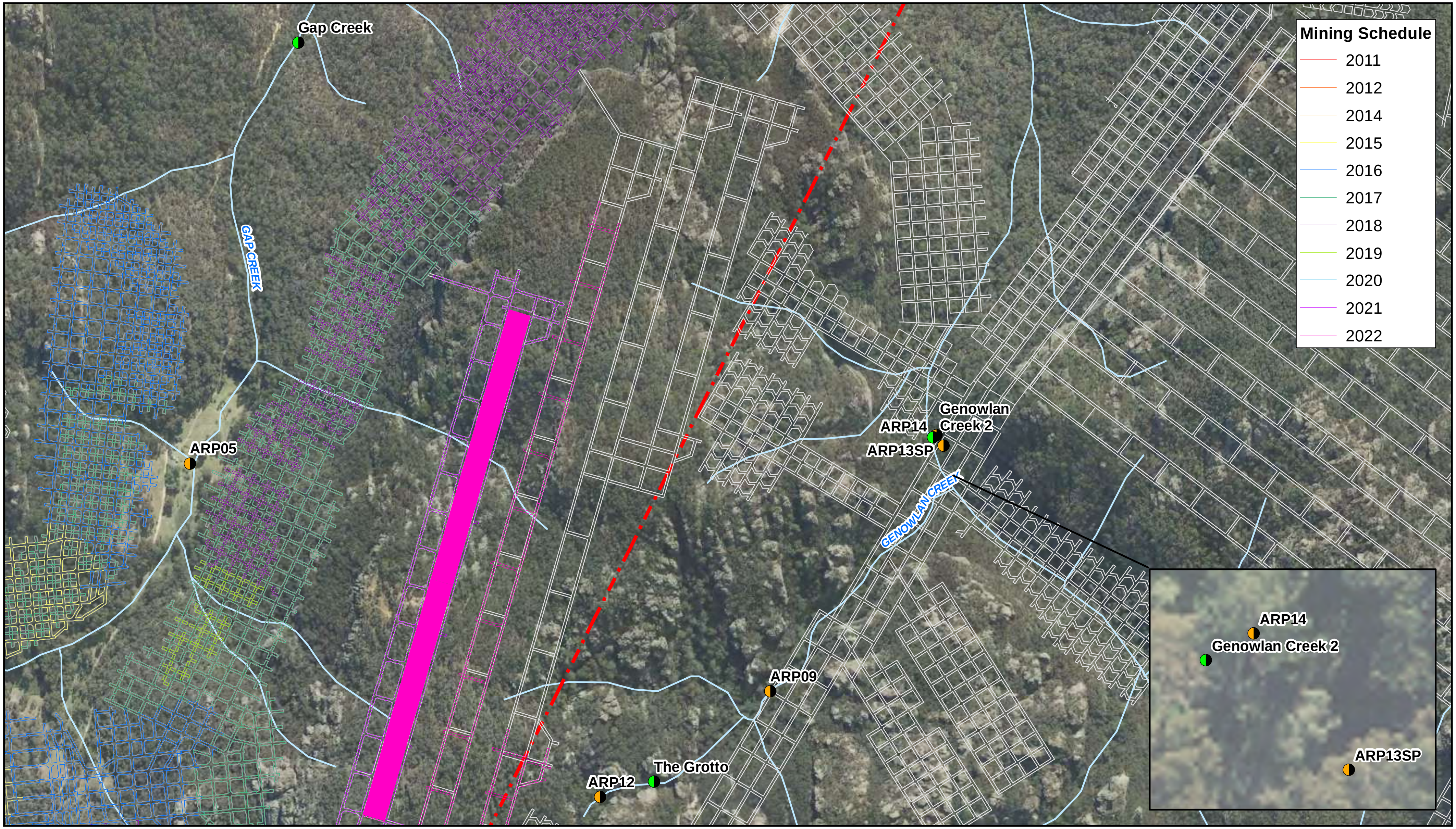

Legend

Waterway

Proposed workings

Existing workings

● Surface water quality location

● Standpipe monitoring bore

Paper Size ISO A4

0 0.08 0.16 0.24 0.32

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

Centennial Airly Pty Ltd
Airly Mine Water Monitoring
2022 Annual Monitoring Report

Genowlan Creek monitoring sites
and mining schedule

Project No.	12572078
Revision No.	0
Date	3/03/2023

FIGURE 6.1

G:\22\0105001\GIS\Maps\Deliverables\Western\Airly\12572078\AWR\12572078_AWR005_site_comparison_A.mxd
Print date: 03 Mar 2023 - 15:56

Data source: LPI: DTDB 2012; Centennial: Aerial Imagery, boundaries, 2013, Monitoring Locations, 2017 © Department of Customer Service 2020. Created by: aharvey3

6.1.4 Production bore AM2B-1

Approximately 47.49 kL of groundwater was extracted from the production bore during 2022. All extraction occurred during purging of the bore for routine water monitoring purposes. This is within the annual extraction limit of 158 ML/year. All monitoring data for AM2B-1 are shown in Appendix C.

Significant water quality changes were observed during April to August and in October 2022. As noted in Section 4.4.2, these were the result of inaccurate sampling methodologies carried out by the sampling contractor (ALS). Water results are otherwise consistent with historical records and there are no trends of concern.

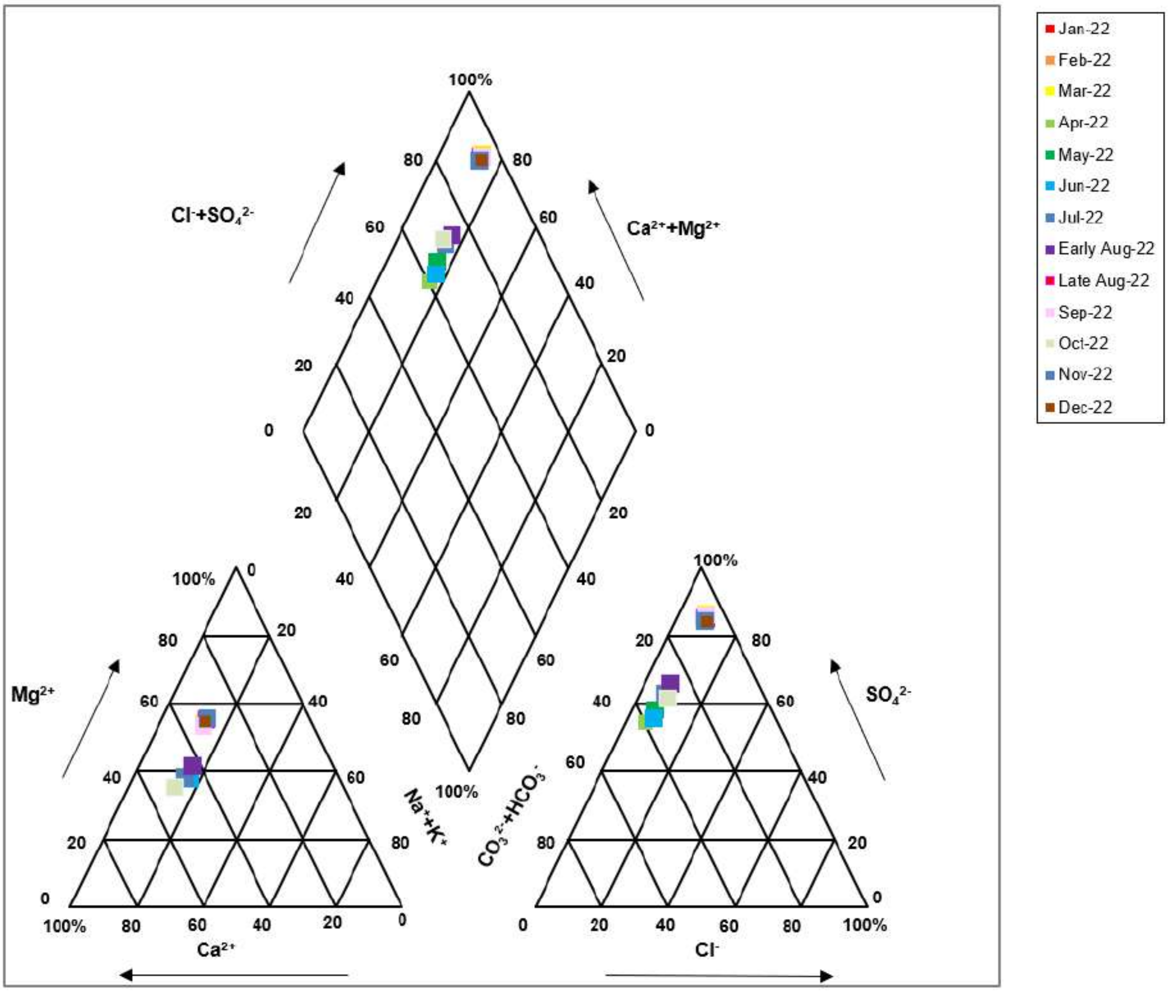

Figure 6.2 Piper chart of water quality changes at AM2B-1 in 2022

6.1.5 Old production bore

Water level monitoring data for the old production bore are presented in Appendix A. The groundwater level increased from 2021 through November 2022 rising from 9.8 m BGL in December to 6.4 m BTOC. Thereafter the water level dropped to 7.6 m in December 2022.

6.1.6 Site water balance

A site water balance model was previously developed for Airly Mine as part of the Airly Mine Extension Project (GHD 2014) to quantify transfers within the site under future operational conditions using various rainfall patterns. The site water balance was updated to reflect the current mine plan and operational conditions (GHD 2019b). The site water balance for the 2018 calendar year is presented in Table 6.2 for comparison to 2022 water volumes discussed below.

Table 6.2 Annual water balance – average existing conditions (2018)

Water flow	Volume (ML/year)
INPUTS	
Direct rainfall onto storages and catchment runoff	57
External potable water supply	1
Groundwater inflows into underground workings	10
Extraction from production bore	38
In situ coal moisture	23
TOTAL INPUTS	**129**
OUTPUTS	
Evaporation	49
Dust suppression	5
Sewage to Ecomax effluent treatment system	2
Discharge through LDP001	0
Discharge through LDP002	0
Discharge through LDP003	0
Product coal moisture	78
TOTAL OUTPUTS	**134**
CHANGE IN STORAGE	
Surface water storages	-5
Underground workings	0
TOTAL CHANGE IN STORAGE	**-5**
BALANCE	
Inputs – outputs – change in storage	0

The observed water flows during 2022 at Airly Mine were reviewed qualitatively:

- Groundwater inflows intercepted by the underground workings were not measurable and are considered only to present in increased coal moisture.
- Extraction from the production bore remained low compared to the licensed extraction limit (refer to Section 1).
- Ten off-site discharges were reported from the site water management system (refer to Section 6.1.3), as a result of increased rainfall throughout 2022.

Coal moisture fluxes likely remained proportional to the ROM coal production at Airly Mine, and rainfall, runoff and evaporation aligned with site rainfall conditions (refer to Section 3.2). Approximately 1.1 ML of potable water was imported and 3.5 ML of rainfall was captured for site reuse. Approximately 69 ML of production (reuse) water was used from the production dam to tanks.

Existing conditions at Airly Mine during 2022 are therefore considered to be generally aligned with the 2018 annual water balance.

6.2 2023 operations

The proposed mining activities for 2023 include continuation of first workings to the east of the existing workings; south of ARP12 and ARP06 and including panel and pillar extraction north of ARP14. The depth of cover (i.e., thickness of overlying strata) throughout these areas ranges from approximately 100 m to 180 m. Depth of cover above proposed first workings varies from approximately 200 m to 300 m.

6.2.1 Groundwater

The hydrogeological model for Airly Mine (GHD, 2021b) was updated to reflect the proposed workings for 2023. The updated model simulates groundwater inflows of approximately 31.1 ML/year into mined voids. Groundwater inflows are simulated to occur predominantly from the overlying Permian strata and from the coal seam itself, with a smaller amount originating from the underlying Marrangaroo Formation.

No changes to groundwater quality along Gap Creek are expected.

6.2.2 Surface water

Subsidence impacts assessed in the Surface Water Subsidence Impact Assessment (GHD 2022) indicates there were no evidence of subsidence related impacts to surface water flows at the gauged locations along Gap and Genowlan Creeks, post mining. In addition, there have been no adverse impacts predicted for these hydrological or hydraulic conditions of catchments or waterways. The upper reaches of Gap and Genowlan Creeks are undermined by existing mine workings. Existing mine workings are generally within 100 m of Gap Creek. 2023 panel and pillar mine workings will come within 100 m of Genowlan Creek.

Changes to the site water balance and mine water discharges from surface facilities area are not expected. Water levels within the Production Dam are typically managed to maintain sufficient freeboard in case of significant rain events. However, based on available water quality data for Production Dam (and as assessed in Section 5.2.3), it is unlikely that a discharge would adversely impact Airly Creek.

7. Summary

Table 7.1 consolidates the monitoring locations and monitoring status for 2022 into a single table.

Table 7.1 Summary of monitoring

	ID	Lithology	Level/ Flow Monitored	Quality Monitored	Level/Flow Triggered	Quality Triggered
Groundwater						
VWPs	ARP01	Narrabeen Sandstone	No, logger dysfunctional since 2018	NA	NA	NA
		Irondale Coal Seam			NA	
		Lithgow coal seam			NA	
		Marrangaroo Formation			NA	
	ARP02A	Narrabeen Sandstone	Yes, dry since installation		NA	
		Irondale Coal Seam	No, logger dysfunctional since 2020		NA	
		Lithgow Seam			NA	
		Marrangaroo Formation			NA (753 m AHD)	
	ARP03A	Narrabeen sandstone	No, logger dysfunctional since 2020		NA (865 m AHD)	
		Middle River Coal Seam	Yes, dry since installation		NA	
		Lithgow Seam	No, dry since installation and dysfunctional since 2021		NA	
		Marrangaroo Formation	No, logger dysfunctional since 2022		NA (745 m AHD)	
	ARP04	Lithgow Seam	Yes		NA	
		Marrangaroo Formation			No, (734 m AHD)	
		Shoalhaven			No, (669 m AHD)	
	ARP06	Narrabeen Sandstone	Yes		No, (866 m AHD)	
		Irondale Coal Seam	Yes, dry since 2013		NA	
		Lithgow coal seam	Yes, dry since installation		NA	
		Marrangaroo Formation	Yes, dry since 2016		NA	
	ARP07	Middle River coal seam	Yes, dry since installation		NA	
		Lithgow coal seam			NA	

	ID	Lithology	Level/ Flow Monitored	Quality Monitored	Level/Flow Triggered	Quality Triggered
	ARP08	Narrabeen sandstone	Yes, dry since 2016		NA	
		Lower Irondale	Partially, dysfunctional since November 2022		NA	
	ARP13	Shoalhaven	Partially. Loggers functional, data storage device malfunctioned and replaced in December 2022		NA	
		Devonian formation			Yes, (570 m AHD)	
	ARP15[4]	Lithgow Coal Seam	Yes		NA	
		Shoalhaven	Yes, dry since 2017		NA	
		Devonian formation	Yes		NA	
Standpipes	AM2B-1		NA	2009–present	NA	NA
	Old Production Bore		Yes	May 2017-present	NA	NA
	ARP05	Gap Creek Alluvium	Yes	August 2012–present	NA	WMP 2021 SSGV
	ARP07	Narrabeen Sandstone	Yes	July 2013–present	NA	No
	ARP08	Lithgow Seam	Yes	September 2013–September 2022	NA	ANZECC DGV
	ARP09	Genowlan Creek Alluvium	Yes	June 2013–present	NA	ANZECC DGV
	ARP11	Permian Strata	Yes	January 2017–present	NA	ANZECC DGV
	ARP12	Genowlan Creek Alluvium	Yes	January 2017–present	NA	ANZECC DGV
	ARP13SP	Lithgow Seam	Yes	January 2017–present	NA	WMP 2021 SSGV
	ARP14	Genowlan Creek Alluvium	Yes	January 2017–present	No (781 m AHD)	WMP 2021 SSGV
	ARP15SP	Narrabeen Sandstone	Yes	January 2017–present	No (829.1 m AHD)	WMP 2021 SSGV
	ARP16 (Nissan Hut)	NA	Yes, dry since installation in 2021.	December 2021 – present	NA	No

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[4] Logger box damaged by tree fall January 2021

	ID	Lithology	Level/ Flow Monitored	Quality Monitored	Level/Flow Triggered	Quality Triggered
Landholder bores	Nioka	Devonian Strata	NA	January 2017 – present	NA	ANZECC DGV
	Kingdom	Devonian Strata	NA	November 2019– present	NA	ANZECC DGV
	GW80876	NA	NA	December 2021 - present	NA	ANZECC DGV
Seepage	Village Spring	Permian Strata	Yes	February 2011– present	NA	WMP 2021 SSGV
	Mine workings		Yes	December 2009– present	NA	NA
Surface Water						
Creeks	Airly Creek		NA	Yes	NA	No
	Airly Upstream		NA	Yes	NA	WMP 2021 SSGV
	Airly Tributary		NA	Yes	NA	WMP 2021 SSGV
	Genowlan Creek 2		Yes	Yes	NA	WMP 2021 SSGV
	Gap Creek		Yes	Yes	NA	WMP 2021 SSGV
	The Grotto		NA	Yes	NA	WMP 2021 SSGV
Discharge Points	LDP001		Yes	No	Yes	NA
	LDP002		NA continuous monitoring not available	No	Yes	NA
	LDP003		Yes	No	Yes	NA

8. References

ALS (2022), ALS Client Data Portal, obtained from: https://hydportal.alsglobal.com/web.html

ANZECC (2000), *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand.

Centennial (2021) *Memorandum: Recovery of ARP08.* Letter prepared by Centennial 17 December 2021.

GHD (2014) Airly Mine Extension Project: Water and Salt Balance Assessment, prepared by GHD Pty Ltd for Centennial Airly Pty Limited.

GHD (2016), *Gap Creek and Genowlan Creek Flow Investigation.*

GHD (2017a) *Hydrogeological Model Recalibration*: Letter prepared for Centennial 24 July 2017.

GHD (2017b) Airly Mine - Additional Water and Salt Balance Modelling.

GHD (2017c) *Airly Mine – 2016 Annual Water Monitoring Report.*

GHD (2018a) *SSGV Update and EPL Review*: Letter prepared for Centennial 14 February 2018.

GHD (2018b) *Airly aquatic ecology 2017.*

GHD (2021) *Airly Mine Water Management Plan.*

GHD (2019a) *Airly Mine Mod 3: Hydrogeological Model Report.*

GHD (2019b) *Airly Mine Extension Project Modification 2: Surface Water Impact Assessment*, prepared by GHD Pty Ltd for Centennial Airly Pty Limited.

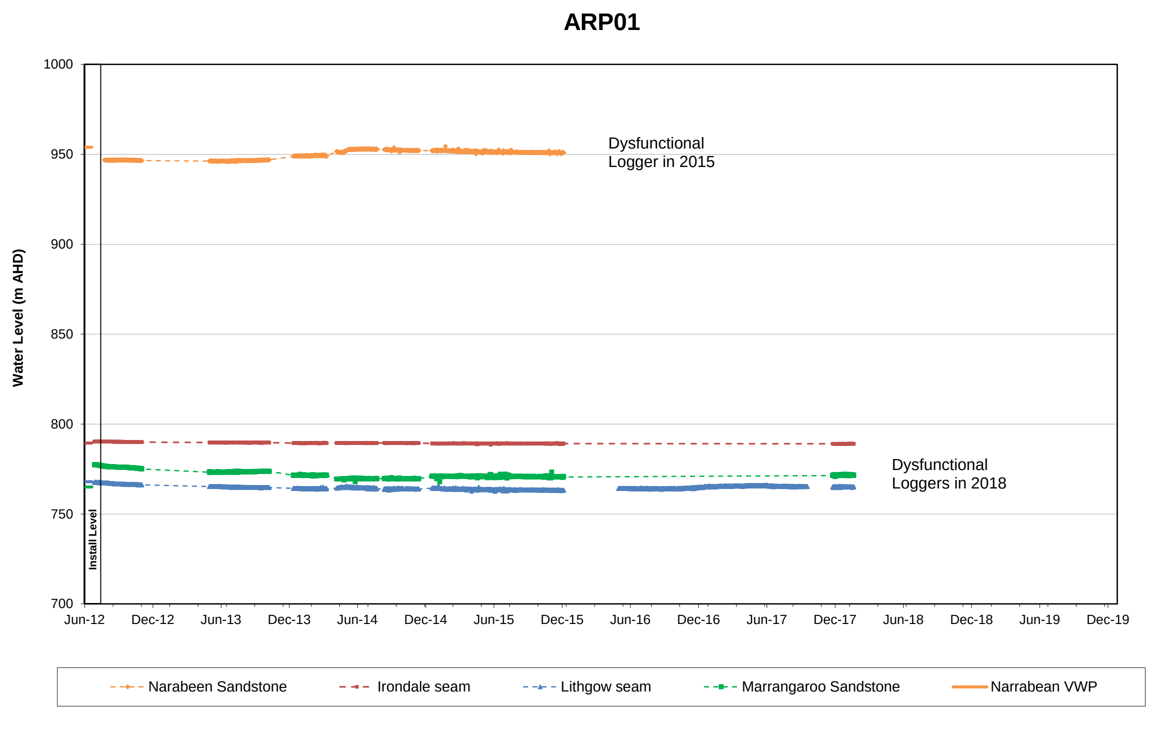
GHD (2022) *Surface Water Subsidence Impact Review*. Prepared by GHD Pty Ltd for Centennial Airly Pty Limited.

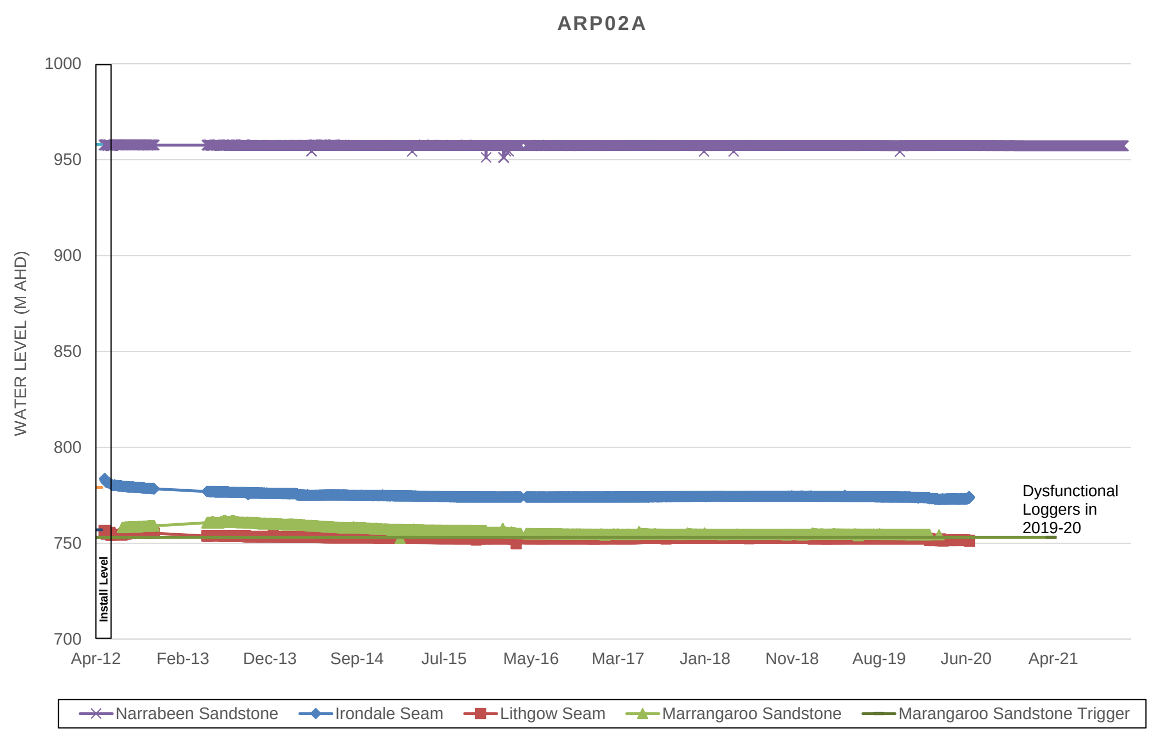
GHD (2023) Airly Mine Water Management Plan (Not yet approved). Prepared by GHD Pty Ltd for Centennial Airly Pty Limited.

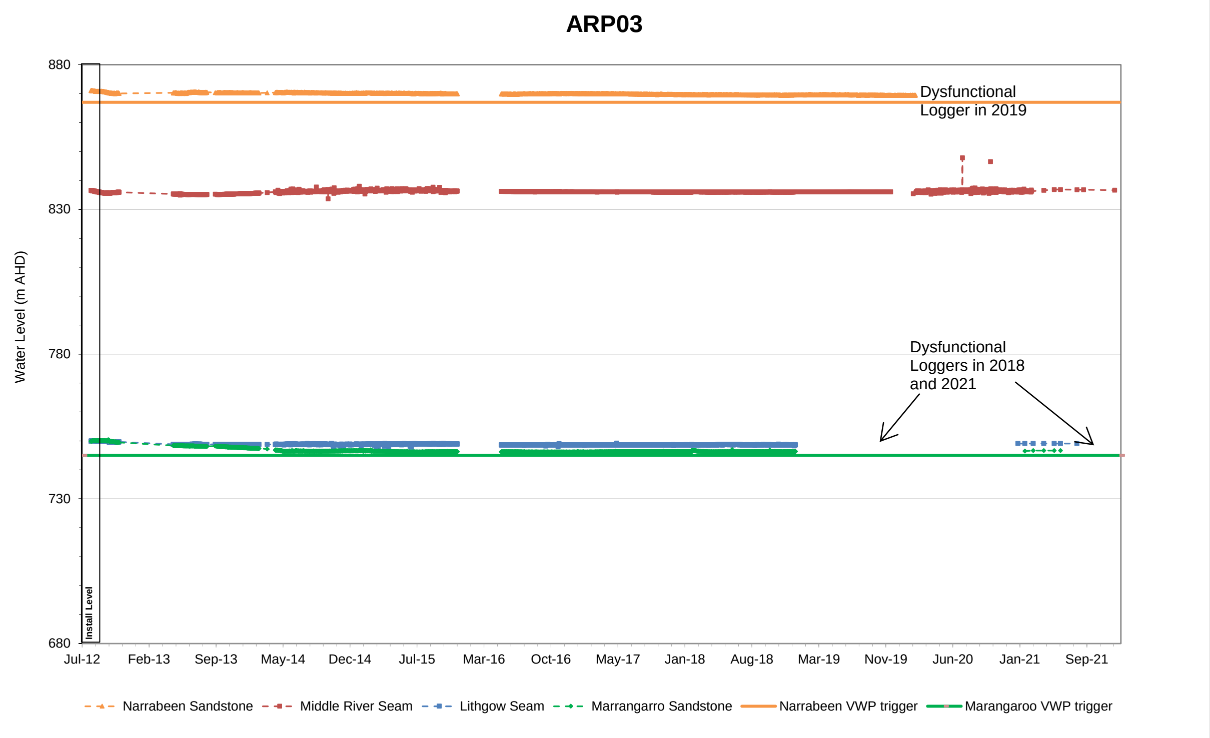
Appendices

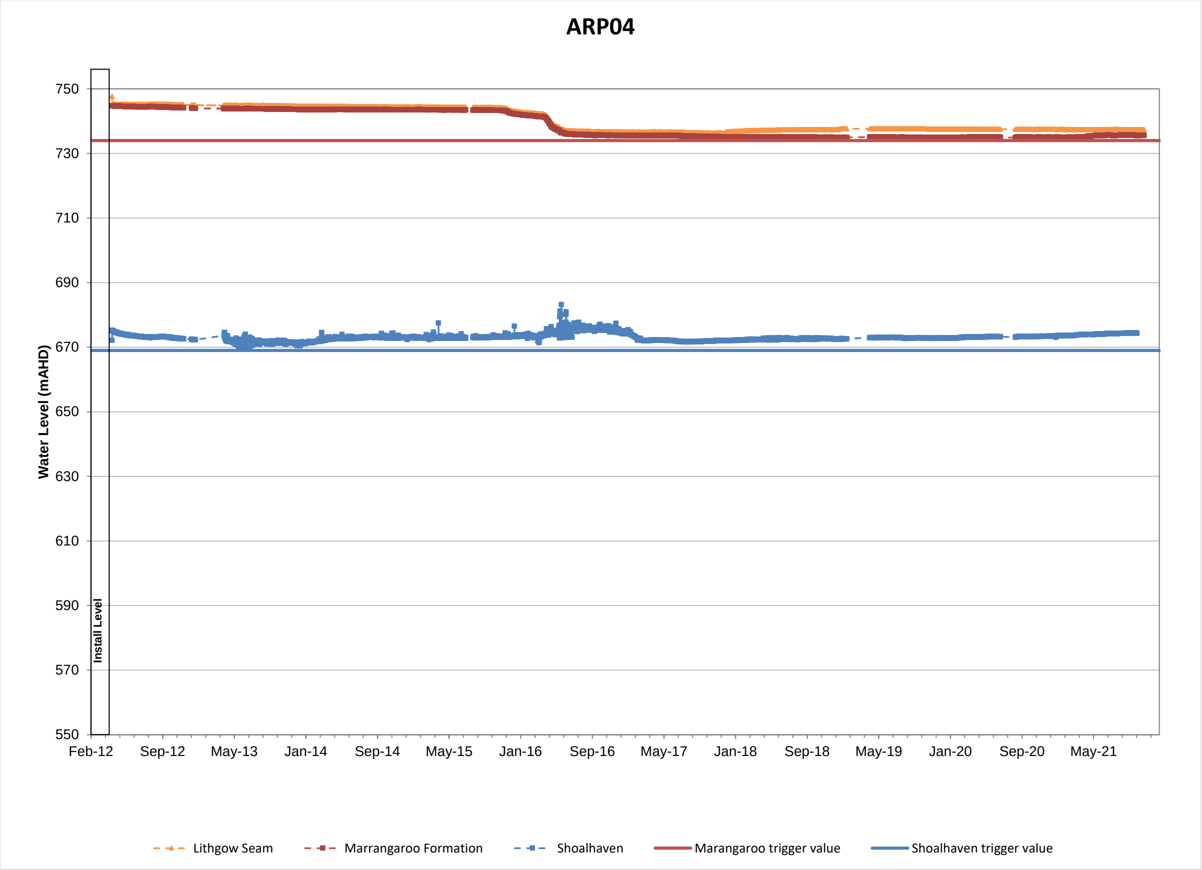
Appendix A

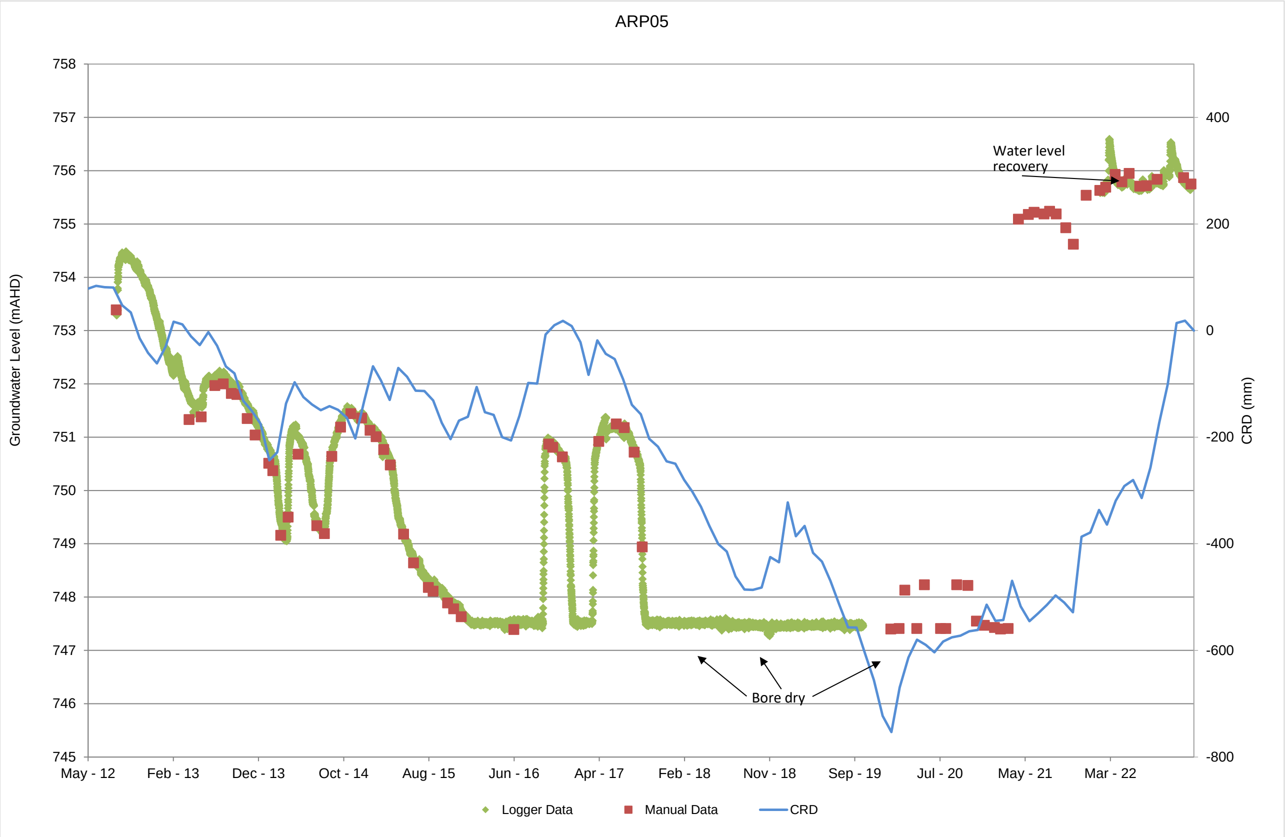
Groundwater hydrographs

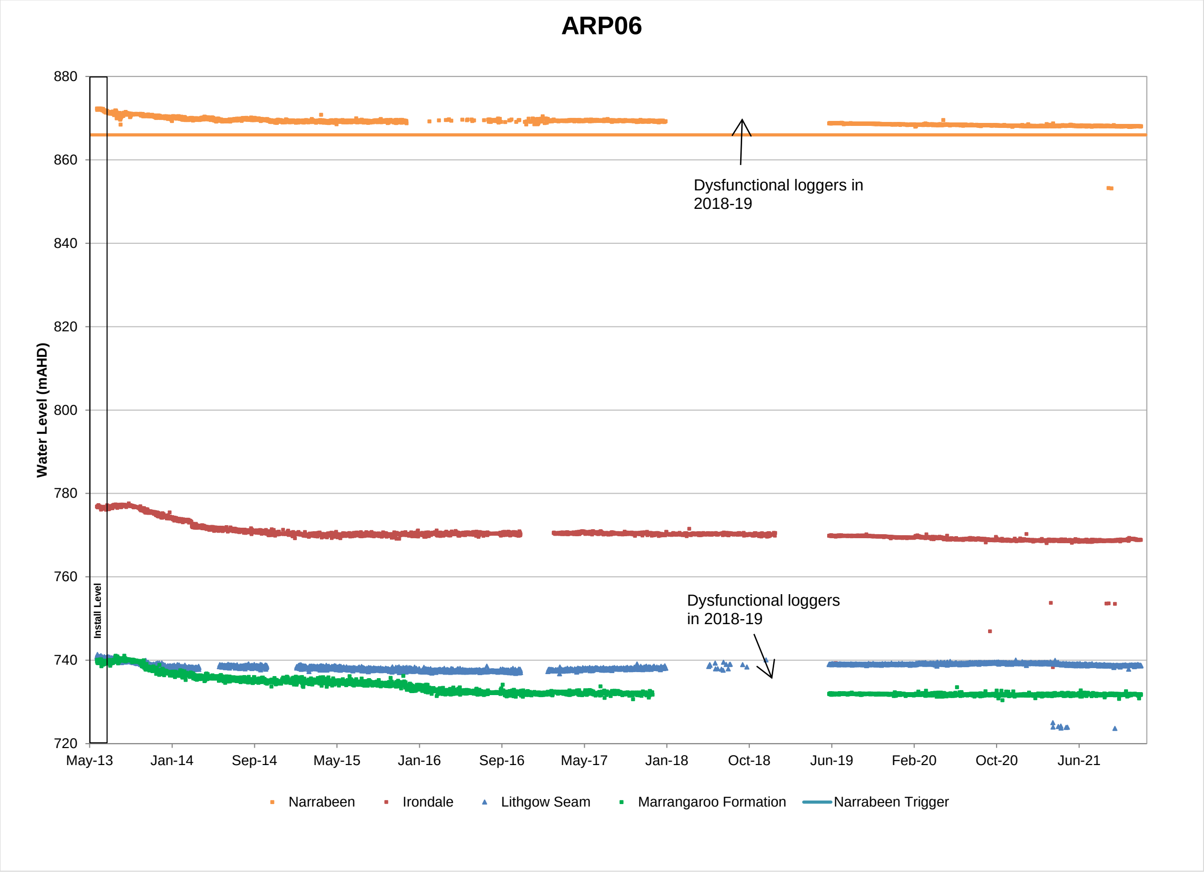

ARP01
Water Level (m AHD)
1000
950
900
850
800
750
700
Install Level
Dysfunctional Logger in 2015
Dysfunctional Loggers in 2018
Jun-12
Dec-12
Jun-13
Dec-13
Jun-14
Dec-14
Jun-15
Dec-15
Jun-16
Dec-16
Jun-17
Dec-17
Jun-18
Dec-18
Jun-19
Dec-19
Narabeen Sandstone
Irondale seam
Lithgow seam
Marrangaroo Sandstone
Narrabean VWP

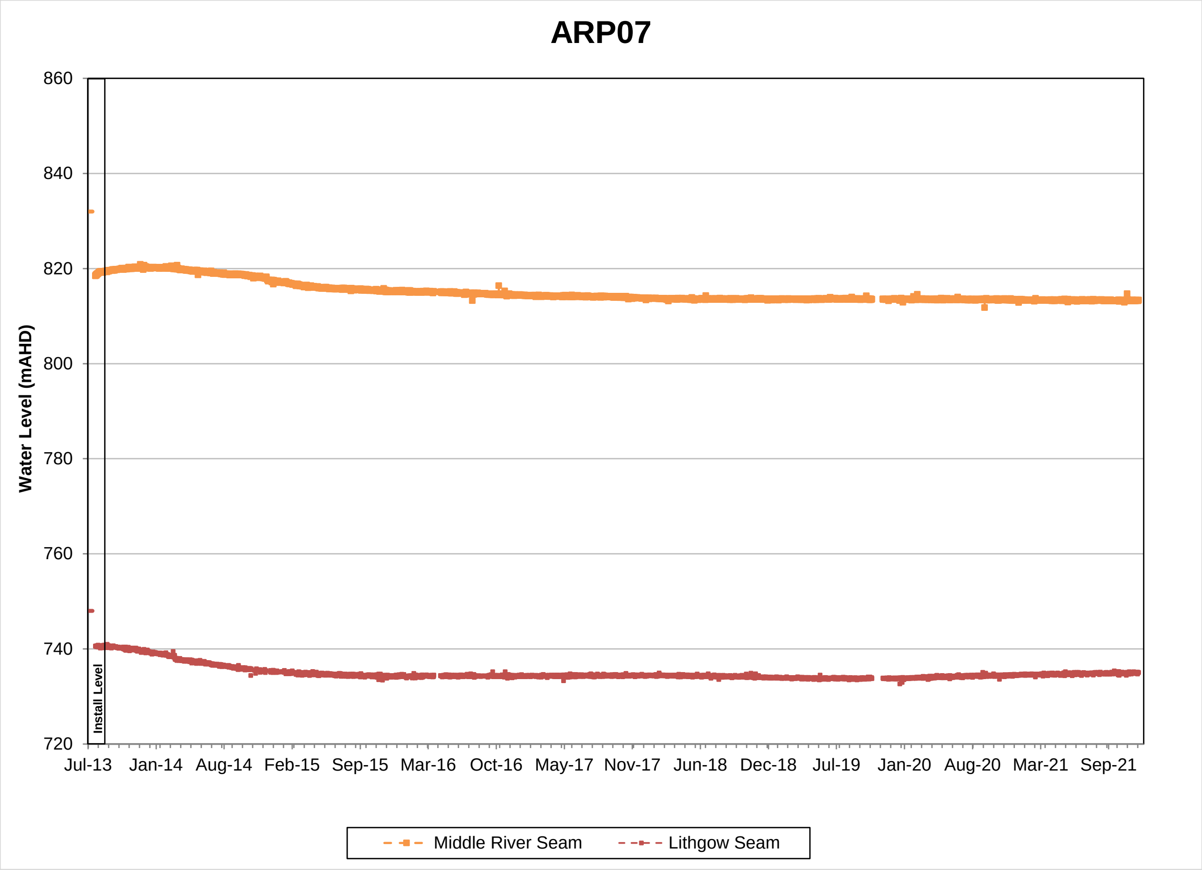

ARP02A
WATER LEVEL (M AHD)
1000
950
900
850
800
750
700
Install Level
Dysfunctional Loggers in 2019-20
Apr-12
Feb-13
Dec-13
Sep-14
Jul-15
May-16
Mar-17
Jan-18
Nov-18
Aug-19
Jun-20
Apr-21
Narrabeen Sandstone
Irondale Seam
Lithgow Seam
Marrangaroo Sandstone
Marangaroo Sandstone Trigger

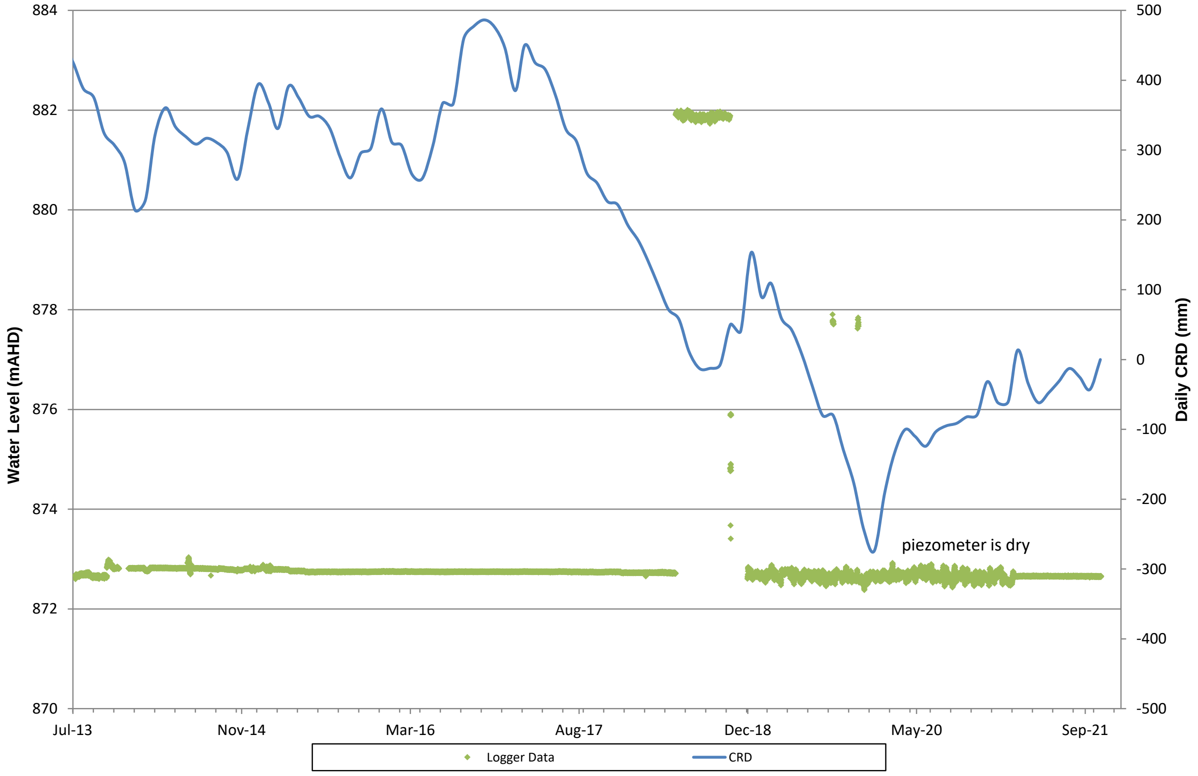

ARP03
Water Level (m AHD)
880
830
780
730
680
Install Level
Jul-12
Feb-13
Sep-13
May-14
Dec-14
Jul-15
Mar-16
Oct-16
May-17
Jan-18
Aug-18
Mar-19
Nov-19
Jun-20
Jan-21
Sep-21
Dysfunctional Logger in 2019
Dysfunctional Loggers in 2018 and 2021
Narrabeen Sandstone
Middle River Seam
Lithgow Seam
Marrangarro Sandstone
Narrabeen VWP trigger
Marangaroo VWP trigger

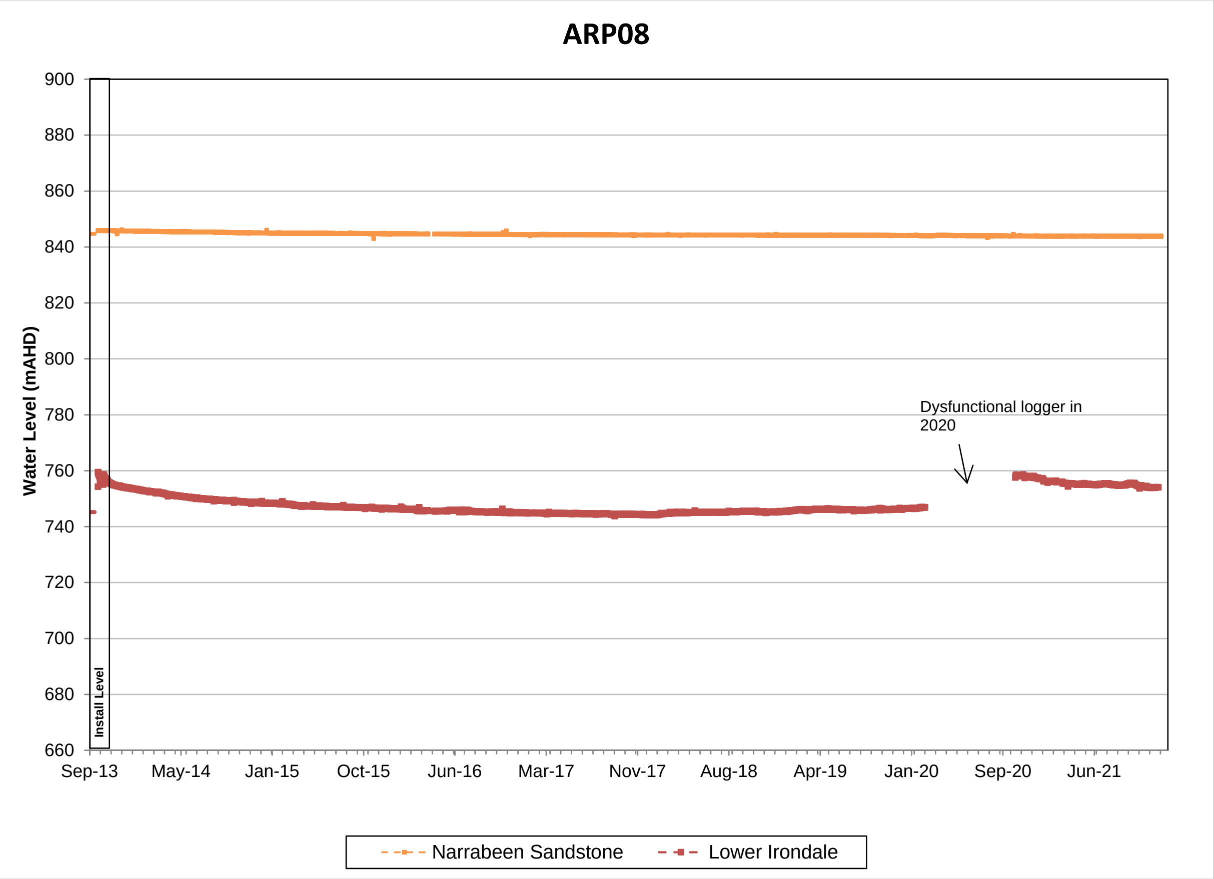

ARP04
Water Level (mAHD)
750
730
710
690
670
650
630
610
590
570
550
Install Level
Feb-12
Sep-12
May-13
Jan-14
Sep-14
May-15
Jan-16
Sep-16
May-17
Jan-18
Sep-18
May-19
Jan-20
Sep-20
May-21
Lithgow Seam
Marrangaroo Formation
Shoalhaven
Marangaroo trigger value
Shoalhaven trigger value


ARP05
Groundwater Level (mAHD)
758
757
756
755
754
753
752
751
750
749
748
747
746
745
CRD (mm)
400
200
0
-200
-400
-600
-800
May - 12
Feb - 13
Dec - 13
Oct - 14
Aug - 15
Jun - 16
Apr - 17
Feb - 18
Nov - 18
Sep - 19
Jul - 20
May - 21
Mar - 22
Water level recovery
Bore dry
Logger Data
Manual Data
CRD

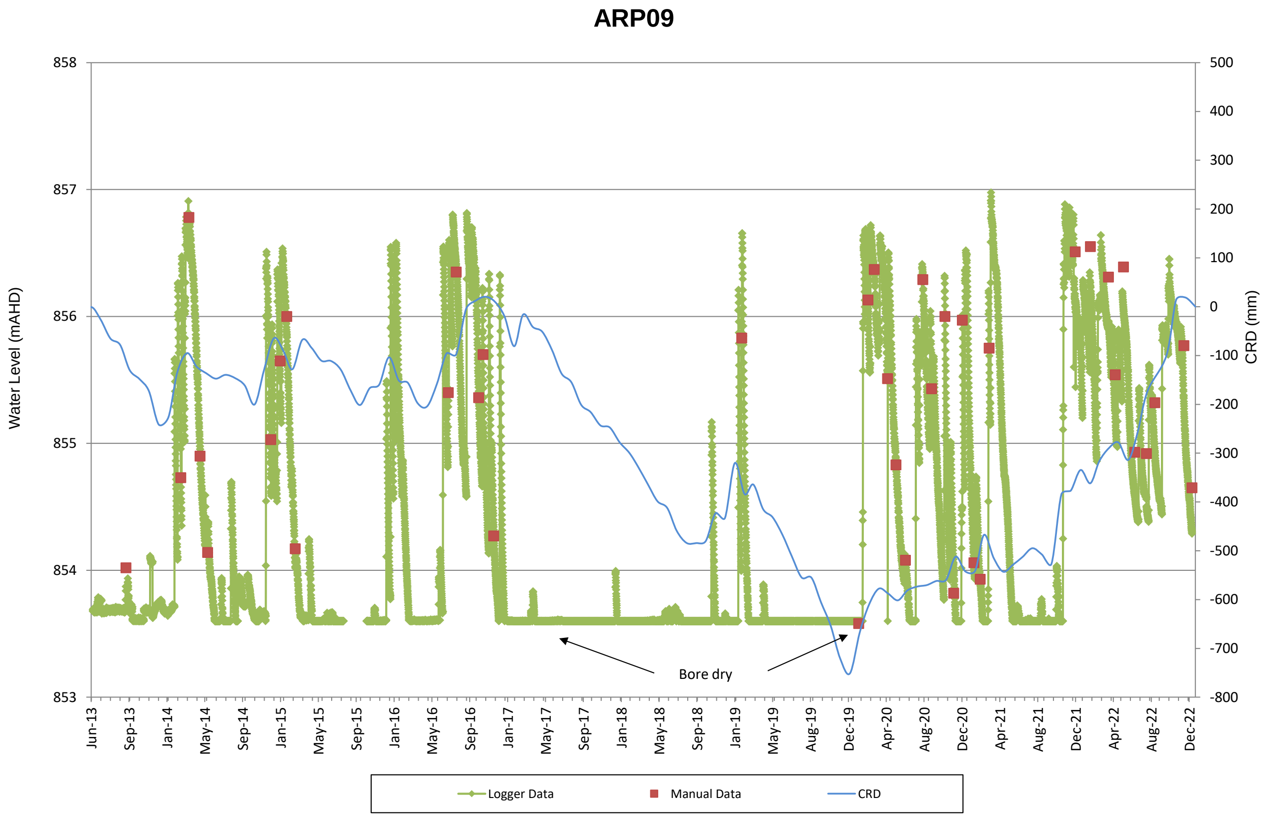

ARP06
Water Level (mAHD)
880
860
840
820
800
780
760
740
720
May-13
Jan-14
Sep-14
May-15
Jan-16
Sep-16
May-17
Jan-18
Oct-18
Jun-19
Feb-20
Oct-20
Jun-21
Install Level
Dysfunctional loggers in 2018-19
Dysfunctional loggers in 2018-19
Narrabeen
Irondale
Lithgow Seam
Marrangaroo Formation
Narrabeen Trigger

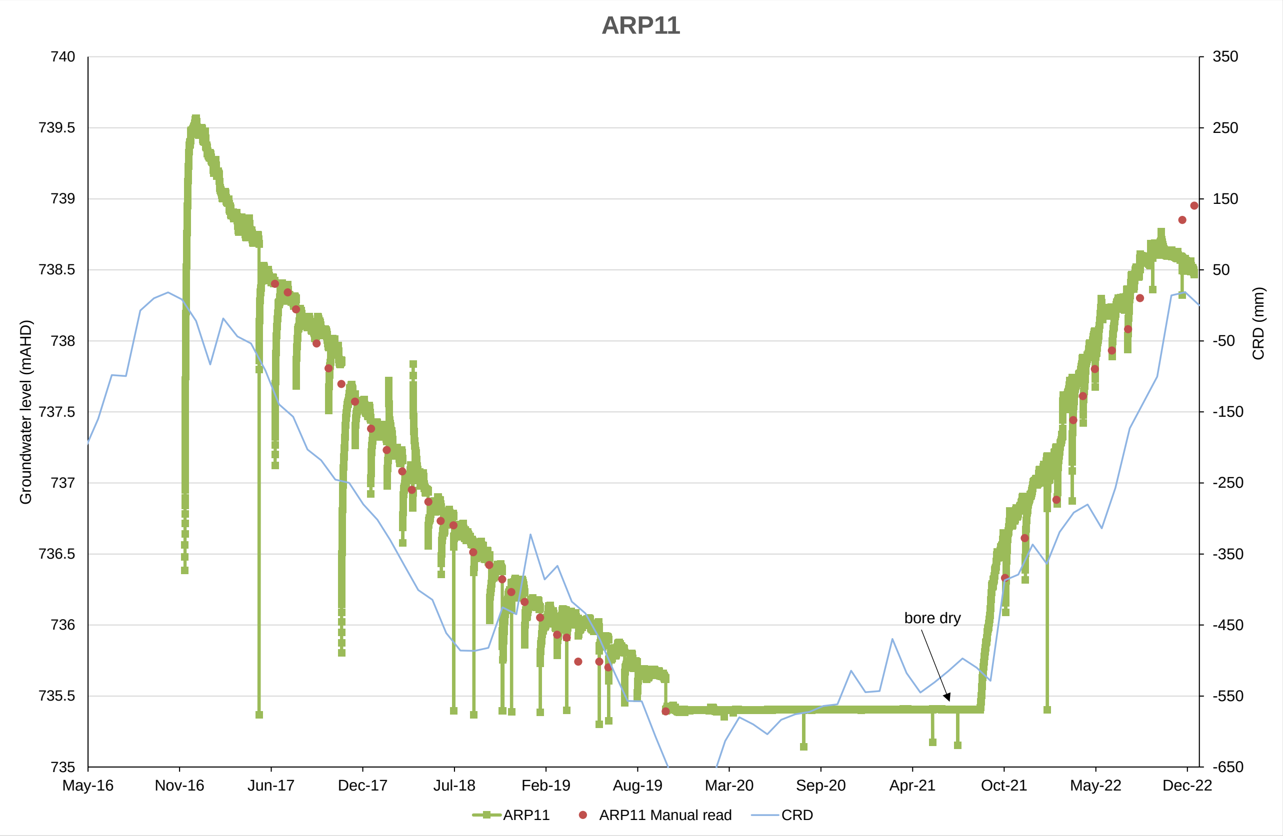

ARP07
Water Level (mAHD)
860
840
820
800
780
760
740
720
Install Level
Jul-13
Jan-14
Aug-14
Feb-15
Sep-15
Mar-16
Oct-16
May-17
Nov-17
Jun-18
Dec-18
Jul-19
Jan-20
Aug-20
Mar-21
Sep-21
Middle River Seam
Lithgow Seam

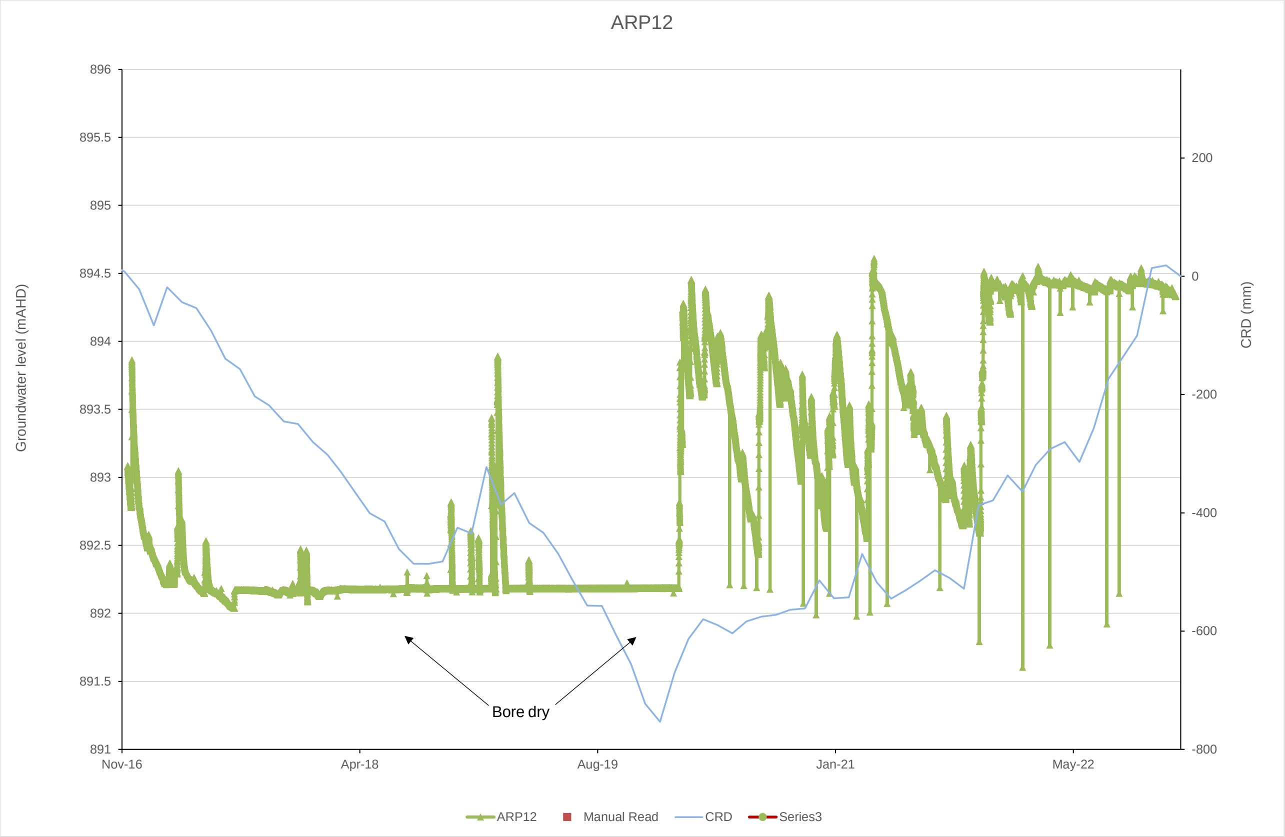

Water Level (mAHD)
884
882
880
878
876
874
872
870
Daily CRD (mm)
500
400
300
200
100
0
-100
-200
-300
-400
-500
piezometer is dry
Jul-13
Nov-14
Mar-16
Aug-17
Dec-18
May-20
Sep-21
Logger Data
CRD

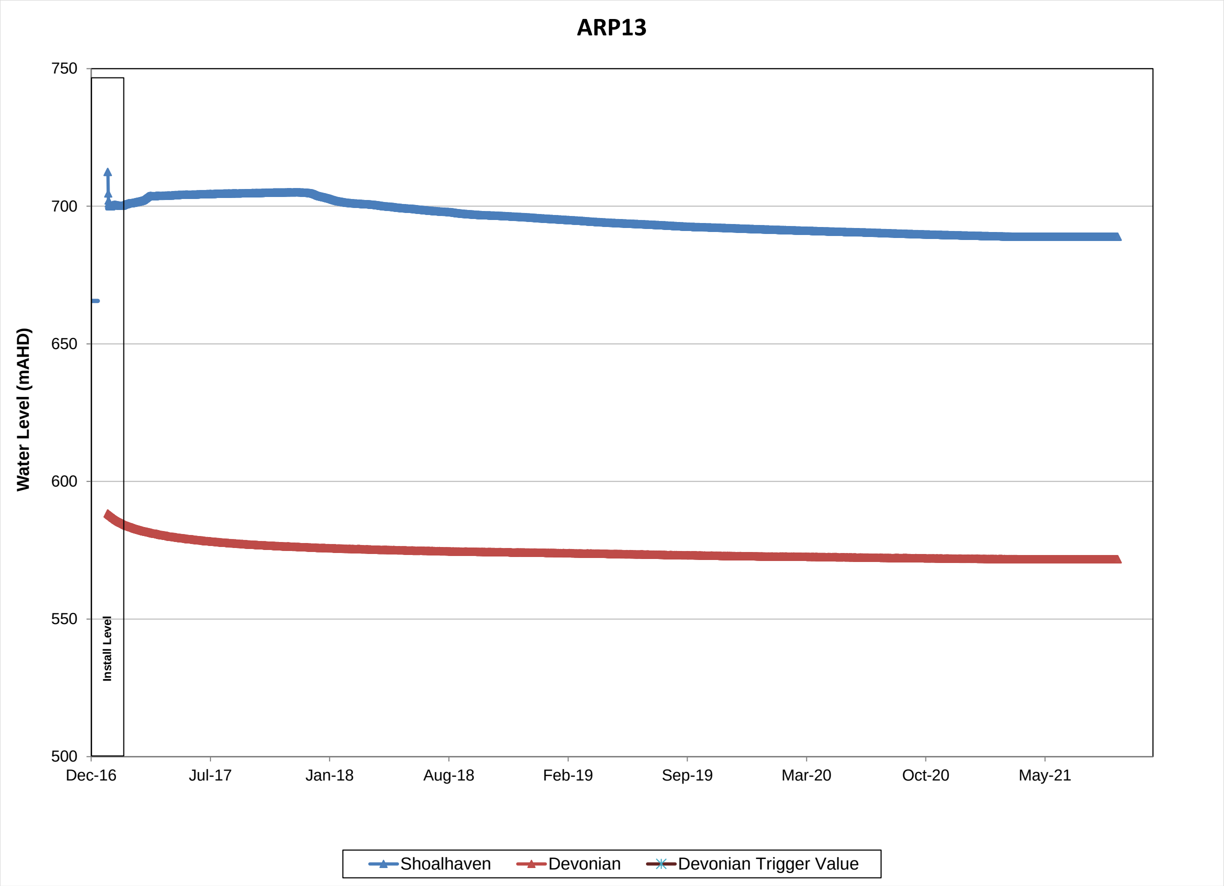

ARP08
Water Level (mAHD)
900
880
860
840
820
800
780
760
740
720
700
680
660
Sep-13
May-14
Jan-15
Oct-15
Jun-16
Mar-17
Nov-17
Aug-18
Apr-19
Jan-20
Sep-20
Jun-21
Install Level
Dysfunctional logger in 2020
Narrabeen Sandstone
Lower Irondale

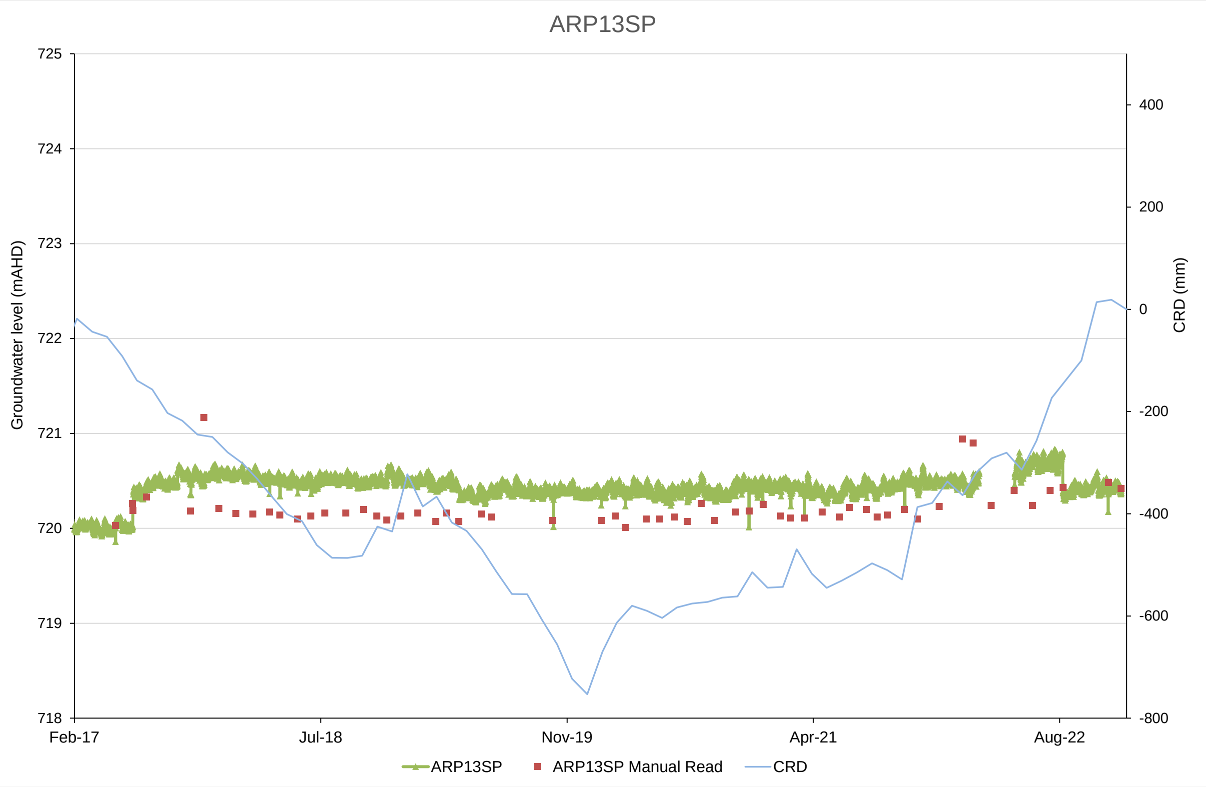

ARP08 SP
Water Level (mAHD)
795
790
785
780
775
770
765
760
755
750
745
740
400
200
0
-200
-400
-600
-800
May-13
Nov-13
May-14
Nov-14
May-15
Nov-15
May-16
Nov-16
May-17
Nov-17
May-18
Oct-18
May-19
Oct-19
Apr-20
Oct-20
Apr-21
Oct-21
Apr-22
Oct-22
Water level increase from February 2020
WL recovery 2020
Logger removed to undertake bore testing works
Logger Data
Manual Data
CRD

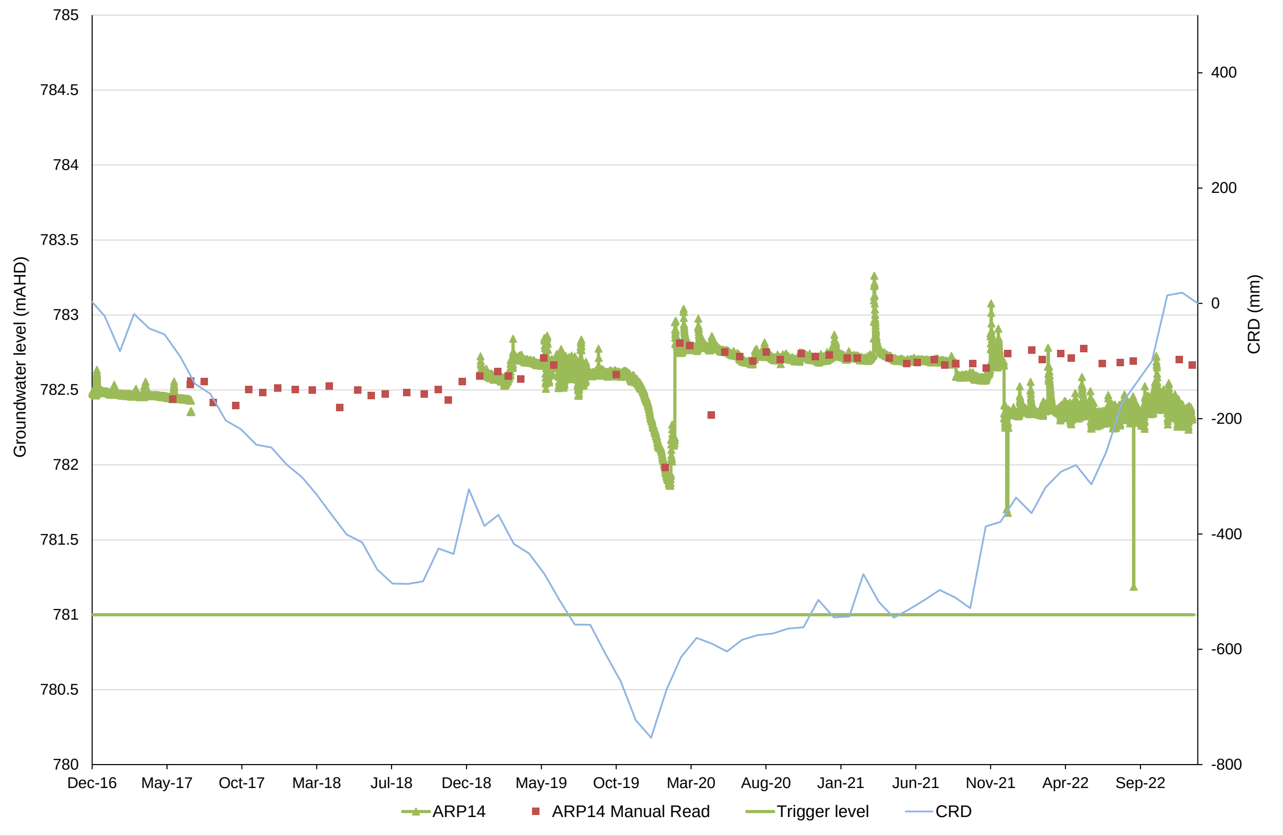

ARP09
Water Level (mAHD)
858
857
856
855
854
853
CRD (mm)
500
400
300
200
100
0
-100
-200
-300
-400
-500
-600
-700
-800
Jun-13
Sep-13
Jan-14
May-14
Sep-14
Jan-15
May-15
Sep-15
Jan-16
May-16
Sep-16
Jan-17
May-17
Sep-17
Jan-18
May-18
Sep-18
Jan-19
May-19
Aug-19
Dec-19
Apr-20
Aug-20
Dec-20
Apr-21
Aug-21
Dec-21
Apr-22
Aug-22
Dec-22
Bore dry
Logger Data
Manual Data
CRD

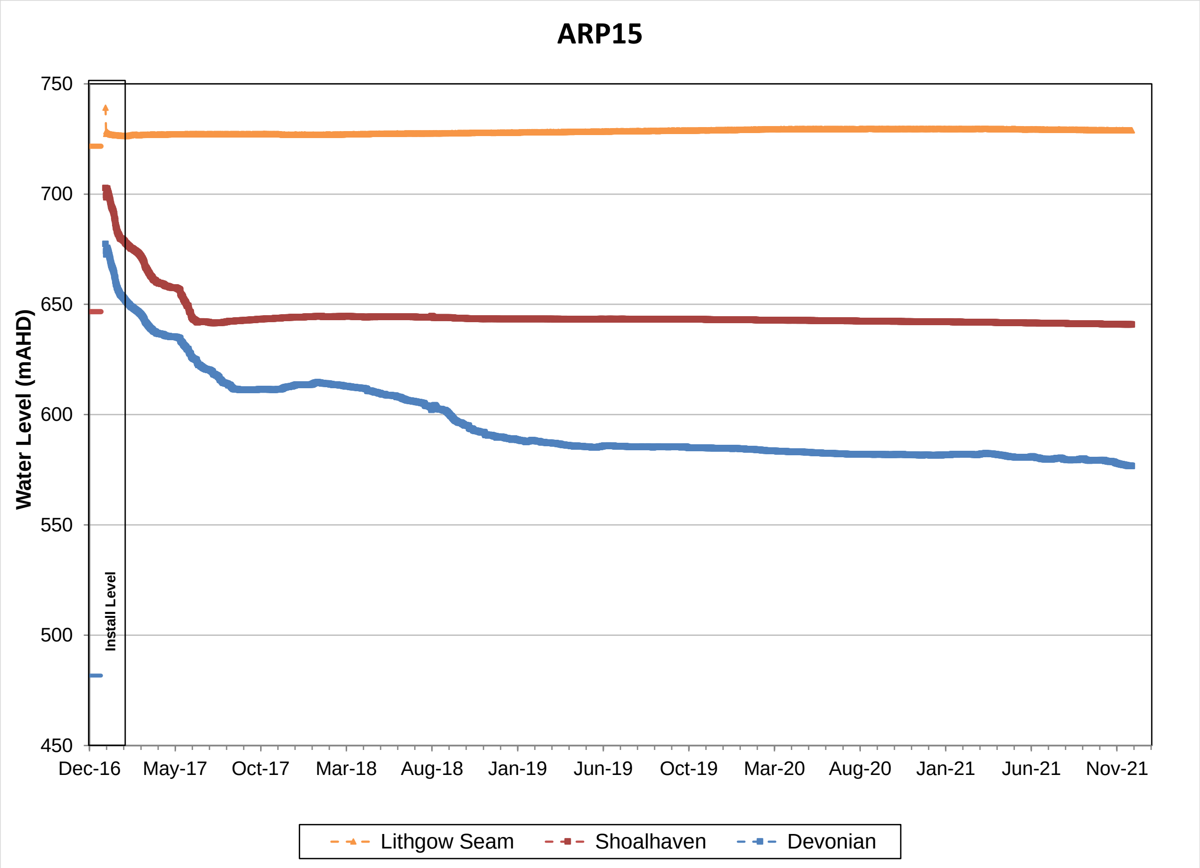

ARP11
Groundwater level (mAHD)
740
739.5
739
738.5
738
737.5
737
736.5
736
735.5
735
CRD (mm)
350
250
150
50
-50
-150
-250
-350
-450
-550
-650
May-16
Nov-16
Jun-17
Dec-17
Jul-18
Feb-19
Aug-19
Mar-20
Sep-20
Apr-21
Oct-21
May-22
Dec-22
bore dry
ARP11
ARP11 Manual read
CRD


ARP12
Groundwater level (mAHD)
896
895.5
895
894.5
894
893.5
893
892.5
892
891.5
891
CRD (mm)
200
0
-200
-400
-600
-800
Nov-16
Apr-18
Aug-19
Jan-21
May-22
Bore dry
ARP12
Manual Read
CRD
Series3

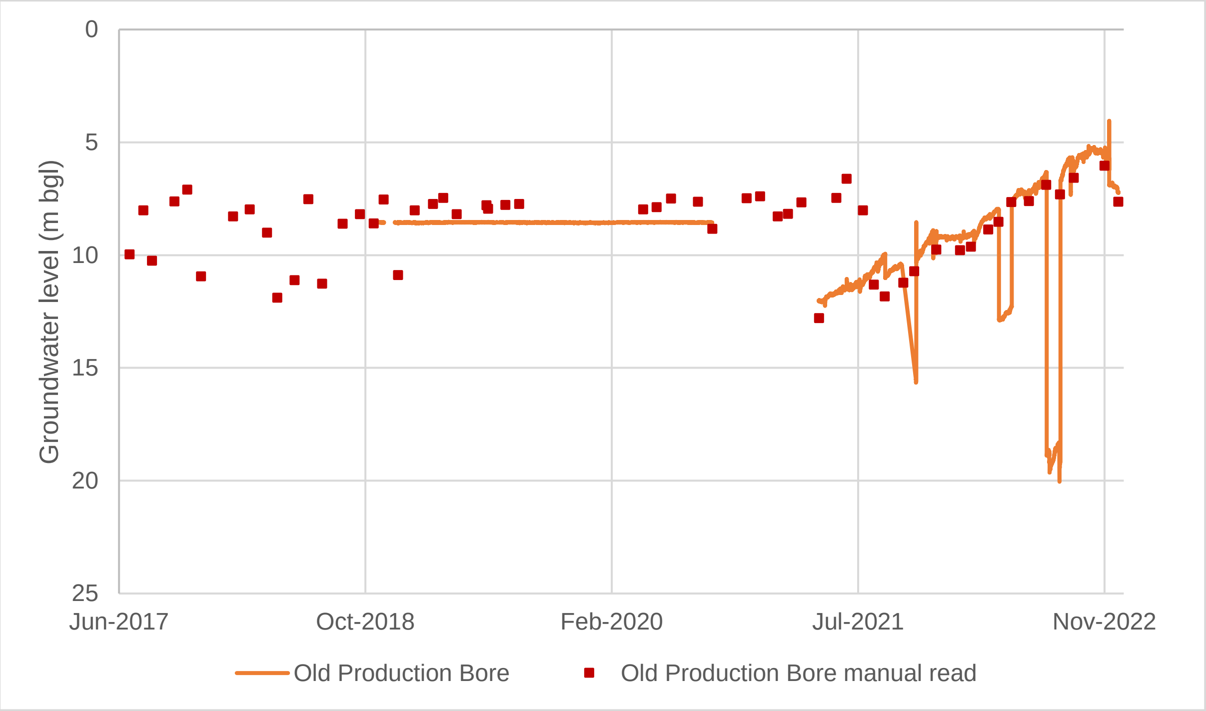

ARP13
Water Level (mAHD)
750
700
650
600
550
500
Install Level
Dec-16
Jul-17
Jan-18
Aug-18
Feb-19
Sep-19
Mar-20
Oct-20
May-21
Shoalhaven
Devonian
Devonian Trigger Value


ARP13SP
Groundwater level (mAHD)
725
724
723
722
721
720
719
718
CRD (mm)
400
200
0
-200
-400
-600
-800
Feb-17
Jul-18
Nov-19
Apr-21
Aug-22
ARP13SP
ARP13SP Manual Read
CRD


Groundwater level (mAHD)
785
784.5
784
783.5
783
782.5
782
781.5
781
780.5
780
CRD (mm)
400
200
0
-200
-400
-600
-800
Dec-16
May-17
Oct-17
Mar-18
Jul-18
Dec-18
May-19
Oct-19
Mar-20
Aug-20
Jan-21
Jun-21
Nov-21
Apr-22
Sep-22
ARP14
ARP14 Manual Read
Trigger level
CRD


ARP15
Water Level (mAHD)
750
700
650
600
550
500
450
Install Level
Dec-16
May-17
Oct-17
Mar-18
Aug-18
Jan-19
Jun-19
Oct-19
Mar-20
Aug-20
Jan-21
Jun-21
Nov-21
Lithgow Seam
Shoalhaven
Devonian


Groundwater level (mAHD)
838
837
836
835
834
833
832
831
830
829
828
CRD (mm)
400
200
0
-200
-400
-600
-800
Dec-16
Apr-18
Sep-19
Jan-21
May-22
ARP15SP
ARP15SP Manual Read
Trigger value
CRD

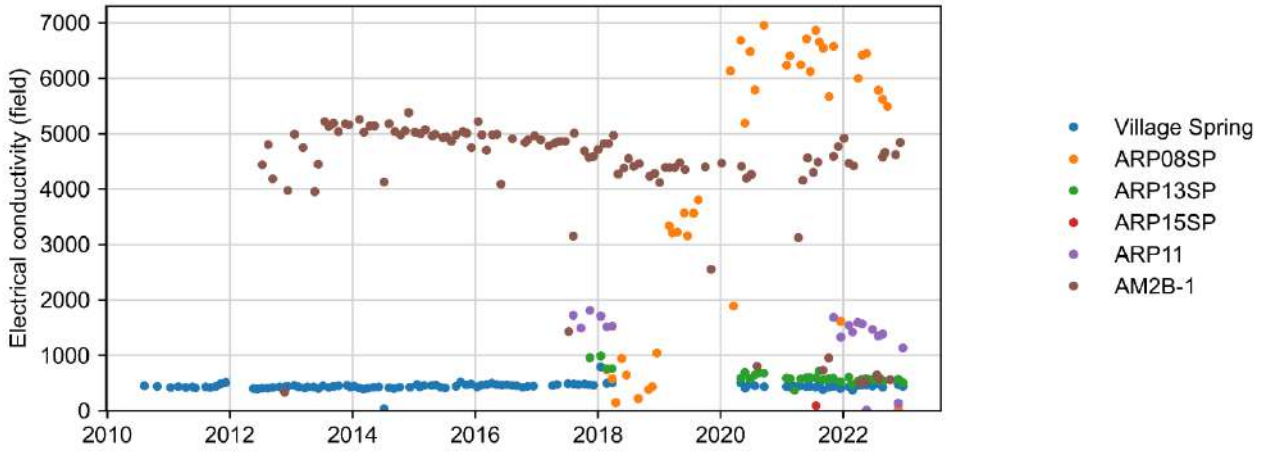

Groundwater level (m bgl)
0
5
10
15
20
25
Jun-2017
Oct-2018
Feb-2020
Jul-2021
Nov-2022
Old Production Bore
Old Production Bore manual read

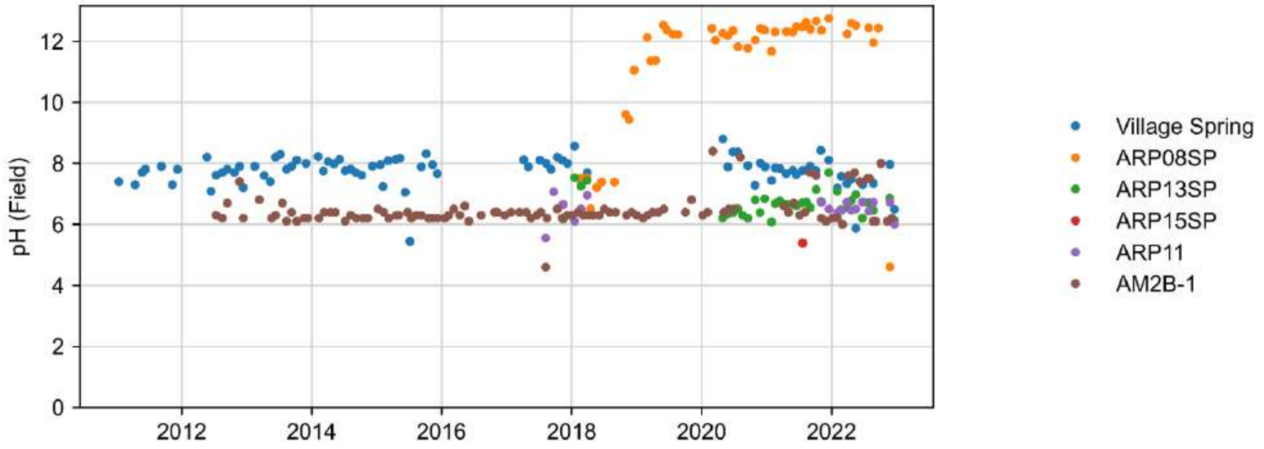
Appendix B

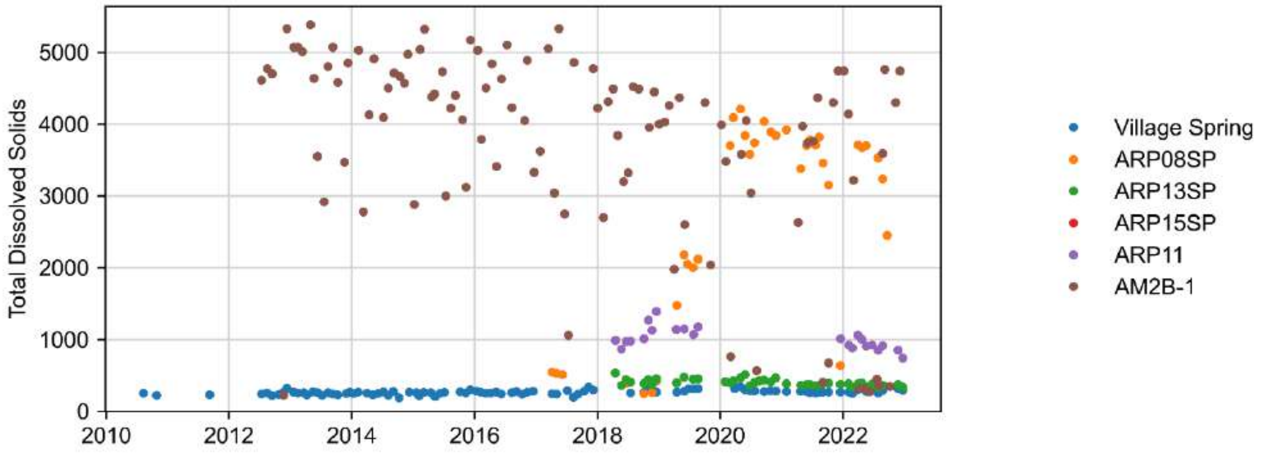
Water quality timeseries

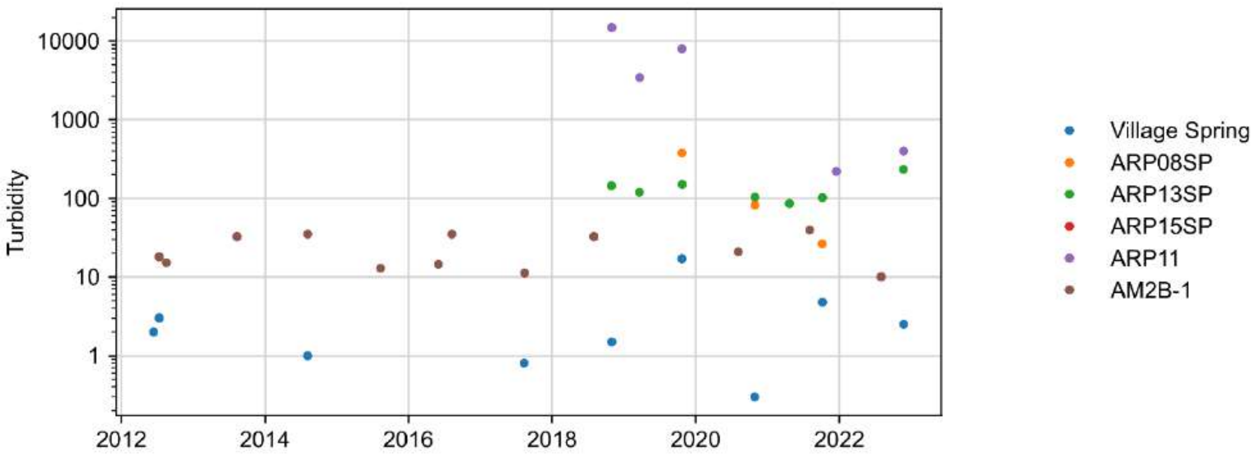
Fractured Rock groundwater bores

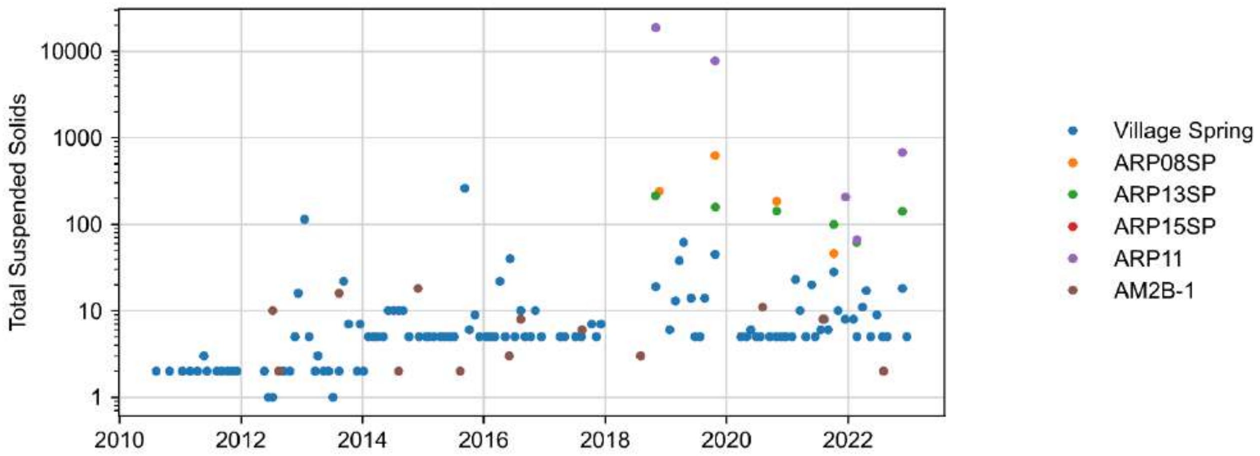
Physicochemical parameters

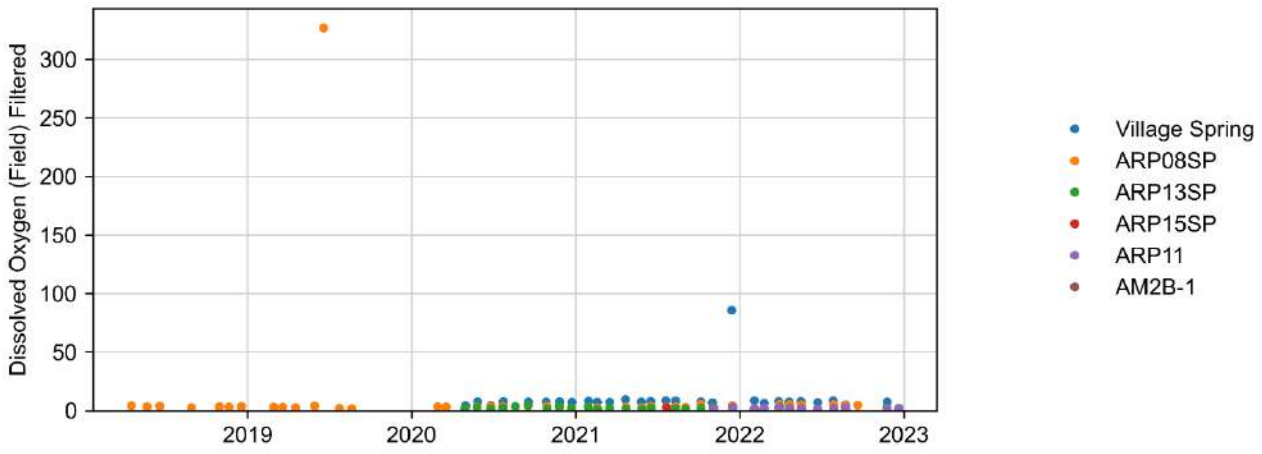


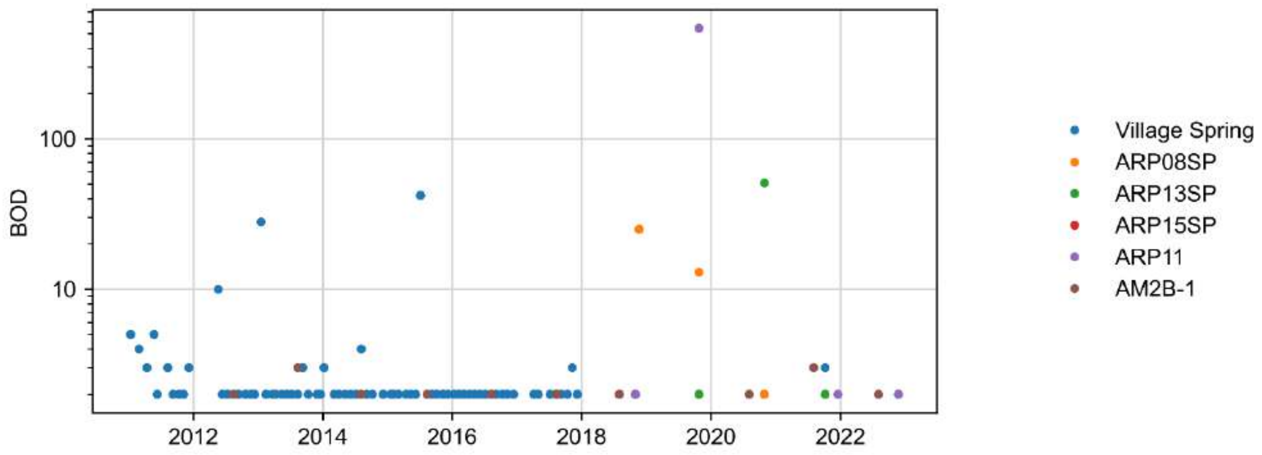




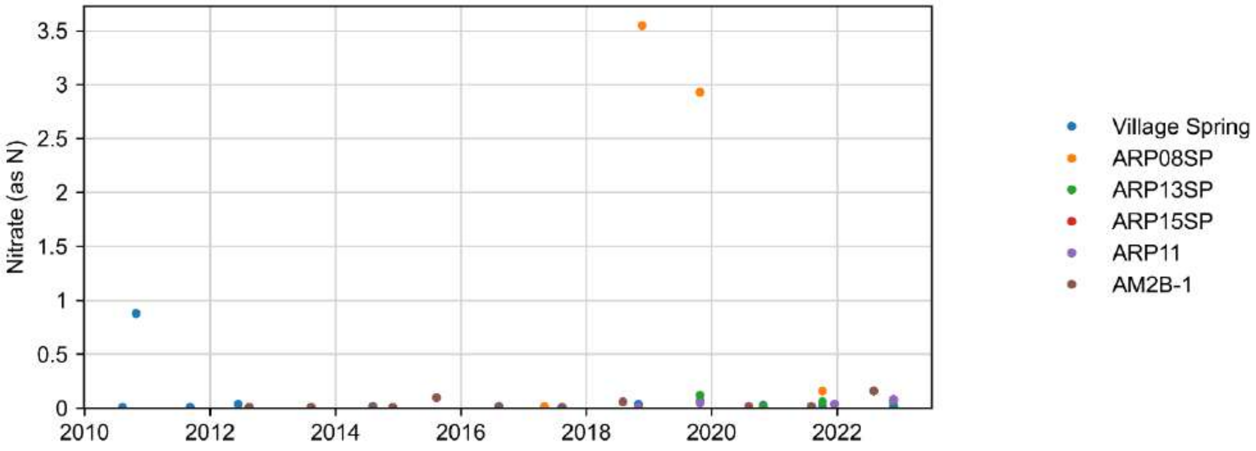

Turbidity
10000
1000
100
10
1
2012
2014
2016
2018
2020
2022
● Village Spring
● ARP08SP
● ARP13SP
● ARP15SP
● ARP11
● AM2B-1


Total Suspended Solids
10000
1000
100
10
1
2010
2012
2014
2016
2018
2020
2022
● Village Spring
● ARP08SP
● ARP13SP
● ARP15SP
● ARP11
● AM2B-1

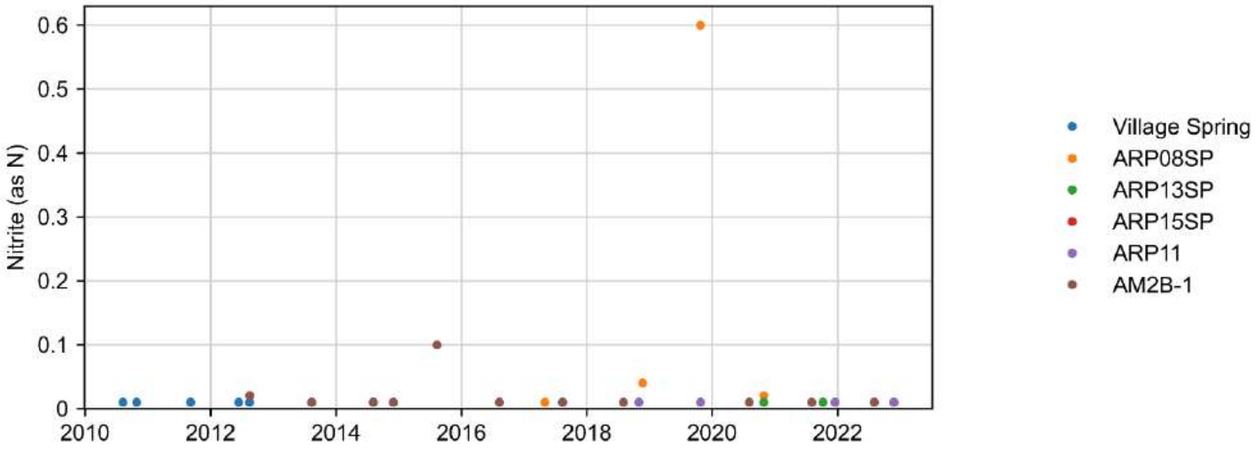

Dissolved Oxygen (Field) Filtered
300
250
200
150
100
50
0
2019
2020
2021
2022
2023
Village Spring
ARP08SP
ARP13SP
ARP15SP
ARP11
AM2B-1


BOD
100
10
2012
2014
2016
2018
2020
2022
Village Spring
ARP08SP
ARP13SP
ARP15SP
ARP11
AM2B-1

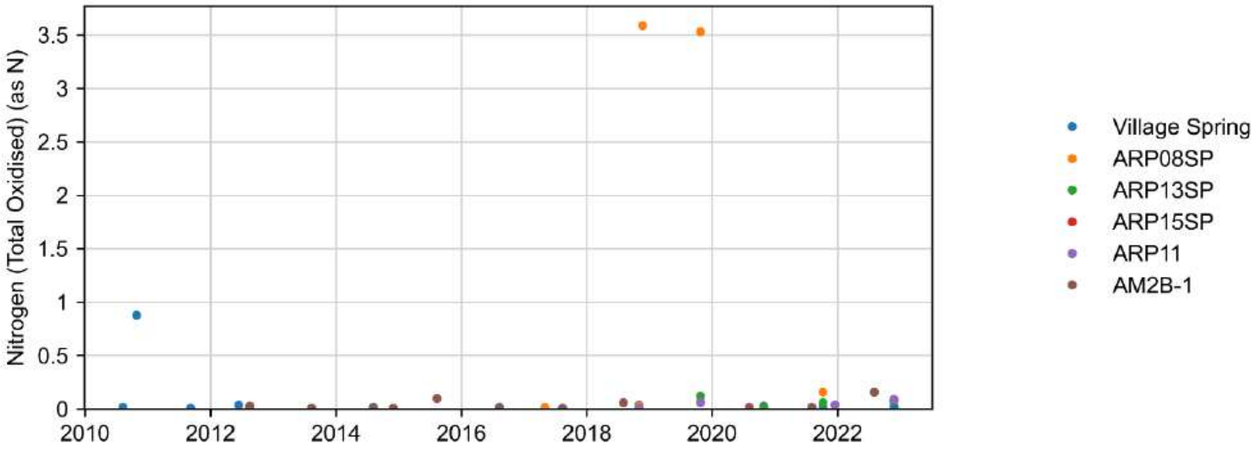
Nutrients



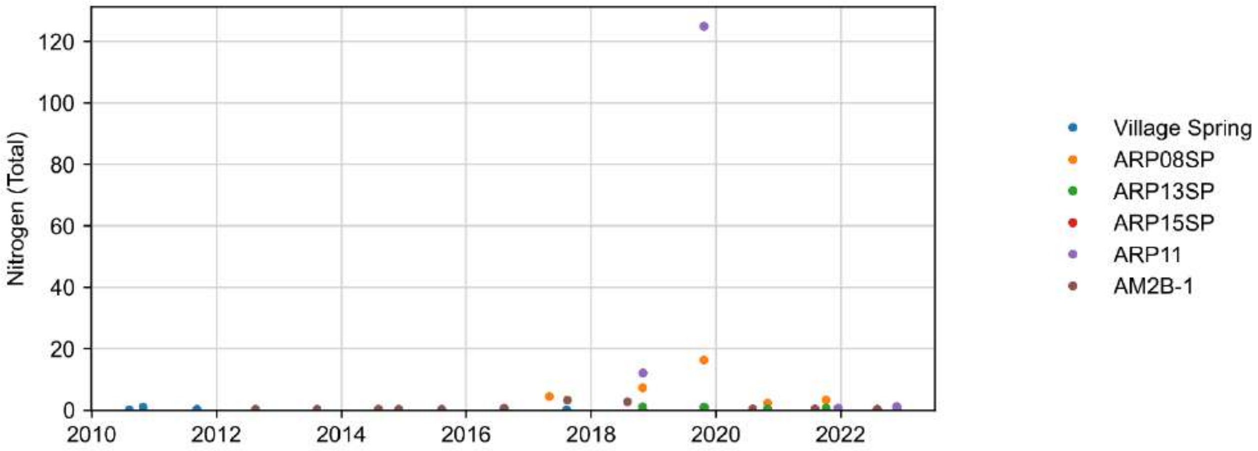
Nitrate (as N)
3.5
3
2.5
2
1.5
1
0.5
0
2010
2012
2014
2016
2018
2020
2022
Village Spring
ARP08SP
ARP13SP
ARP15SP
ARP11
AM2B-1



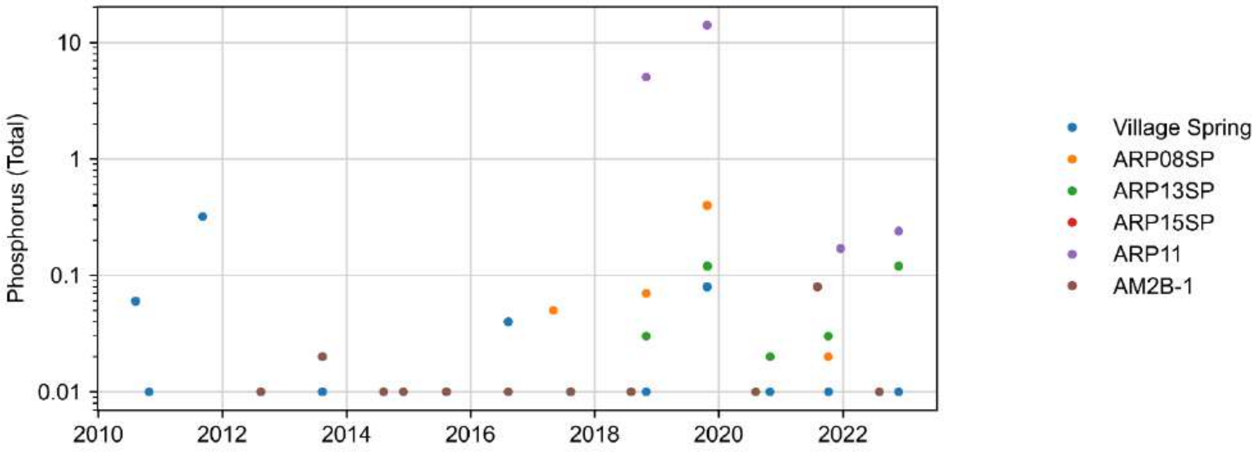
Nitrite (as N)
0.6
0.5
0.4
0.3
0.2
0.1
0
2010
2012
2014
2016
2018
2020
2022
Village Spring
ARP08SP
ARP13SP
ARP15SP
ARP11
AM2B-1



Nitrogen (Total Oxidised) (as N)
3.5
3
2.5
2
1.5
1
0.5
0
2010
2012
2014
2016
2018
2020
2022
Village Spring
ARP08SP
ARP13SP
ARP15SP
ARP11
AM2B-1

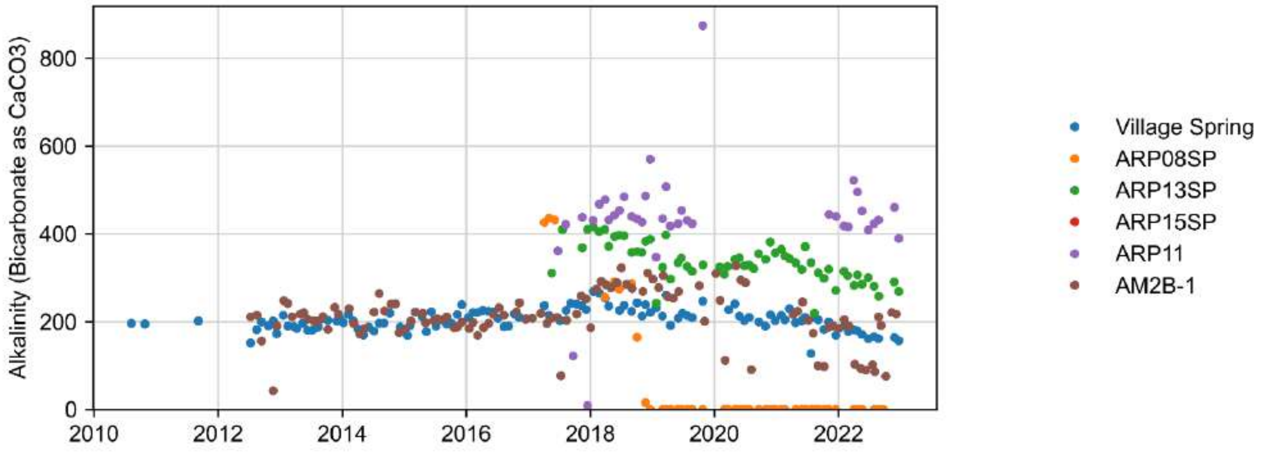


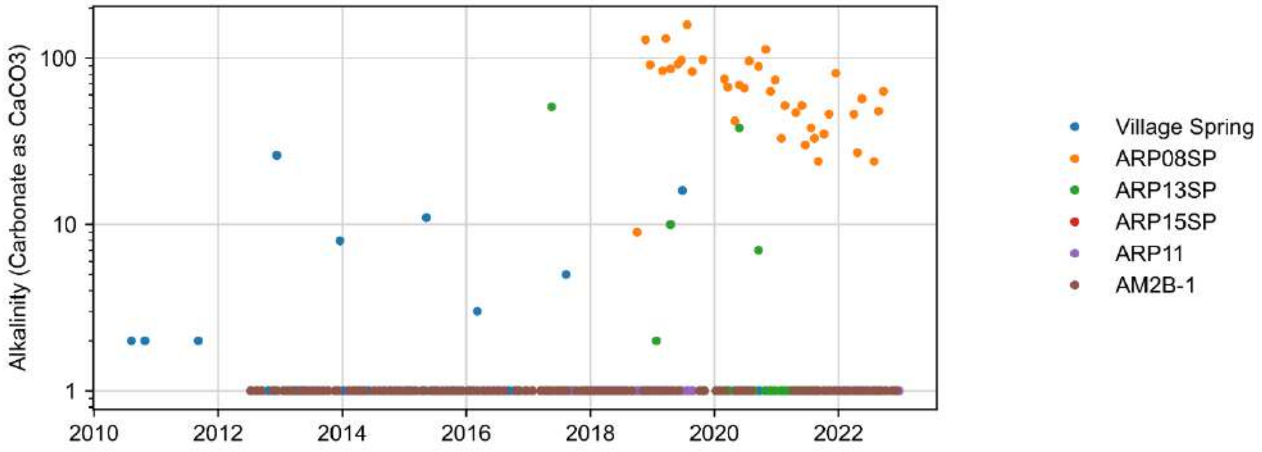
Nitrogen (Total)
120
100
80
60
40
20
0
2010
2012
2014
2016
2018
2020
2022
● Village Spring
● ARP08SP
● ARP13SP
● ARP15SP
● ARP11
● AM2B-1

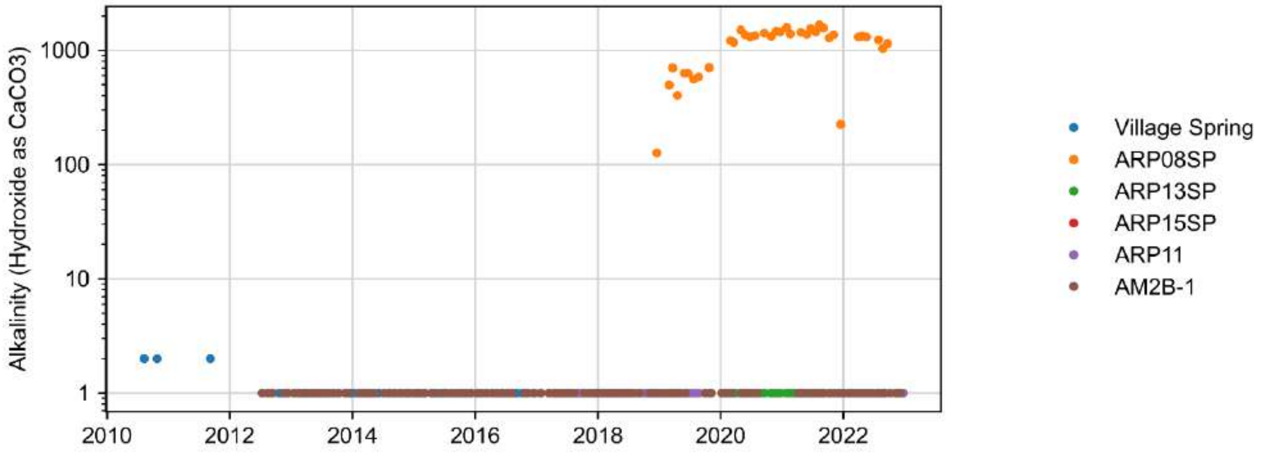


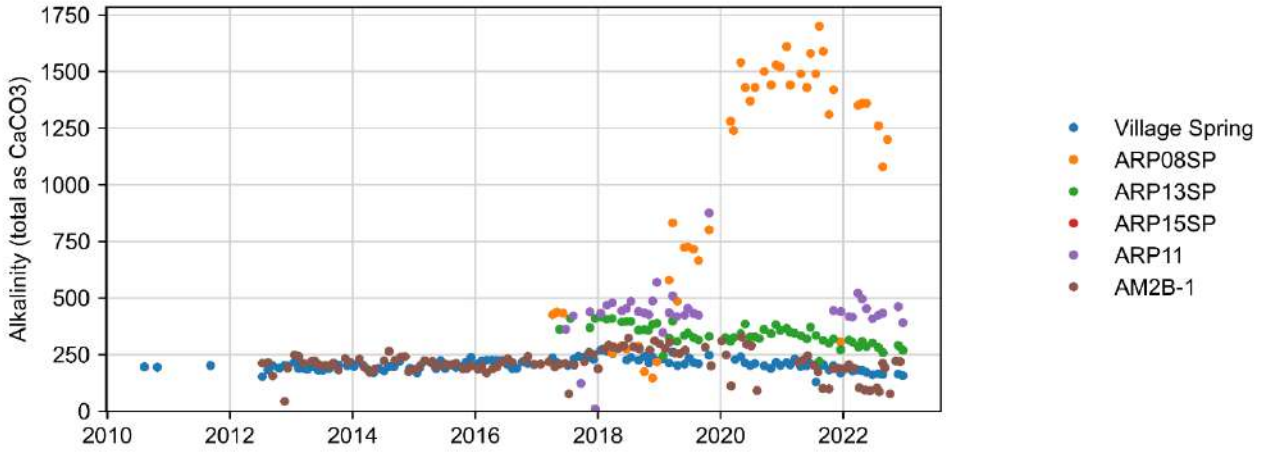
Phosphorus (Total)
10
1
0.1
0.01
2010
2012
2014
2016
2018
2020
2022
● Village Spring
● ARP08SP
● ARP13SP
● ARP15SP
● ARP11
● AM2B-1

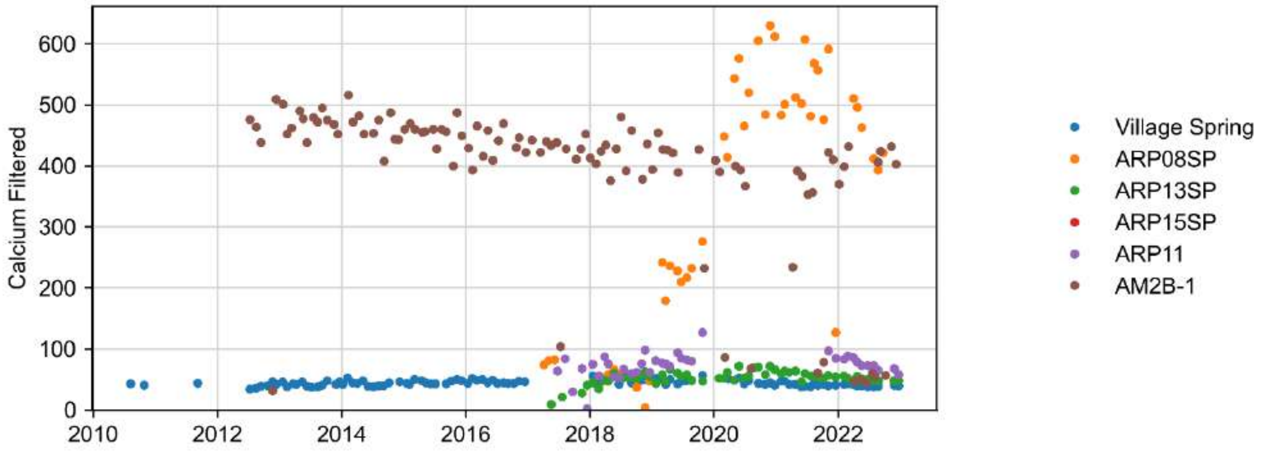
Major Ions

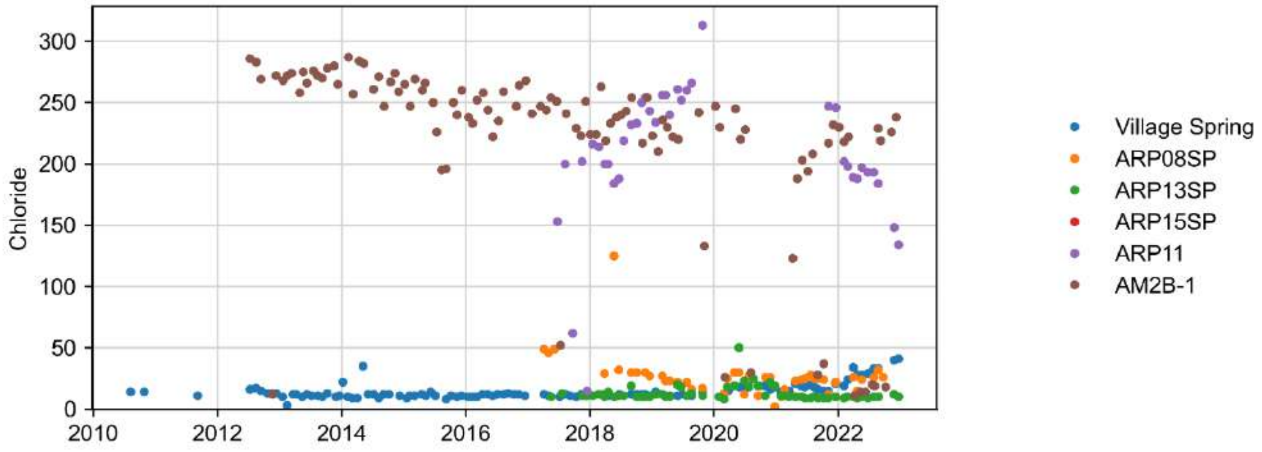

Alkalinity (Bicarbonate as CaCO3)
800
600
400
200
0
2010
2012
2014
2016
2018
2020
2022
● Village Spring
● ARP08SP
● ARP13SP
● ARP15SP
● ARP11
● AM2B-1

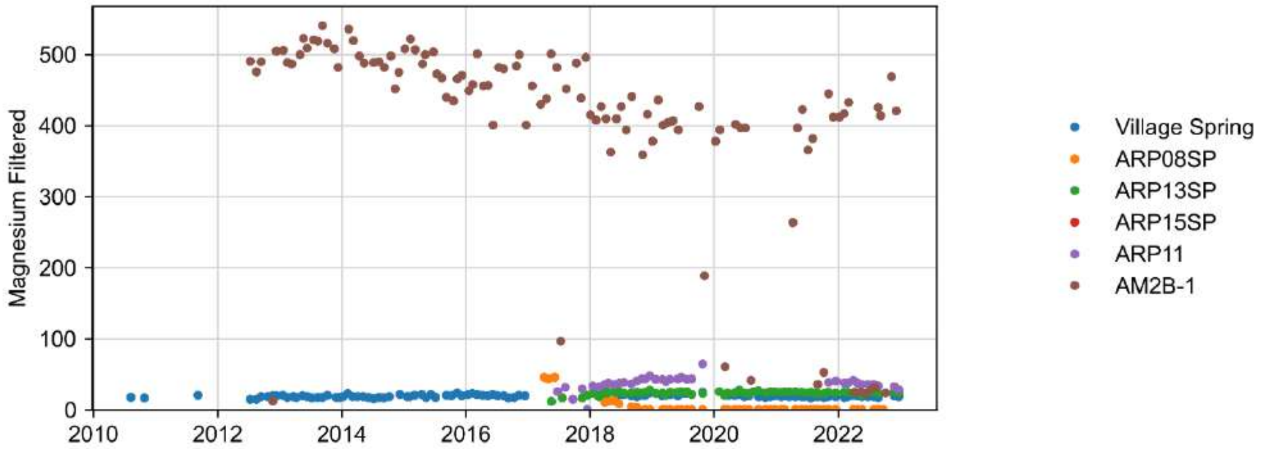

Alkalinity (Carbonate as CaCO3)
100
10
1
2010
2012
2014
2016
2018
2020
2022
● Village Spring
● ARP08SP
● ARP13SP
● ARP15SP
● ARP11
● AM2B-1

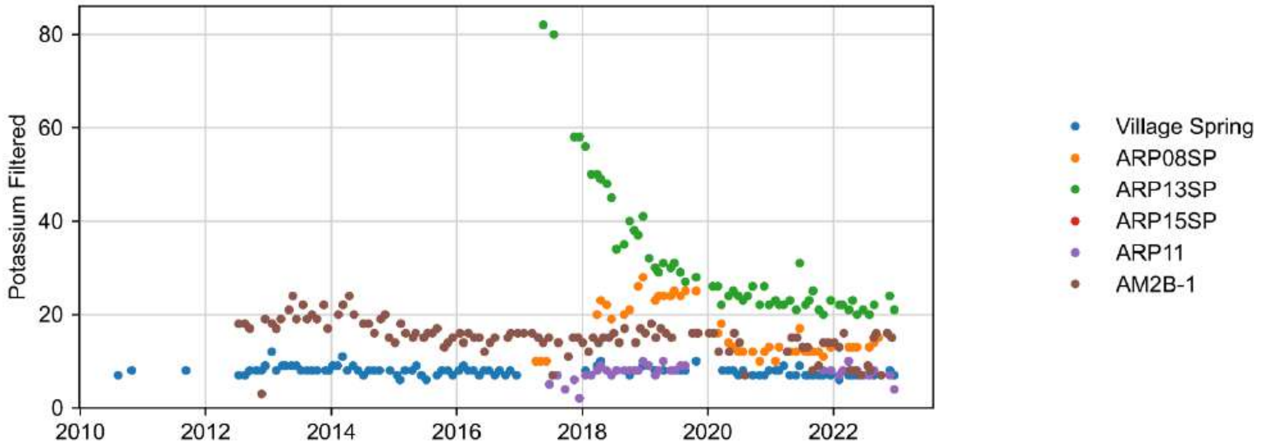

Alkalinity (Hydroxide as CaCO3)
1000
100
10
1
2010
2012
2014
2016
2018
2020
2022
● Village Spring
● ARP08SP
● ARP13SP
● ARP15SP
● ARP11
● AM2B-1

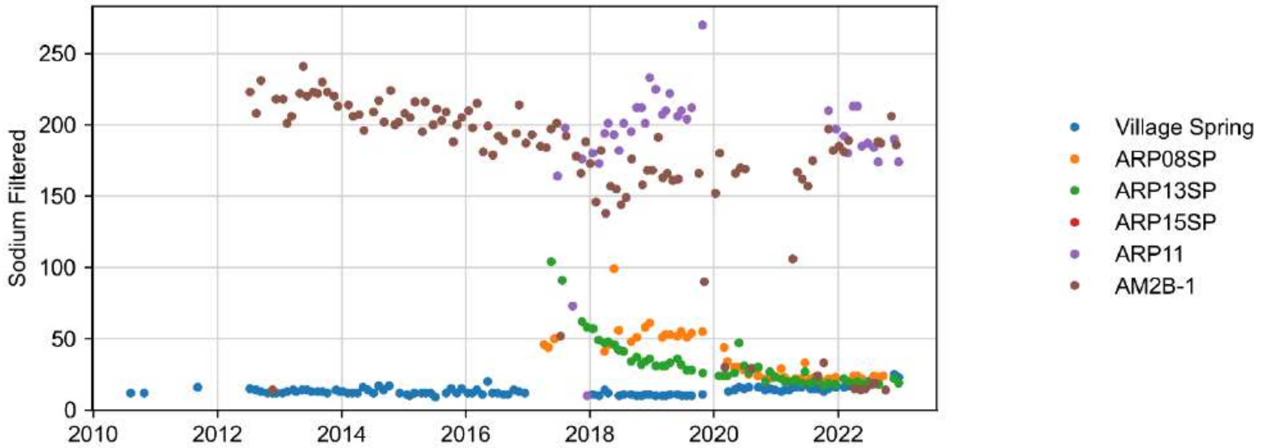

Alkalinity (total as CaCO3)
0
250
500
750
1000
1250
1500
1750
2010
2012
2014
2016
2018
2020
2022
● Village Spring
● ARP08SP
● ARP13SP
● ARP15SP
● ARP11
● AM2B-1

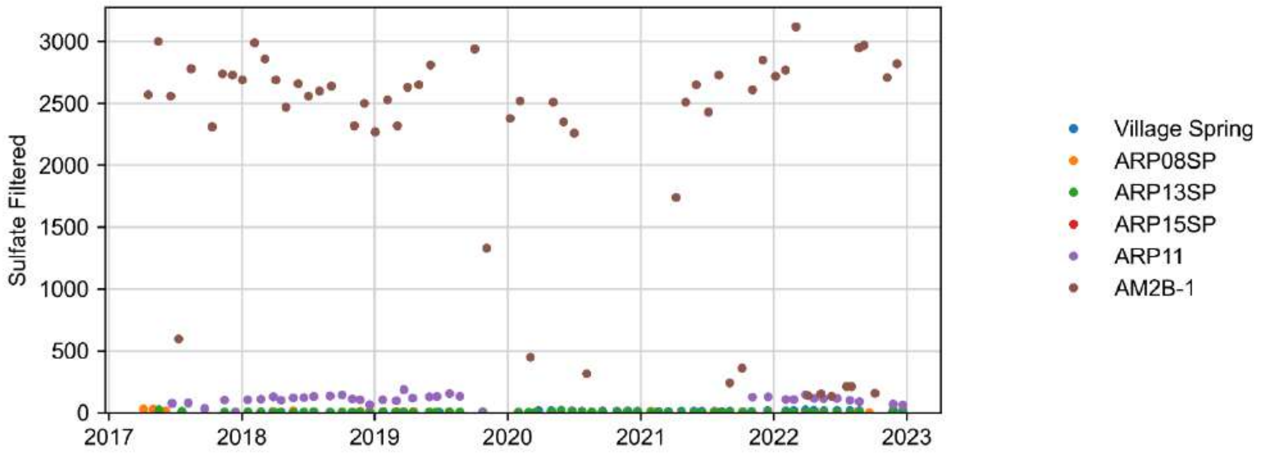

Calcium Filtered
0
100
200
300
400
500
600
2010
2012
2014
2016
2018
2020
2022
● Village Spring
● ARP08SP
● ARP13SP
● ARP15SP
● ARP11
● AM2B-1

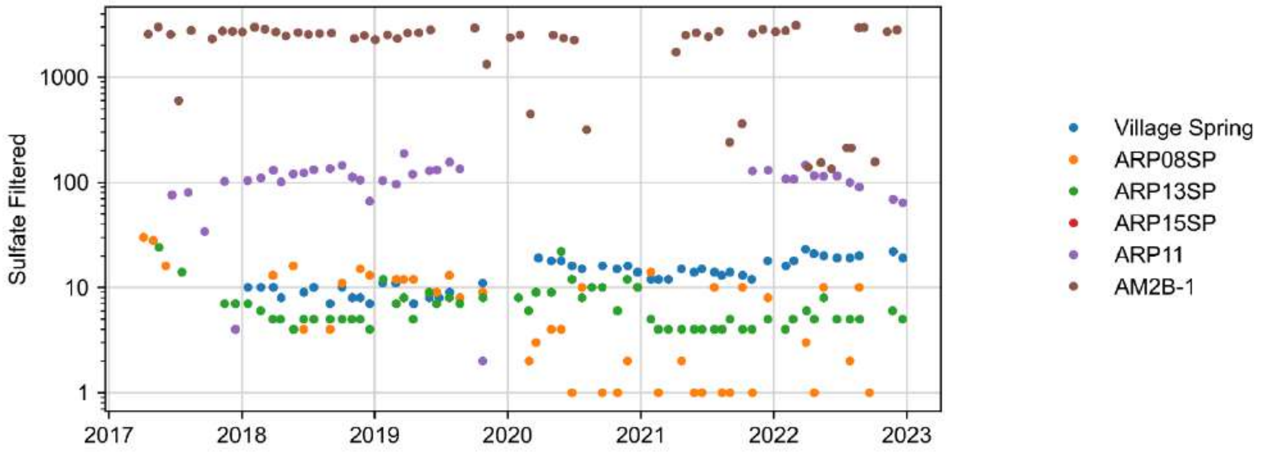

Chloride
0
50
100
150
200
250
300
2010
2012
2014
2016
2018
2020
2022
● Village Spring
● ARP08SP
● ARP13SP
● ARP15SP
● ARP11
● AM2B-1


Magnesium Filtered
0
100
200
300
400
500
2010
2012
2014
2016
2018
2020
2022
Village Spring
ARP08SP
ARP13SP
ARP15SP
ARP11
AM2B-1

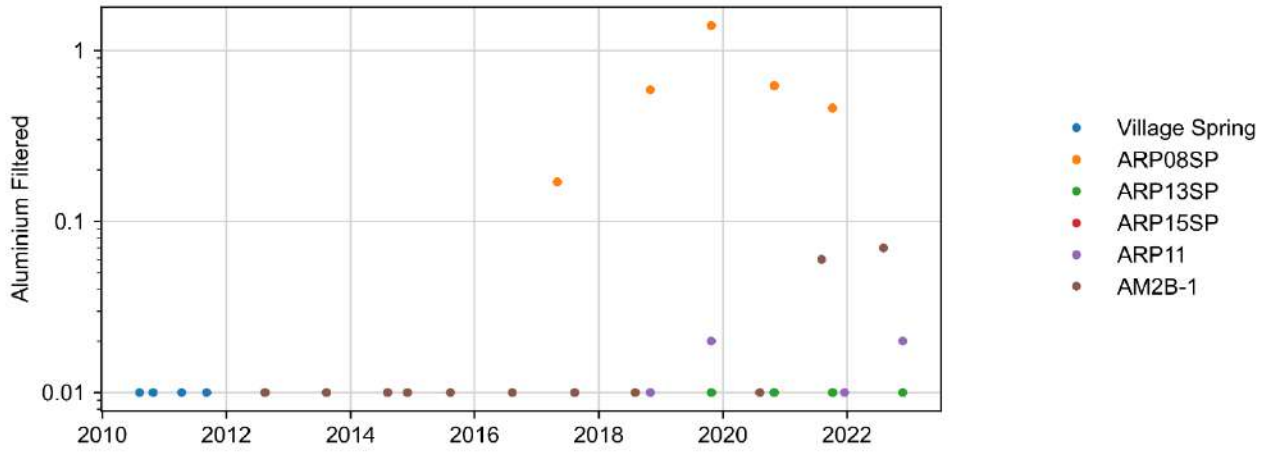

Potassium Filtered
0
20
40
60
80
2010
2012
2014
2016
2018
2020
2022
Village Spring
ARP08SP
ARP13SP
ARP15SP
ARP11
AM2B-1

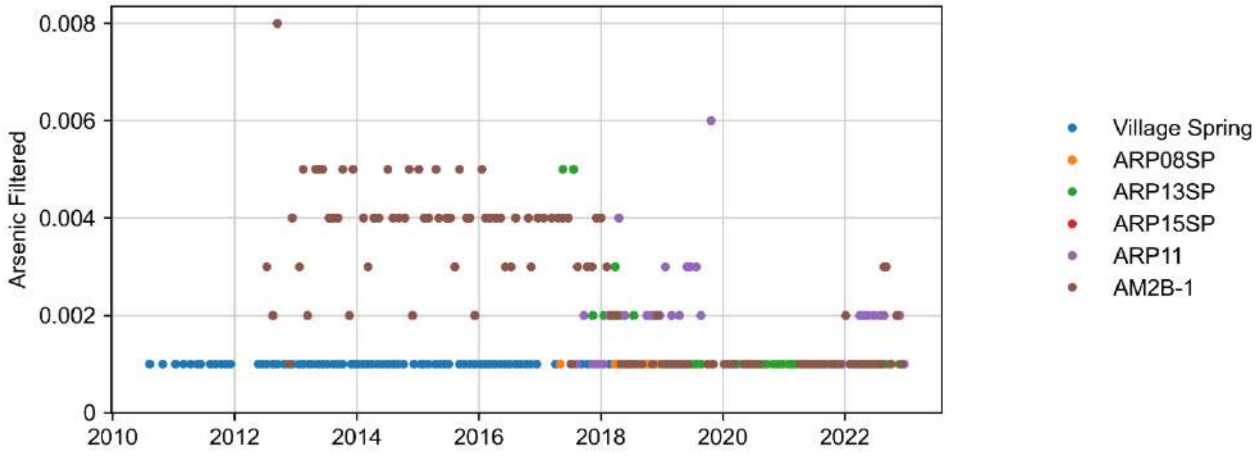

Sodium Filtered
0
50
100
150
200
250
2010
2012
2014
2016
2018
2020
2022
Village Spring
ARP08SP
ARP13SP
ARP15SP
ARP11
AM2B-1

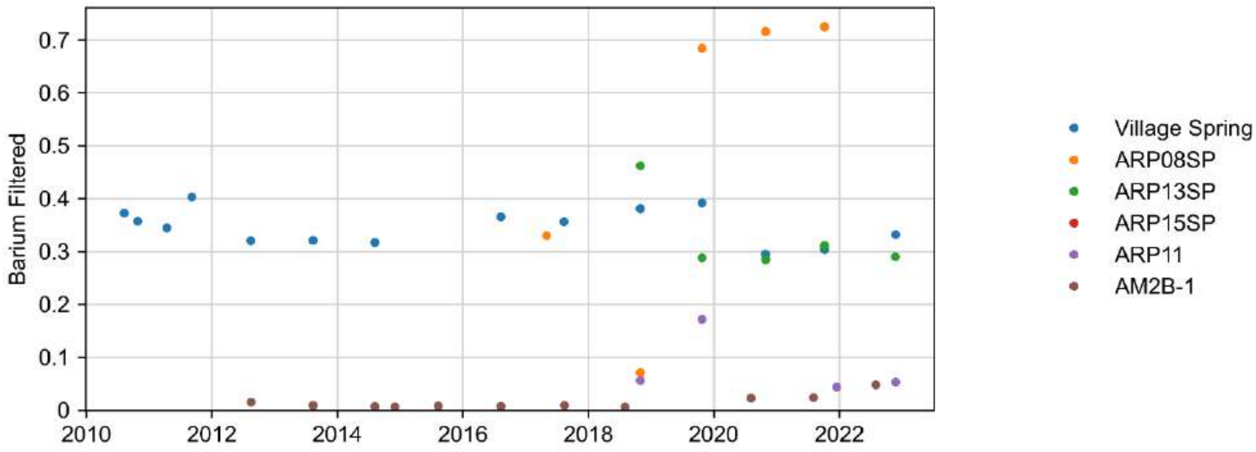

Sulfate Filtered
3000
2500
2000
1500
1000
500
0
2017
2018
2019
2020
2021
2022
2023
Village Spring
ARP08SP
ARP13SP
ARP15SP
ARP11
AM2B-1

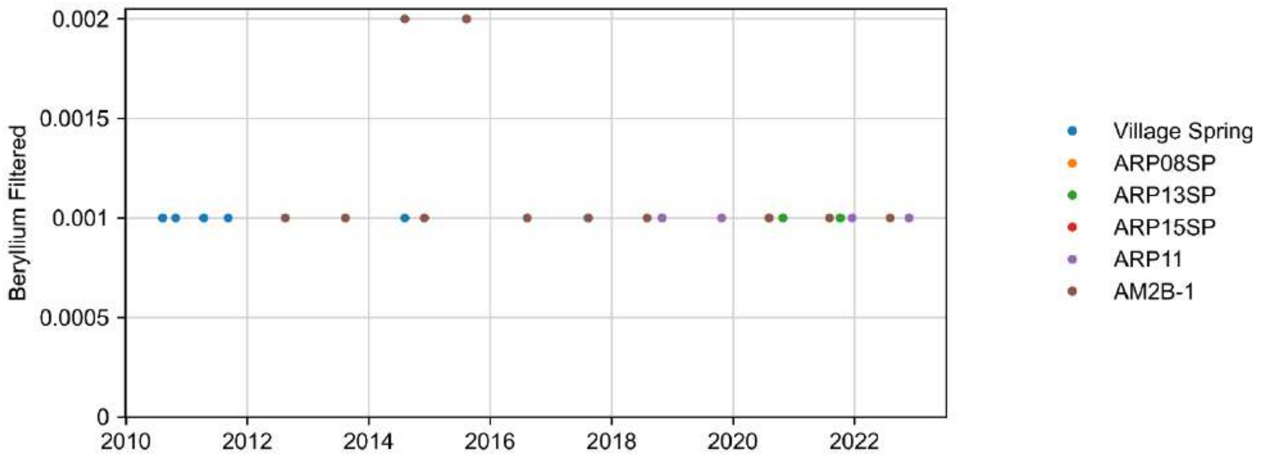

Sulfate Filtered
1000
100
10
1
2017
2018
2019
2020
2021
2022
2023
Village Spring
ARP08SP
ARP13SP
ARP15SP
ARP11
AM2B-1

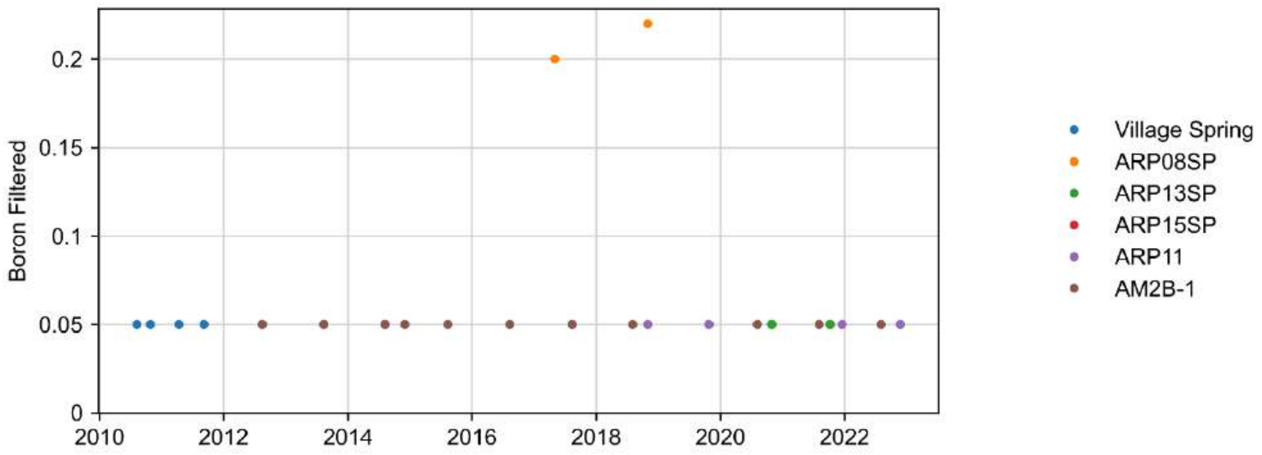
Metals (dissolved)

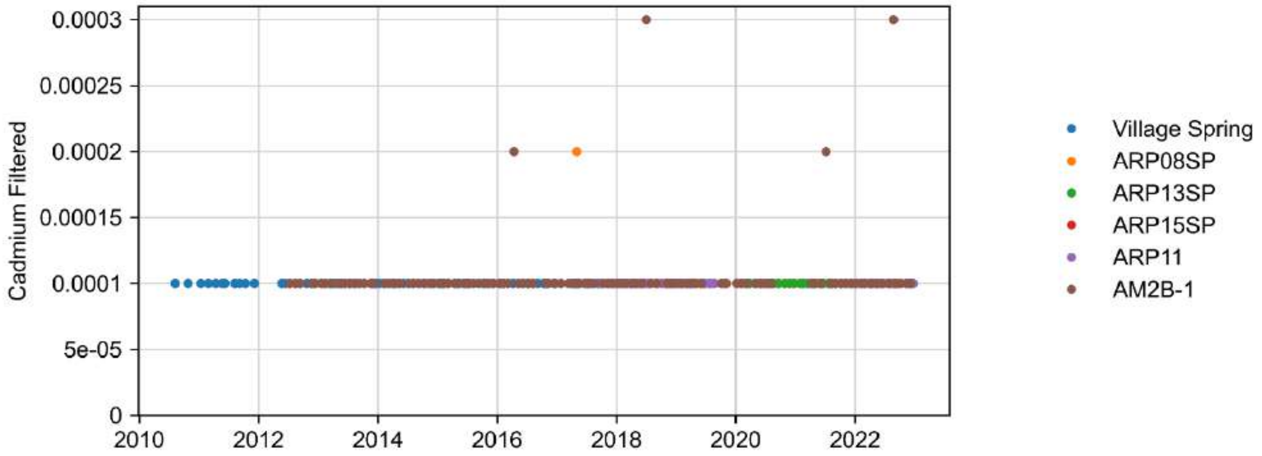


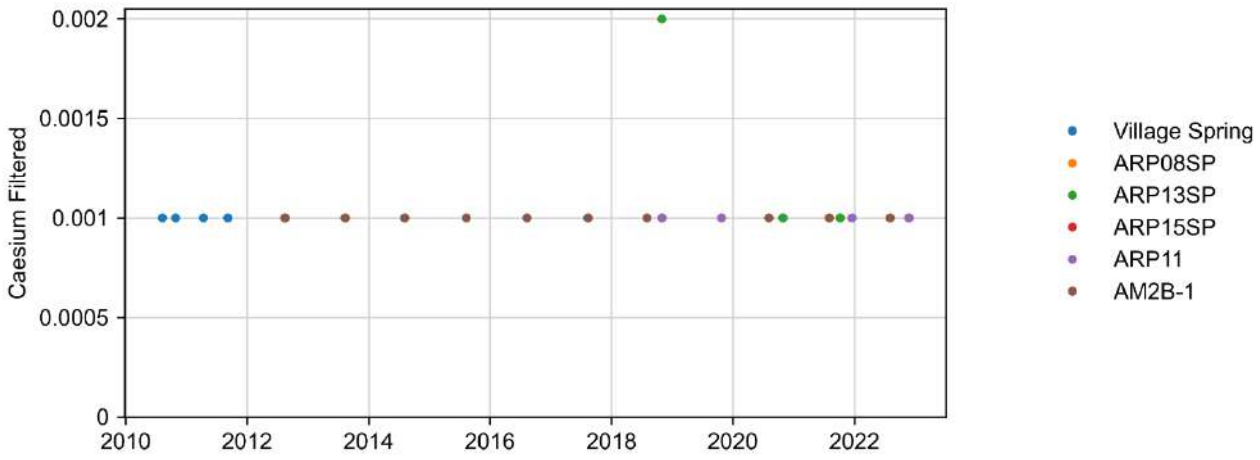


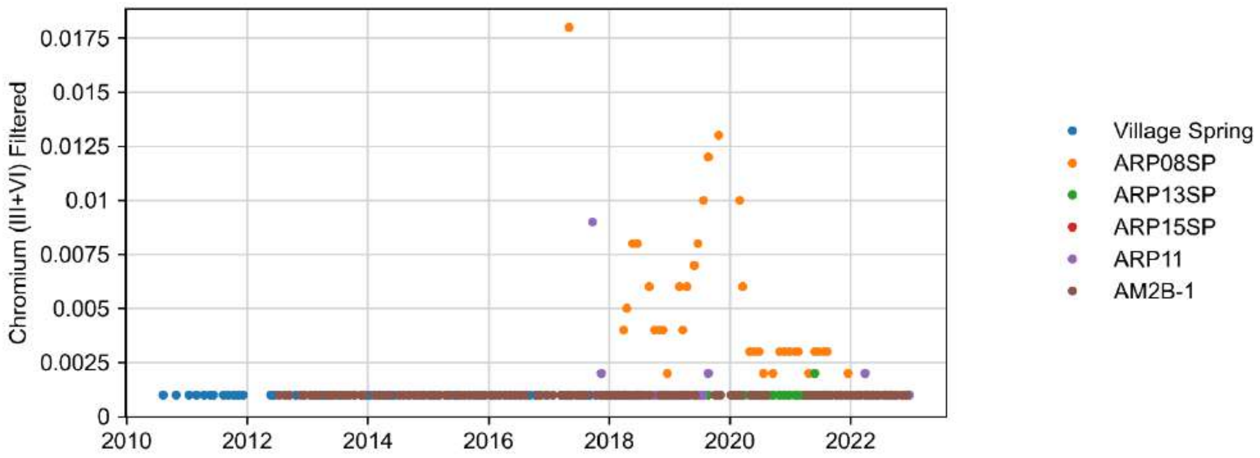


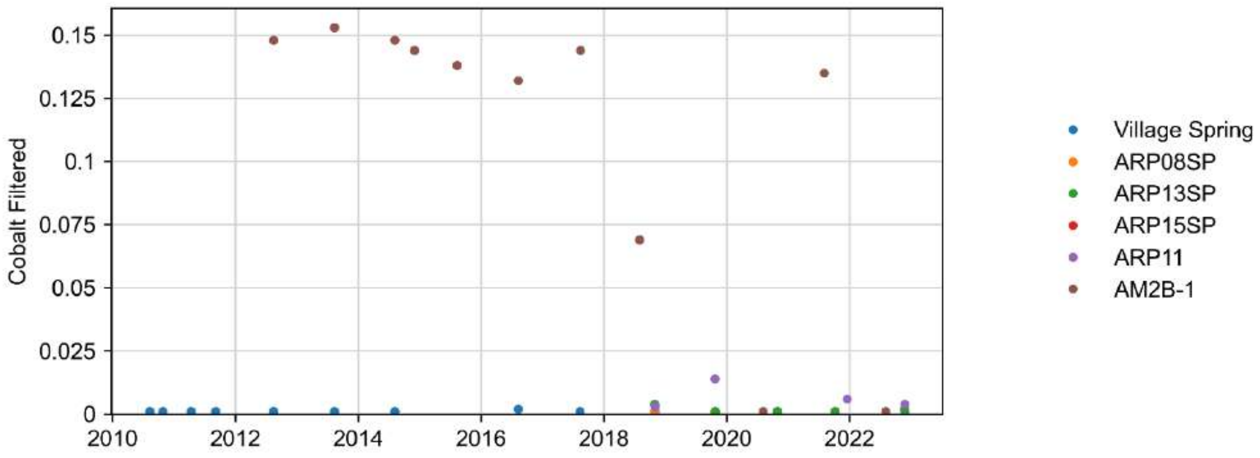

Beryllium Filtered
0.002
0.0015
0.001
0.0005
0
2010
2012
2014
2016
2018
2020
2022
● Village Spring
● ARP08SP
● ARP13SP
● ARP15SP
● ARP11
● AM2B-1

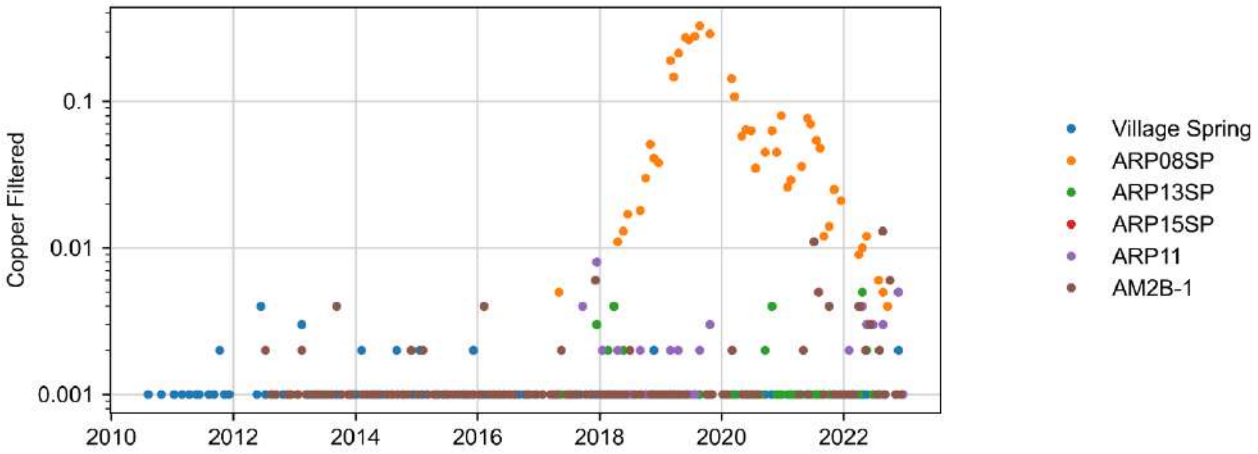

Boron Filtered
0.2
0.15
0.1
0.05
0
2010
2012
2014
2016
2018
2020
2022
● Village Spring
● ARP08SP
● ARP13SP
● ARP15SP
● ARP11
● AM2B-1

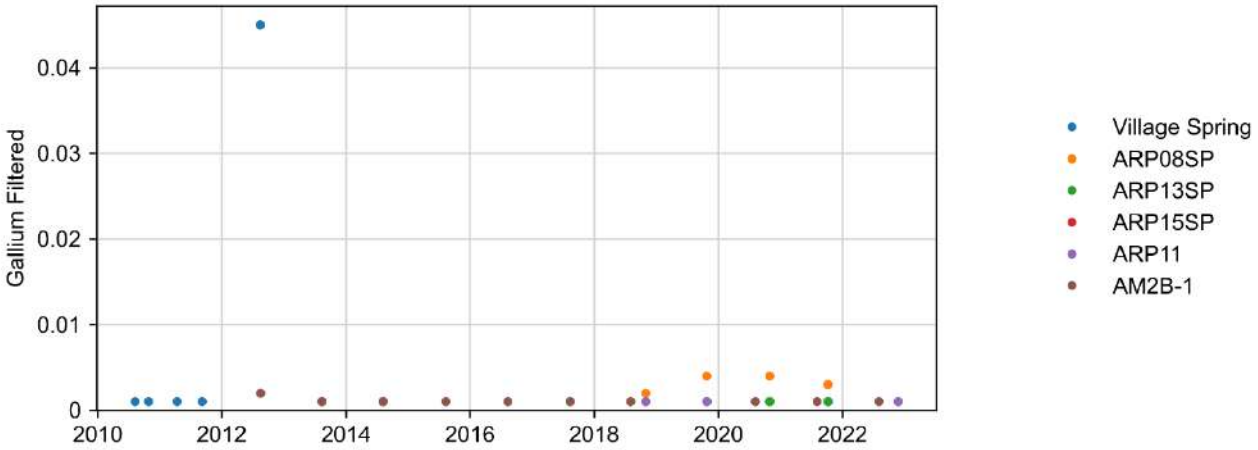

Cadmium Filtered
0.0003
0.00025
0.0002
0.00015
0.0001
5e-05
0
2010
2012
2014
2016
2018
2020
2022
● Village Spring
● ARP08SP
● ARP13SP
● ARP15SP
● ARP11
● AM2B-1

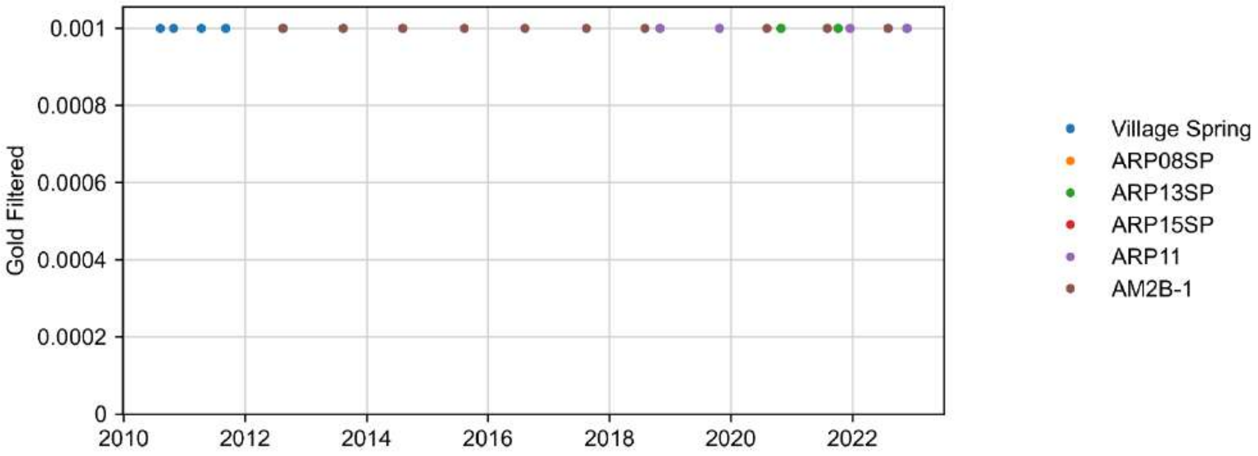

Caesium Filtered
0.002
0.0015
0.001
0.0005
0
2010
2012
2014
2016
2018
2020
2022
Village Spring
ARP08SP
ARP13SP
ARP15SP
ARP11
AM2B-1

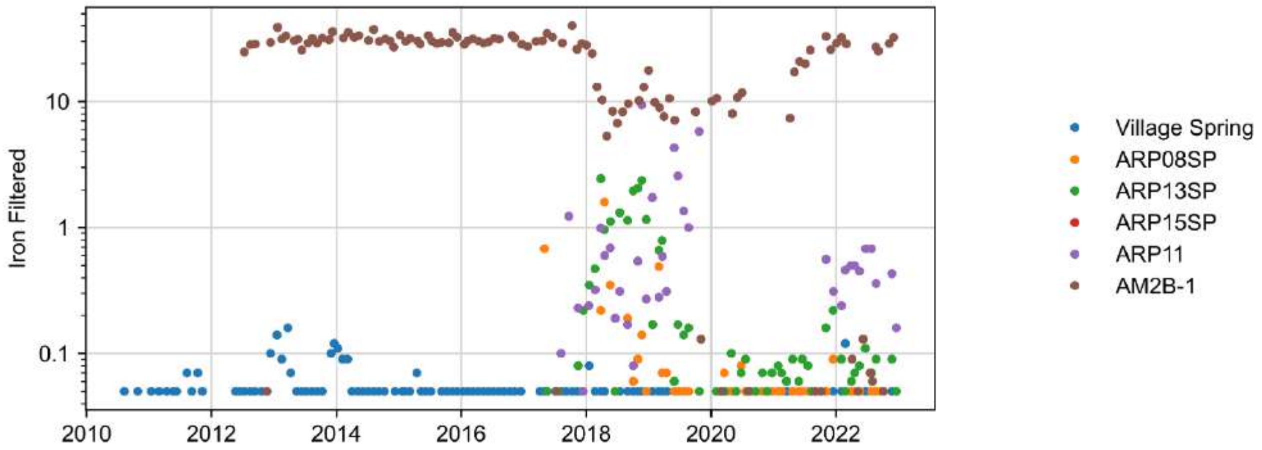

Chromium (III+VI) Filtered
0.0175
0.015
0.0125
0.01
0.0075
0.005
0.0025
0
2010
2012
2014
2016
2018
2020
2022
Village Spring
ARP08SP
ARP13SP
ARP15SP
ARP11
AM2B-1

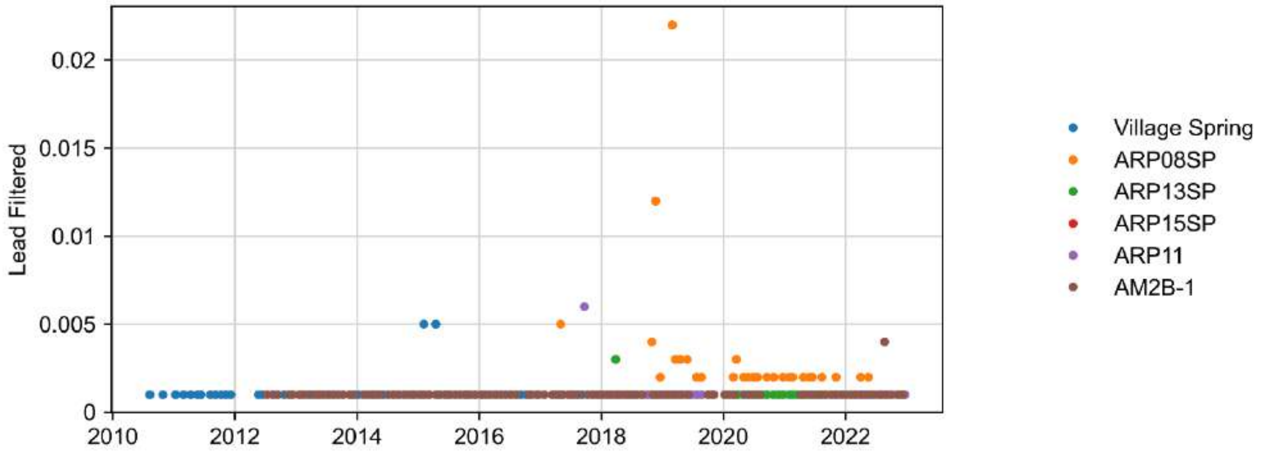

Cobalt Filtered
0.15
0.125
0.1
0.075
0.05
0.025
0
2010
2012
2014
2016
2018
2020
2022
Village Spring
ARP08SP
ARP13SP
ARP15SP
ARP11
AM2B-1

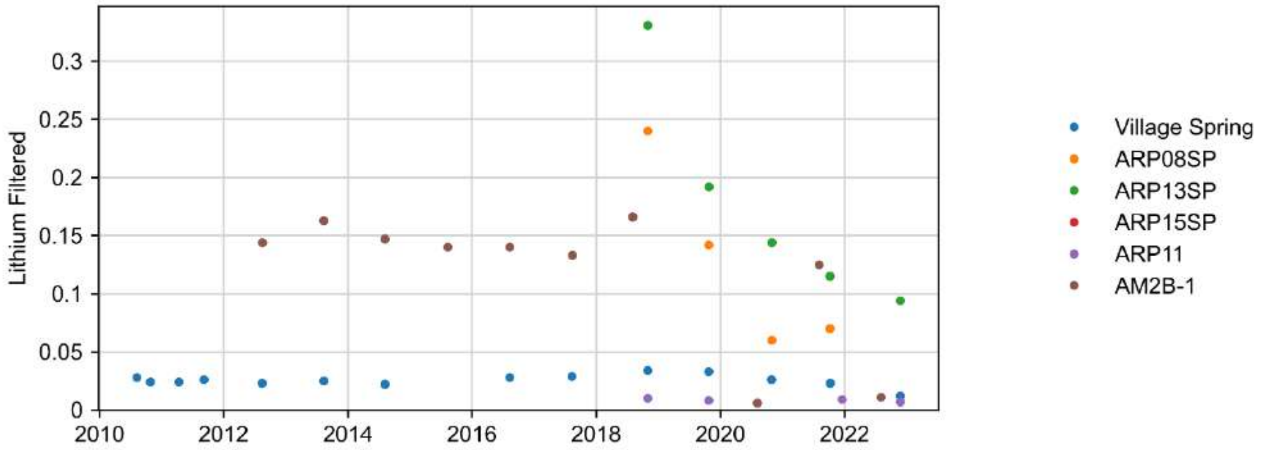

Copper Filtered
0.1
0.01
0.001
2010
2012
2014
2016
2018
2020
2022
Village Spring
ARP08SP
ARP13SP
ARP15SP
ARP11
AM2B-1

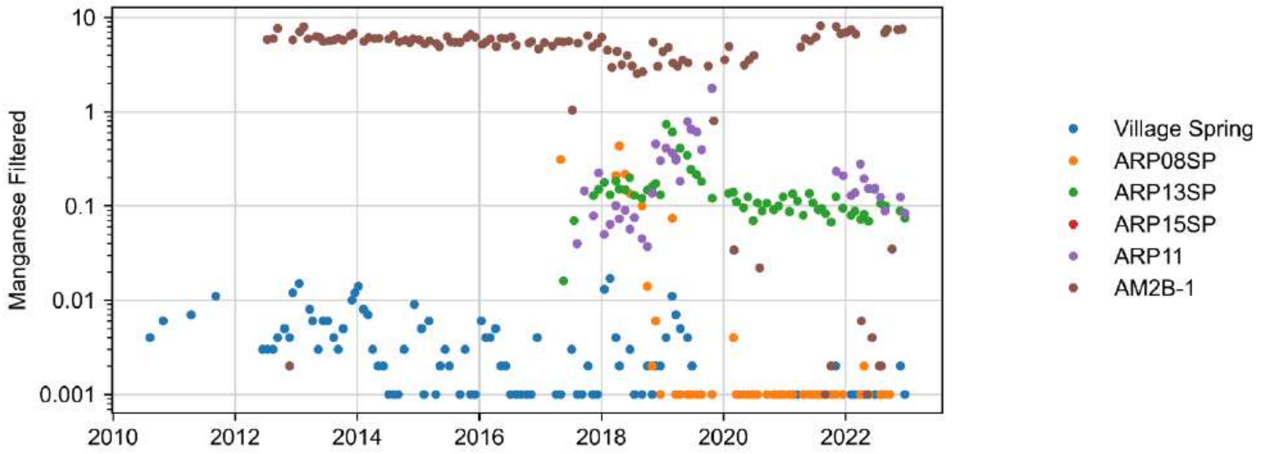

Gallium Filtered
0.04
0.03
0.02
0.01
0
2010
2012
2014
2016
2018
2020
2022
Village Spring
ARP08SP
ARP13SP
ARP15SP
ARP11
AM2B-1

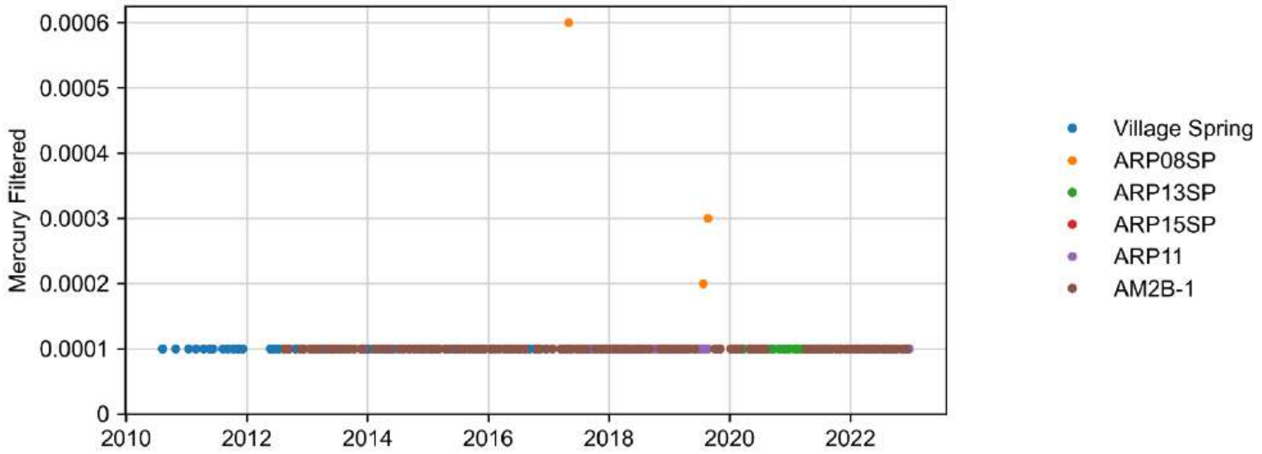

Gold Filtered
0.001
0.0008
0.0006
0.0004
0.0002
0
2010
2012
2014
2016
2018
2020
2022
Village Spring
ARP08SP
ARP13SP
ARP15SP
ARP11
AM2B-1

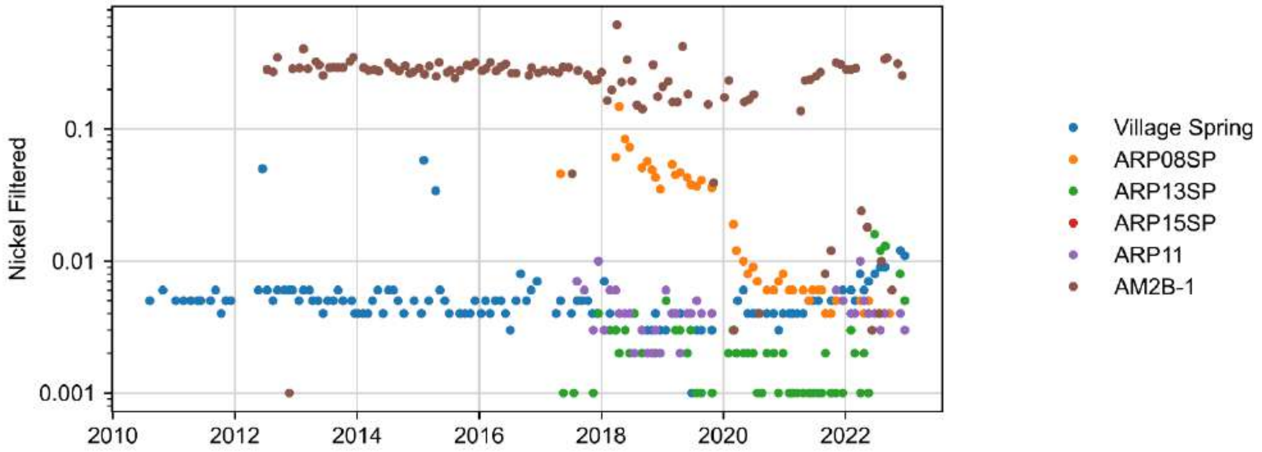

Iron Filtered
10
1
0.1
2010
2012
2014
2016
2018
2020
2022
Village Spring
ARP08SP
ARP13SP
ARP15SP
ARP11
AM2B-1

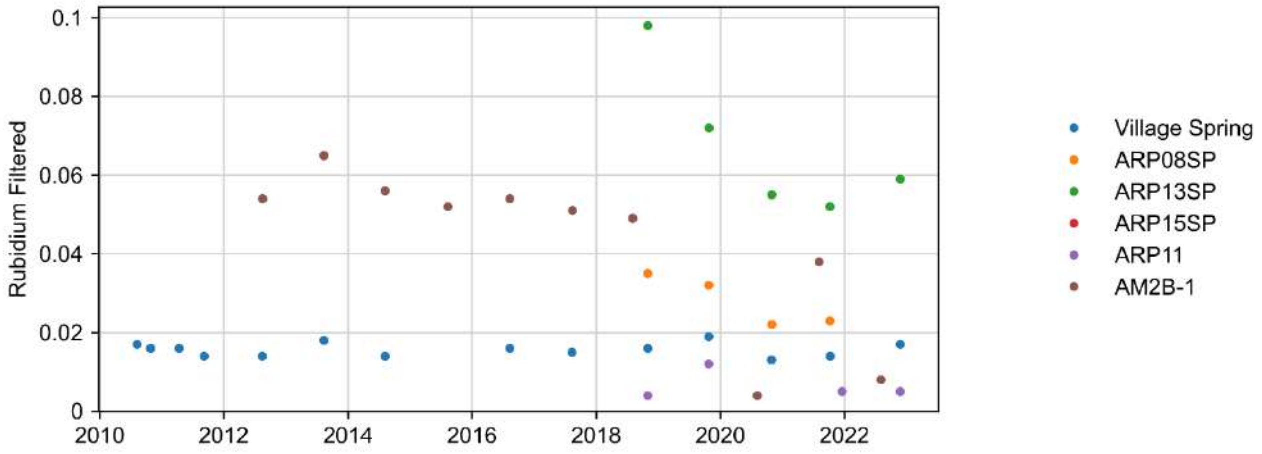

Lead Filtered
0.02
0.015
0.01
0.005
0
2010
2012
2014
2016
2018
2020
2022
Village Spring
ARP08SP
ARP13SP
ARP15SP
ARP11
AM2B-1

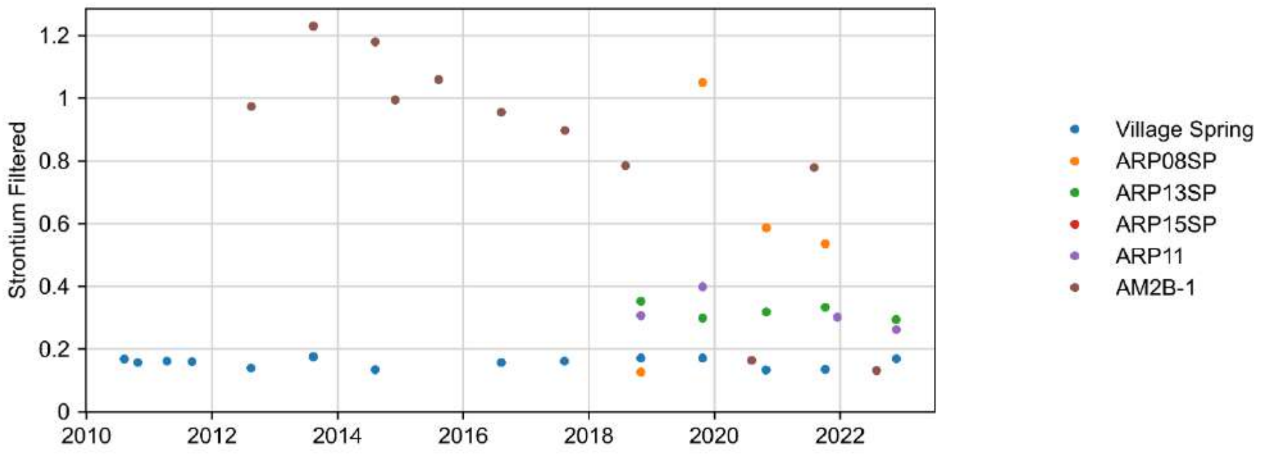

Lithium Filtered
0.3
0.25
0.2
0.15
0.1
0.05
0
2010
2012
2014
2016
2018
2020
2022
Village Spring
ARP08SP
ARP13SP
ARP15SP
ARP11
AM2B-1

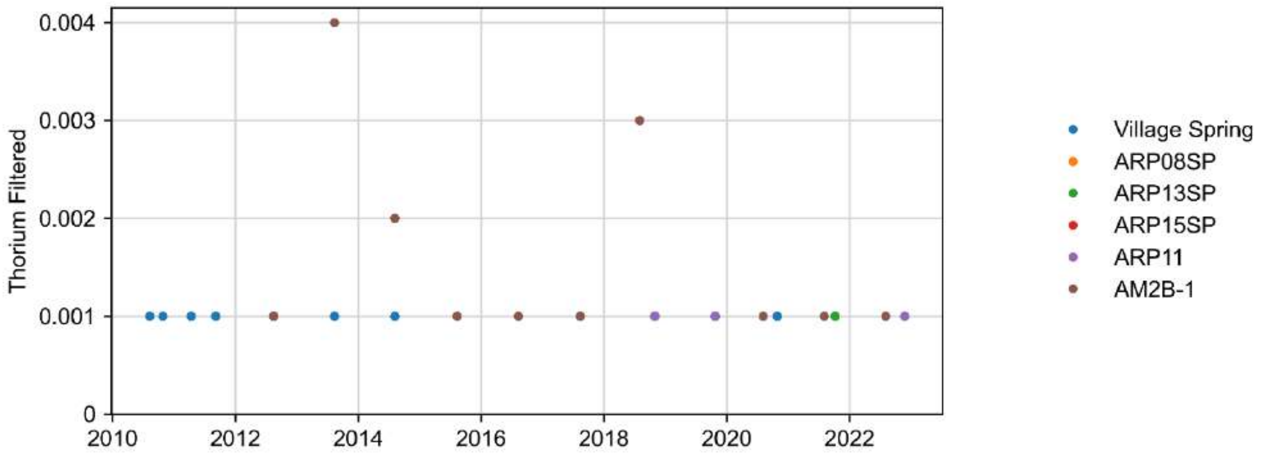

Manganese Filtered
10
1
0.1
0.01
0.001
2010
2012
2014
2016
2018
2020
2022
Village Spring
ARP08SP
ARP13SP
ARP15SP
ARP11
AM2B-1

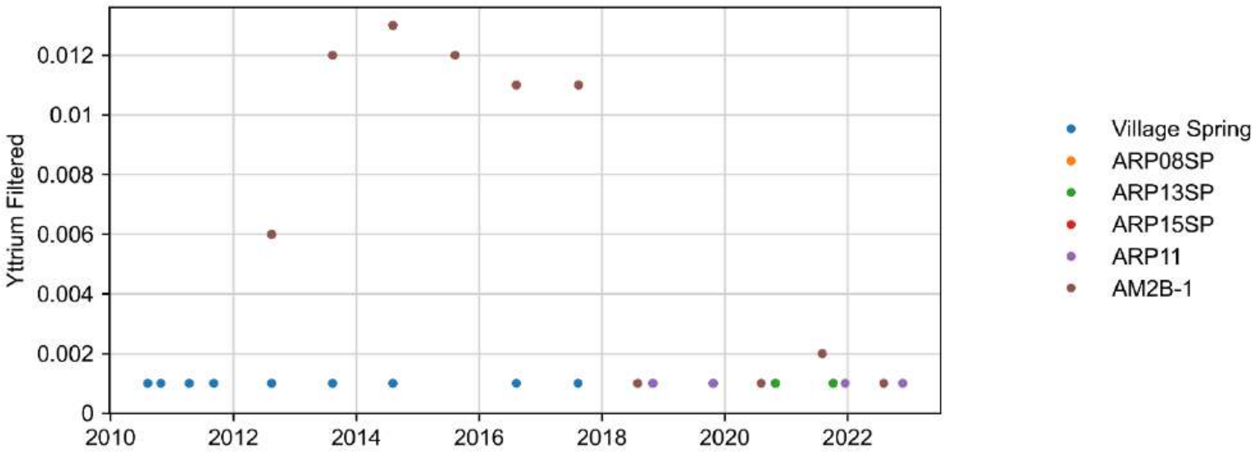

Mercury Filtered
0.0006
0.0005
0.0004
0.0003
0.0002
0.0001
0
2010
2012
2014
2016
2018
2020
2022
Village Spring
ARP08SP
ARP13SP
ARP15SP
ARP11
AM2B-1

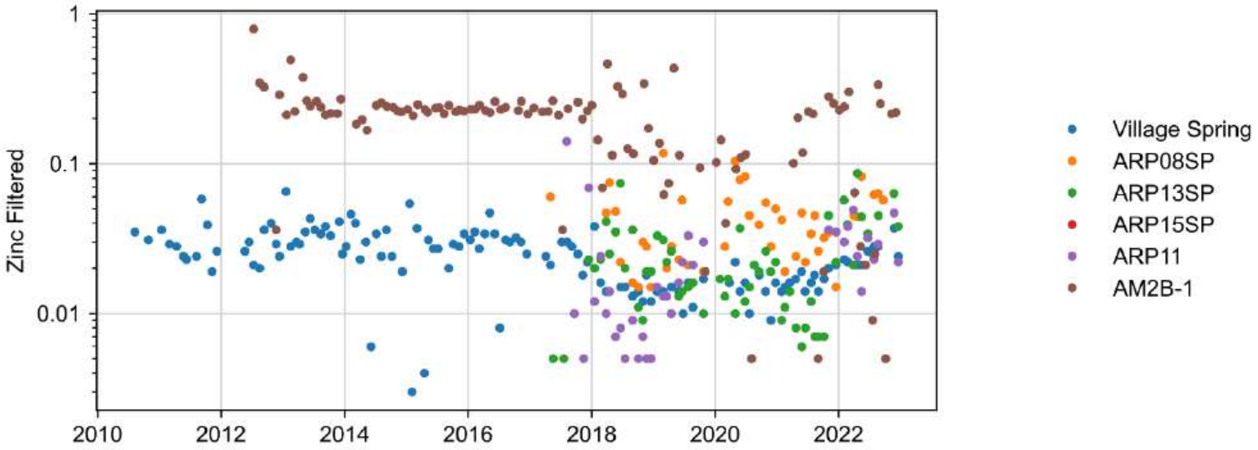

Nickel Filtered
0.1
0.01
0.001
2010
2012
2014
2016
2018
2020
2022
Village Spring
ARP08SP
ARP13SP
ARP15SP
ARP11
AM2B-1


Rubidium Filtered
0.1
0.08
0.06
0.04
0.02
0
2010
2012
2014
2016
2018
2020
2022
Village Spring
ARP08SP
ARP13SP
ARP15SP
ARP11
AM2B-1

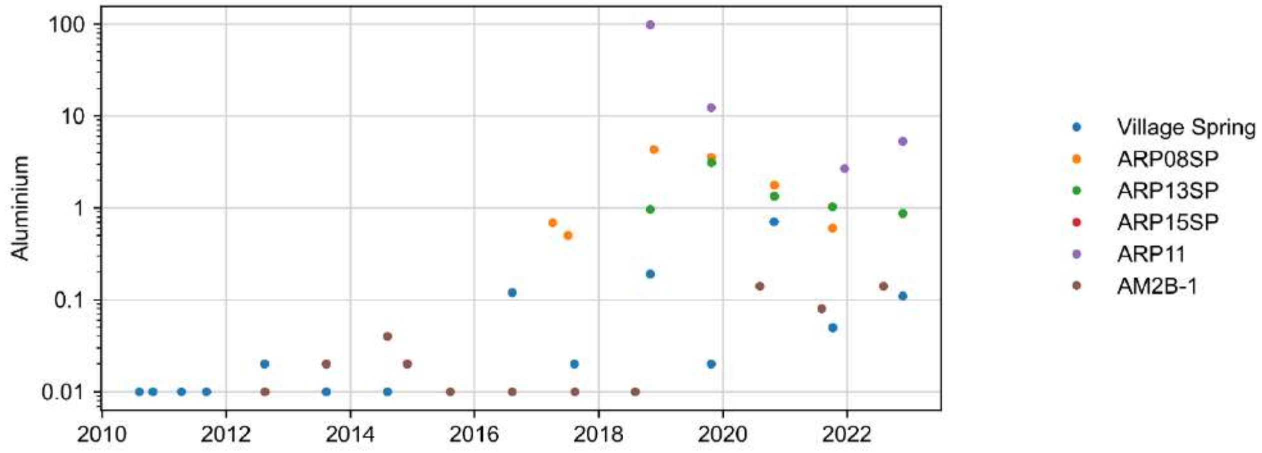

Strontium Filtered
1.2
1
0.8
0.6
0.4
0.2
0
2010
2012
2014
2016
2018
2020
2022
Village Spring
ARP08SP
ARP13SP
ARP15SP
ARP11
AM2B-1

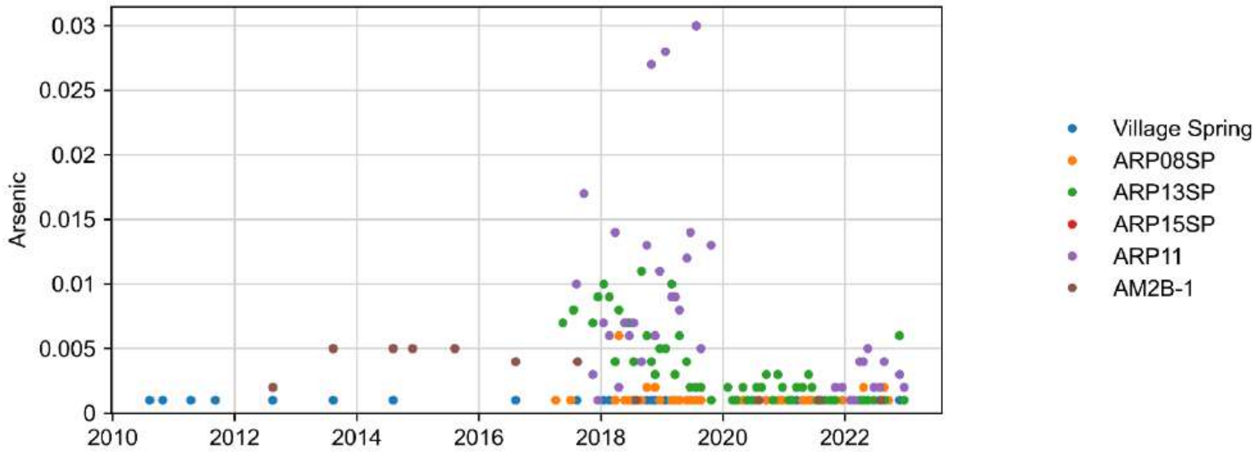

Thorium Filtered
0.004
0.003
0.002
0.001
0
2010
2012
2014
2016
2018
2020
2022
Village Spring
ARP08SP
ARP13SP
ARP15SP
ARP11
AM2B-1

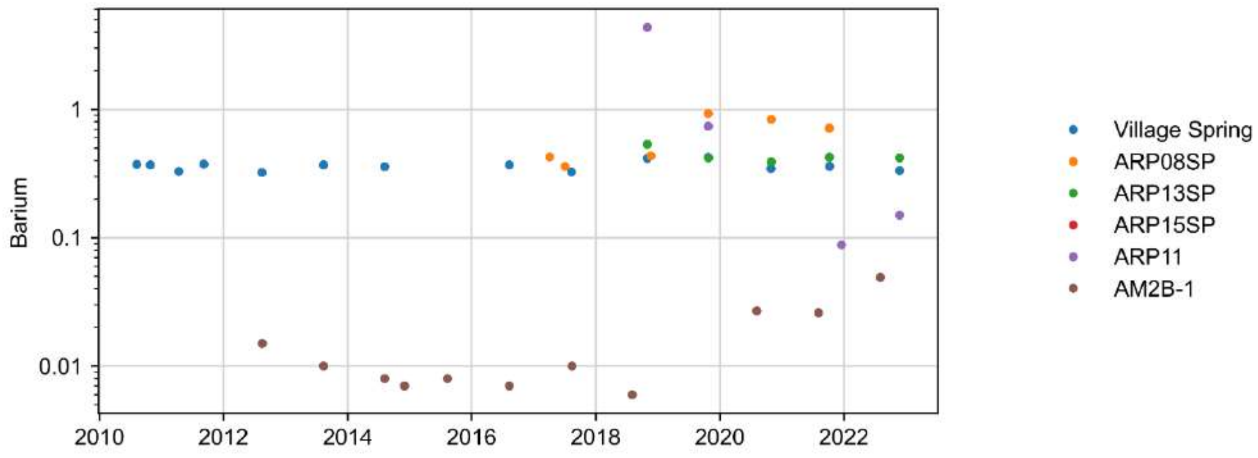

Yttrium Filtered
0.012
0.01
0.008
0.006
0.004
0.002
0
2010
2012
2014
2016
2018
2020
2022
Village Spring
ARP08SP
ARP13SP
ARP15SP
ARP11
AM2B-1

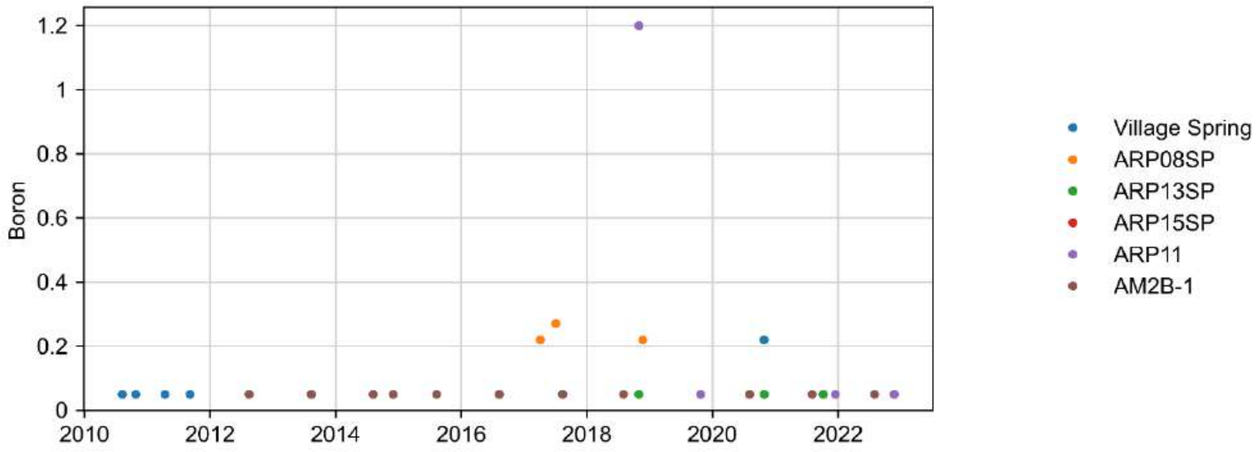

Zinc Filtered
1
0.1
0.01
2010
2012
2014
2016
2018
2020
2022
Village Spring
ARP08SP
ARP13SP
ARP15SP
ARP11
AM2B-1

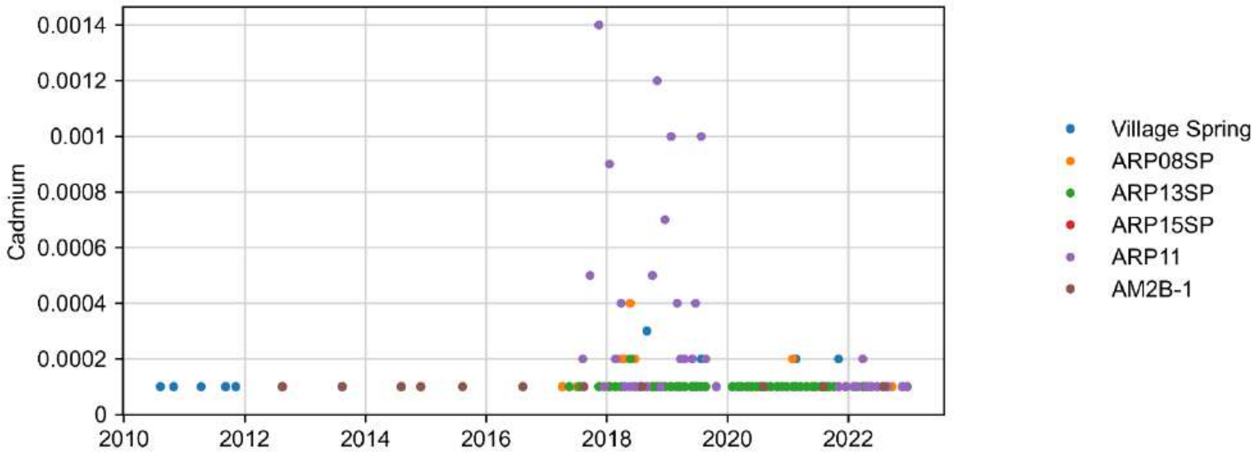
Metals (total)

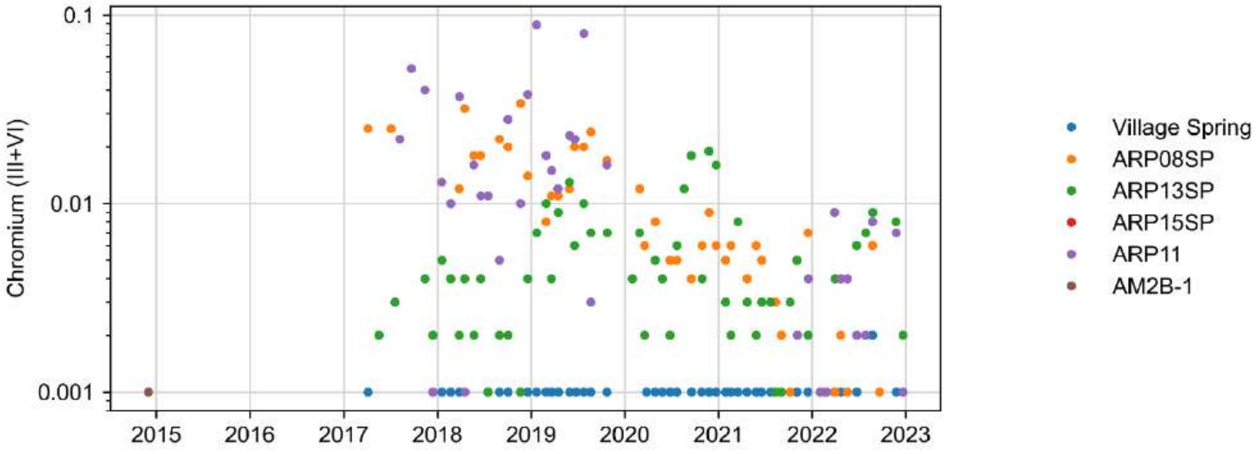


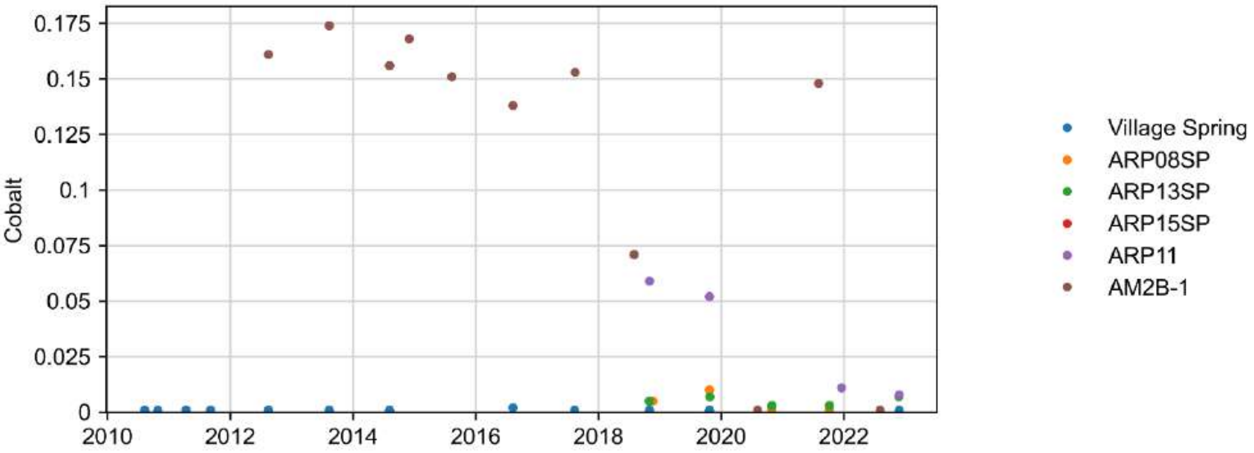


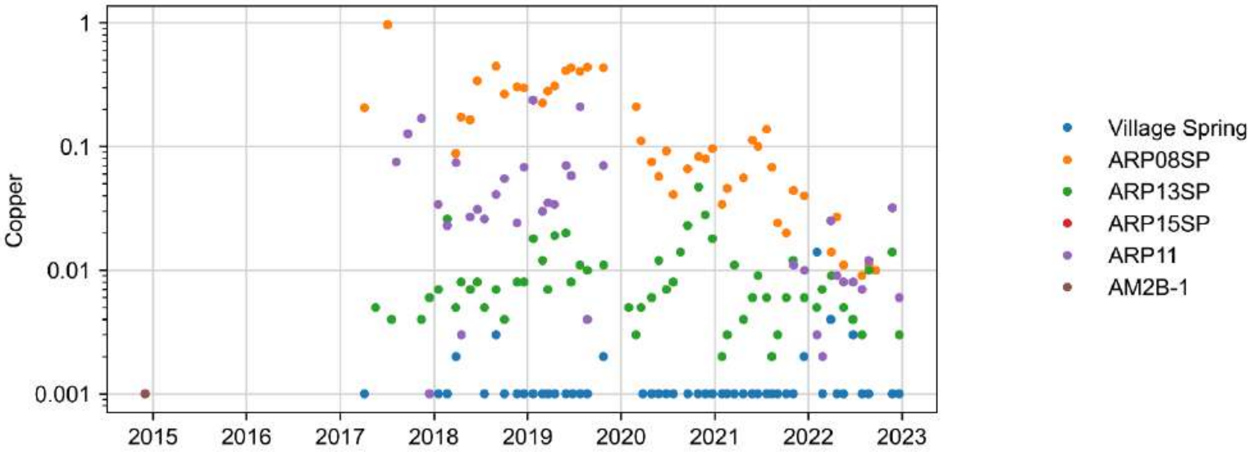


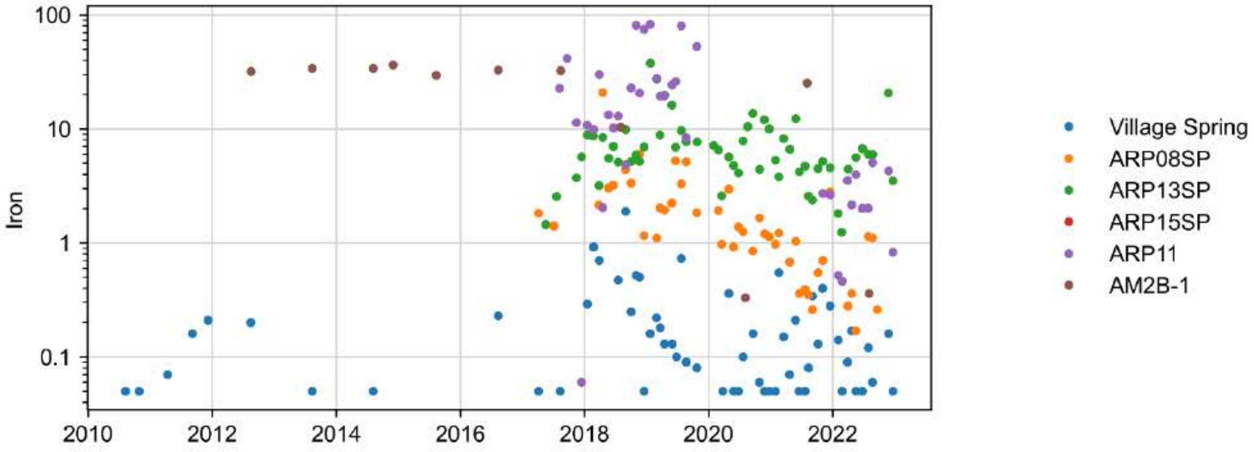

Boron
1.2
1
0.8
0.6
0.4
0.2
0
2010
2012
2014
2016
2018
2020
2022
Village Spring
ARP08SP
ARP13SP
ARP15SP
ARP11
AM2B-1

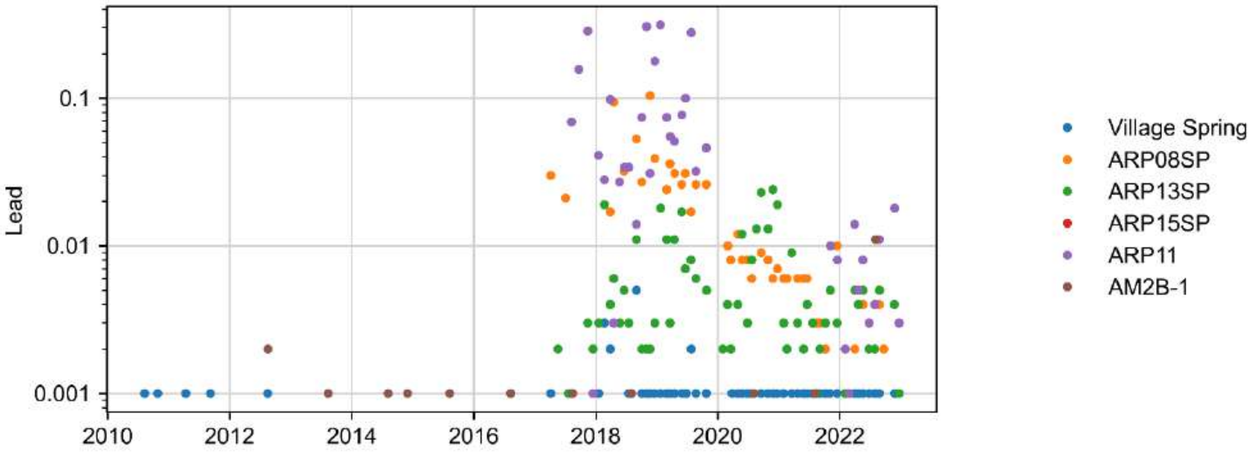

Cadmium
0.0014
0.0012
0.001
0.0008
0.0006
0.0004
0.0002
0
2010
2012
2014
2016
2018
2020
2022
Village Spring
ARP08SP
ARP13SP
ARP15SP
ARP11
AM2B-1

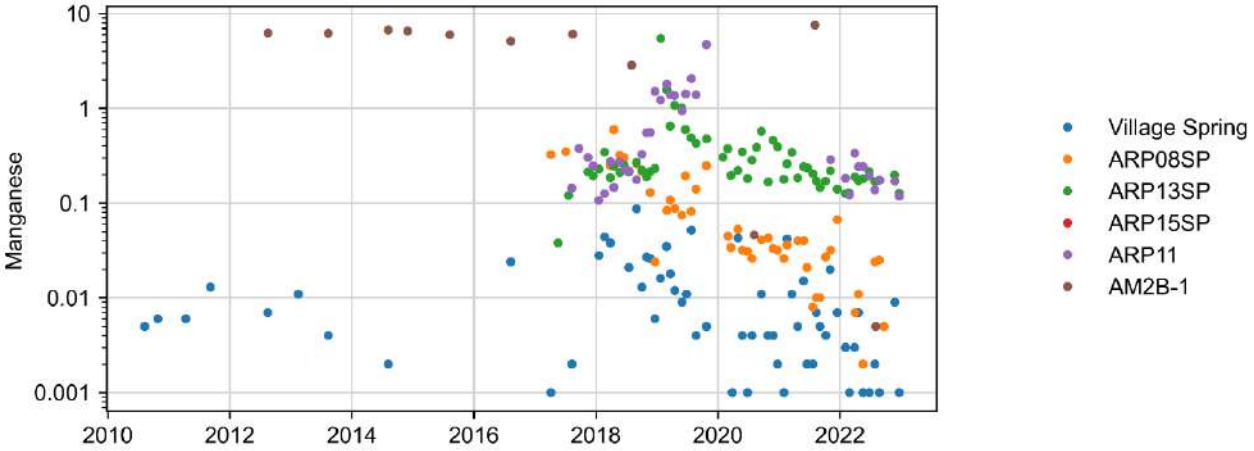

Chromium (III+VI)
0.1
0.01
0.001
2015
2016
2017
2018
2019
2020
2021
2022
2023
Village Spring
ARP08SP
ARP13SP
ARP15SP
ARP11
AM2B-1

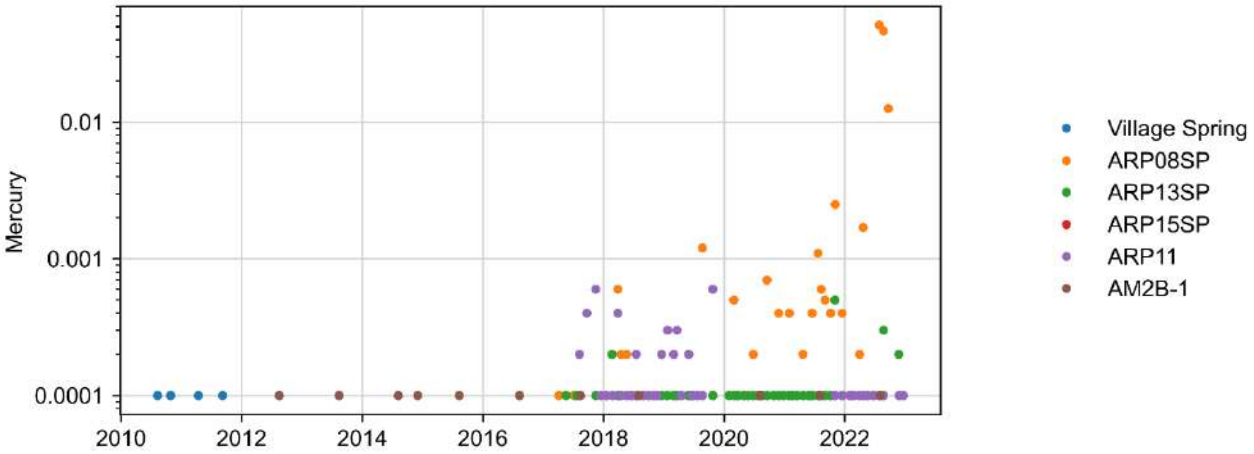

Cobalt
0.175
0.15
0.125
0.1
0.075
0.05
0.025
0
2010
2012
2014
2016
2018
2020
2022
● Village Spring
● ARP08SP
● ARP13SP
● ARP15SP
● ARP11
● AM2B-1

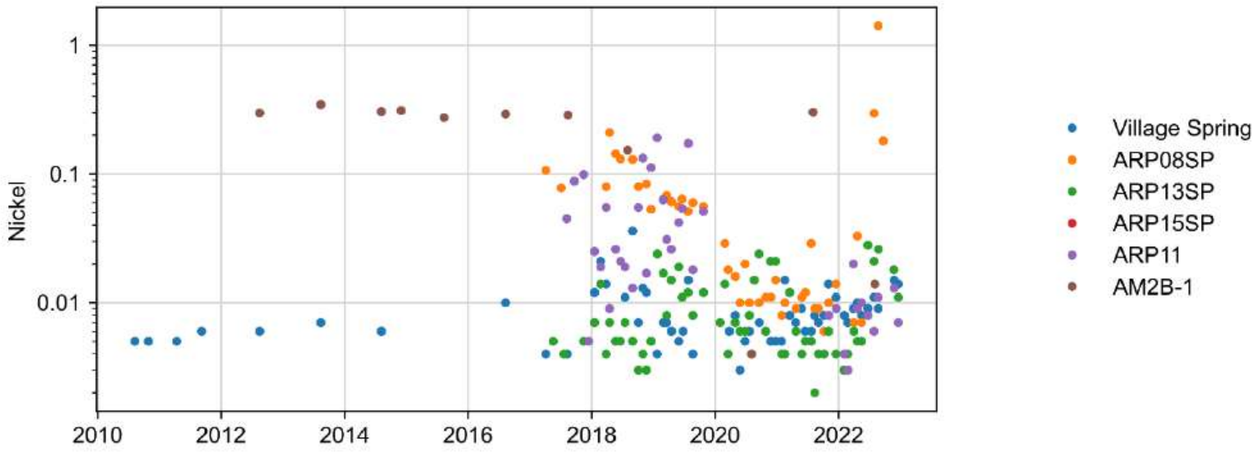

Copper
1
0.1
0.01
0.001
2015
2016
2017
2018
2019
2020
2021
2022
2023
● Village Spring
● ARP08SP
● ARP13SP
● ARP15SP
● ARP11
● AM2B-1

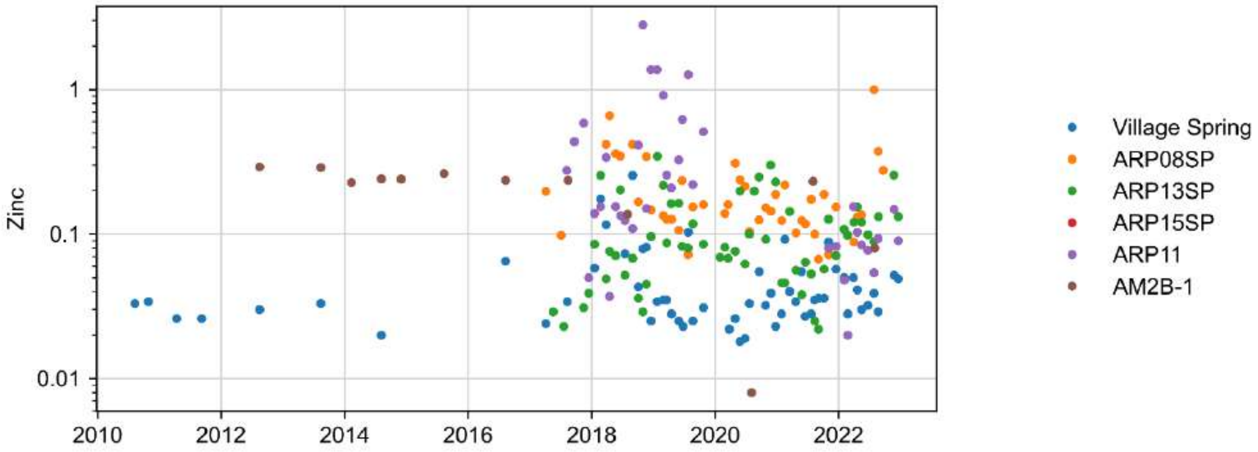

Iron
100
10
1
0.1
2010
2012
2014
2016
2018
2020
2022
● Village Spring
● ARP08SP
● ARP13SP
● ARP15SP
● ARP11
● AM2B-1


Lead
0.1
0.01
0.001
2010
2012
2014
2016
2018
2020
2022
● Village Spring
● ARP08SP
● ARP13SP
● ARP15SP
● ARP11
● AM2B-1

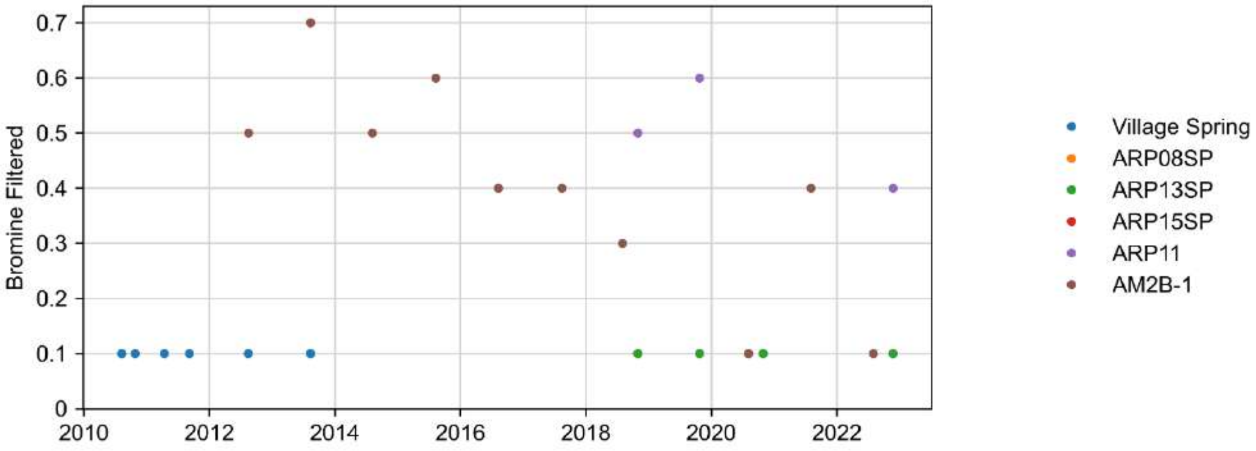

Manganese
10
1
0.1
0.01
0.001
2010
2012
2014
2016
2018
2020
2022
● Village Spring
● ARP08SP
● ARP13SP
● ARP15SP
● ARP11
● AM2B-1

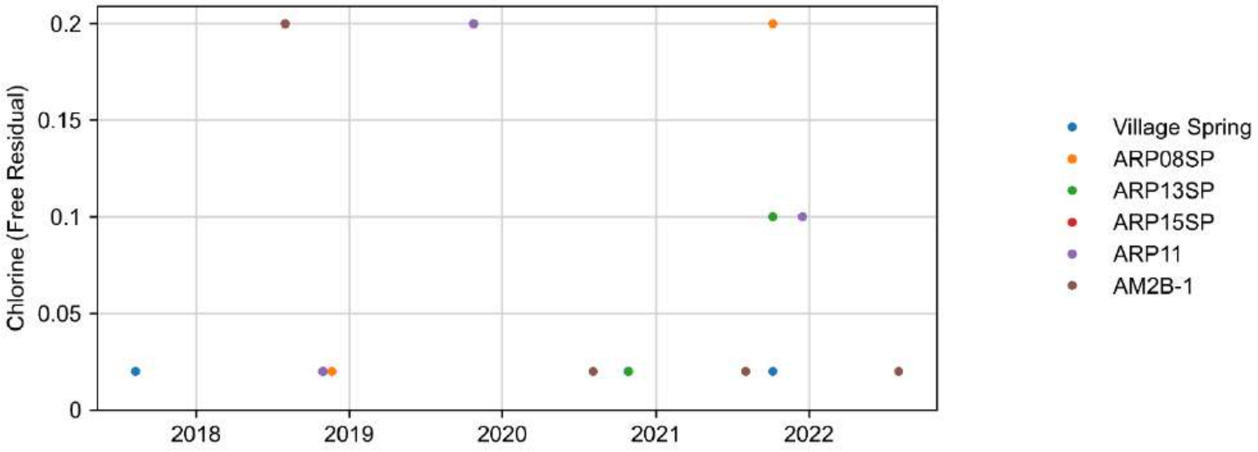

Mercury
0.01
0.001
0.0001
2010
2012
2014
2016
2018
2020
2022
● Village Spring
● ARP08SP
● ARP13SP
● ARP15SP
● ARP11
● AM2B-1

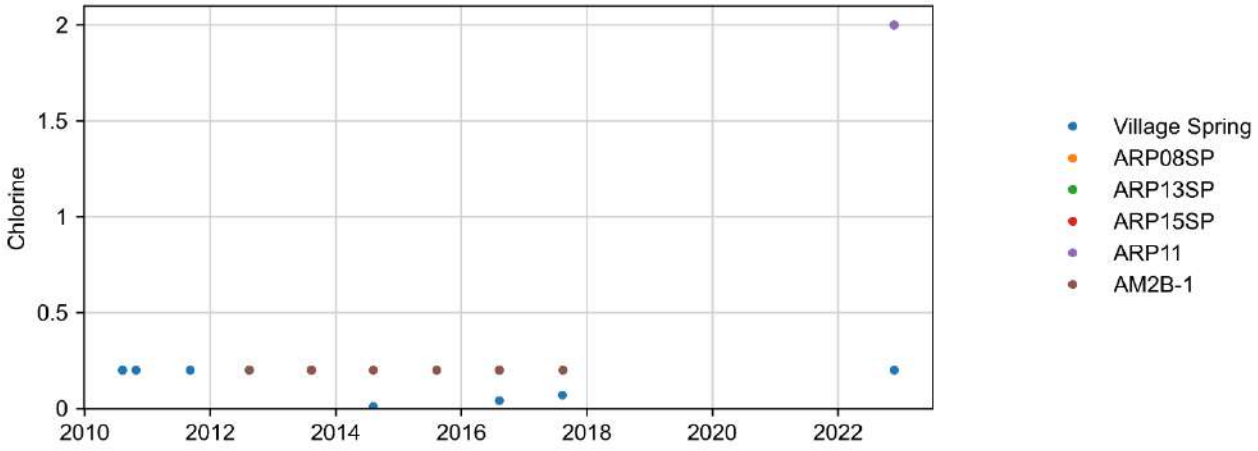

Nickel
1
0.1
0.01
2010
2012
2014
2016
2018
2020
2022
● Village Spring
● ARP08SP
● ARP13SP
● ARP15SP
● ARP11
● AM2B-1

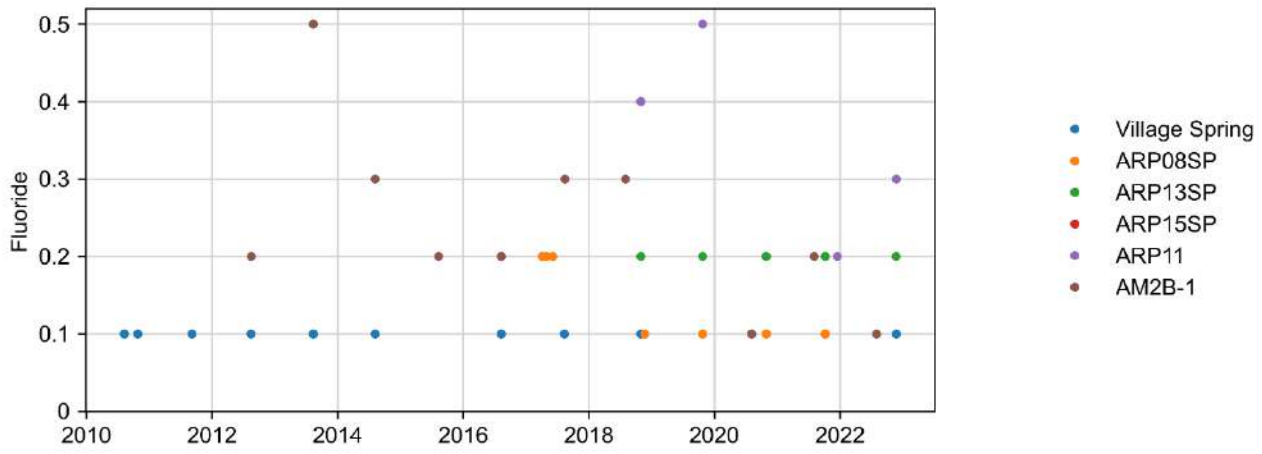

Zinc
1
0.1
0.01
2010
2012
2014
2016
2018
2020
2022
● Village Spring
● ARP08SP
● ARP13SP
● ARP15SP
● ARP11
● AM2B-1

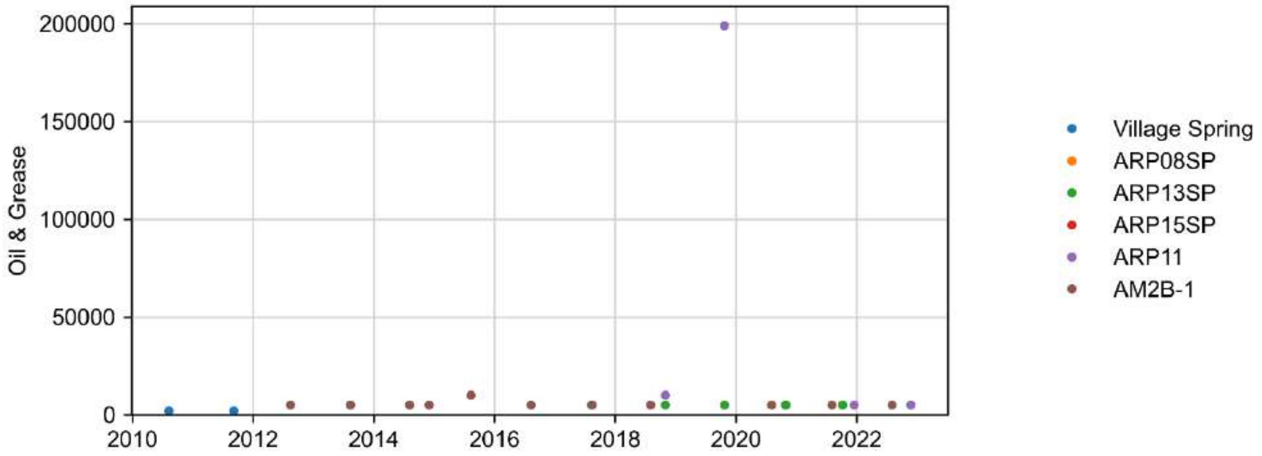
Other

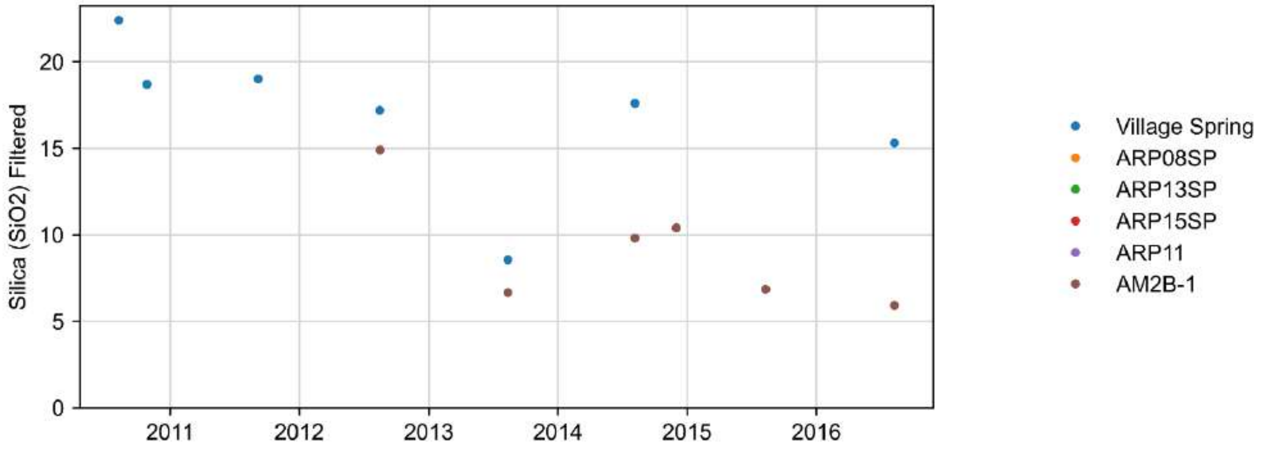

Bromine Filtered
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
2010
2012
2014
2016
2018
2020
2022
Village Spring
ARP08SP
ARP13SP
ARP15SP
ARP11
AM2B-1

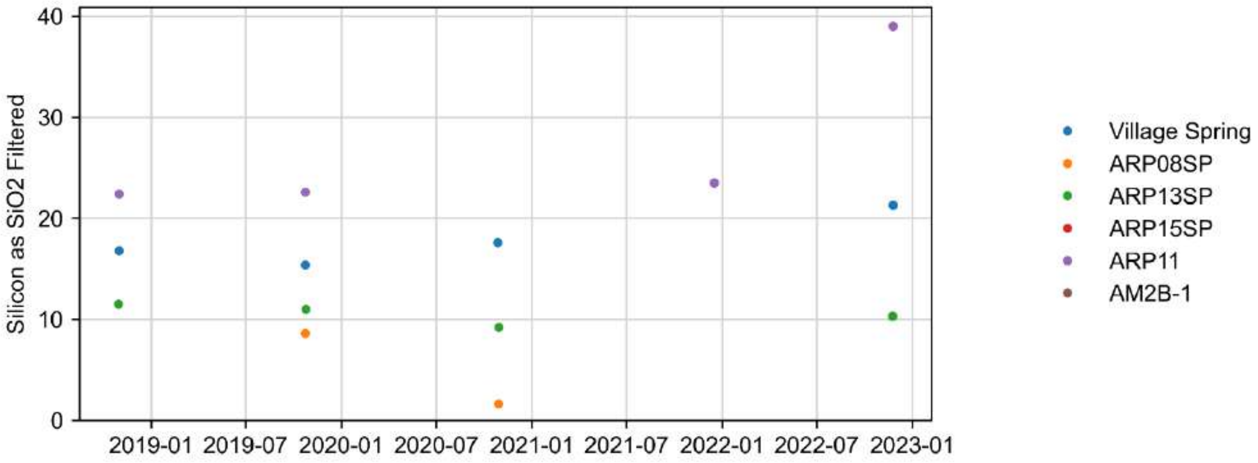

Chlorine (Free Residual)
0.2
0.15
0.1
0.05
0
2018
2019
2020
2021
2022
Village Spring
ARP08SP
ARP13SP
ARP15SP
ARP11
AM2B-1

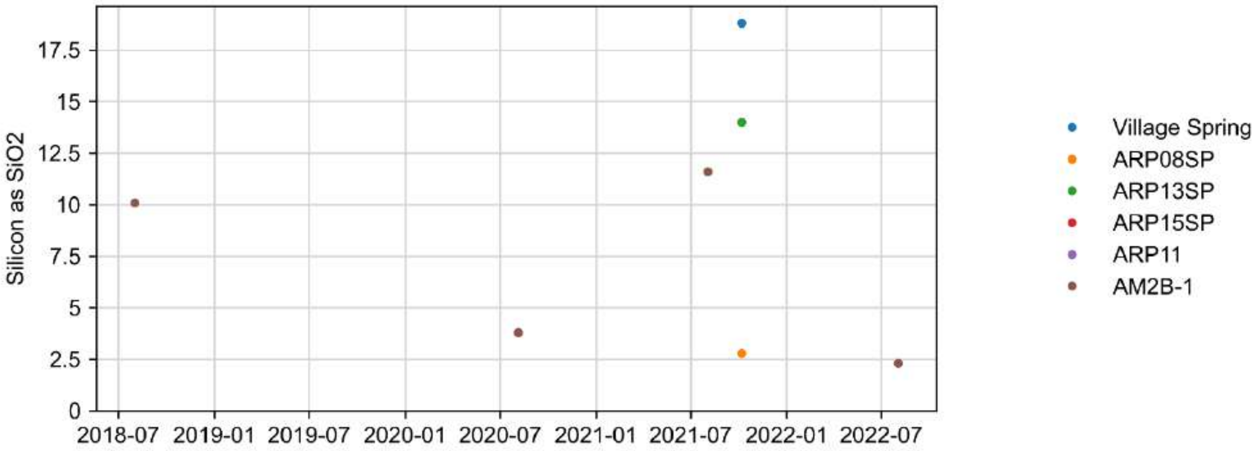

Chlorine
2
1.5
1
0.5
0
2010
2012
2014
2016
2018
2020
2022
Village Spring
ARP08SP
ARP13SP
ARP15SP
ARP11
AM2B-1

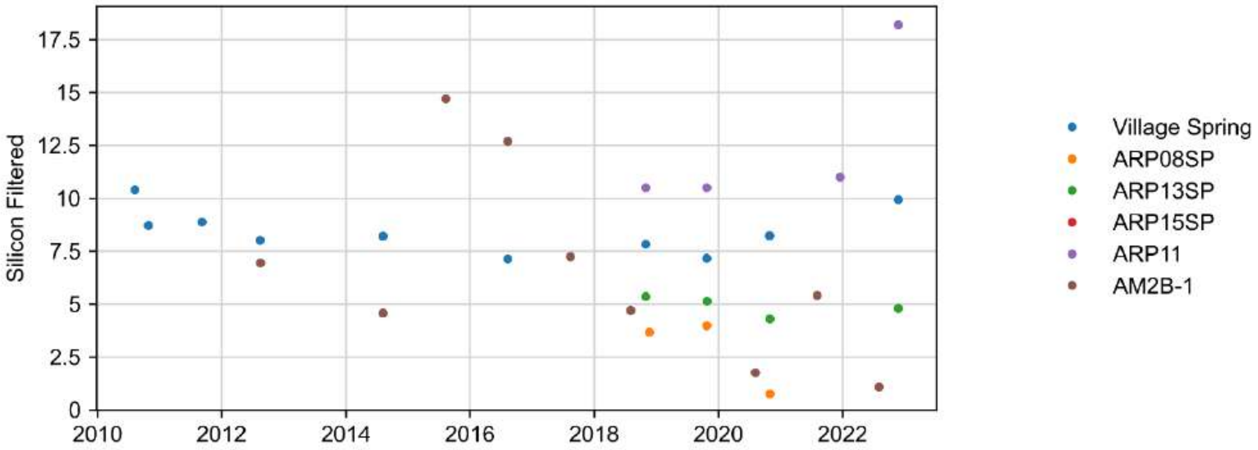

Fluoride
0.5
0.4
0.3
0.2
0.1
0
2010
2012
2014
2016
2018
2020
2022
Village Spring
ARP08SP
ARP13SP
ARP15SP
ARP11
AM2B-1


Oil & Grease
200000
150000
100000
50000
0
2010
2012
2014
2016
2018
2020
2022
Village Spring
ARP08SP
ARP13SP
ARP15SP
ARP11
AM2B-1


Silica (SiO2) Filtered
20
15
10
5
0
2011
2012
2013
2014
2015
2016
Village Spring
ARP08SP
ARP13SP
ARP15SP
ARP11
AM2B-1

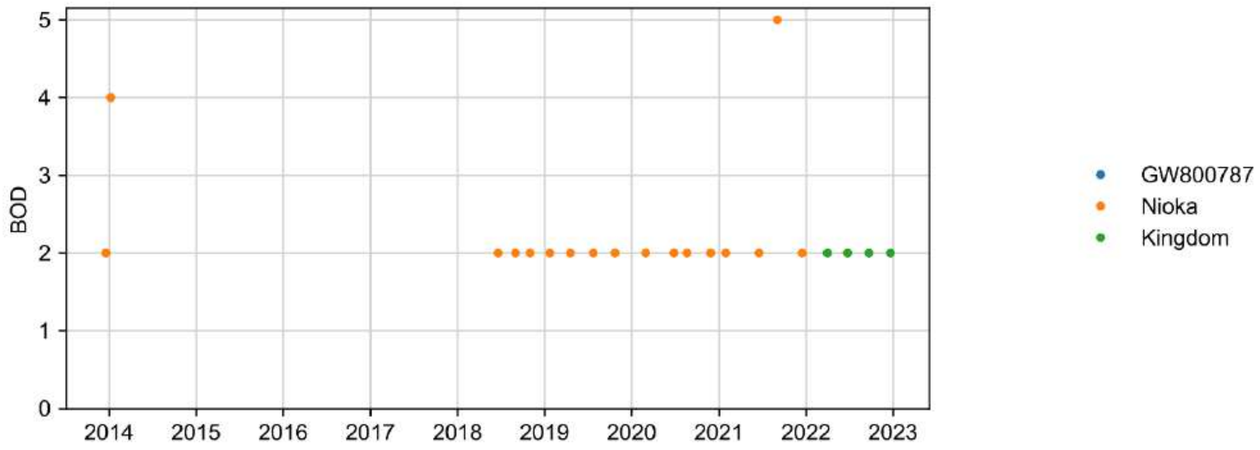

Silicon as SiO2 Filtered
0
10
20
30
40
2019-01
2019-07
2020-01
2020-07
2021-01
2021-07
2022-01
2022-07
2023-01
Village Spring
ARP08SP
ARP13SP
ARP15SP
ARP11
AM2B-1

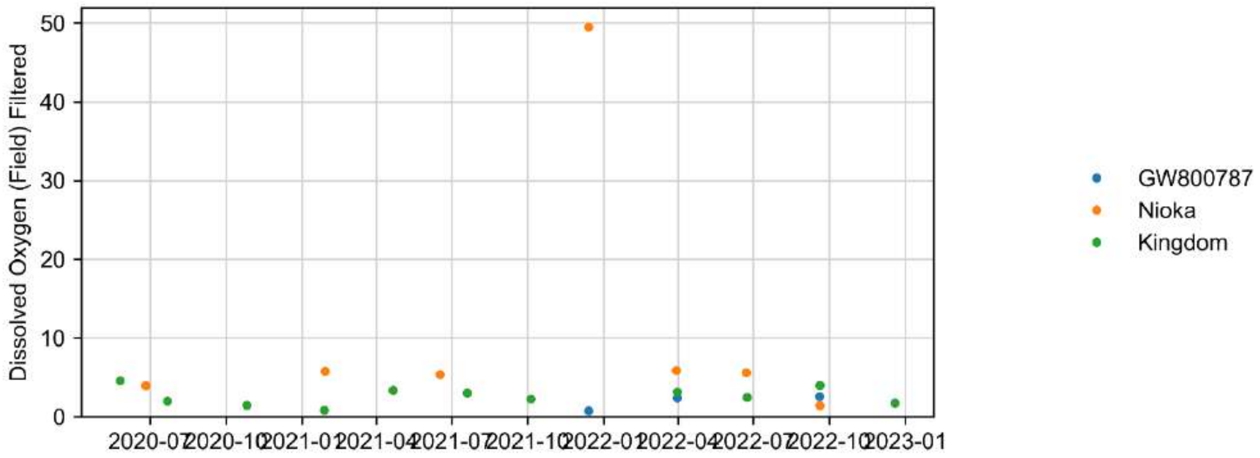

Silicon as SiO2
0
2.5
5
7.5
10
12.5
15
17.5
2018-07
2019-01
2019-07
2020-01
2020-07
2021-01
2021-07
2022-01
2022-07
Village Spring
ARP08SP
ARP13SP
ARP15SP
ARP11
AM2B-1

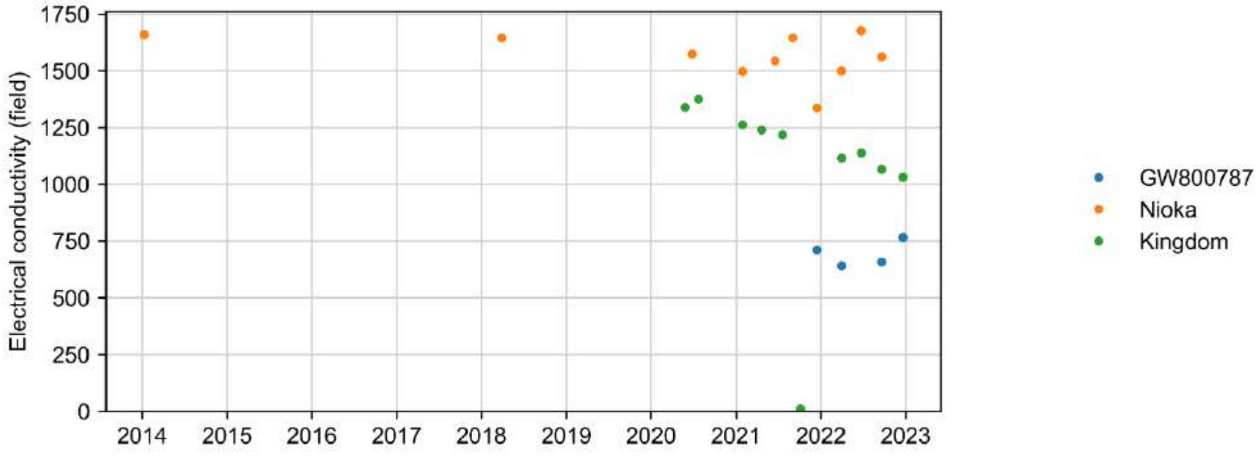

Silicon Filtered
0
2.5
5
7.5
10
12.5
15
17.5
2010
2012
2014
2016
2018
2020
2022
Village Spring
ARP08SP
ARP13SP
ARP15SP
ARP11
AM2B-1

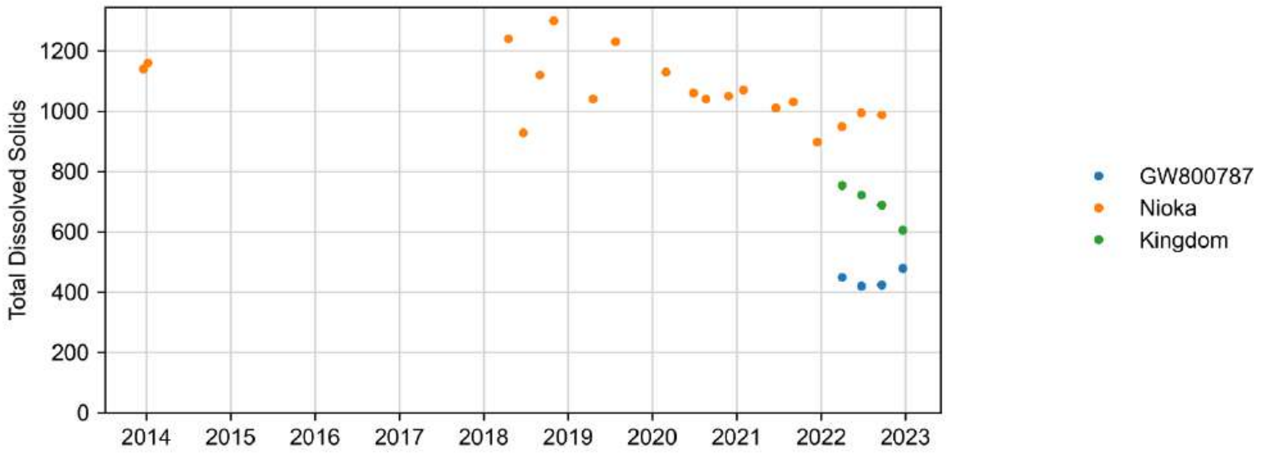
Landholder bores

Physicochemical

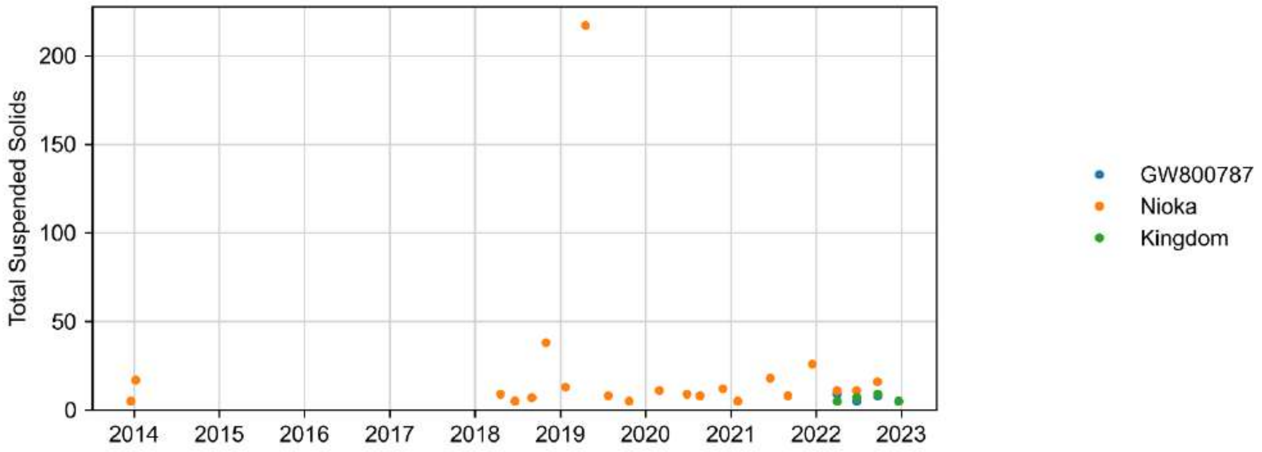




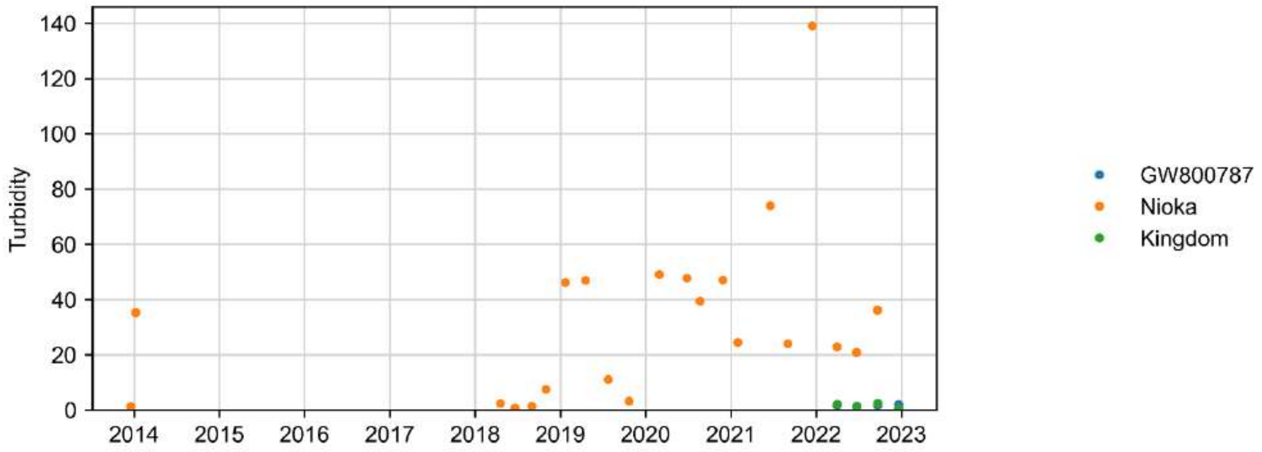




Total Dissolved Solids
0
200
400
600
800
1000
1200
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
● GW800787
● Nioka
● Kingdom

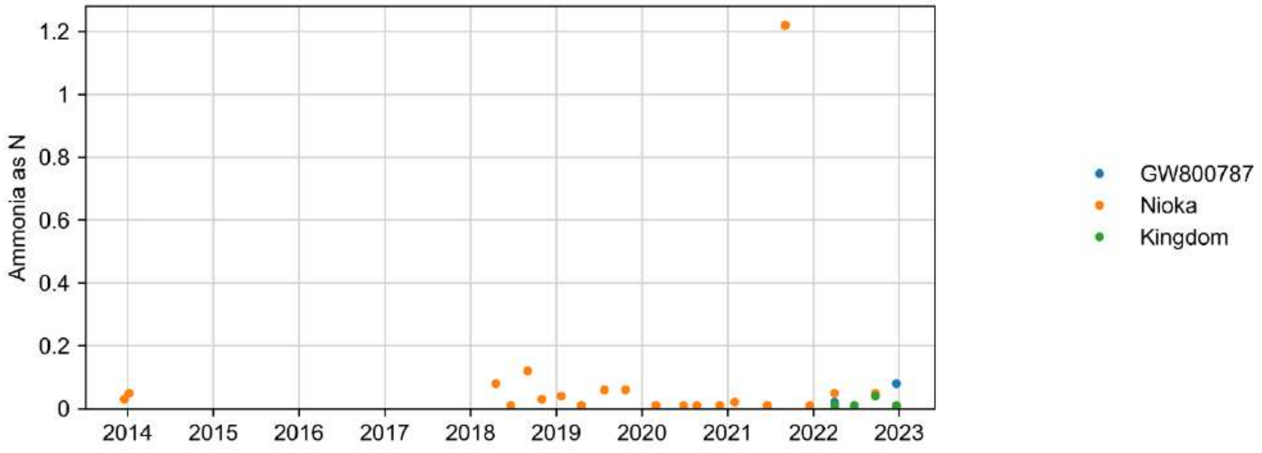


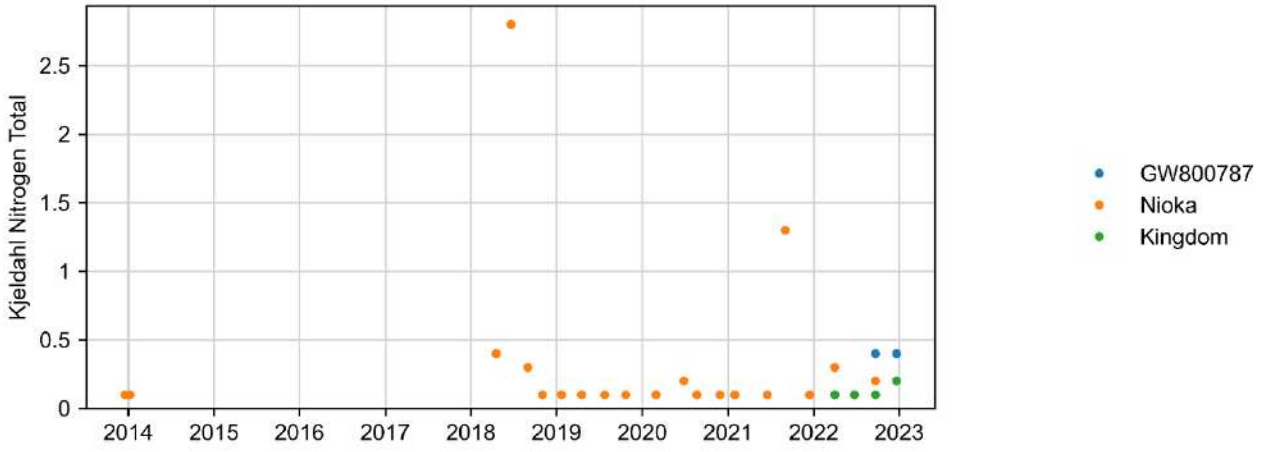
Total Suspended Solids
0
50
100
150
200
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
● GW800787
● Nioka
● Kingdom

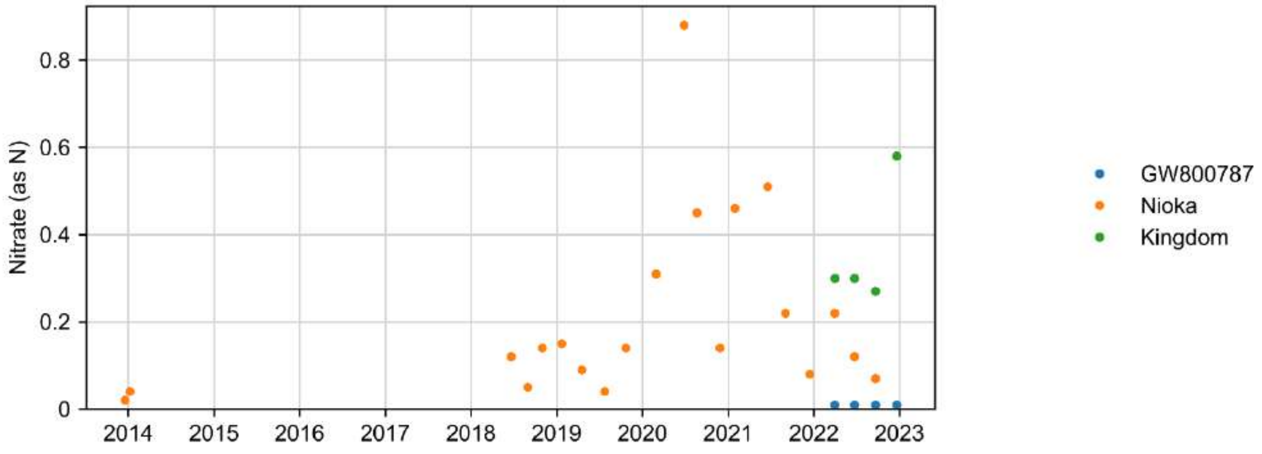


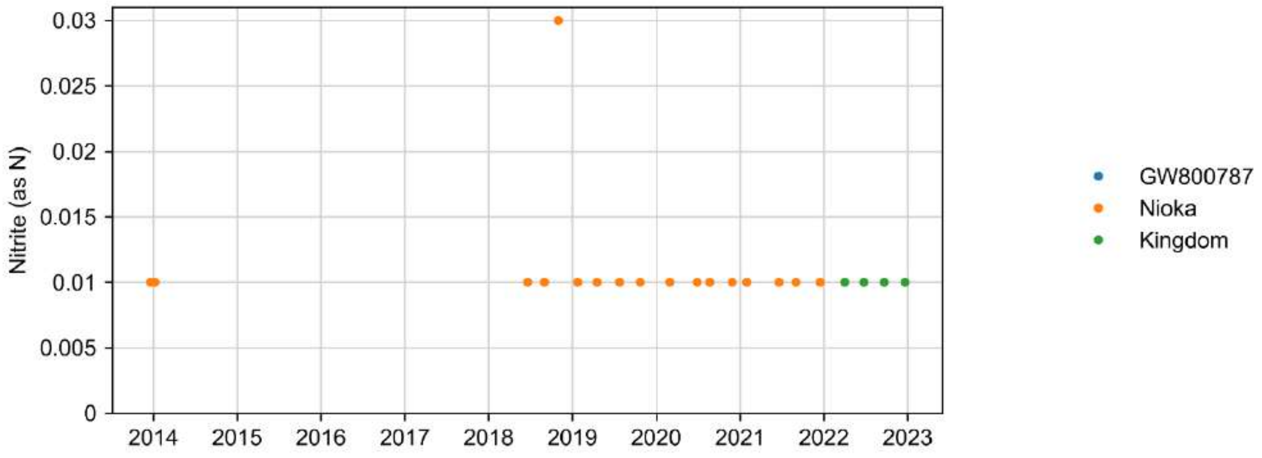
Turbidity
0
20
40
60
80
100
120
140
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
● GW800787
● Nioka
● Kingdom

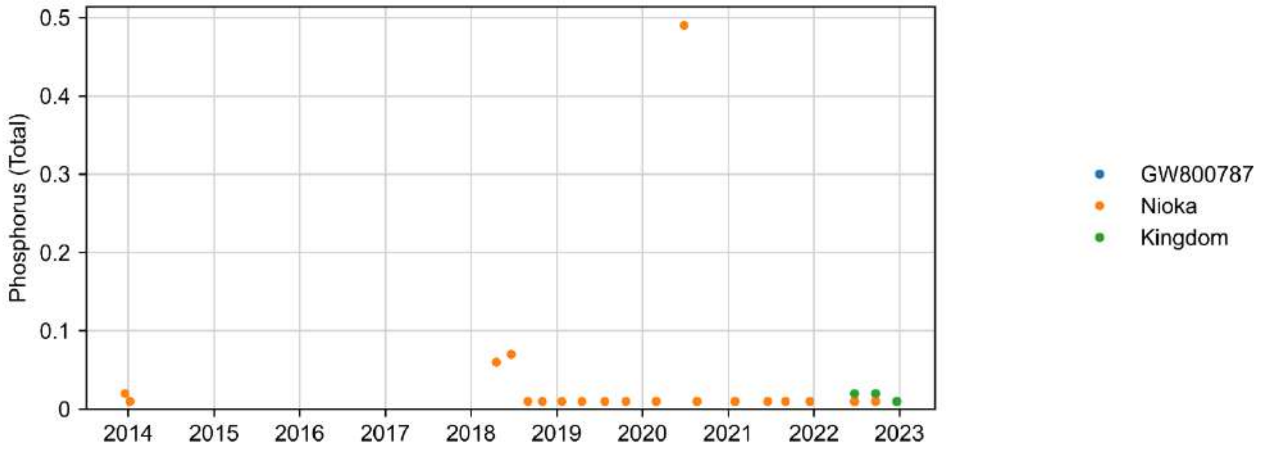
Nutrients

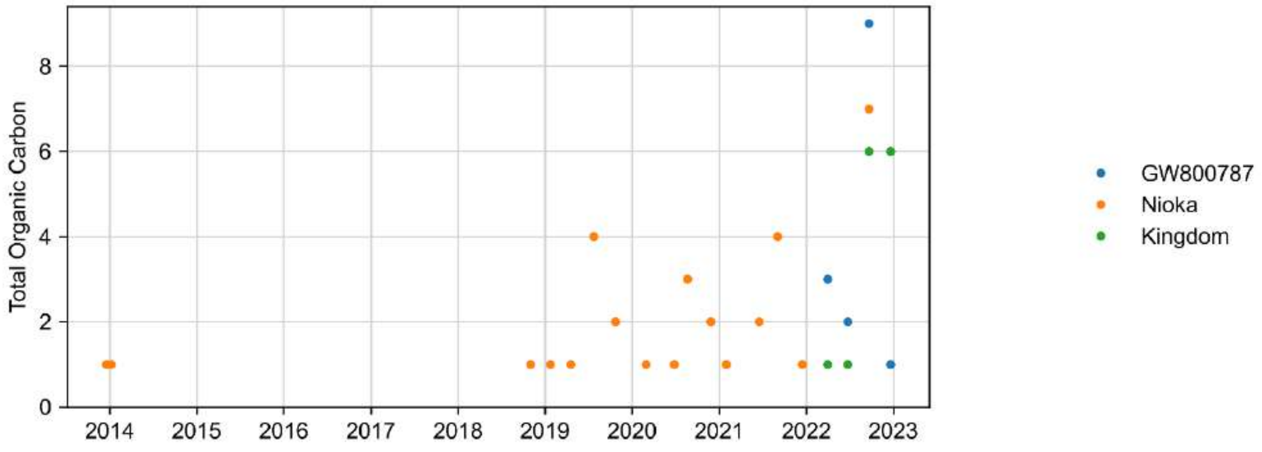

Ammonia as N
1.2
1
0.8
0.6
0.4
0.2
0
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
GW800787
Nioka
Kingdom


Kjeldahl Nitrogen Total
2.5
2
1.5
1
0.5
0
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
GW800787
Nioka
Kingdom

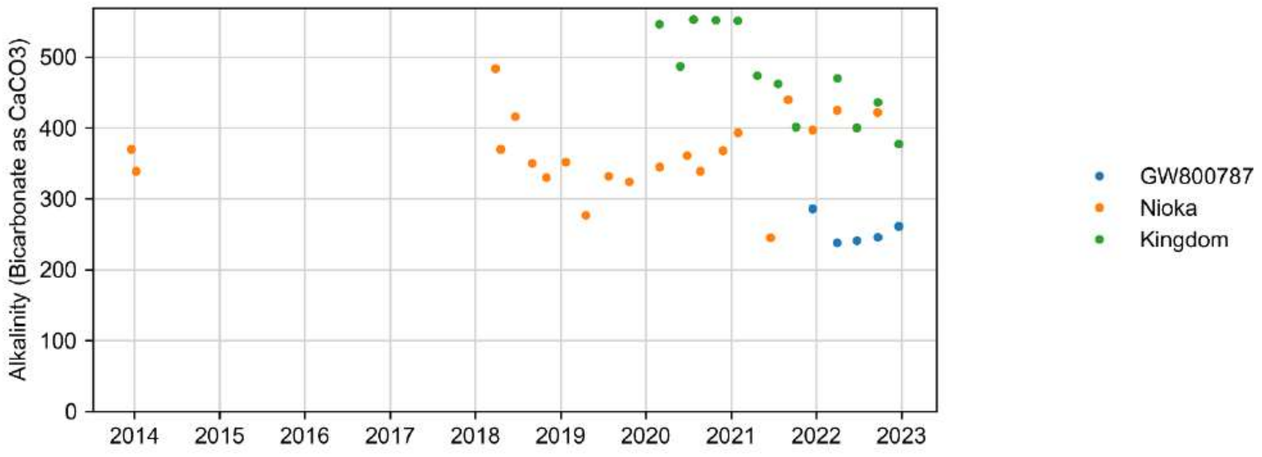

Nitrate (as N)
0.8
0.6
0.4
0.2
0
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
GW800787
Nioka
Kingdom

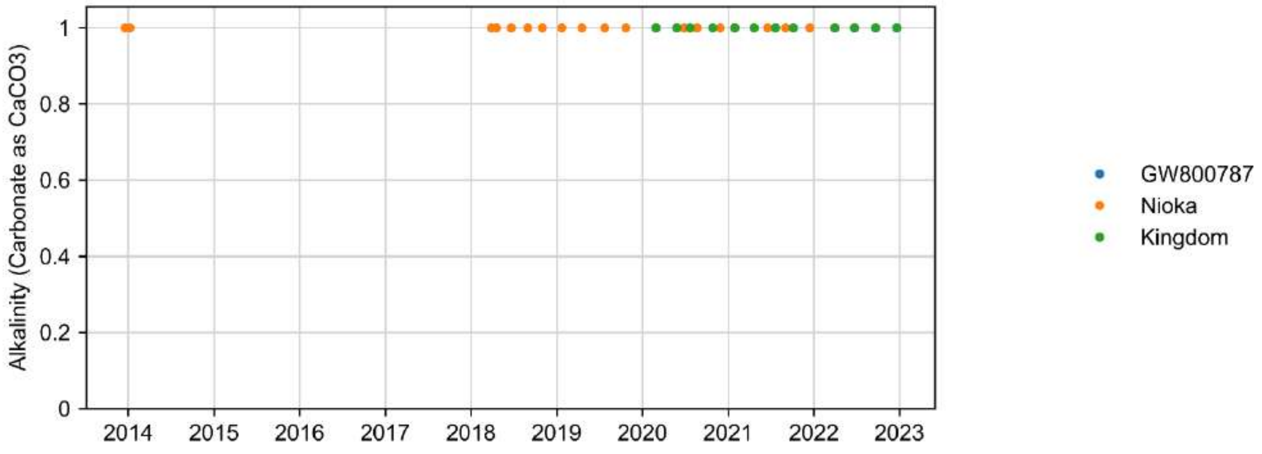

Nitrite (as N)
0.03
0.025
0.02
0.015
0.01
0.005
0
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
GW800787
Nioka
Kingdom

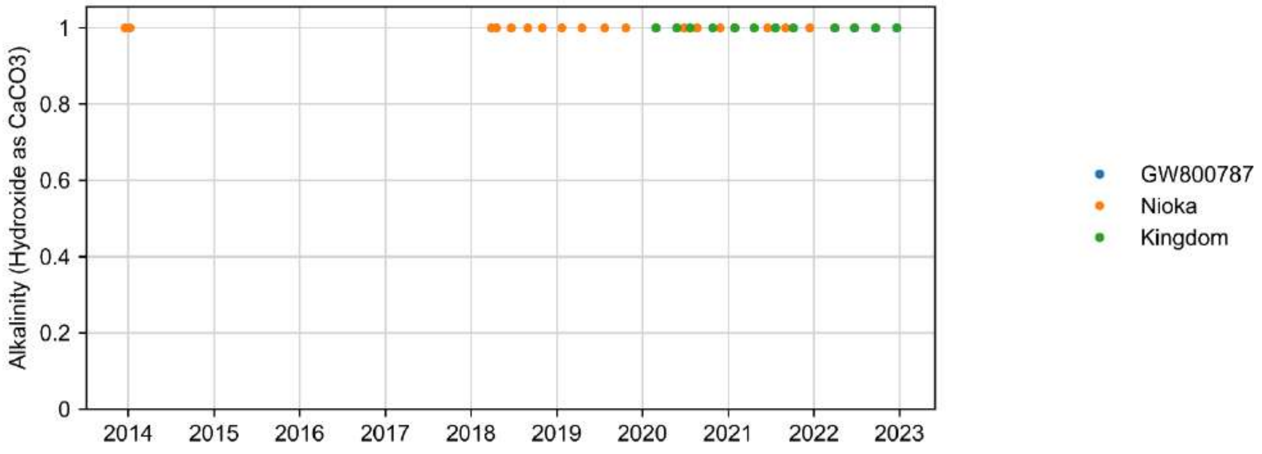

Phosphorus (Total)
0.5
0.4
0.3
0.2
0.1
0
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
GW800787
Nioka
Kingdom

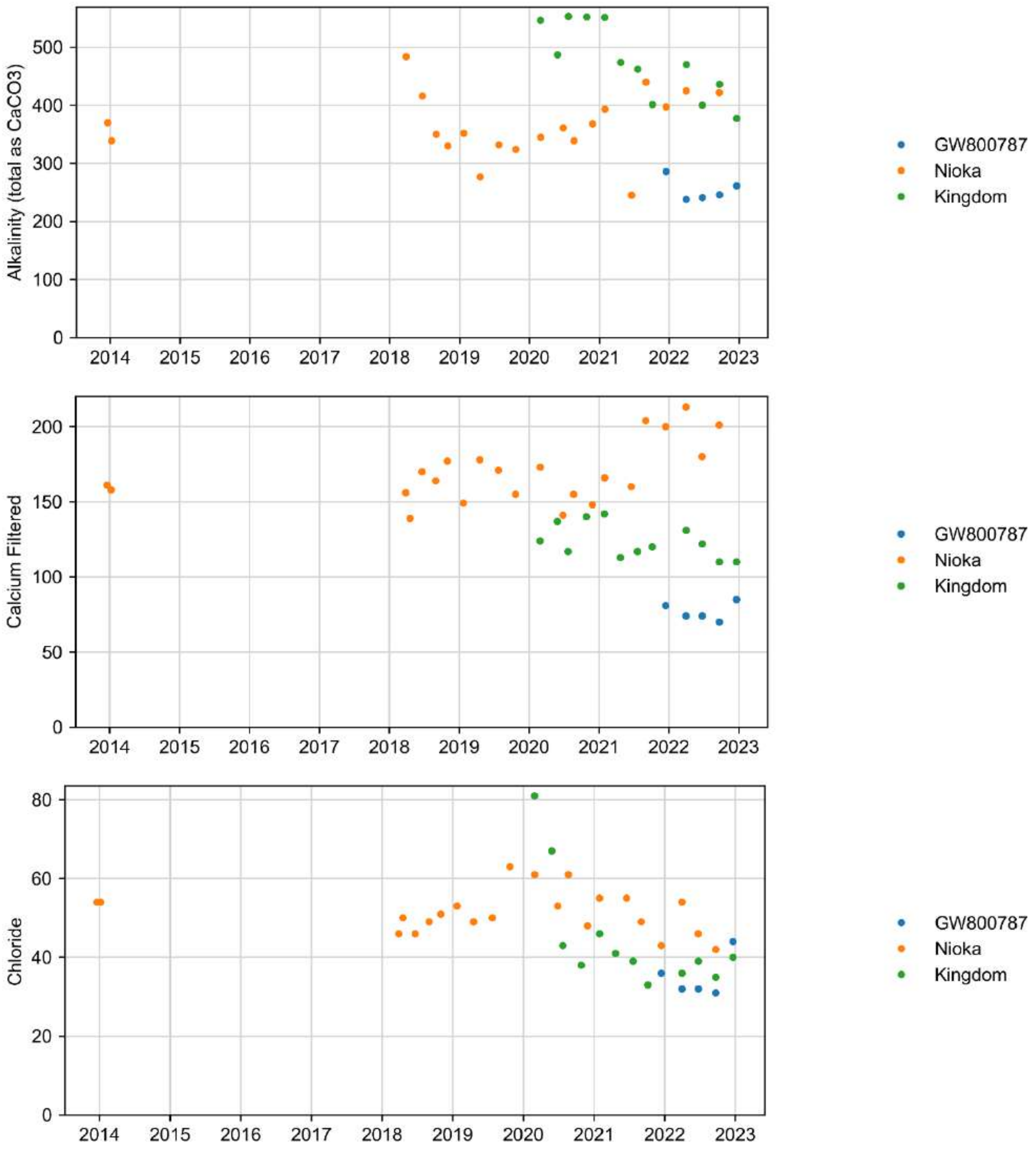

Total Organic Carbon
8
6
4
2
0
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
GW800787
Nioka
Kingdom

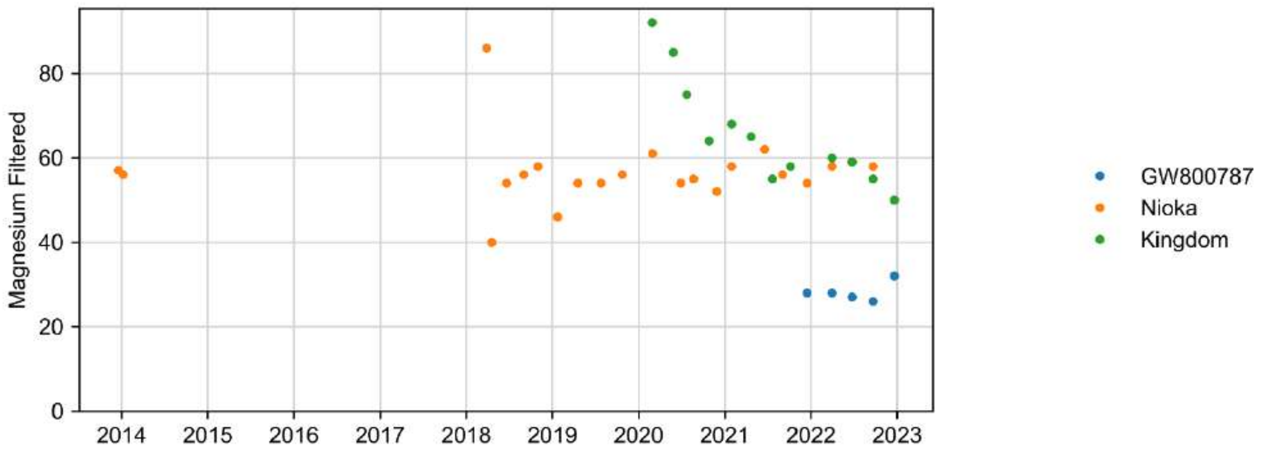
Major Ions

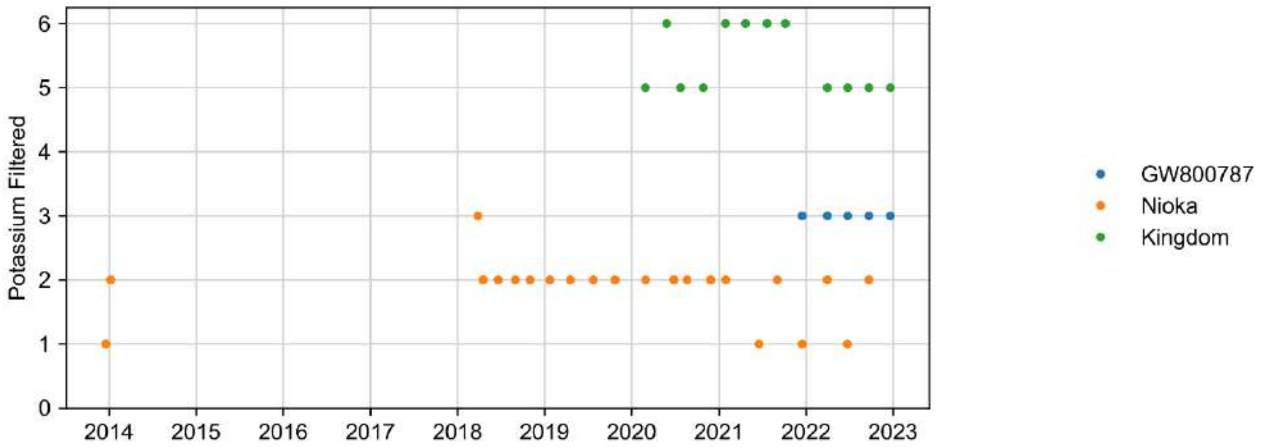

Alkalinity (Bicarbonate as CaCO3)
0
100
200
300
400
500
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
GW800787
Nioka
Kingdom

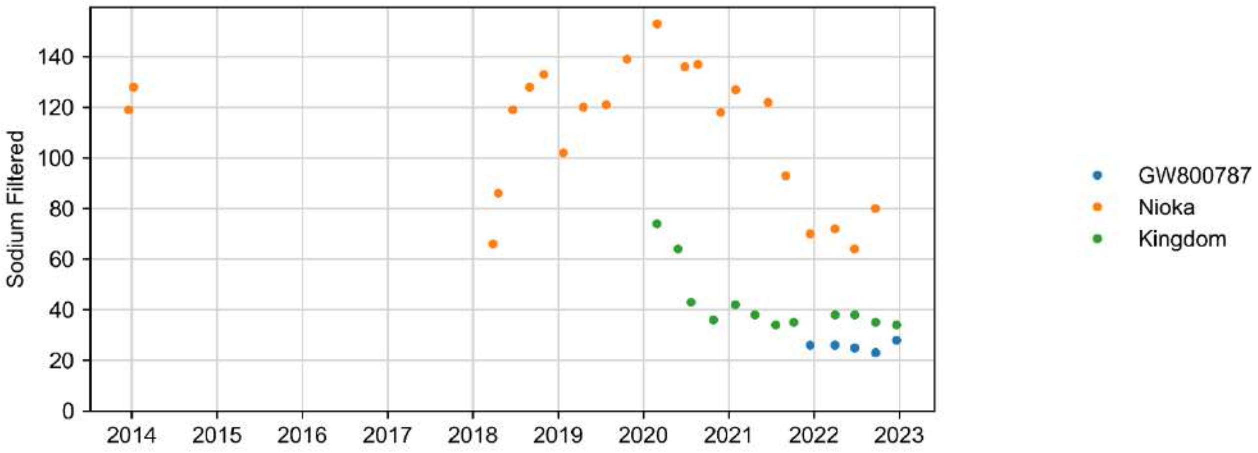

Alkalinity (Carbonate as CaCO3)
0
0.2
0.4
0.6
0.8
1
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
GW800787
Nioka
Kingdom

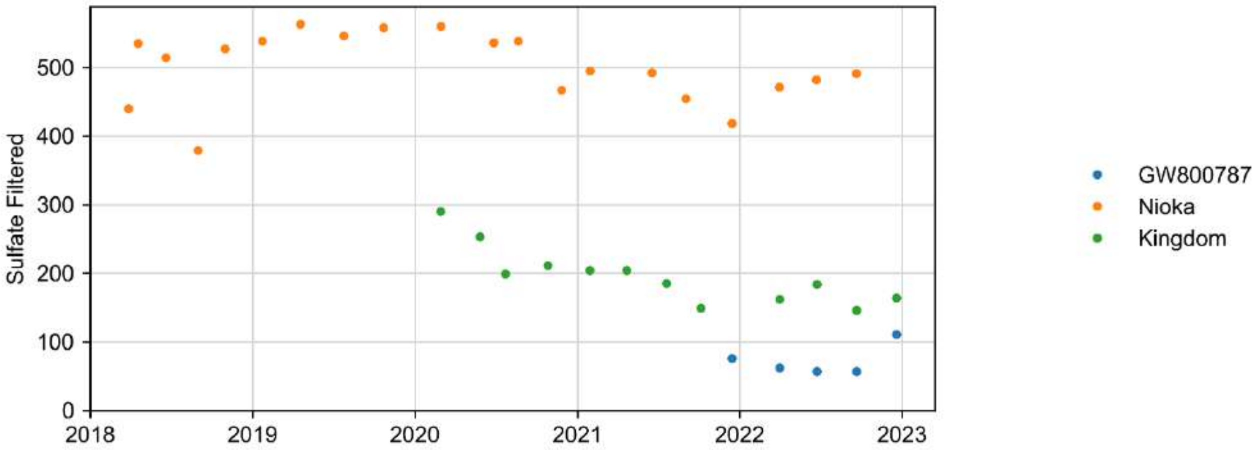

Alkalinity (Hydroxide as CaCO3)
0
0.2
0.4
0.6
0.8
1
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
GW800787
Nioka
Kingdom


Alkalinity (total as CaCO3)
0
100
200
300
400
500
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
GW800787
Nioka
Kingdom
Calcium Filtered
0
50
100
150
200
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
GW800787
Nioka
Kingdom
Chloride
0
20
40
60
80
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
GW800787
Nioka
Kingdom

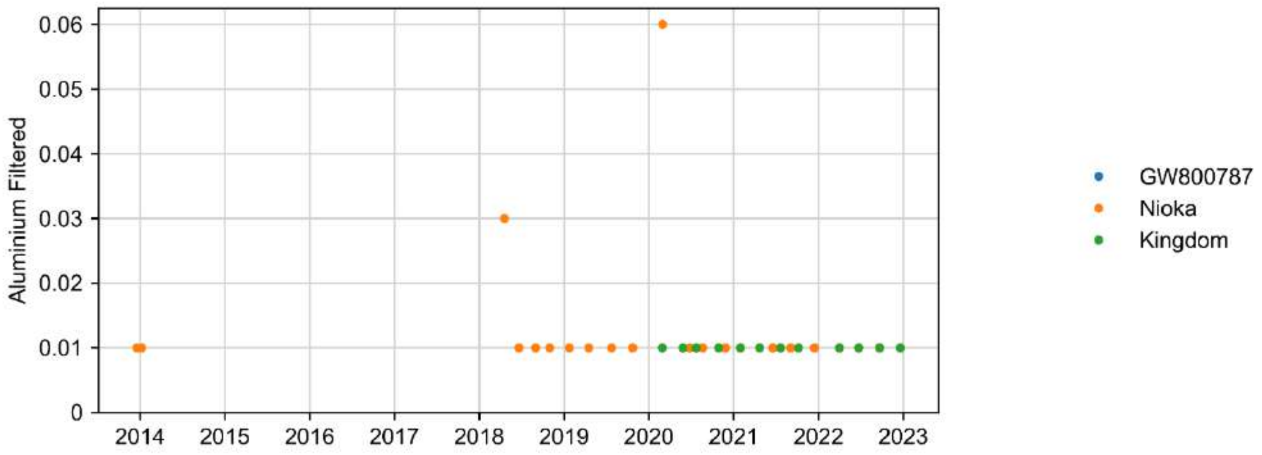

Magnesium Filtered
0
20
40
60
80
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
GW800787
Nioka
Kingdom

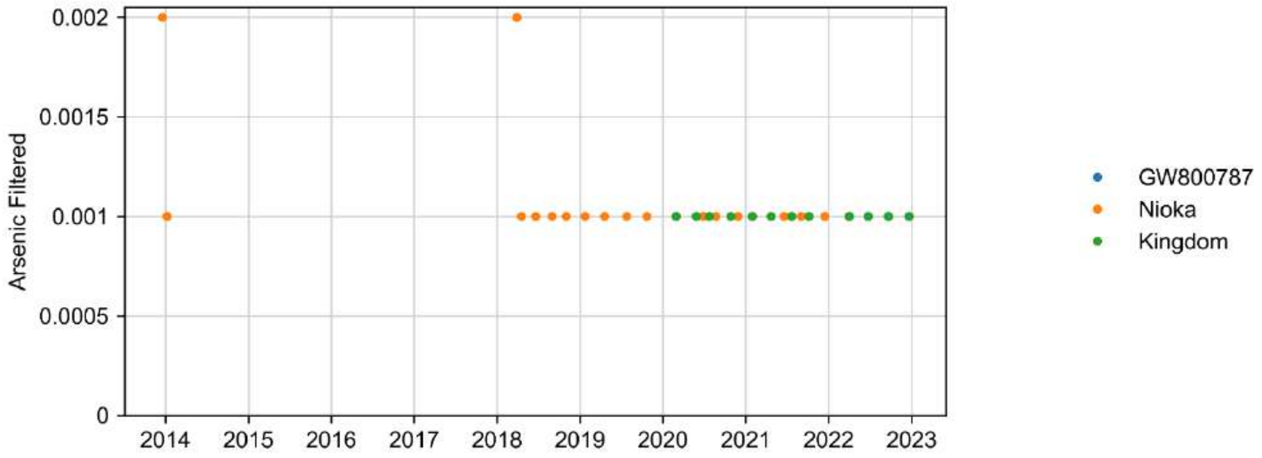

Potassium Filtered
0
1
2
3
4
5
6
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
GW800787
Nioka
Kingdom

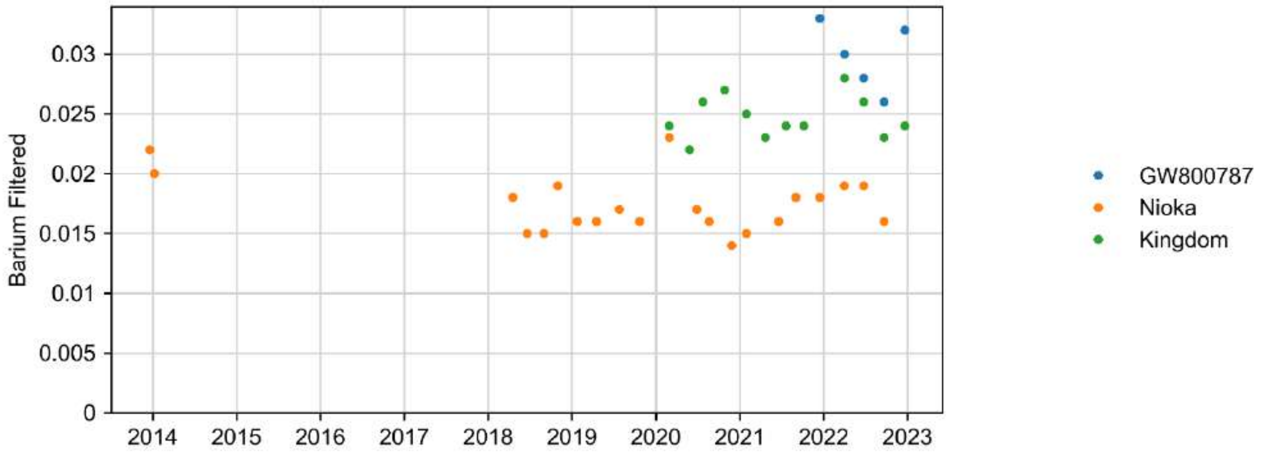

Sodium Filtered
0
20
40
60
80
100
120
140
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
● GW800787
● Nioka
● Kingdom

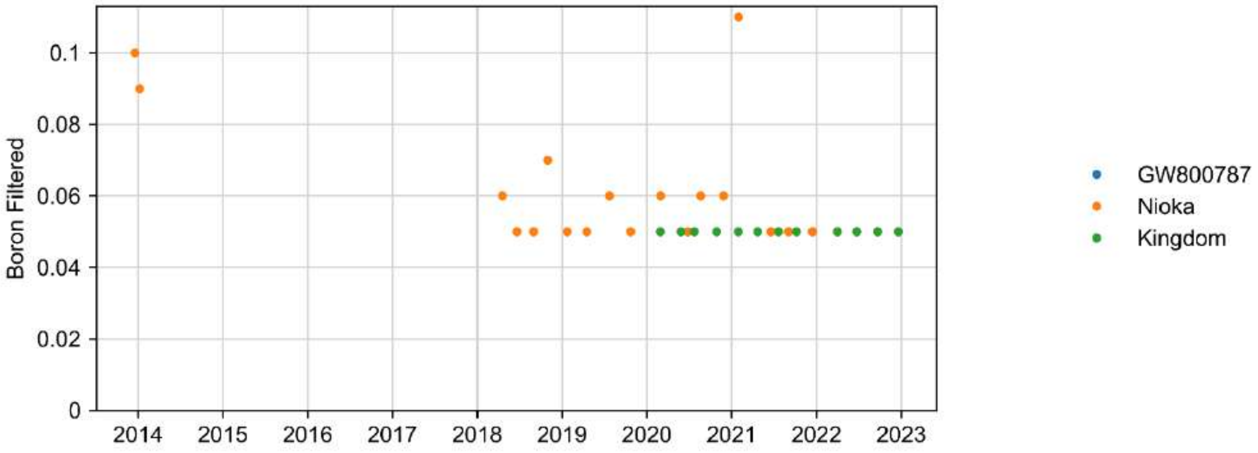

Sulfate Filtered
0
100
200
300
400
500
2018
2019
2020
2021
2022
2023
● GW800787
● Nioka
● Kingdom

Dissolved metals

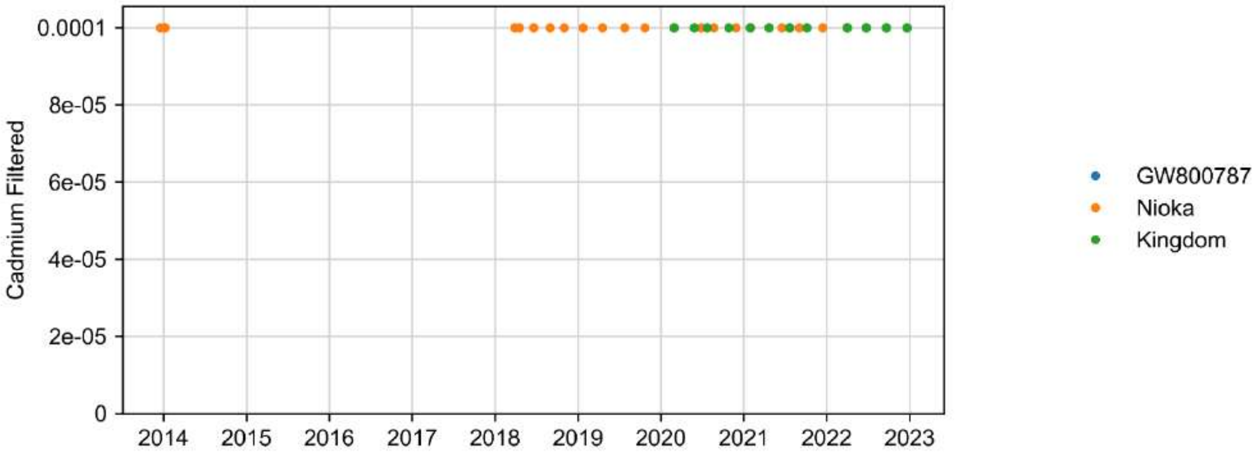




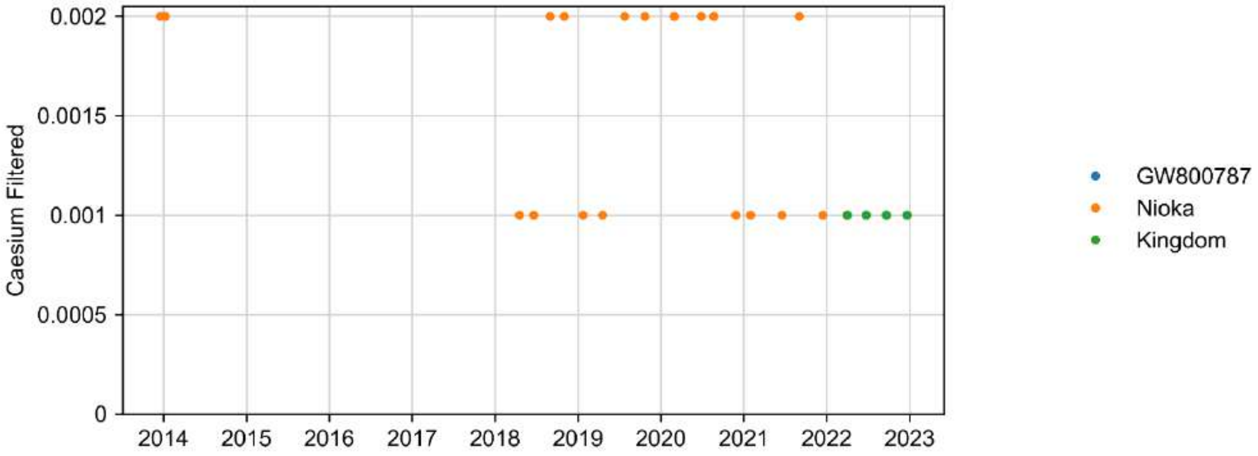




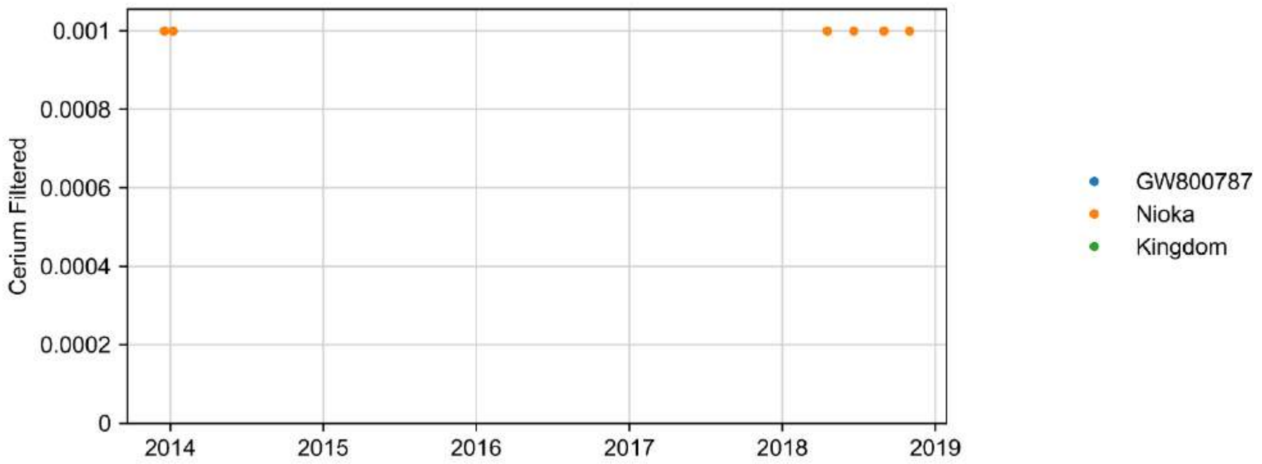
Boron Filtered
0.1
0.08
0.06
0.04
0.02
0
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
GW800787
Nioka
Kingdom

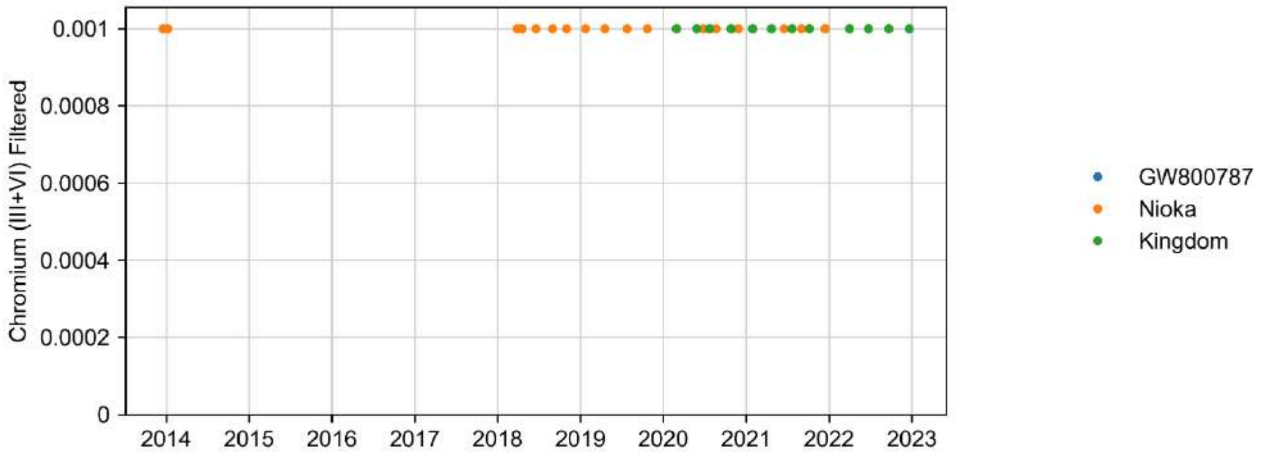


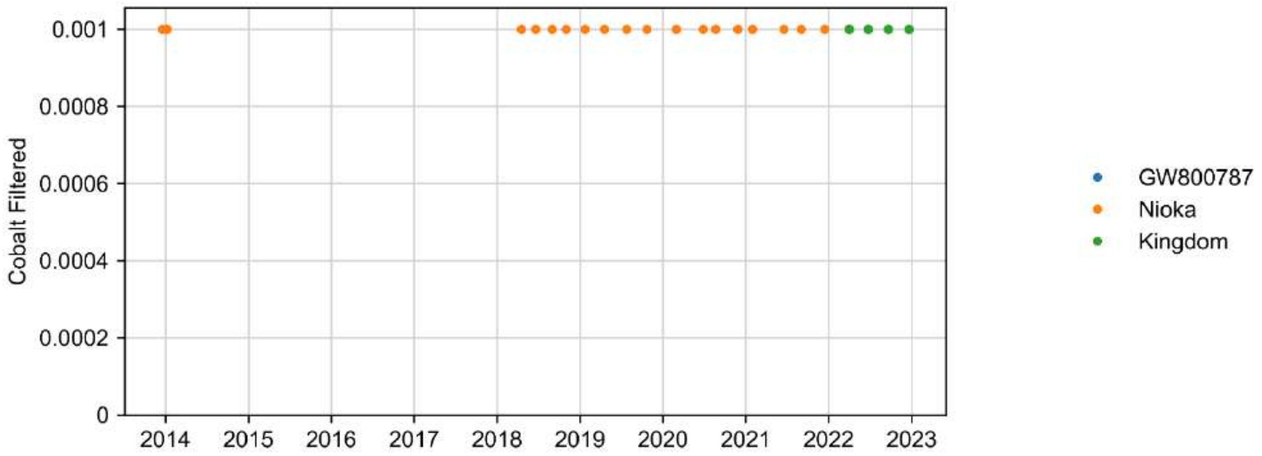
Cadmium Filtered
0.0001
8e-05
6e-05
4e-05
2e-05
0
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
GW800787
Nioka
Kingdom

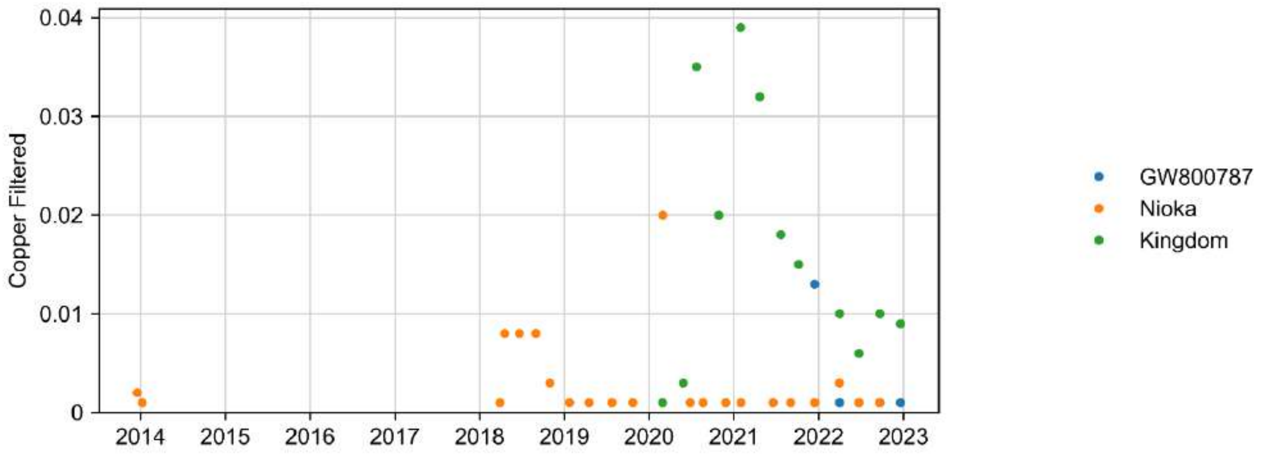


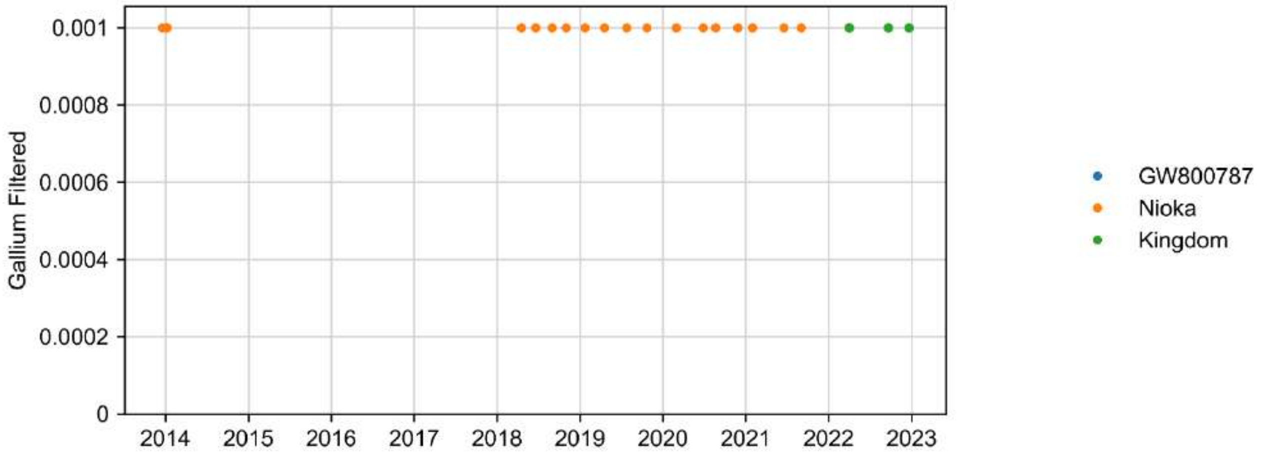
Caesium Filtered
0.002
0.0015
0.001
0.0005
0
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
GW800787
Nioka
Kingdom

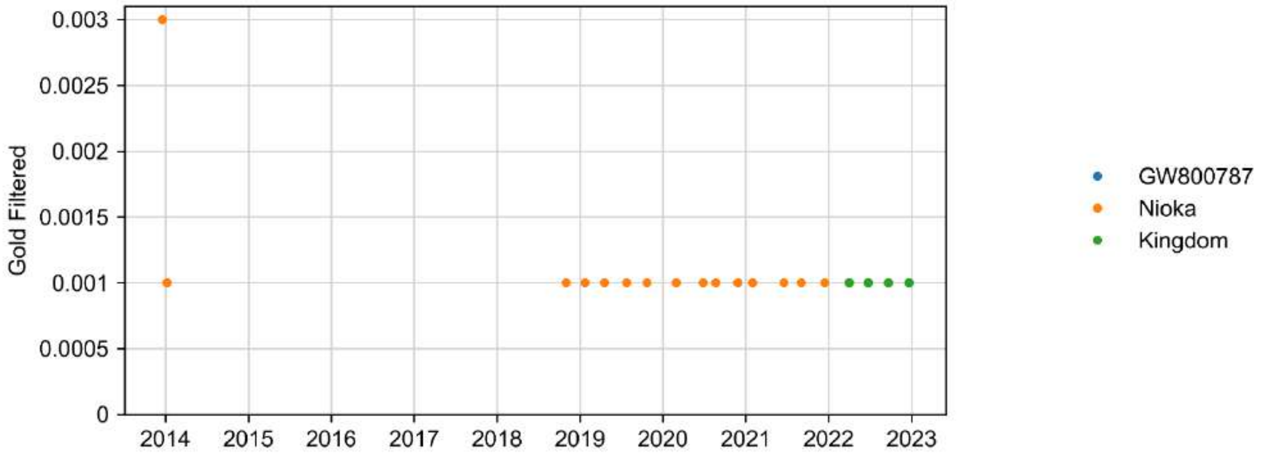

Cerium Filtered
0.001
0.0008
0.0006
0.0004
0.0002
0
2014
2015
2016
2017
2018
2019
GW800787
Nioka
Kingdom

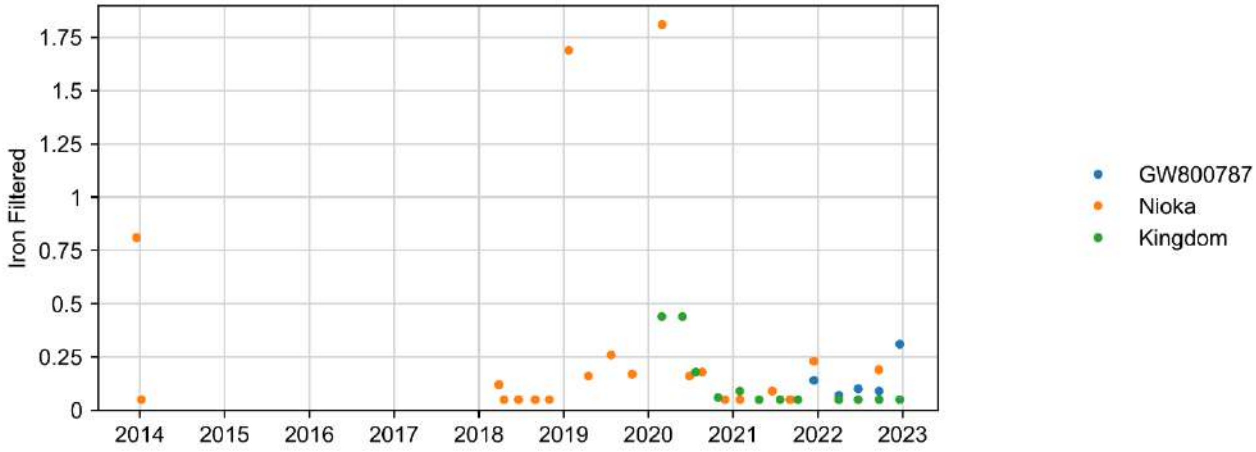

Chromium (III+VI) Filtered
0.001
0.0008
0.0006
0.0004
0.0002
0
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
GW800787
Nioka
Kingdom

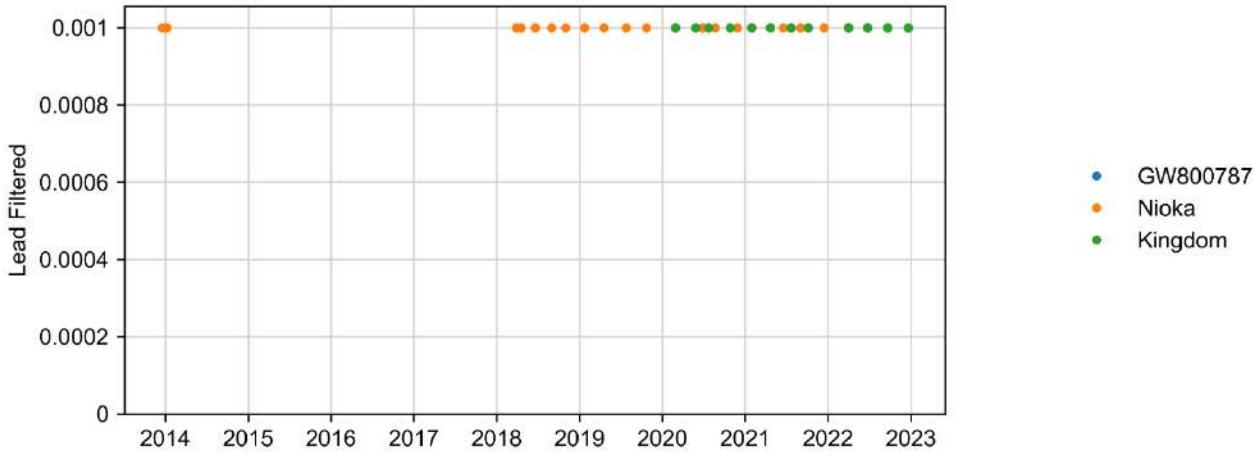

Cobalt Filtered
0.001
0.0008
0.0006
0.0004
0.0002
0
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
GW800787
Nioka
Kingdom

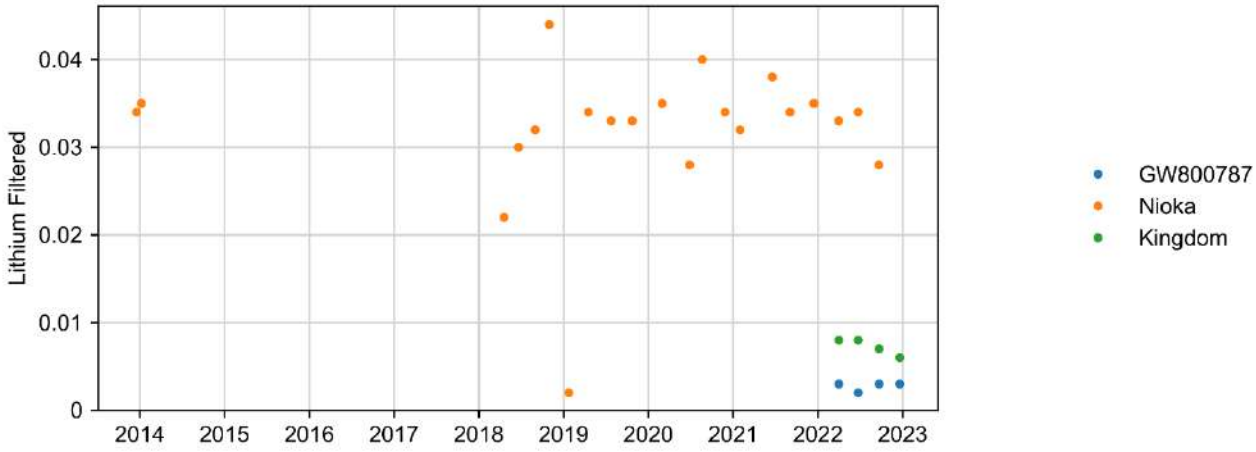

Copper Filtered
0.04
0.03
0.02
0.01
0
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
GW800787
Nioka
Kingdom

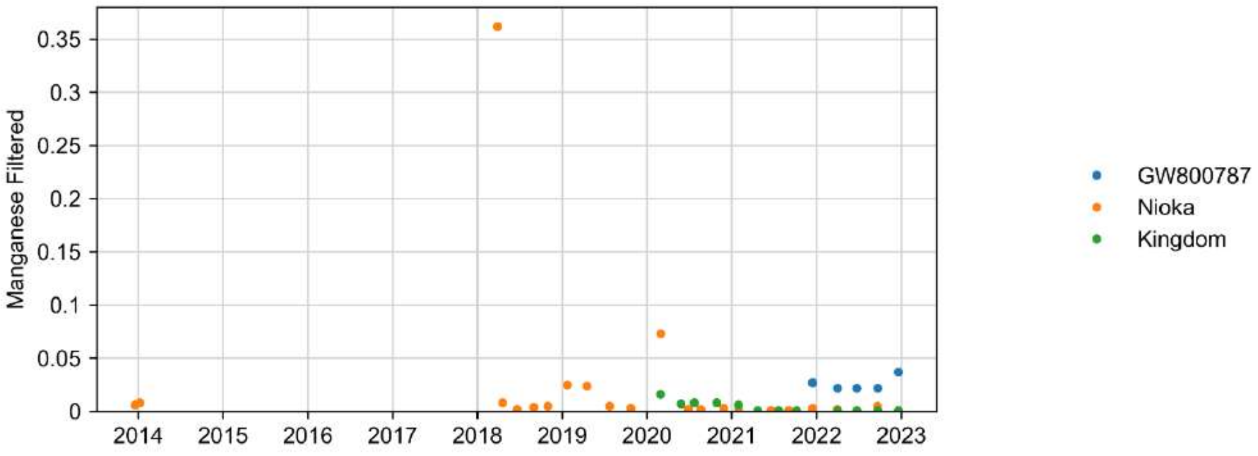

Gallium Filtered
0.001
0.0008
0.0006
0.0004
0.0002
0
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
GW800787
Nioka
Kingdom

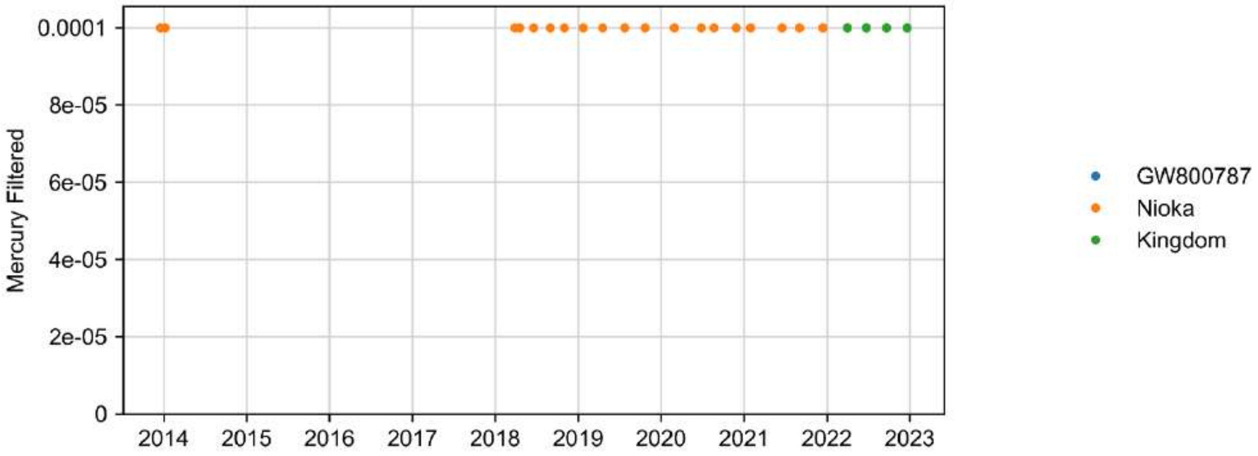

Gold Filtered
0.003
0.0025
0.002
0.0015
0.001
0.0005
0
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
GW800787
Nioka
Kingdom

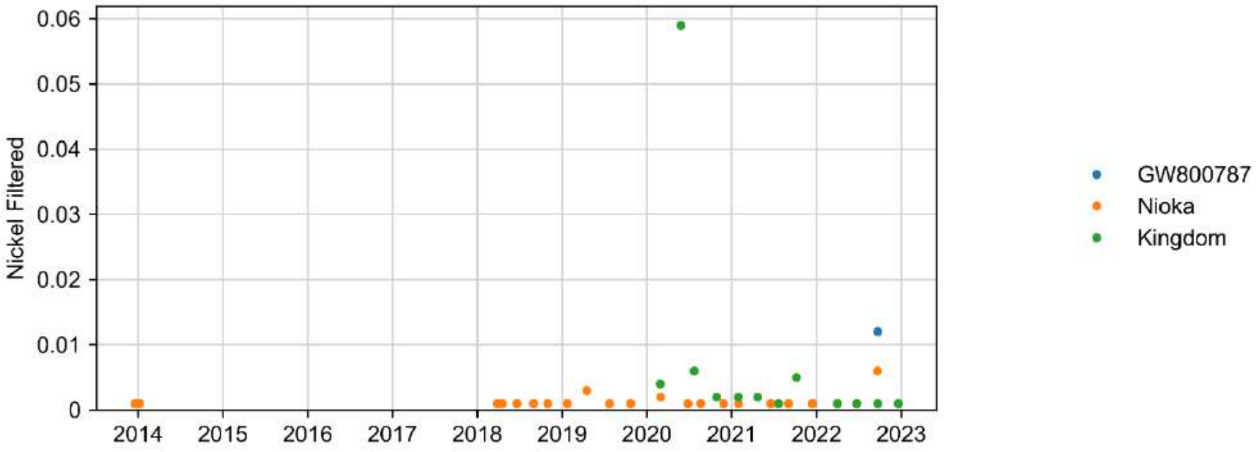

Iron Filtered
1.75
1.5
1.25
1
0.75
0.5
0.25
0
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
● GW800787
● Nioka
● Kingdom

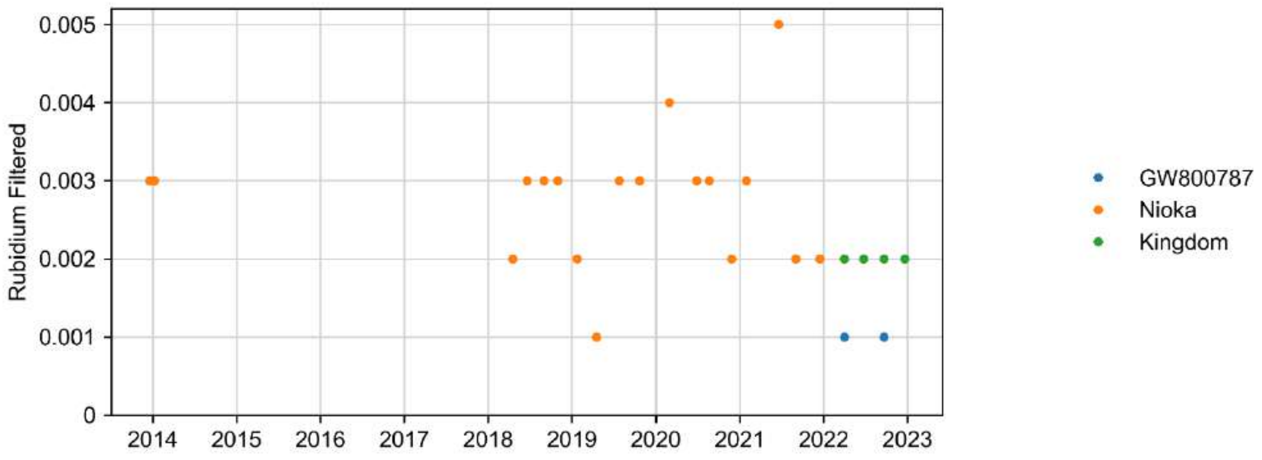

Lead Filtered
0.001
0.0008
0.0006
0.0004
0.0002
0
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
● GW800787
● Nioka
● Kingdom

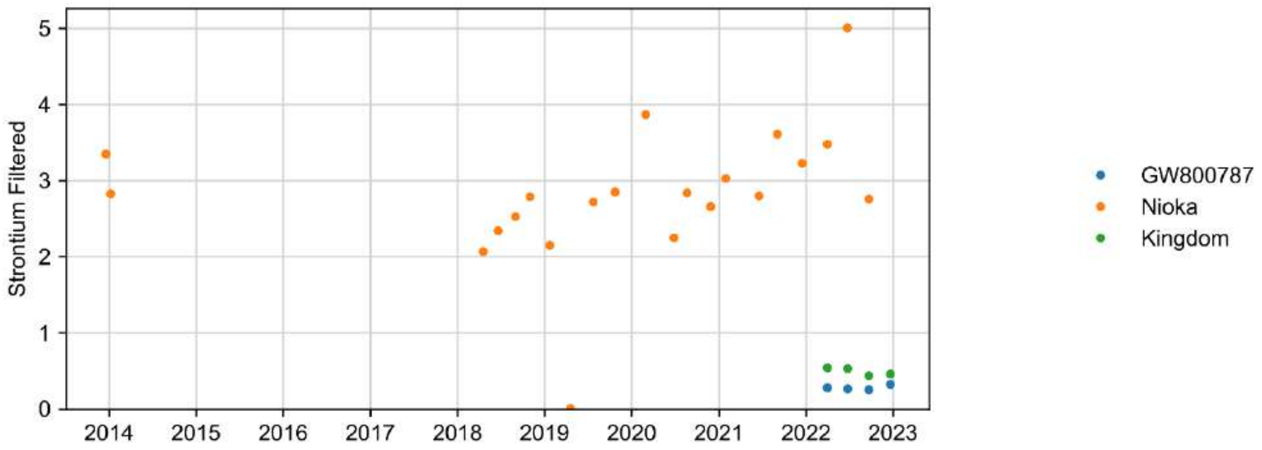

Lithium Filtered
0.04
0.03
0.02
0.01
0
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
● GW800787
● Nioka
● Kingdom

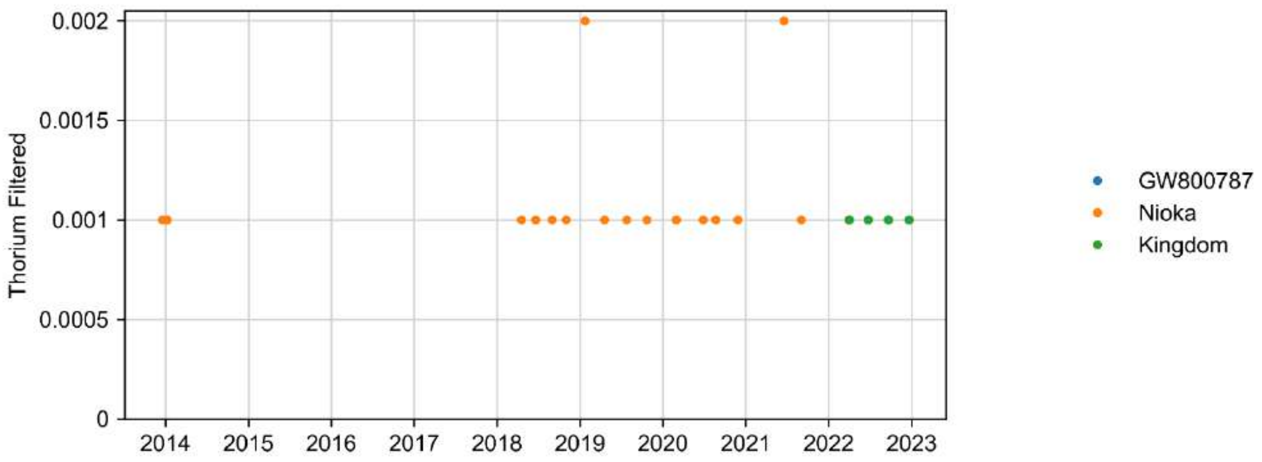

Manganese Filtered
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
GW800787
Nioka
Kingdom

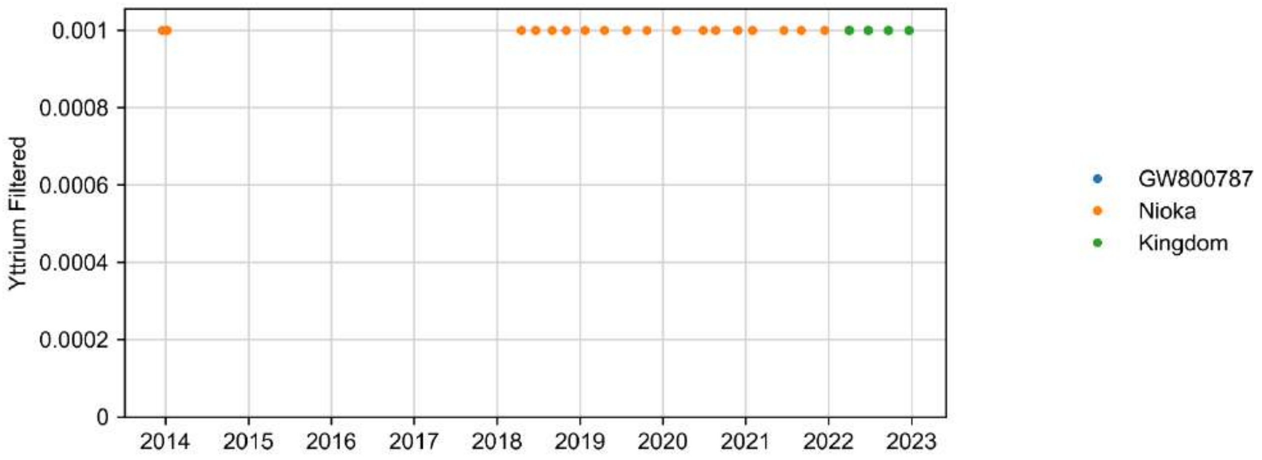

Mercury Filtered
0.0001
8e-05
6e-05
4e-05
2e-05
0
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
GW800787
Nioka
Kingdom

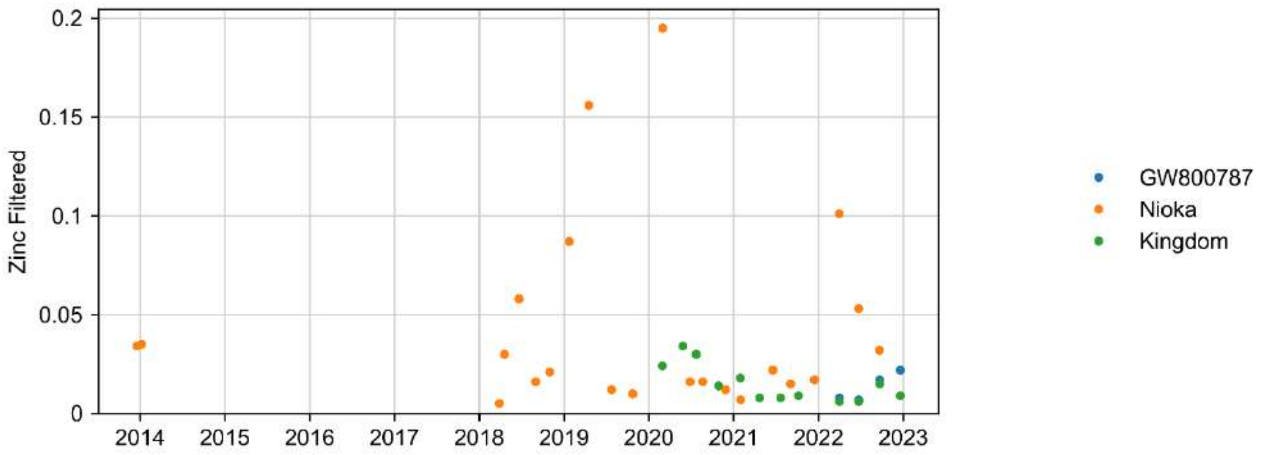

Nickel Filtered
0.06
0.05
0.04
0.03
0.02
0.01
0
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
GW800787
Nioka
Kingdom


Rubidium Filtered
0.005
0.004
0.003
0.002
0.001
0
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
GW800787
Nioka
Kingdom

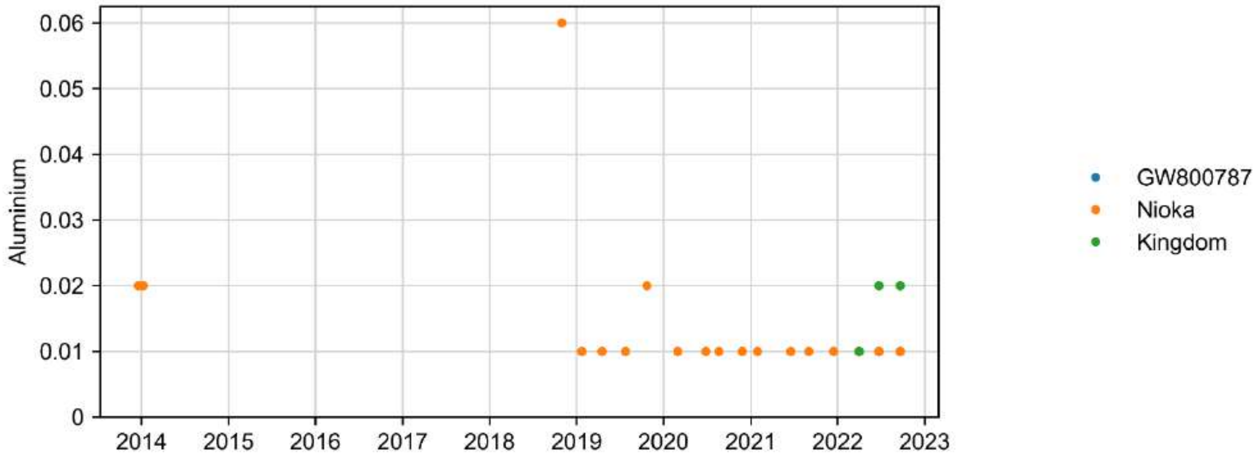

Strontium Filtered
5
4
3
2
1
0
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
GW800787
Nioka
Kingdom

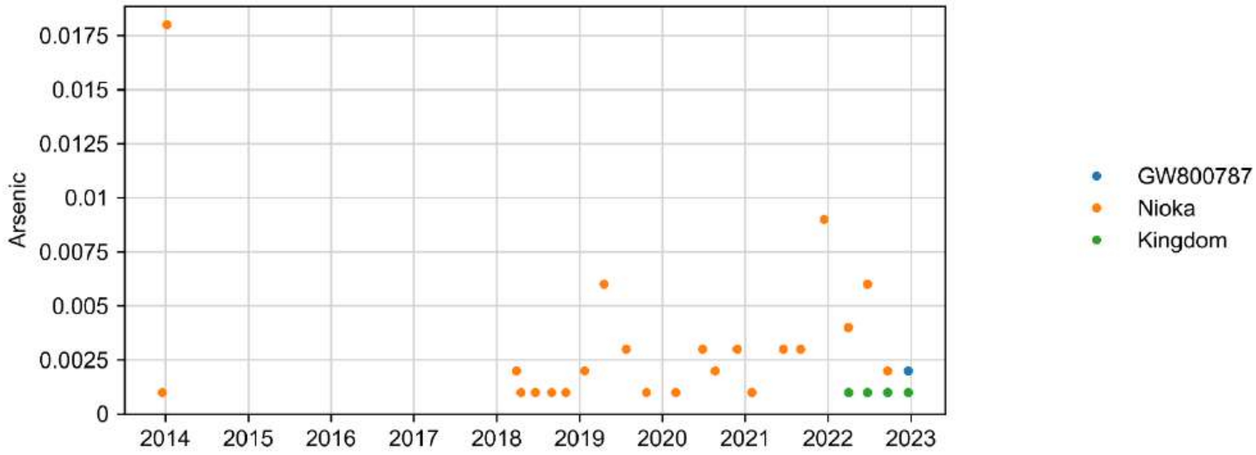

Thorium Filtered
0.002
0.0015
0.001
0.0005
0
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
GW800787
Nioka
Kingdom

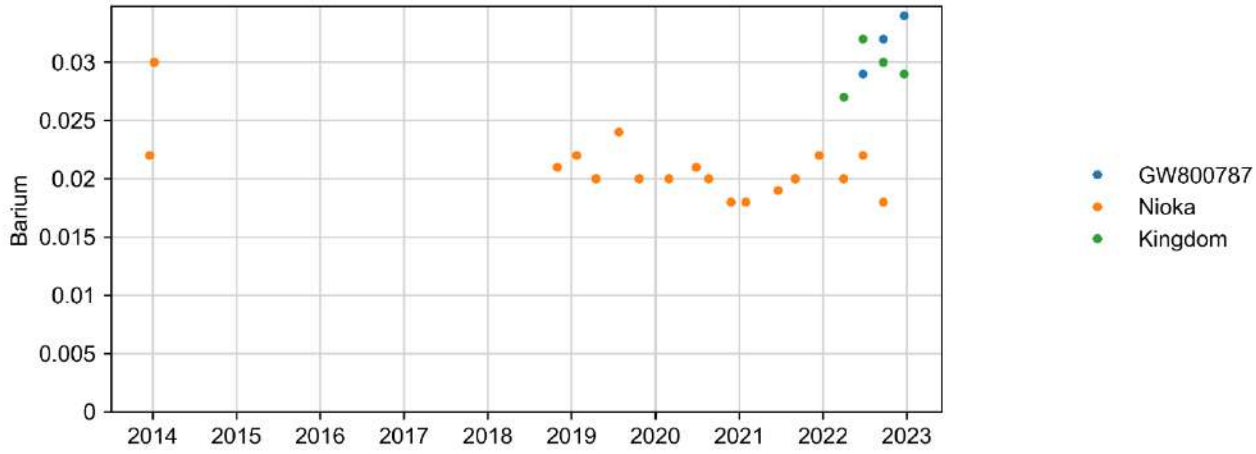

Yttrium Filtered
0.001
0.0008
0.0006
0.0004
0.0002
0
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
GW800787
Nioka
Kingdom

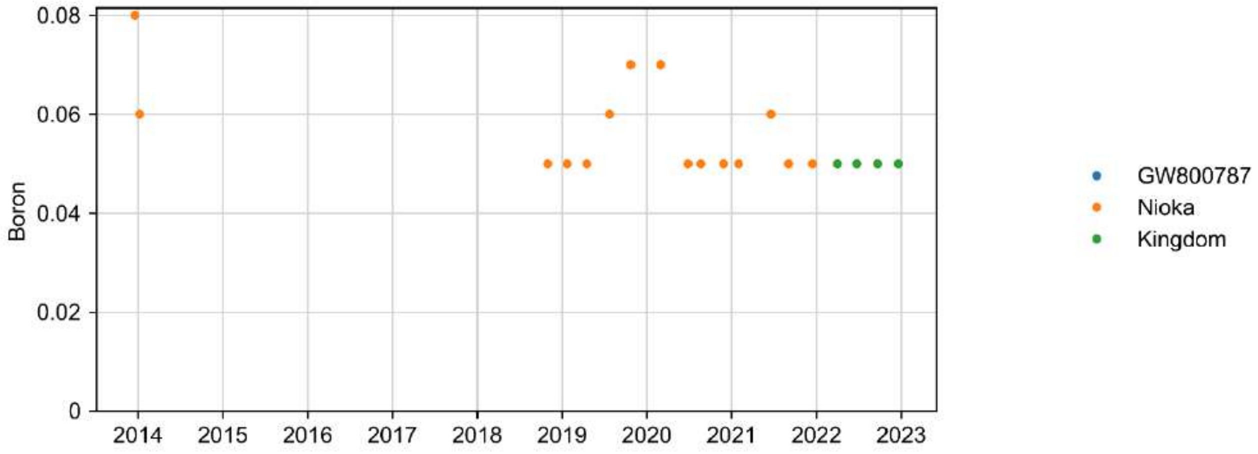

Zinc Filtered
0.2
0.15
0.1
0.05
0
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
GW800787
Nioka
Kingdom

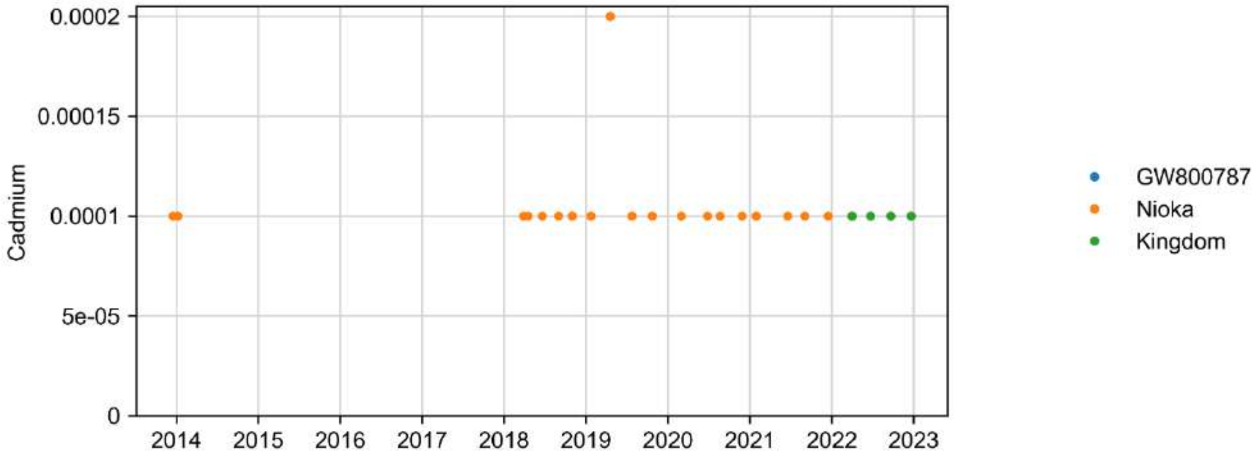
Total metals

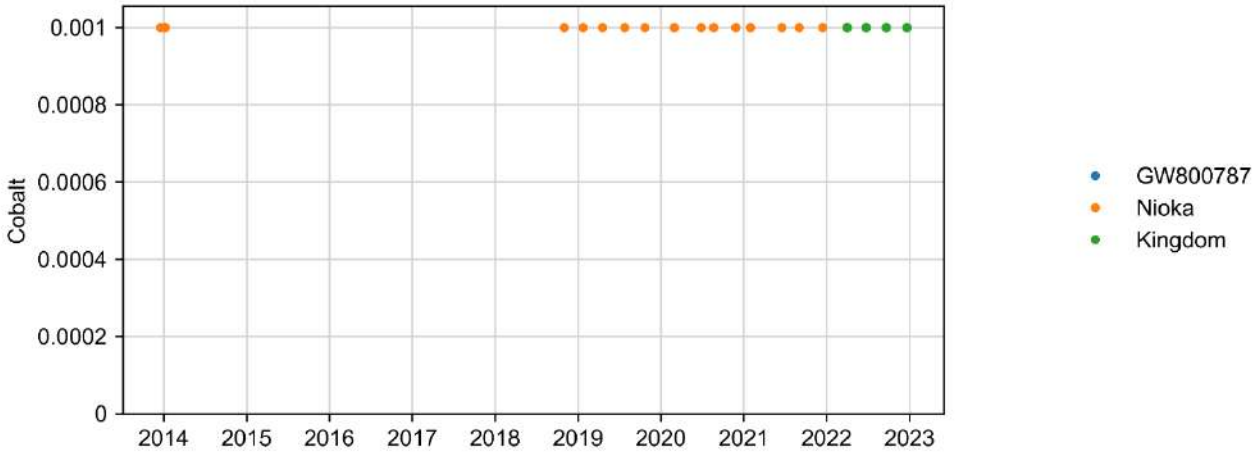


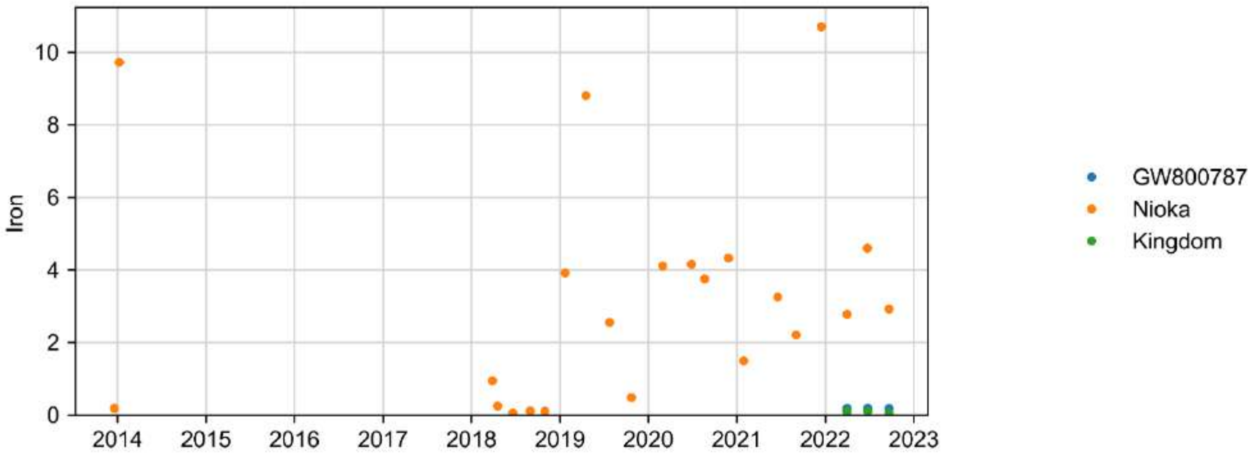


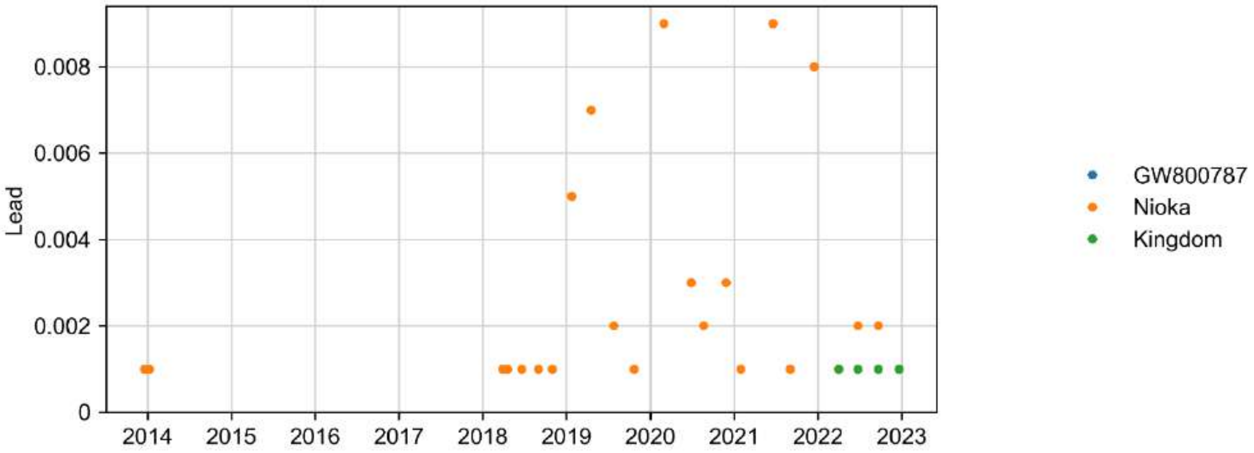


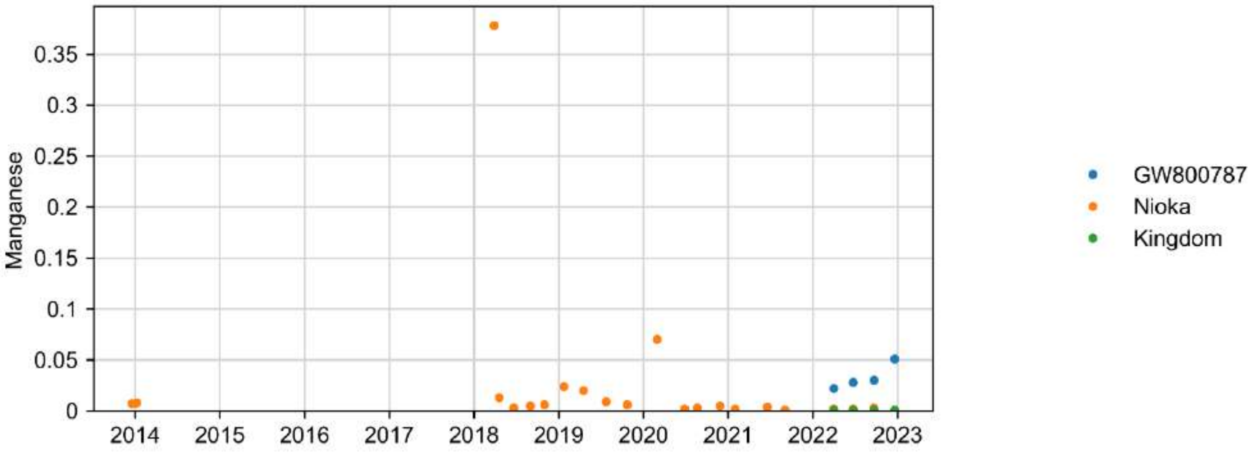

Boron
0.08
0.06
0.04
0.02
0
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
GW800787
Nioka
Kingdom

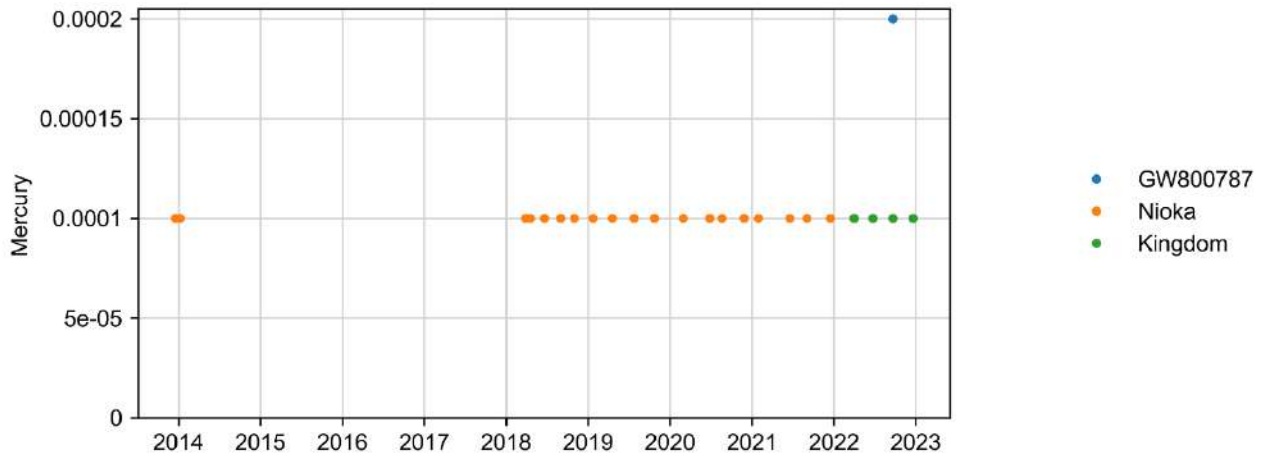

Cadmium
0.0002
0.00015
0.0001
5e-05
0
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
GW800787
Nioka
Kingdom

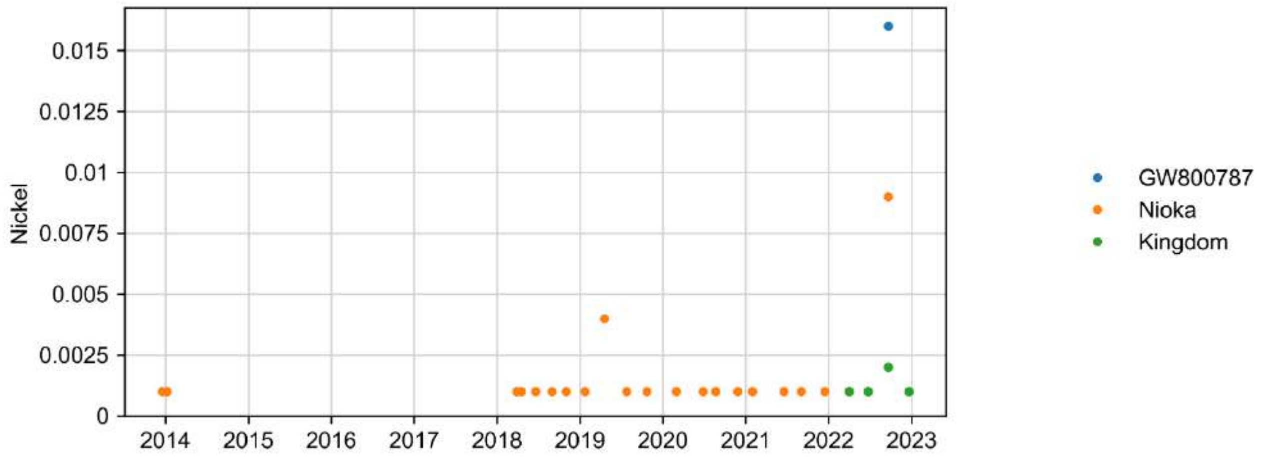

Cobalt
0.001
0.0008
0.0006
0.0004
0.0002
0
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
GW800787
Nioka
Kingdom

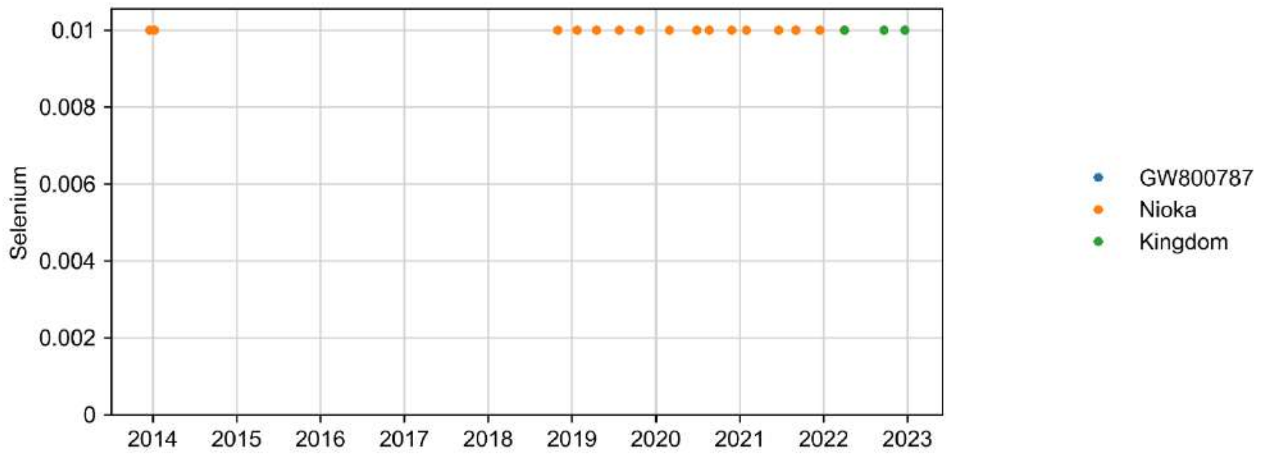

Iron
10
8
6
4
2
0
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
● GW800787
● Nioka
● Kingdom

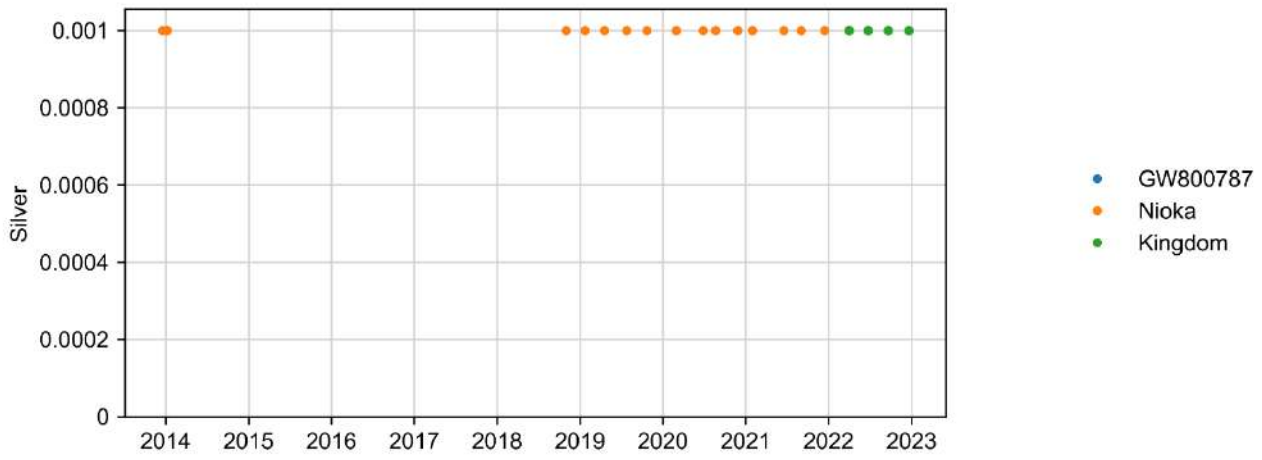

Lead
0.008
0.006
0.004
0.002
0
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
● GW800787
● Nioka
● Kingdom

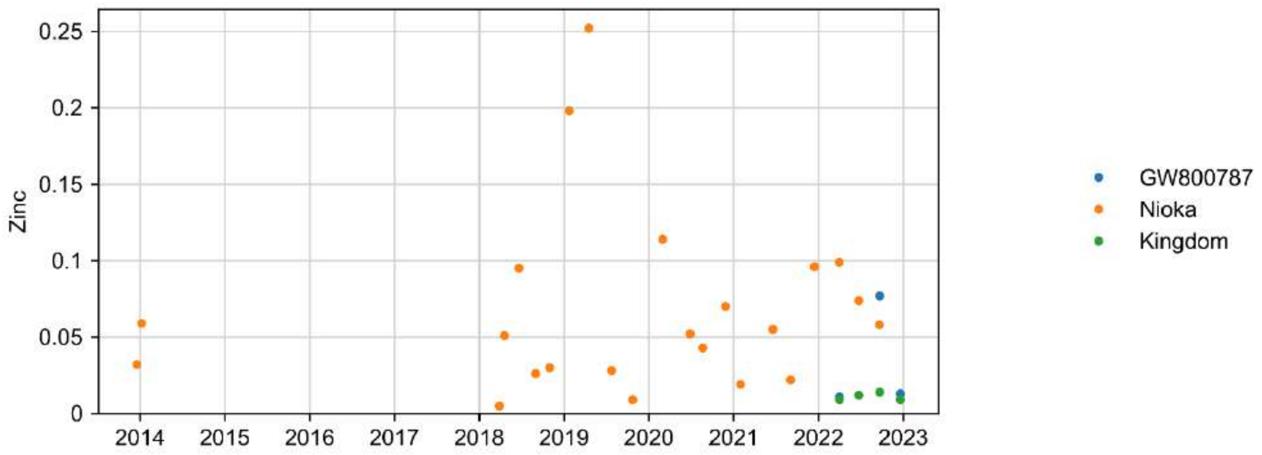

Manganese
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
● GW800787
● Nioka
● Kingdom


Mercury
0.0002
0.00015
0.0001
5e-05
0
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
GW800787
Nioka
Kingdom

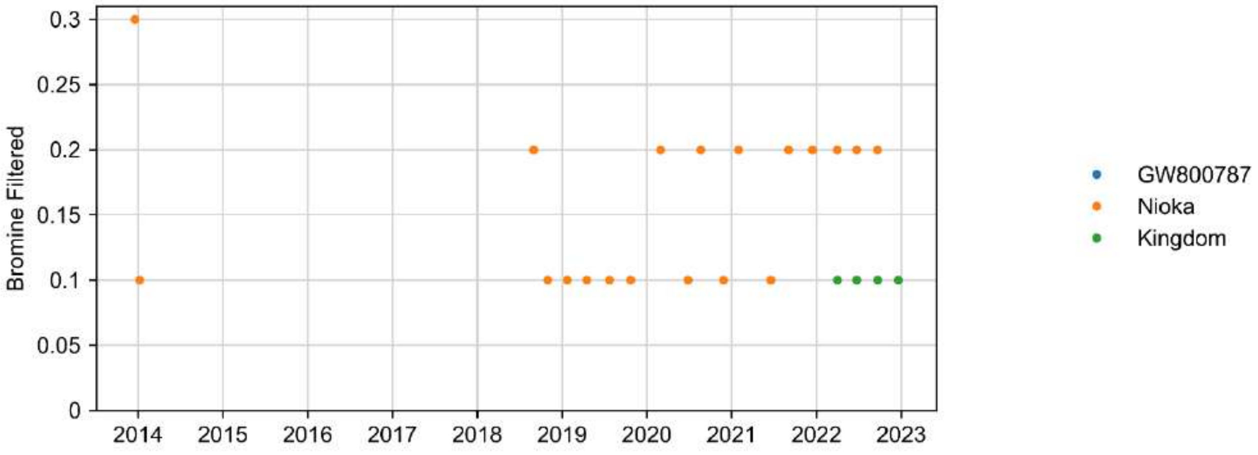

Nickel
0.015
0.0125
0.01
0.0075
0.005
0.0025
0
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
GW800787
Nioka
Kingdom

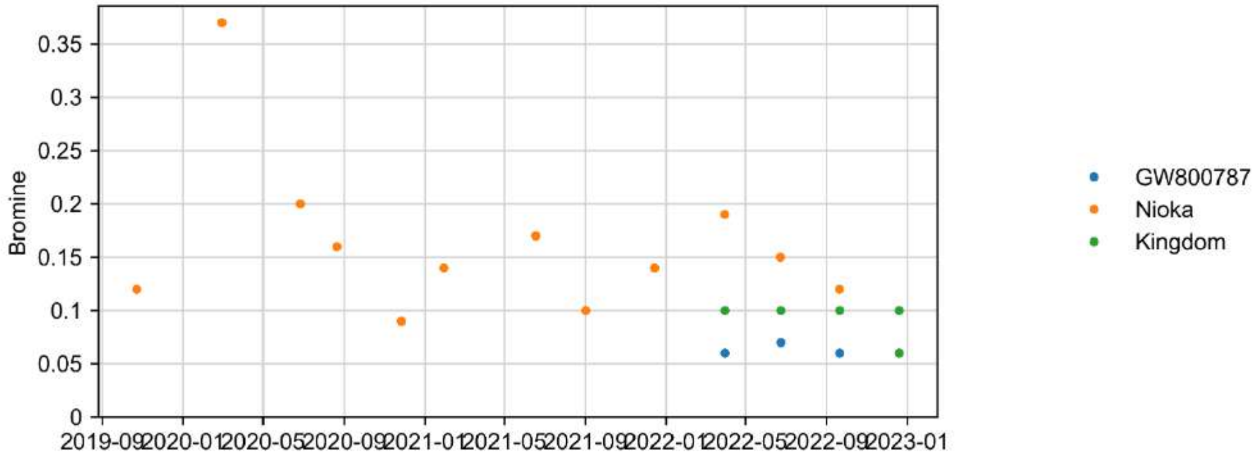

Selenium
0.01
0.008
0.006
0.004
0.002
0
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
GW800787
Nioka
Kingdom

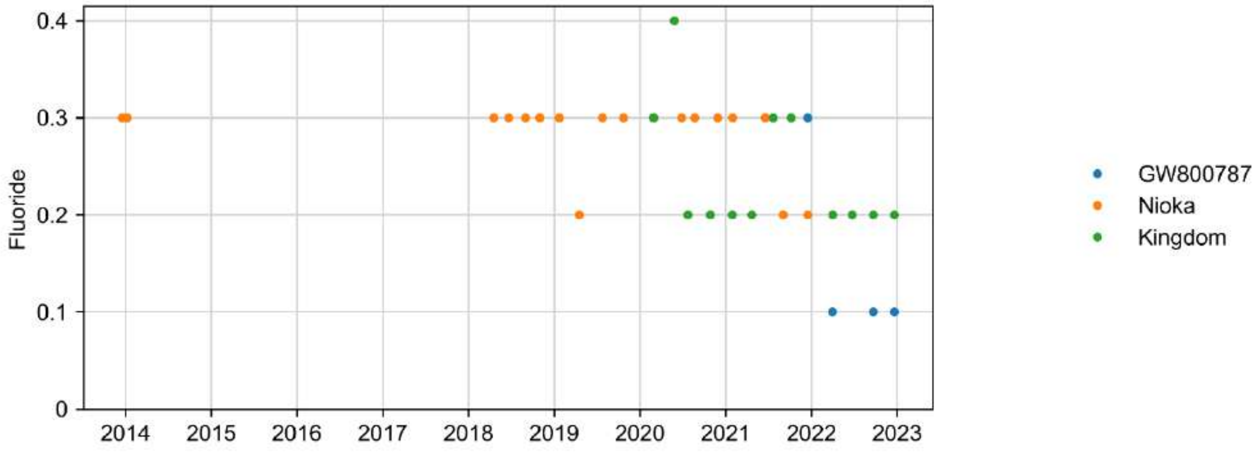

Silver
0.001
0.0008
0.0006
0.0004
0.0002
0
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
GW800787
Nioka
Kingdom

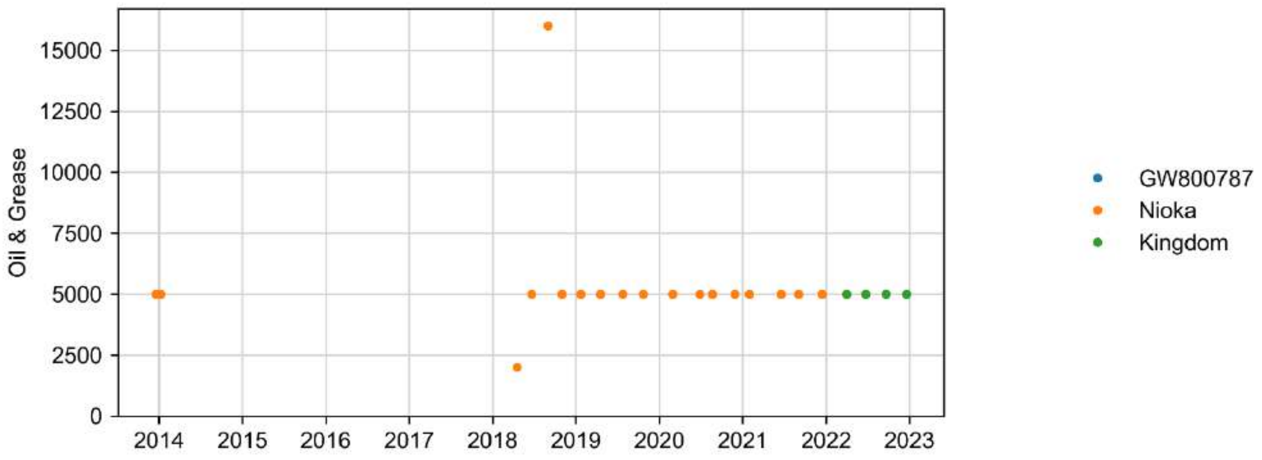

Zinc
0.25
0.2
0.15
0.1
0.05
0
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
GW800787
Nioka
Kingdom

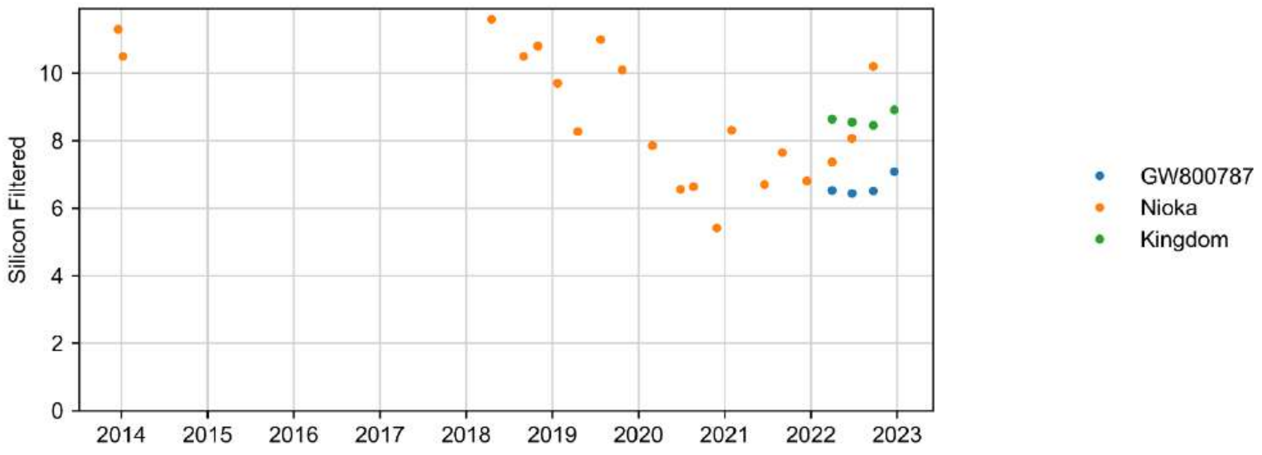
Other


Bromine Filtered
0.3
0.25
0.2
0.15
0.1
0.05
0
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
● GW800787
● Nioka
● Kingdom


Bromine
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
2019-09
2020-01
2020-05
2020-09
2021-01
2021-05
2021-09
2022-01
2022-05
2022-09
2023-01
● GW800787
● Nioka
● Kingdom

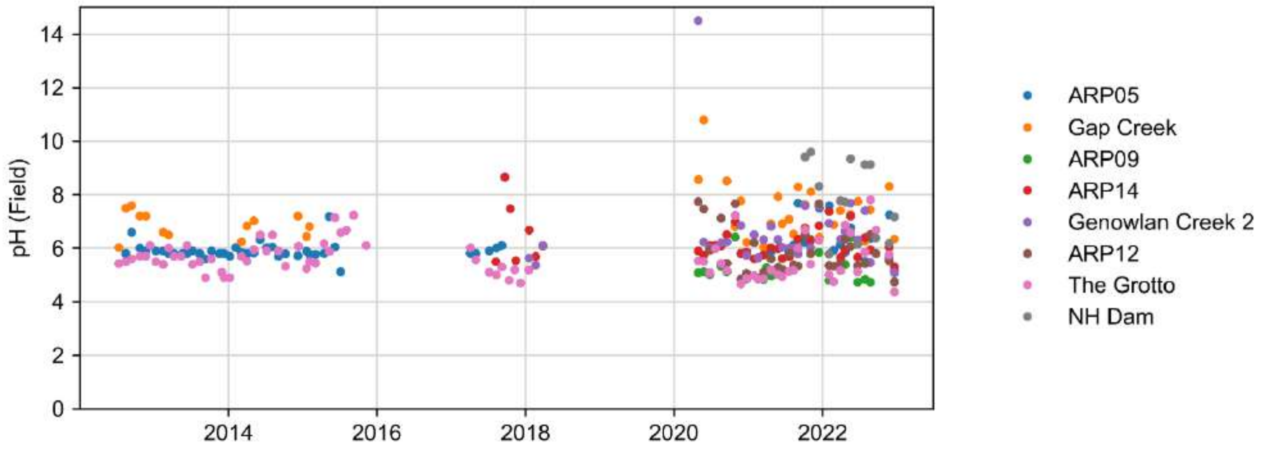

Fluoride
0.4
0.3
0.2
0.1
0
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
● GW800787
● Nioka
● Kingdom

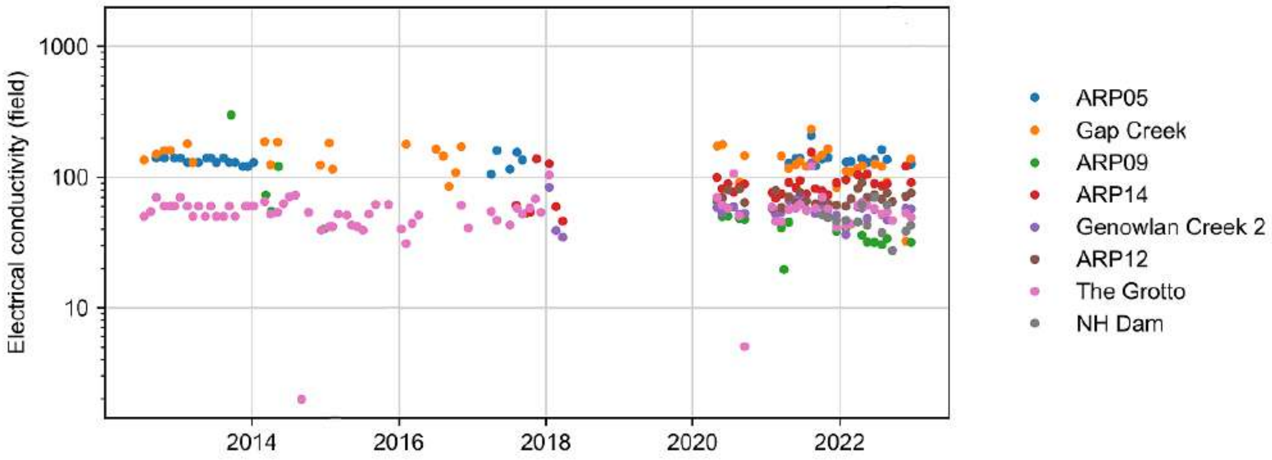


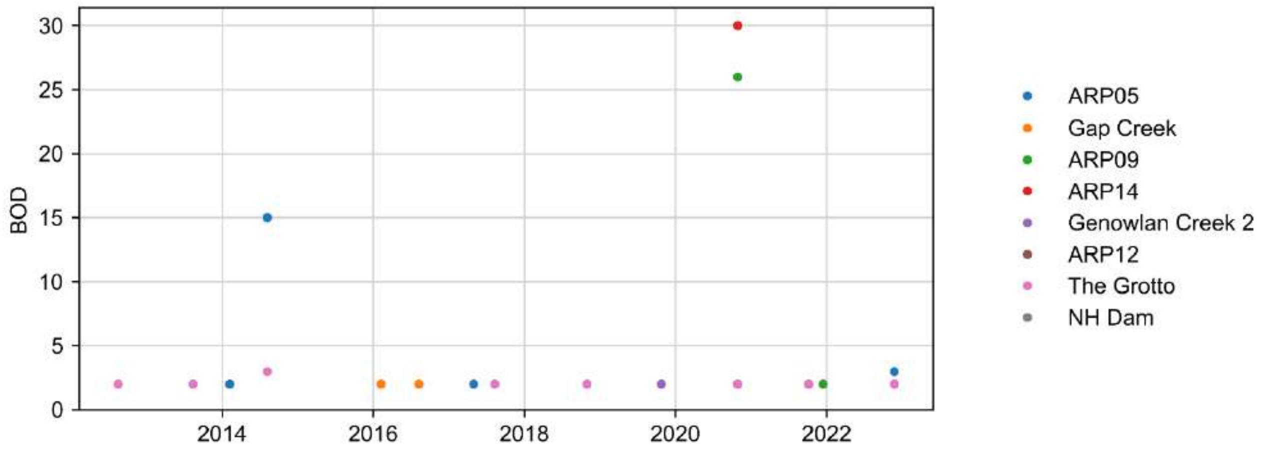


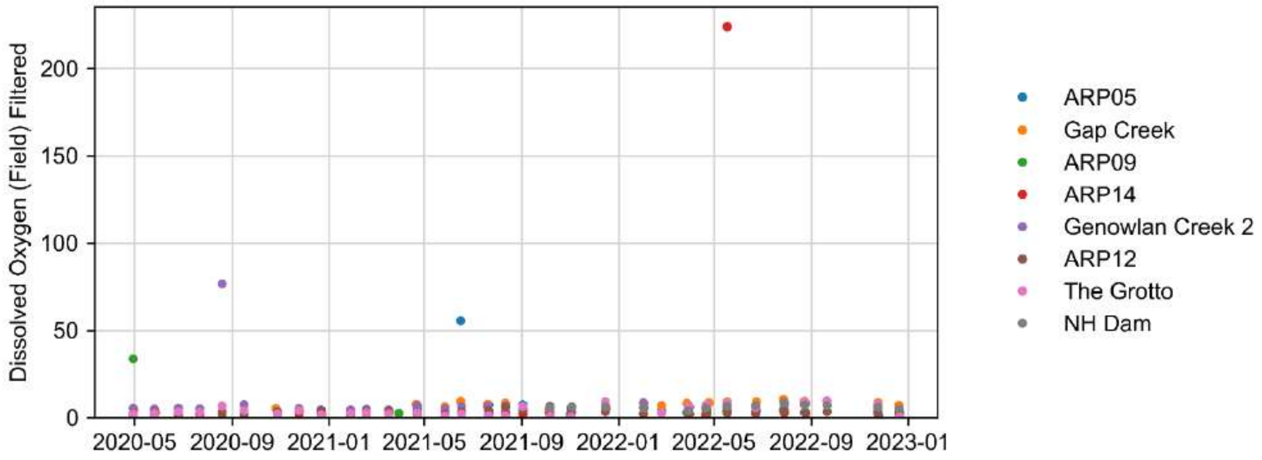
Genowlan Creek Catchment - Surface water and alluvial bores

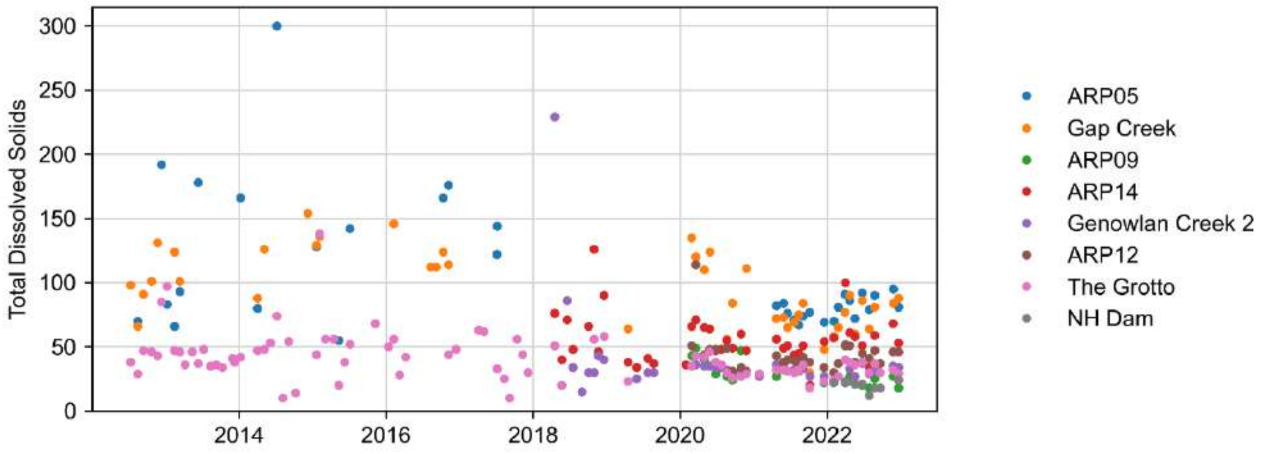
Physicochemical

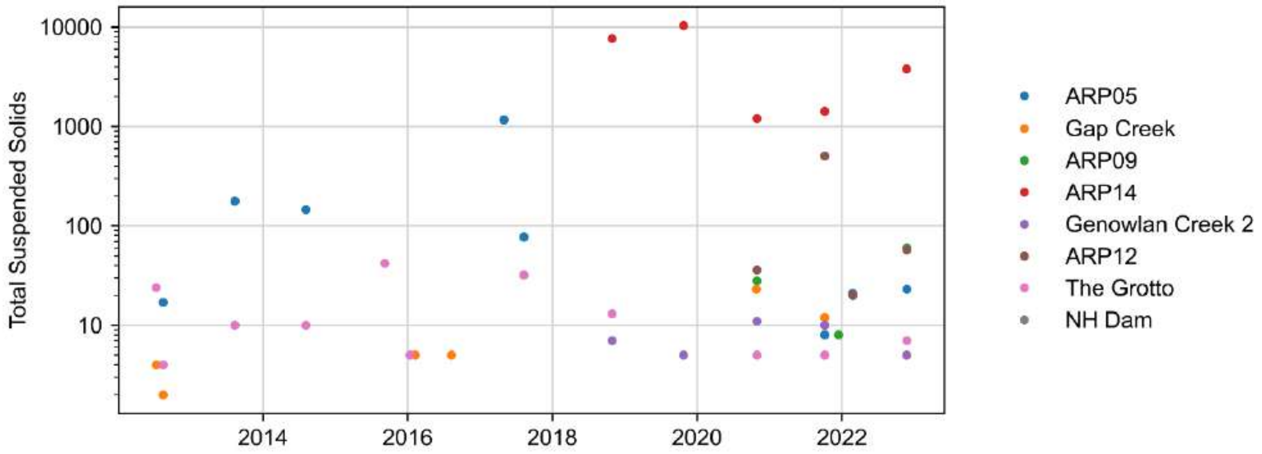


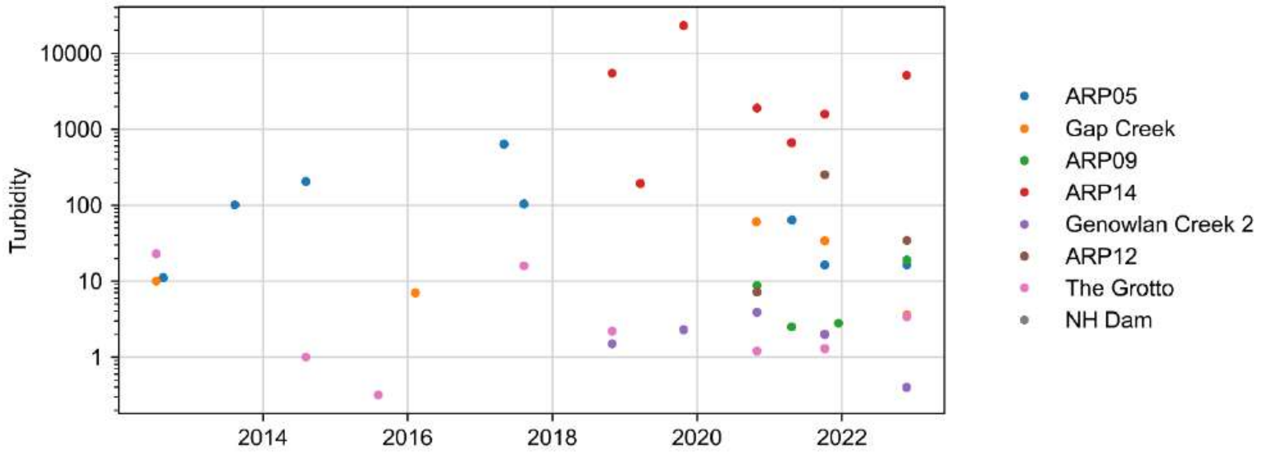

Electrical conductivity (field)
1000
100
10
2014
2016
2018
2020
2022
ARP05
Gap Creek
ARP09
ARP14
Genowlan Creek 2
ARP12
The Grotto
NH Dam


BOD
30
25
20
15
10
5
0
2014
2016
2018
2020
2022
ARP05
Gap Creek
ARP09
ARP14
Genowlan Creek 2
ARP12
The Grotto
NH Dam

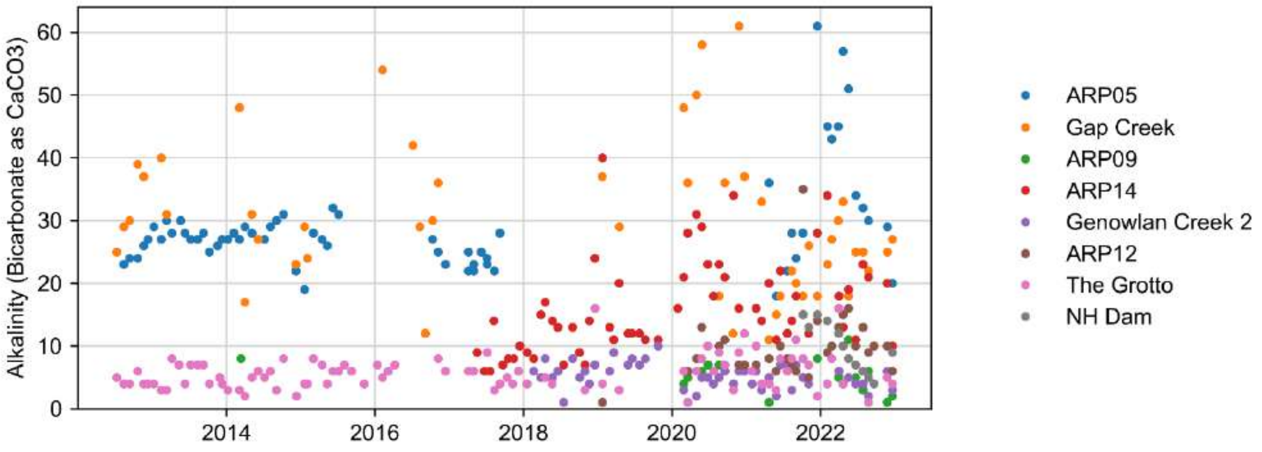

Dissolved Oxygen (Field) Filtered
200
150
100
50
0
2020-05
2020-09
2021-01
2021-05
2021-09
2022-01
2022-05
2022-09
2023-01
ARP05
Gap Creek
ARP09
ARP14
Genowlan Creek 2
ARP12
The Grotto
NH Dam


Total Dissolved Solids
300
250
200
150
100
50
0
2014
2016
2018
2020
2022
ARP05
Gap Creek
ARP09
ARP14
Genowlan Creek 2
ARP12
The Grotto
NH Dam

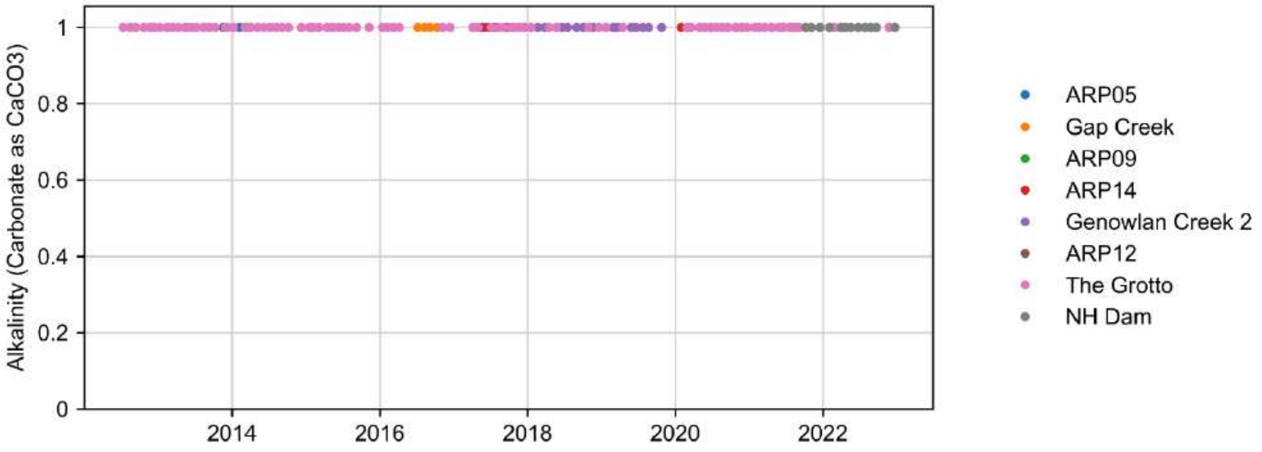

Total Suspended Solids
10000
1000
100
10
2014
2016
2018
2020
2022
ARP05
Gap Creek
ARP09
ARP14
Genowlan Creek 2
ARP12
The Grotto
NH Dam


Turbidity
10000
1000
100
10
1
2014
2016
2018
2020
2022
ARP05
Gap Creek
ARP09
ARP14
Genowlan Creek 2
ARP12
The Grotto
NH Dam

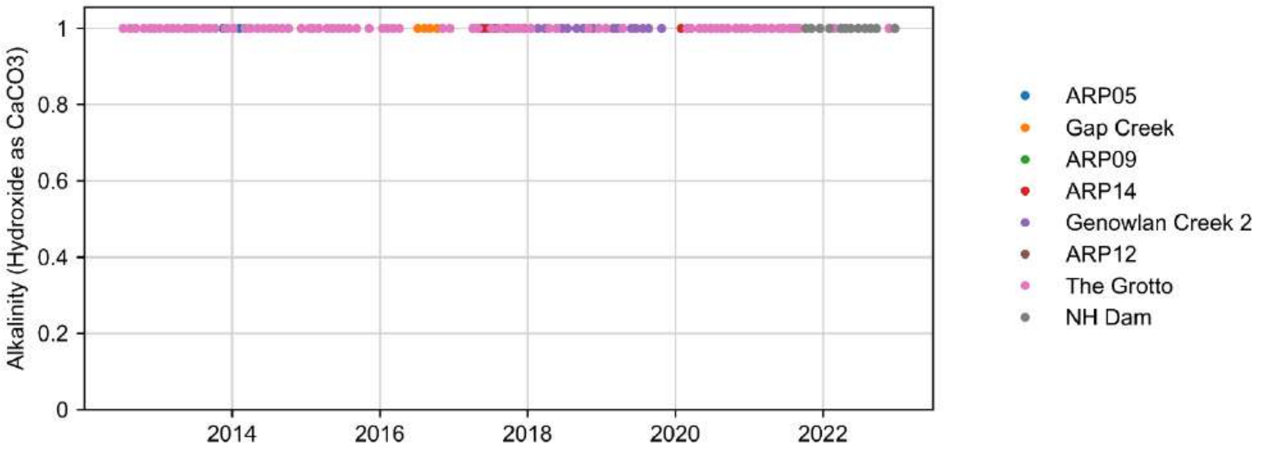
Major ions



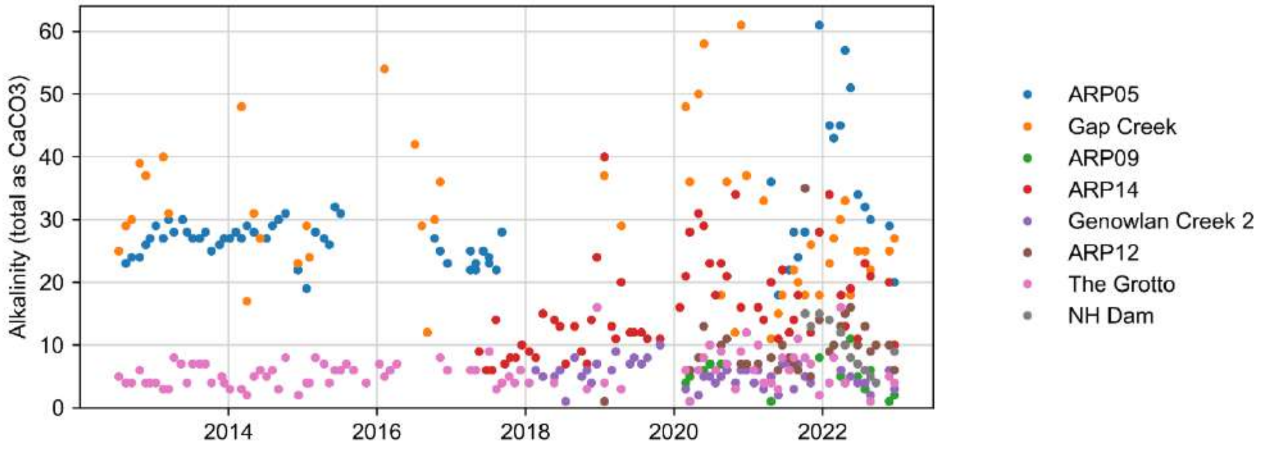
Alkalinity (Bicarbonate as CaCO3)
60
50
40
30
20
10
0
2014
2016
2018
2020
2022
ARP05
Gap Creek
ARP09
ARP14
Genowlan Creek 2
ARP12
The Grotto
NH Dam

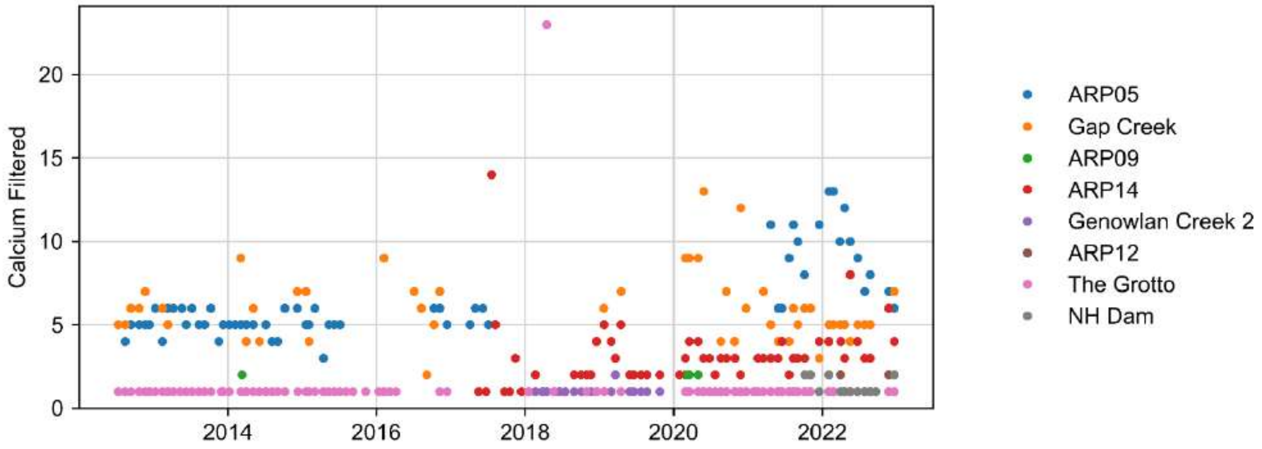


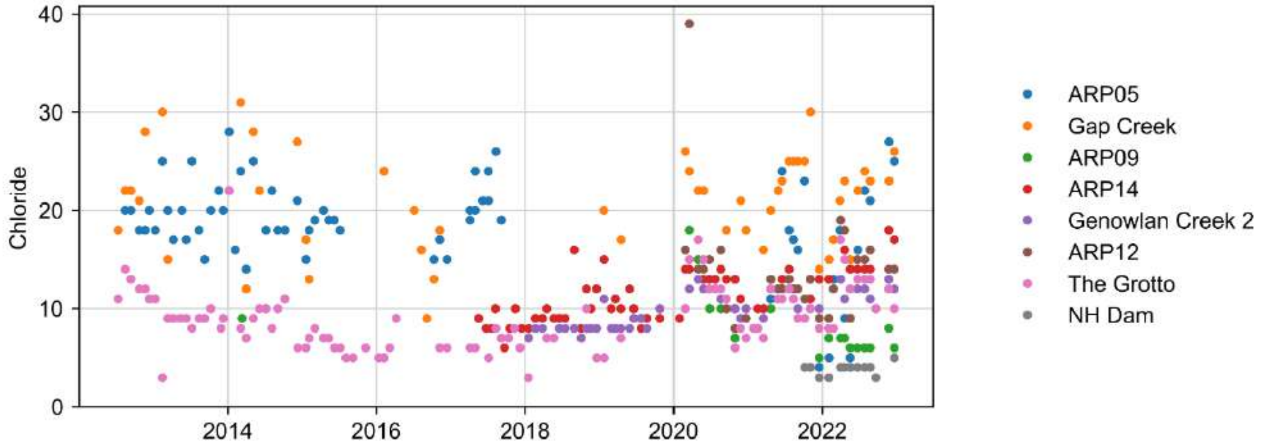
Alkalinity (Carbonate as CaCO3)
1
0.8
0.6
0.4
0.2
0
2014
2016
2018
2020
2022
ARP05
Gap Creek
ARP09
ARP14
Genowlan Creek 2
ARP12
The Grotto
NH Dam

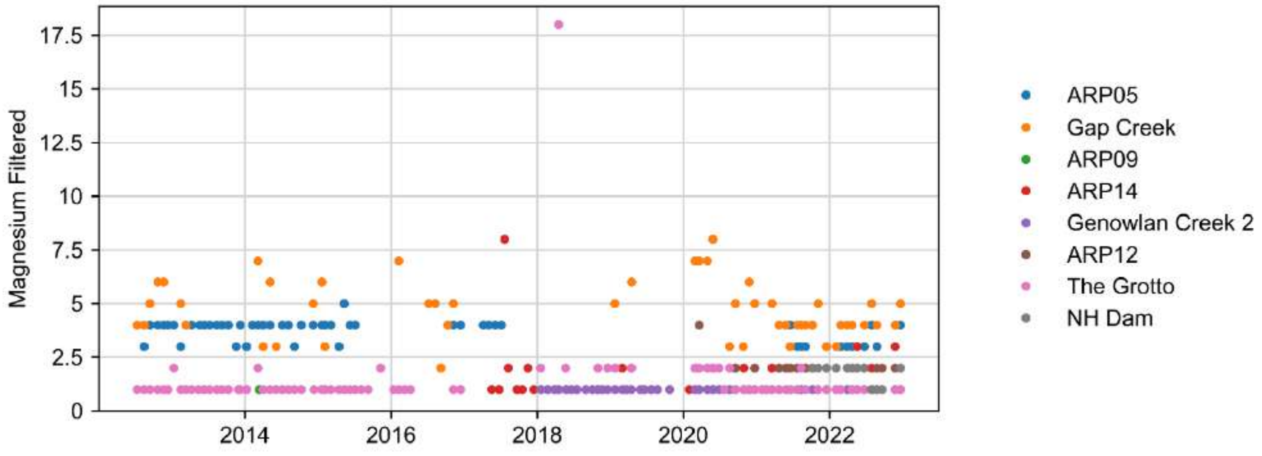


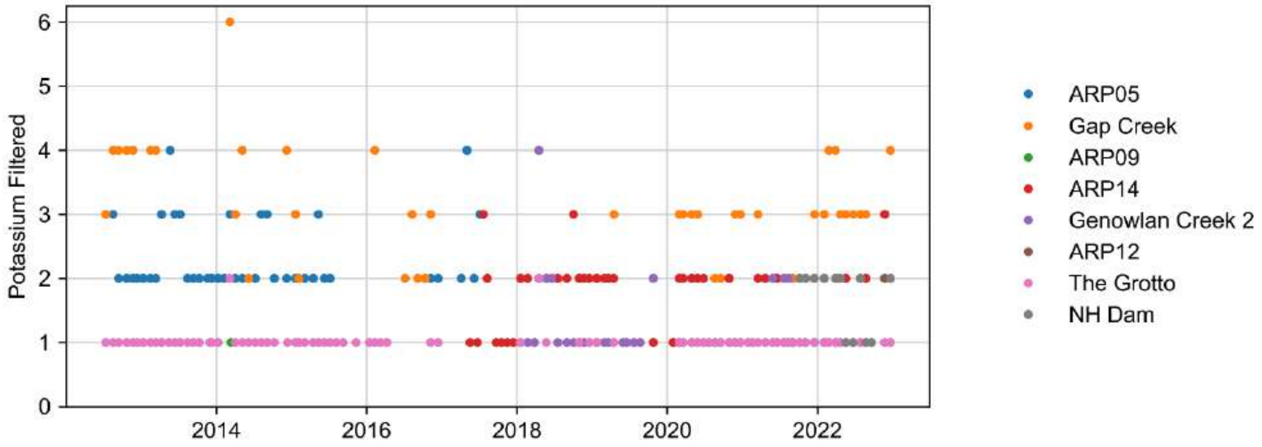
Alkalinity (Hydroxide as CaCO3)
1
0.8
0.6
0.4
0.2
0
2014
2016
2018
2020
2022
ARP05
Gap Creek
ARP09
ARP14
Genowlan Creek 2
ARP12
The Grotto
NH Dam

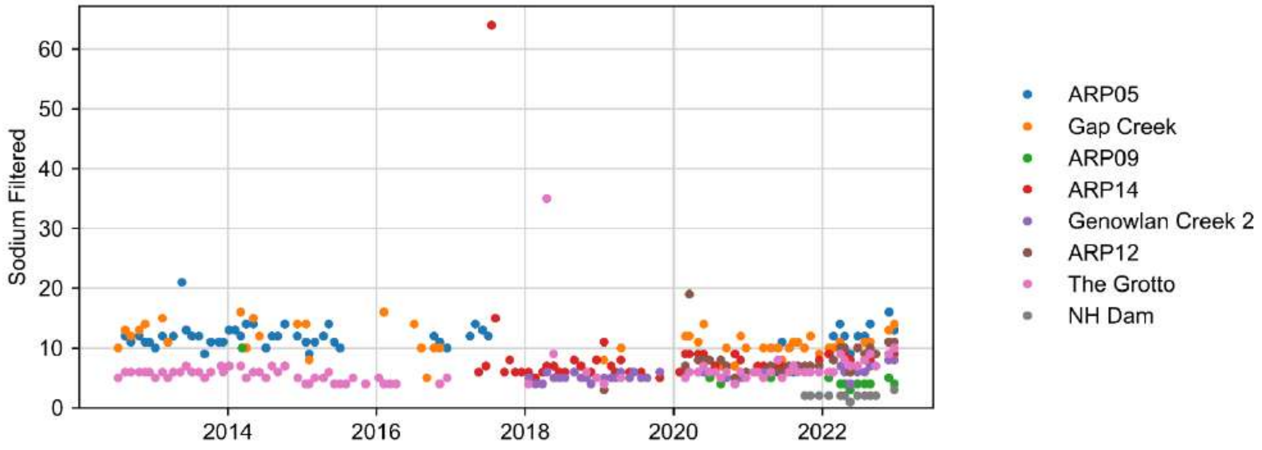

Alkalinity (total as CaCO3)
0
10
20
30
40
50
60
2014
2016
2018
2020
2022
ARP05
Gap Creek
ARP09
ARP14
Genowlan Creek 2
ARP12
The Grotto
NH Dam

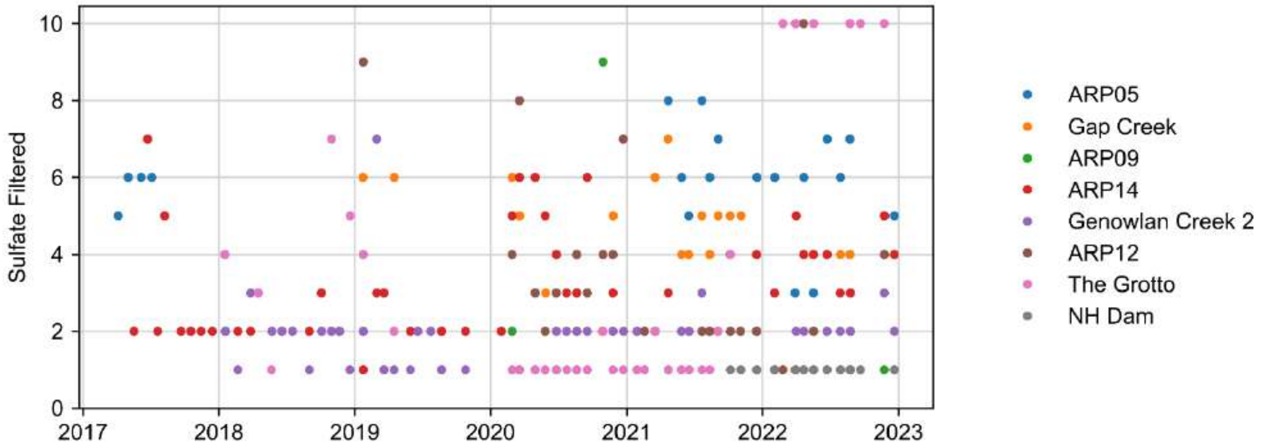

Calcium Filtered
0
5
10
15
20
2014
2016
2018
2020
2022
ARP05
Gap Creek
ARP09
ARP14
Genowlan Creek 2
ARP12
The Grotto
NH Dam

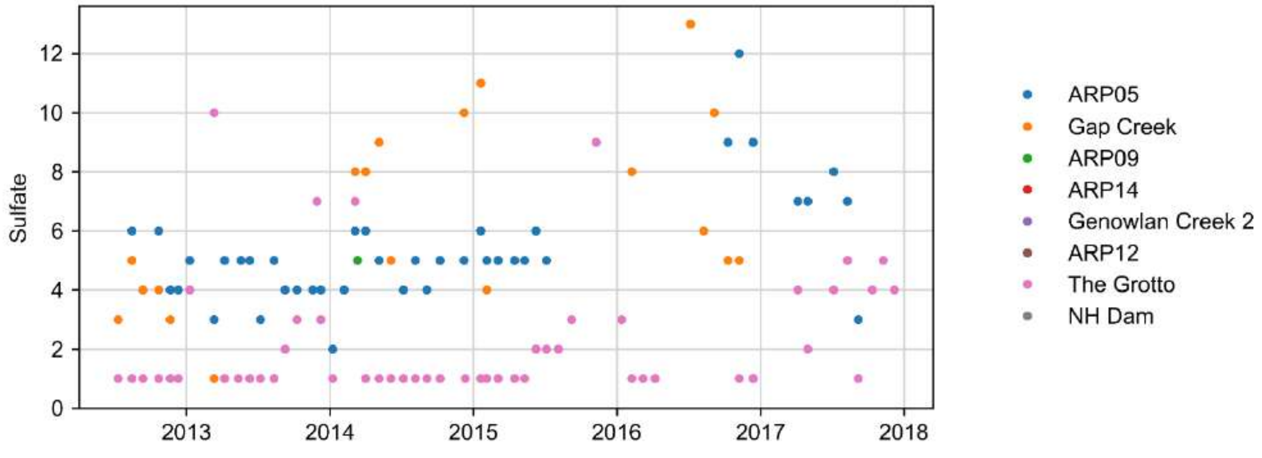

Chloride
0
10
20
30
40
2014
2016
2018
2020
2022
ARP05
Gap Creek
ARP09
ARP14
Genowlan Creek 2
ARP12
The Grotto
NH Dam


Magnesium Filtered
0
2.5
5
7.5
10
12.5
15
17.5
2014
2016
2018
2020
2022
ARP05
Gap Creek
ARP09
ARP14
Genowlan Creek 2
ARP12
The Grotto
NH Dam

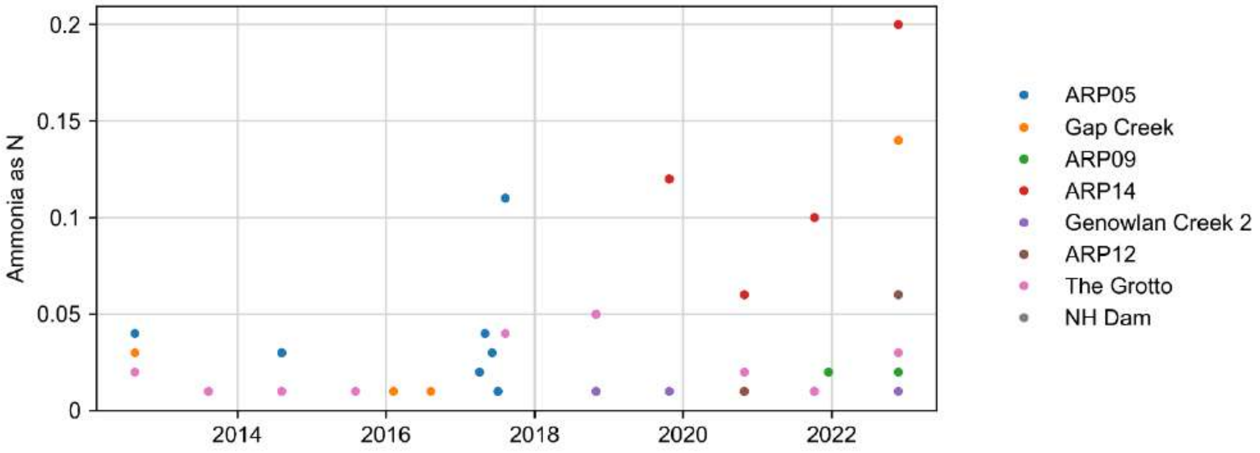

Potassium Filtered
0
1
2
3
4
5
6
2014
2016
2018
2020
2022
ARP05
Gap Creek
ARP09
ARP14
Genowlan Creek 2
ARP12
The Grotto
NH Dam


Sodium Filtered
0
10
20
30
40
50
60
2014
2016
2018
2020
2022
ARP05
Gap Creek
ARP09
ARP14
Genowlan Creek 2
ARP12
The Grotto
NH Dam

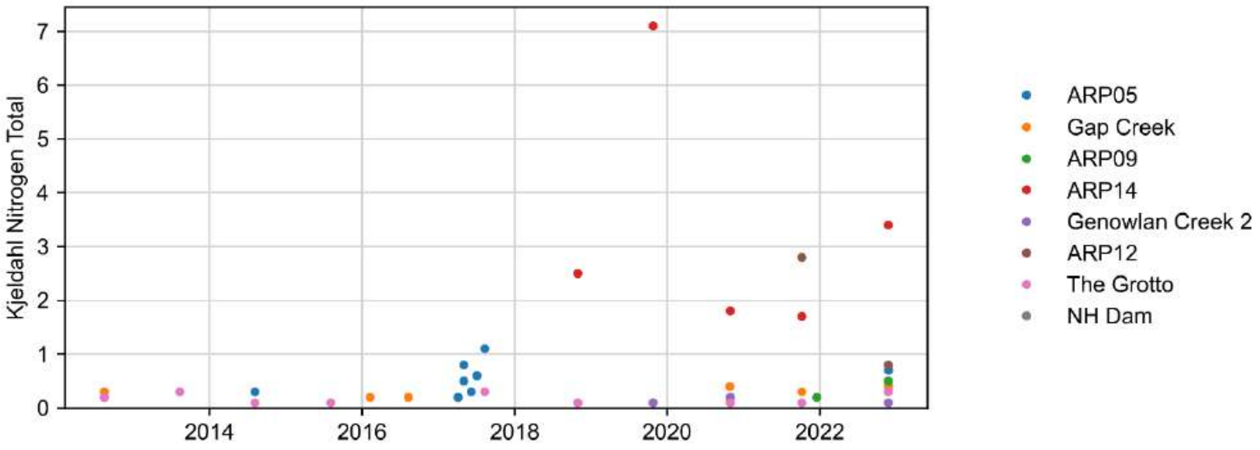

Sulfate Filtered
0
2
4
6
8
10
2017
2018
2019
2020
2021
2022
2023
ARP05
Gap Creek
ARP09
ARP14
Genowlan Creek 2
ARP12
The Grotto
NH Dam


Sulfate
0
2
4
6
8
10
12
2013
2014
2015
2016
2017
2018
ARP05
Gap Creek
ARP09
ARP14
Genowlan Creek 2
ARP12
The Grotto
NH Dam

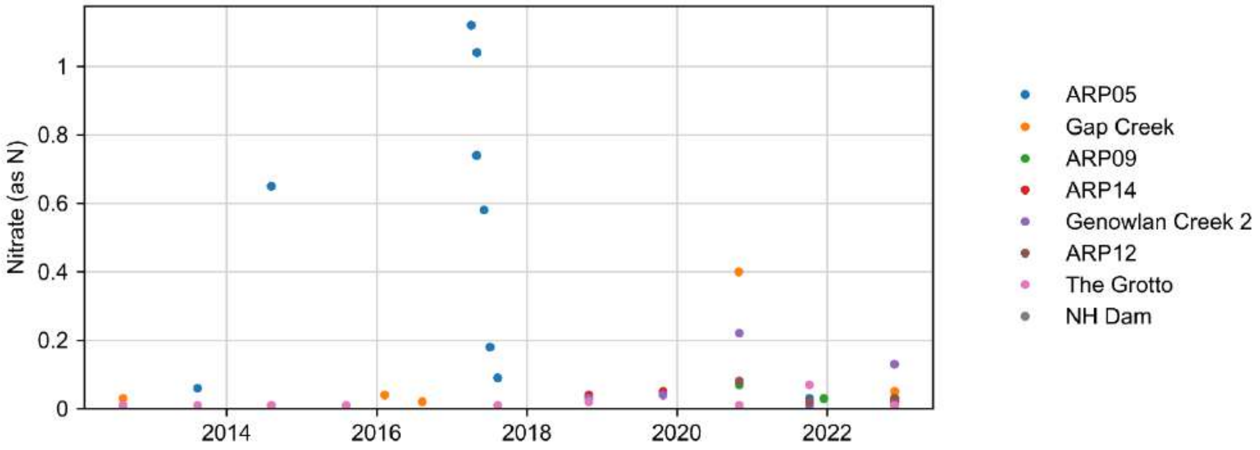
Nutrients



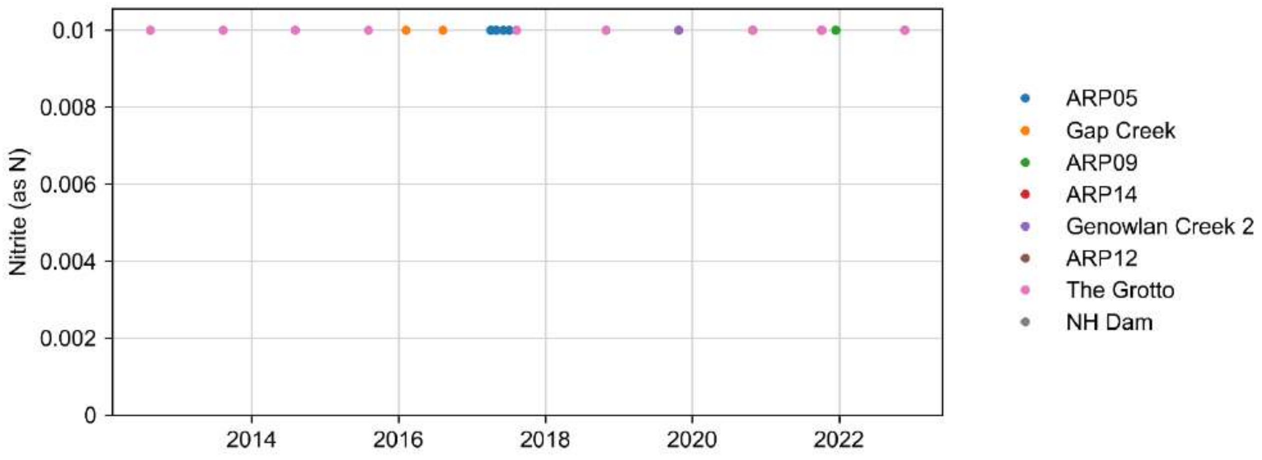
Ammonia as N
0.2
0.15
0.1
0.05
0
2014
2016
2018
2020
2022
ARP05
Gap Creek
ARP09
ARP14
Genowlan Creek 2
ARP12
The Grotto
NH Dam

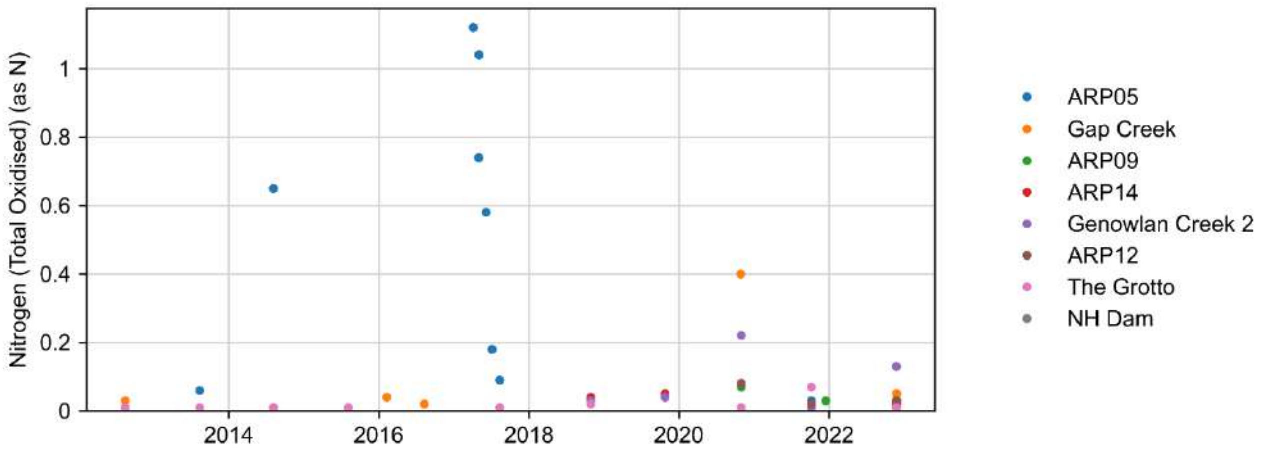


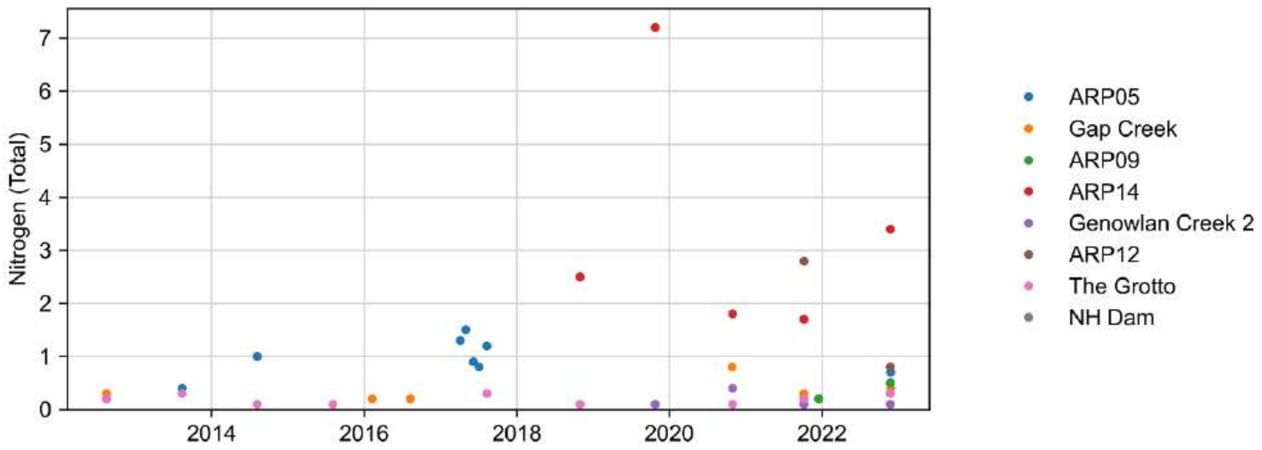
Kjeldahl Nitrogen Total
7
6
5
4
3
2
1
0
2014
2016
2018
2020
2022
ARP05
Gap Creek
ARP09
ARP14
Genowlan Creek 2
ARP12
The Grotto
NH Dam

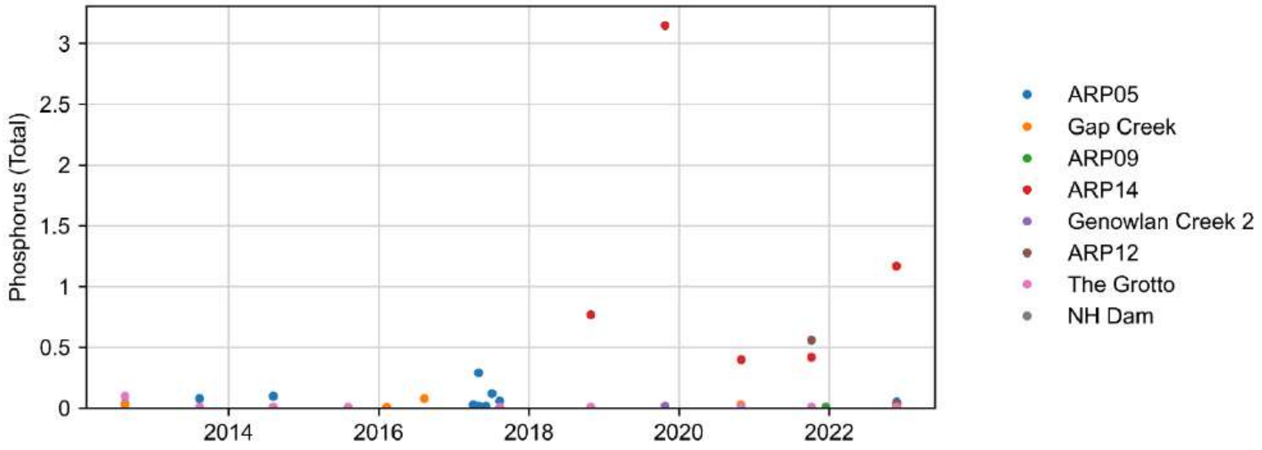


Nitrate (as N)
1
0.8
0.6
0.4
0.2
0
2014
2016
2018
2020
2022
ARP05
Gap Creek
ARP09
ARP14
Genowlan Creek 2
ARP12
The Grotto
NH Dam

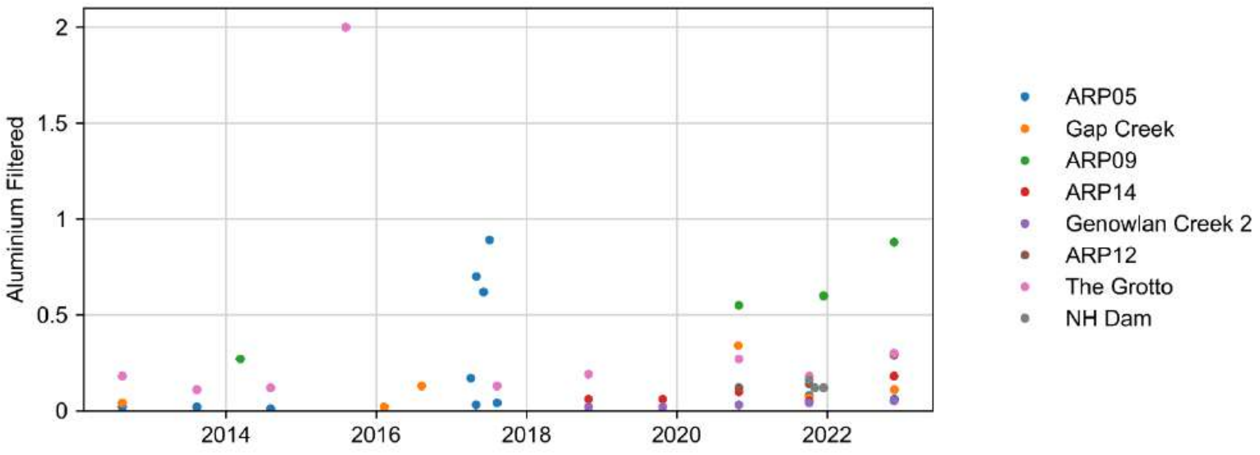

0.01
0.008
0.006
0.004
0.002
0
Nitrite (as N)
2014
2016
2018
2020
2022
ARP05
Gap Creek
ARP09
ARP14
Genowlan Creek 2
ARP12
The Grotto
NH Dam

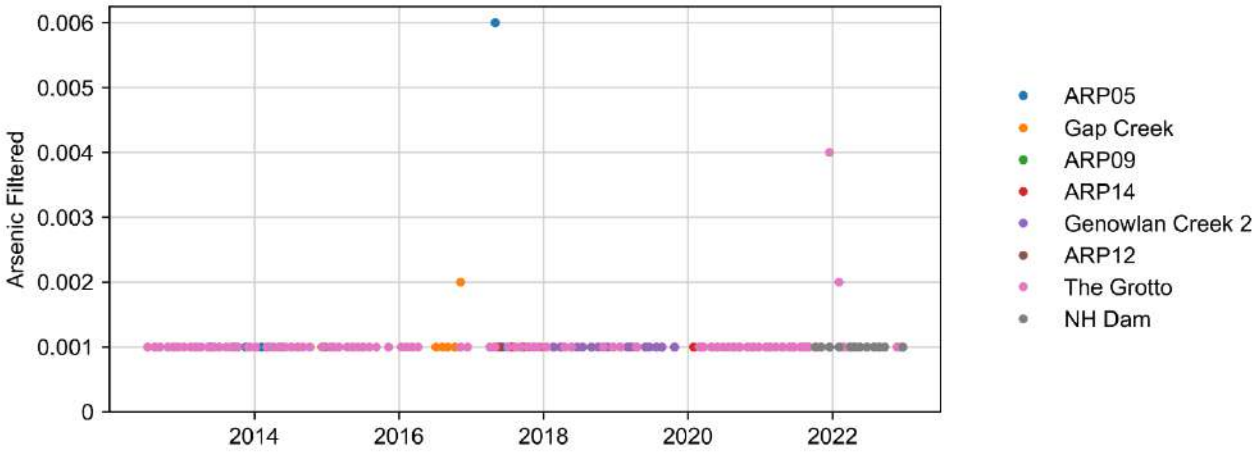

1
0.8
0.6
0.4
0.2
0
Nitrogen (Total Oxidised) (as N)
2014
2016
2018
2020
2022
ARP05
Gap Creek
ARP09
ARP14
Genowlan Creek 2
ARP12
The Grotto
NH Dam

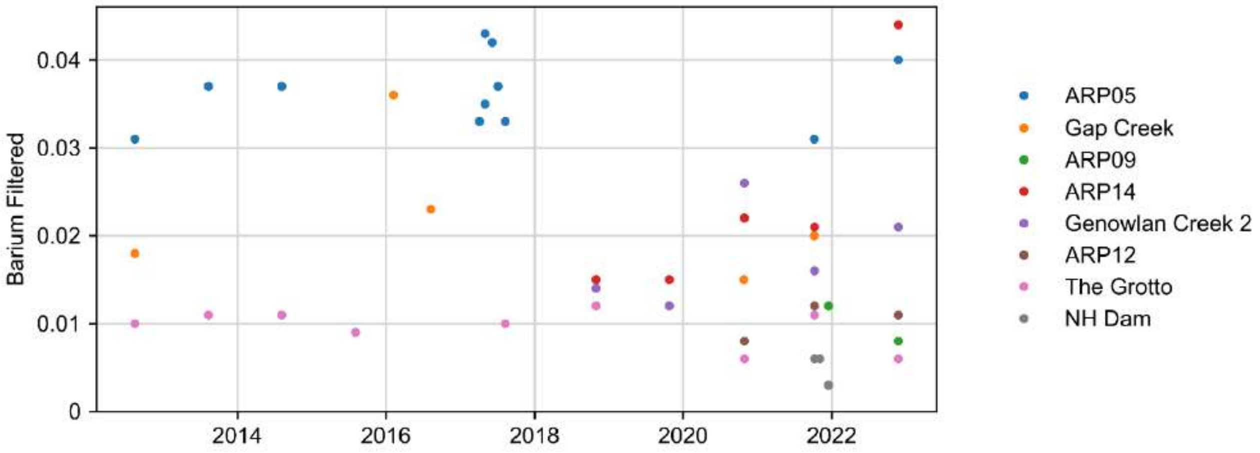

Nitrogen (Total)
7
6
5
4
3
2
1
0
2014
2016
2018
2020
2022
ARP05
Gap Creek
ARP09
ARP14
Genowlan Creek 2
ARP12
The Grotto
NH Dam

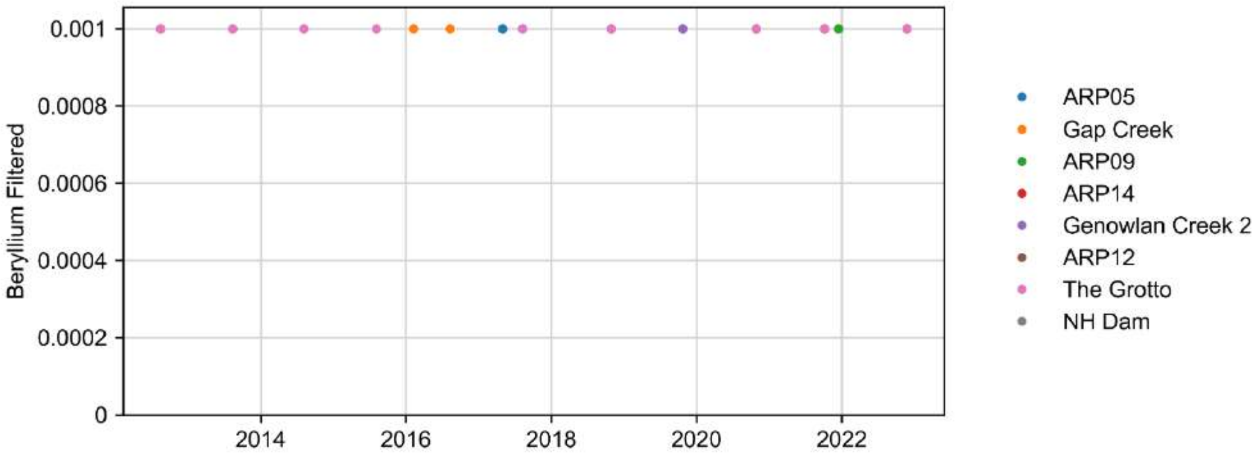

Phosphorus (Total)
3
2.5
2
1.5
1
0.5
0
2014
2016
2018
2020
2022
ARP05
Gap Creek
ARP09
ARP14
Genowlan Creek 2
ARP12
The Grotto
NH Dam

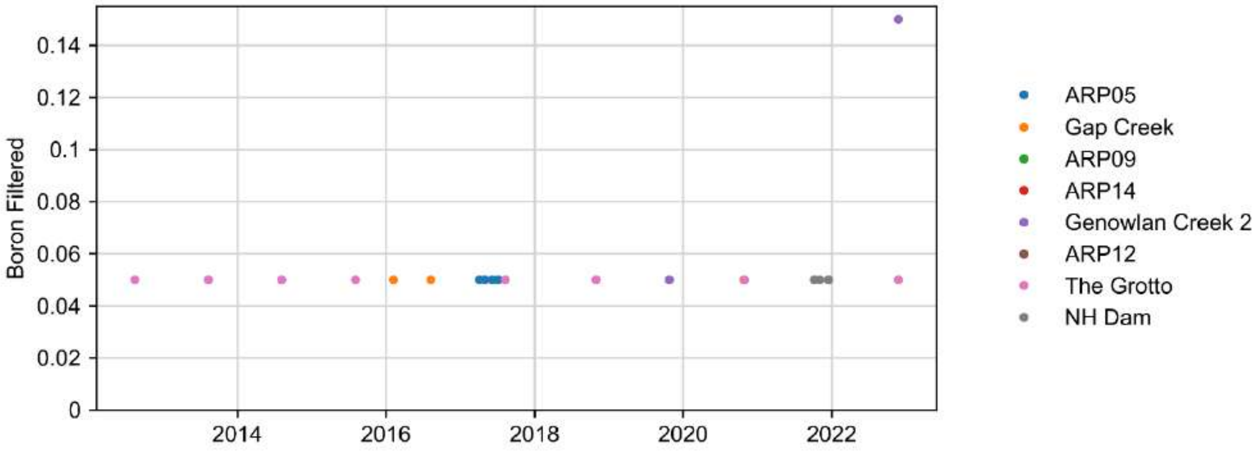
Dissolved metals

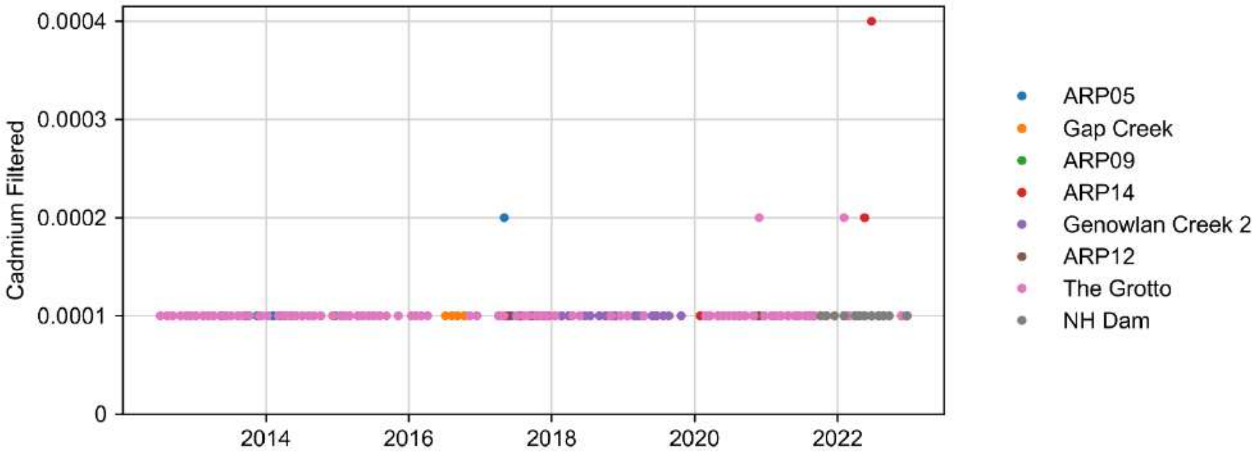


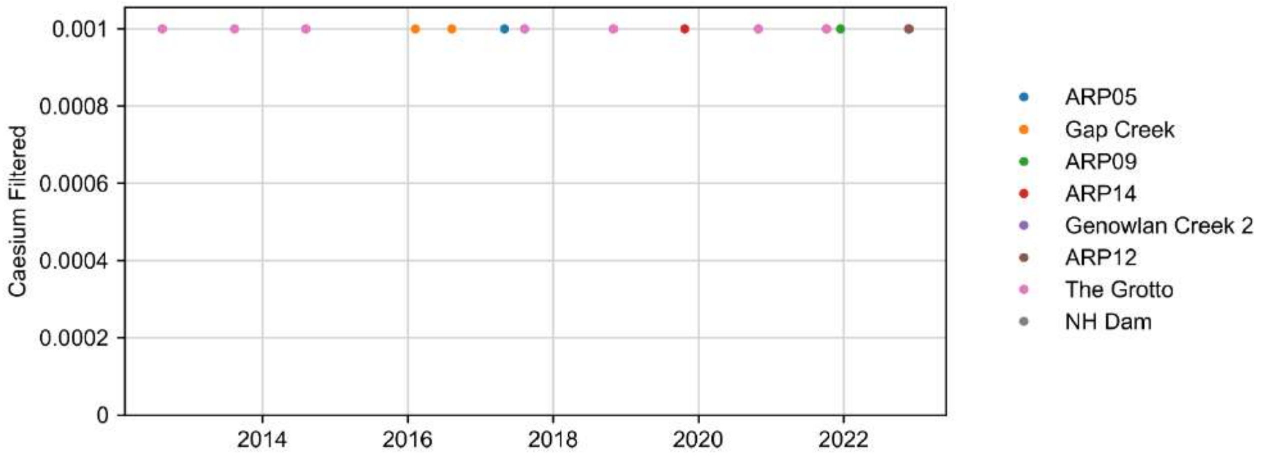


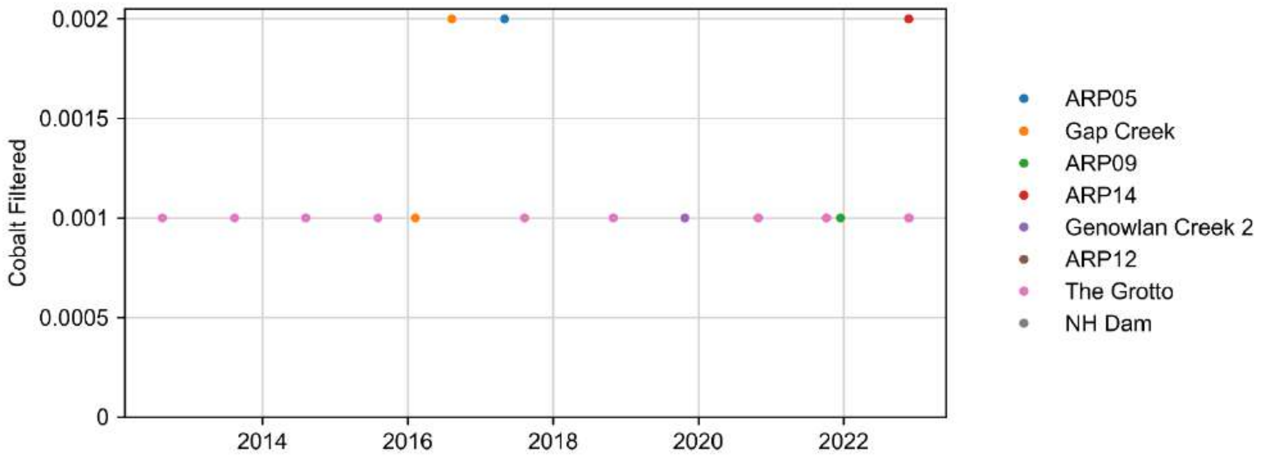


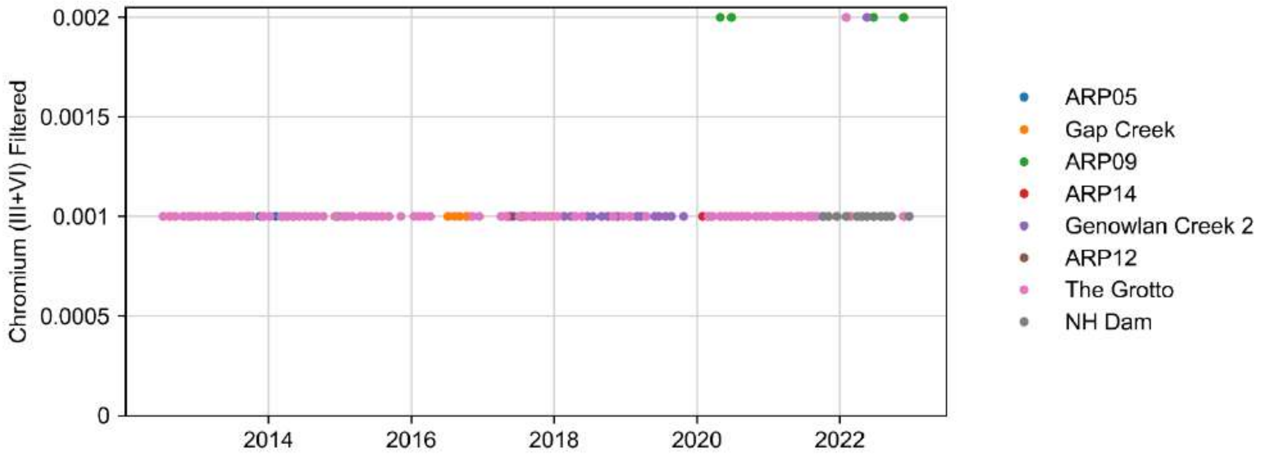

Beryllium Filtered
0.001
0.0008
0.0006
0.0004
0.0002
0
2014
2016
2018
2020
2022
● ARP05
● Gap Creek
● ARP09
● ARP14
● Genowlan Creek 2
● ARP12
● The Grotto
● NH Dam

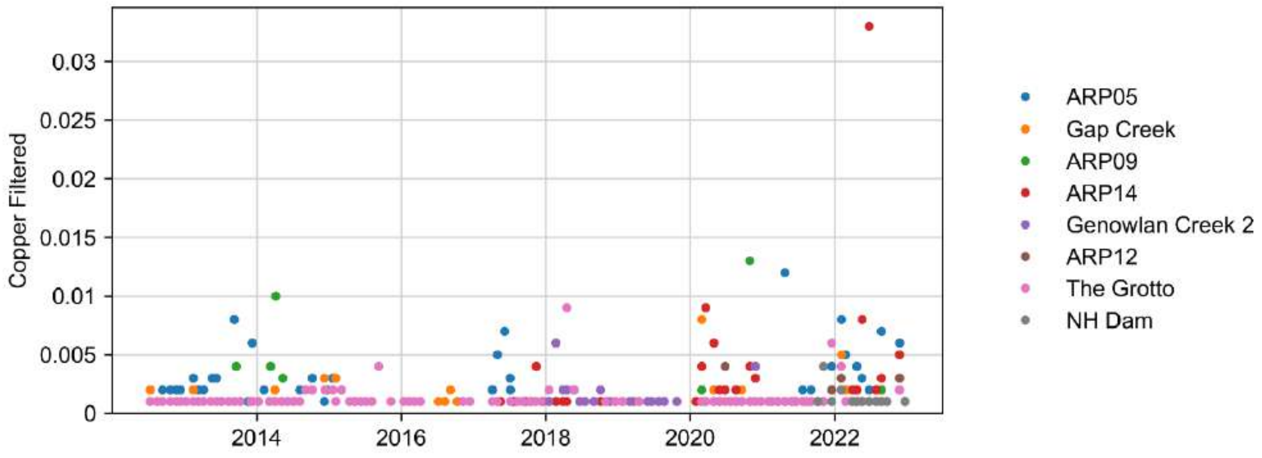

Boron Filtered
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
2014
2016
2018
2020
2022
● ARP05
● Gap Creek
● ARP09
● ARP14
● Genowlan Creek 2
● ARP12
● The Grotto
● NH Dam

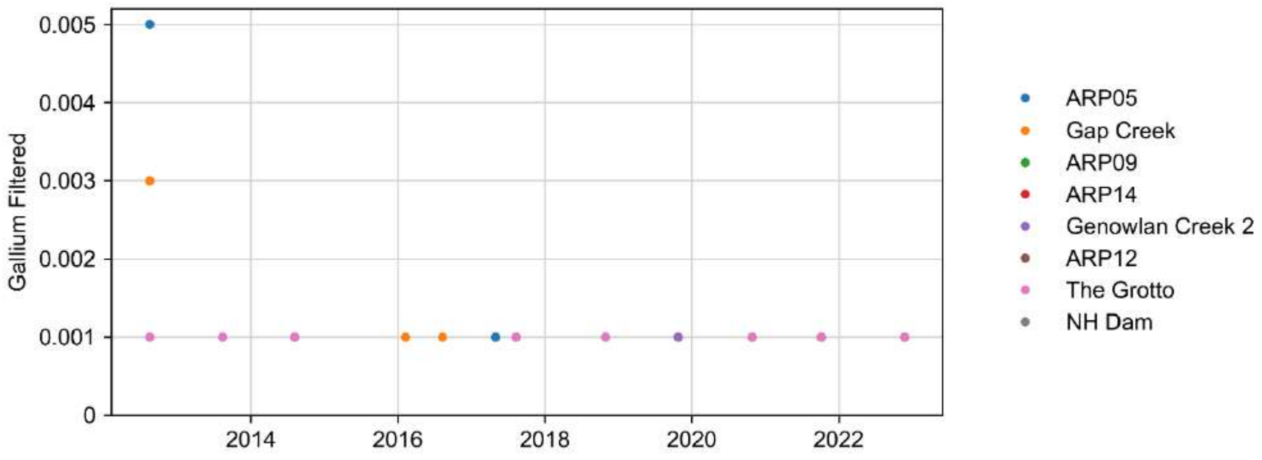

Cadmium Filtered
0.0004
0.0003
0.0002
0.0001
0
2014
2016
2018
2020
2022
● ARP05
● Gap Creek
● ARP09
● ARP14
● Genowlan Creek 2
● ARP12
● The Grotto
● NH Dam

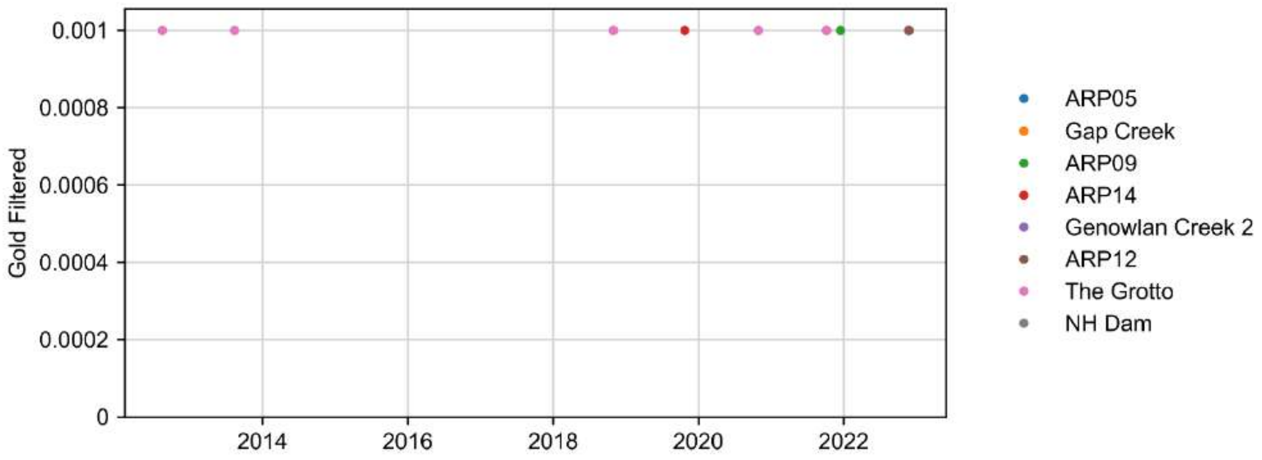

0.001
0.0008
0.0006
0.0004
0.0002
0
Caesium Filtered
2014
2016
2018
2020
2022
ARP05
Gap Creek
ARP09
ARP14
Genowlan Creek 2
ARP12
The Grotto
NH Dam

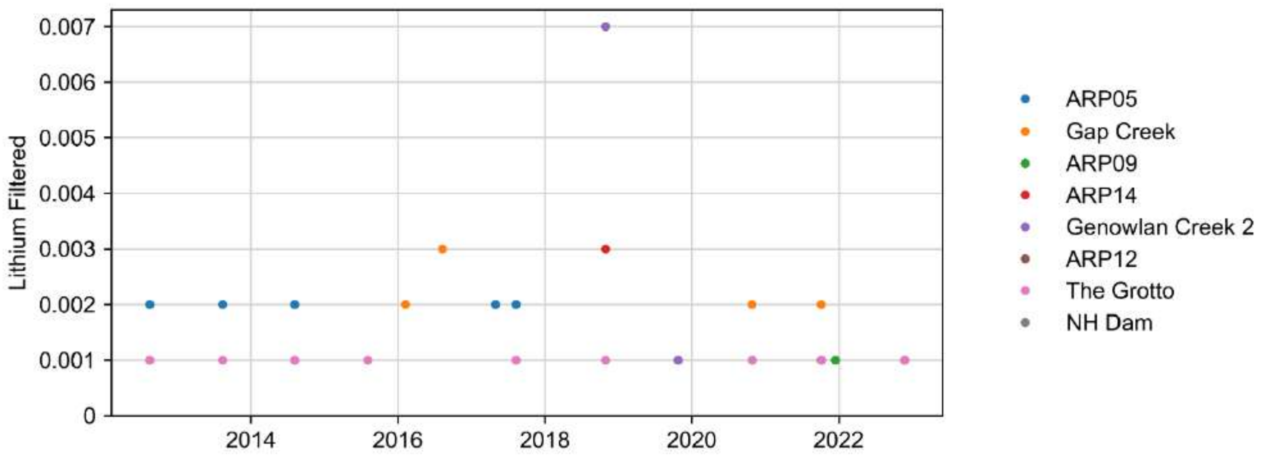

Cobalt Filtered
0.002
0.0015
0.001
0.0005
0
2014
2016
2018
2020
2022
ARP05
Gap Creek
ARP09
ARP14
Genowlan Creek 2
ARP12
The Grotto
NH Dam

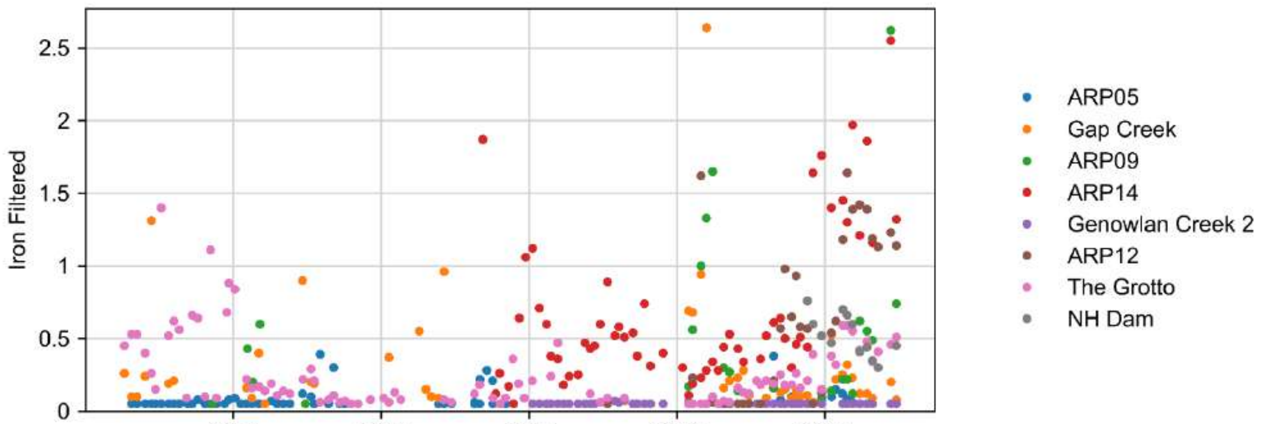

Chromium (III+VI) Filtered
0.002
0.0015
0.001
0.0005
0
2014
2016
2018
2020
2022
ARP05
Gap Creek
ARP09
ARP14
Genowlan Creek 2
ARP12
The Grotto
NH Dam


Copper Filtered
0.03
0.025
0.02
0.015
0.01
0.005
0
2014
2016
2018
2020
2022
ARP05
Gap Creek
ARP09
ARP14
Genowlan Creek 2
ARP12
The Grotto
NH Dam

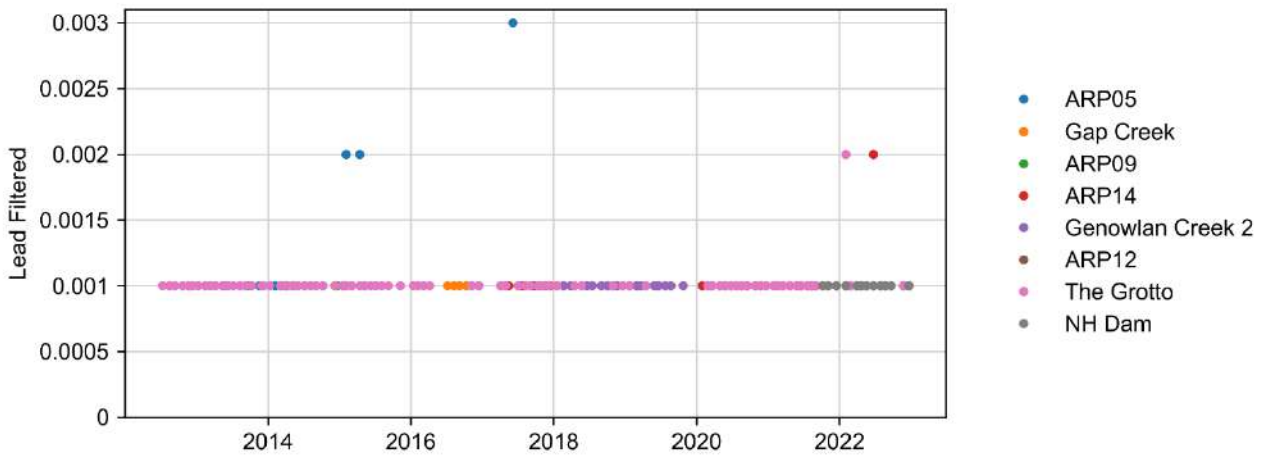

Gallium Filtered
0.005
0.004
0.003
0.002
0.001
0
2014
2016
2018
2020
2022
ARP05
Gap Creek
ARP09
ARP14
Genowlan Creek 2
ARP12
The Grotto
NH Dam


Gold Filtered
0.001
0.0008
0.0006
0.0004
0.0002
0
2014
2016
2018
2020
2022
ARP05
Gap Creek
ARP09
ARP14
Genowlan Creek 2
ARP12
The Grotto
NH Dam

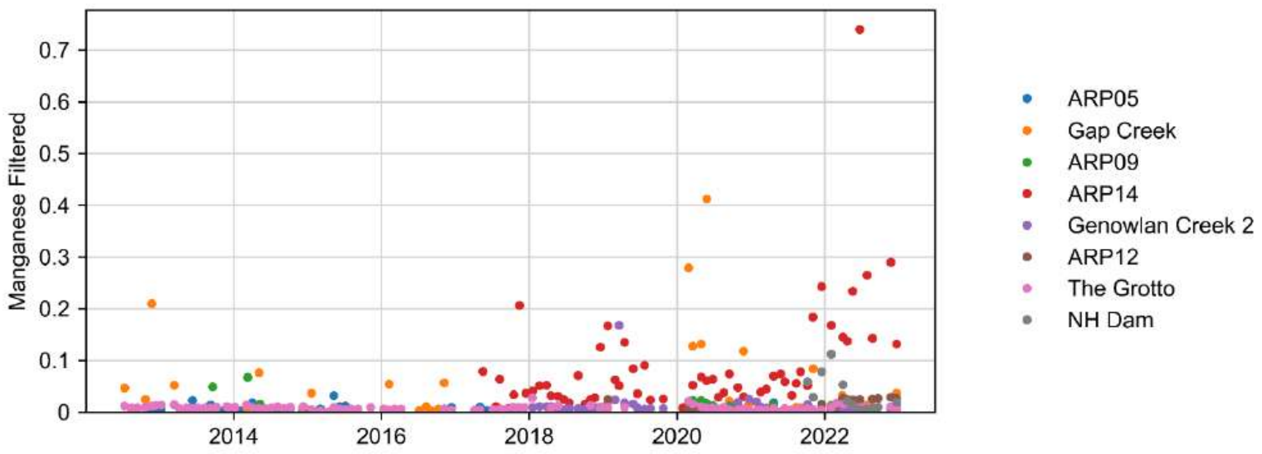

Lithium Filtered
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
2014
2016
2018
2020
2022
ARP05
Gap Creek
ARP09
ARP14
Genowlan Creek 2
ARP12
The Grotto
NH Dam



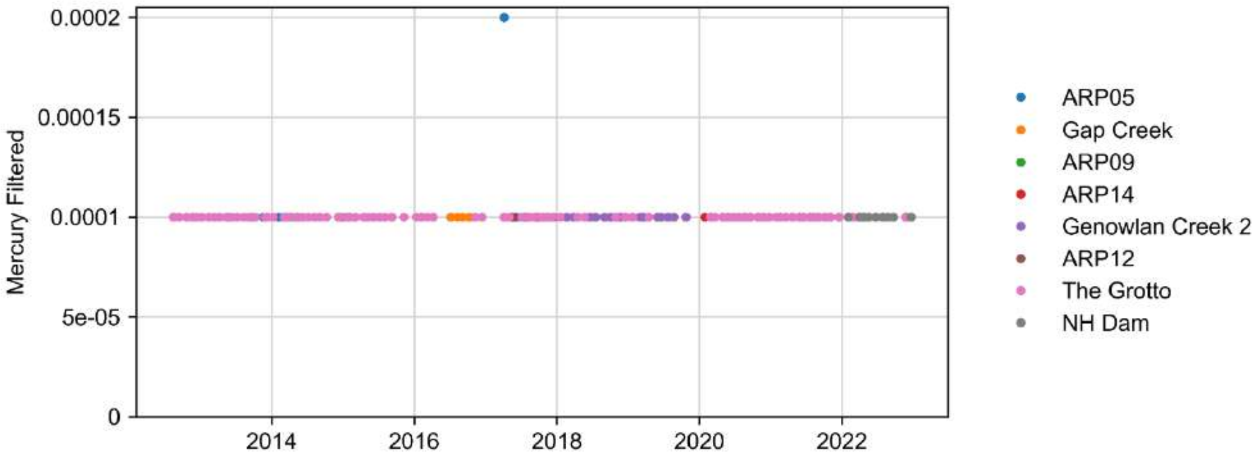
Iron Filtered
2.5
2
1.5
1
0.5
0
2014
2016
2018
2020
2022
● ARP05
● Gap Creek
● ARP09
● ARP14
● Genowlan Creek 2
● ARP12
● The Grotto
● NH Dam

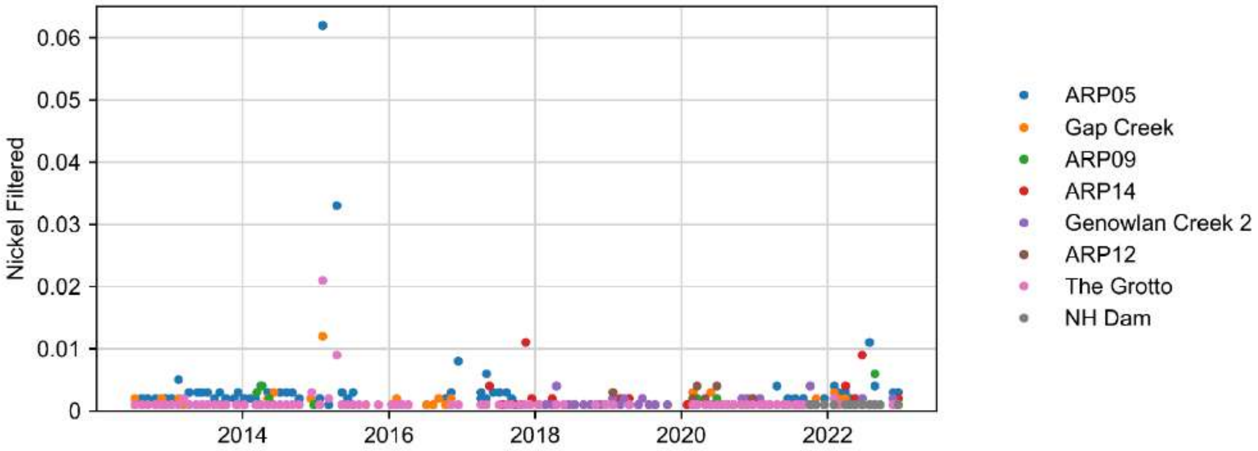


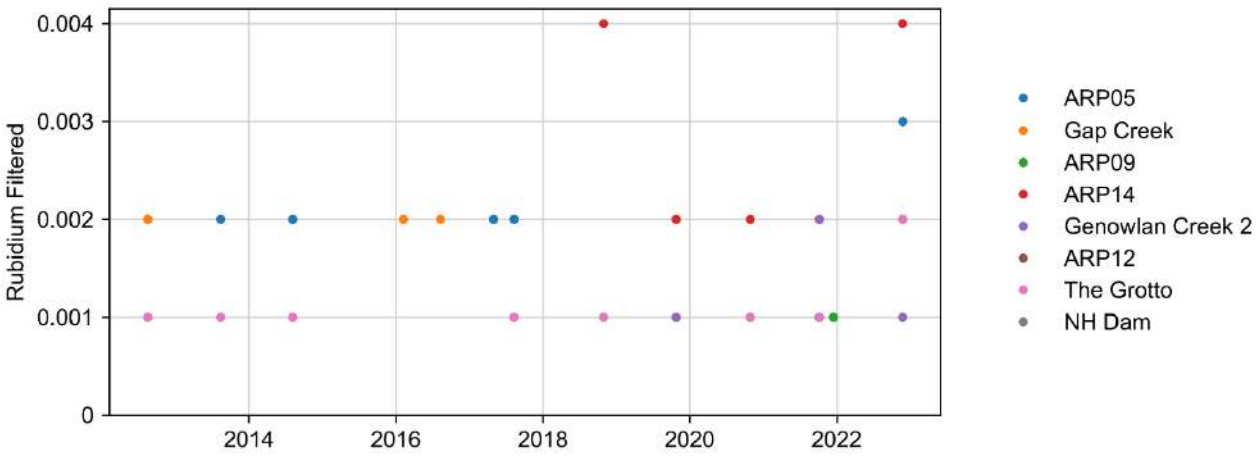
Lead Filtered
0.003
0.0025
0.002
0.0015
0.001
0.0005
0
2014
2016
2018
2020
2022
● ARP05
● Gap Creek
● ARP09
● ARP14
● Genowlan Creek 2
● ARP12
● The Grotto
● NH Dam

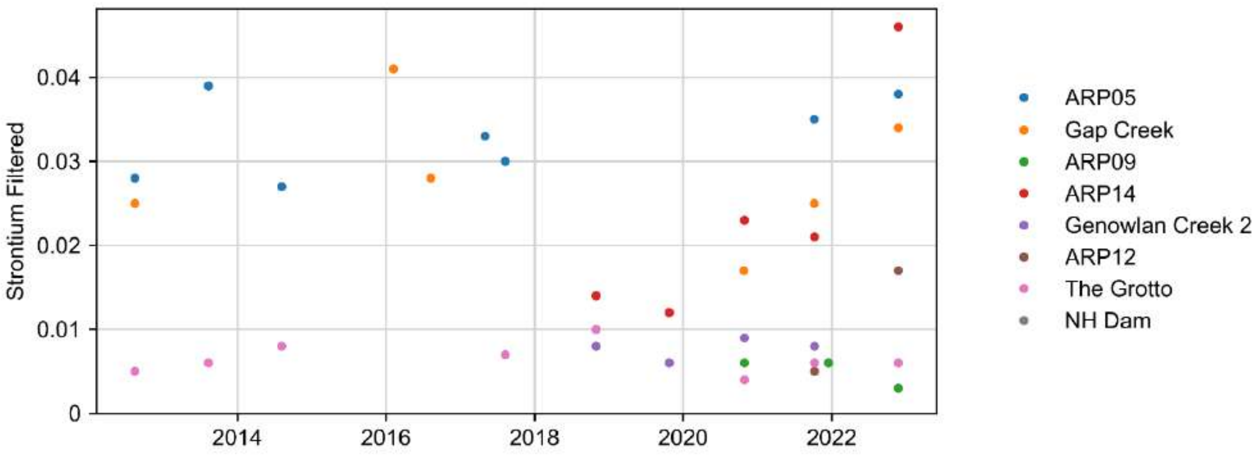


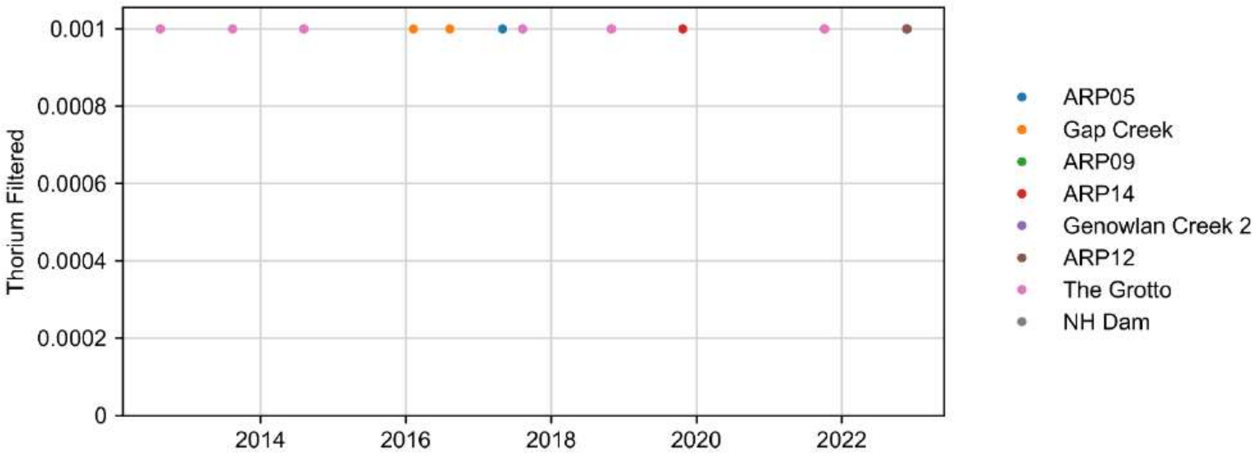
Manganese Filtered
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
2014
2016
2018
2020
2022
● ARP05
● Gap Creek
● ARP09
● ARP14
● Genowlan Creek 2
● ARP12
● The Grotto
● NH Dam

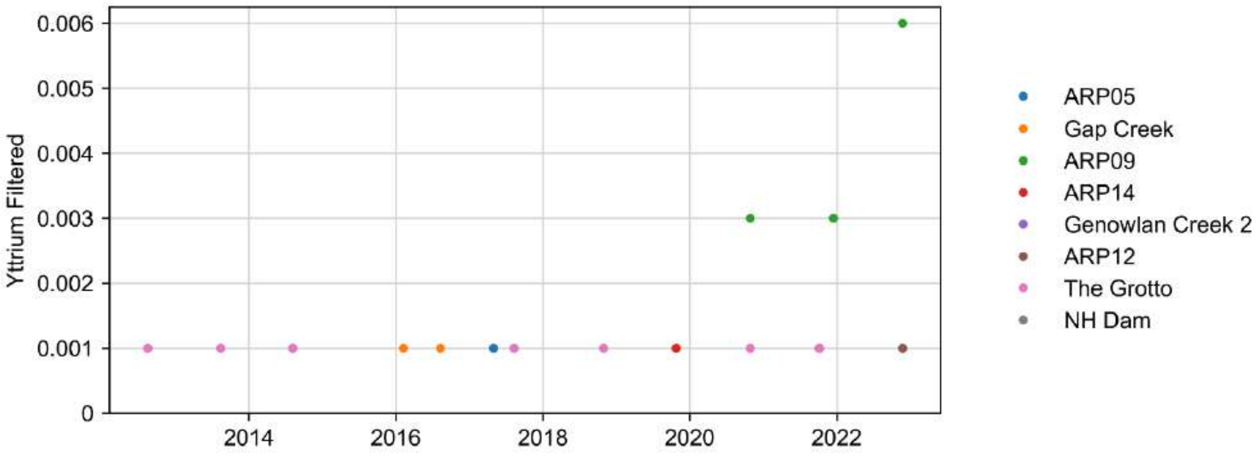

Mercury Filtered
0.0002
0.00015
0.0001
5e-05
0
2014
2016
2018
2020
2022
ARP05
Gap Creek
ARP09
ARP14
Genowlan Creek 2
ARP12
The Grotto
NH Dam


Nickel Filtered
0.06
0.05
0.04
0.03
0.02
0.01
0
2014
2016
2018
2020
2022
ARP05
Gap Creek
ARP09
ARP14
Genowlan Creek 2
ARP12
The Grotto
NH Dam

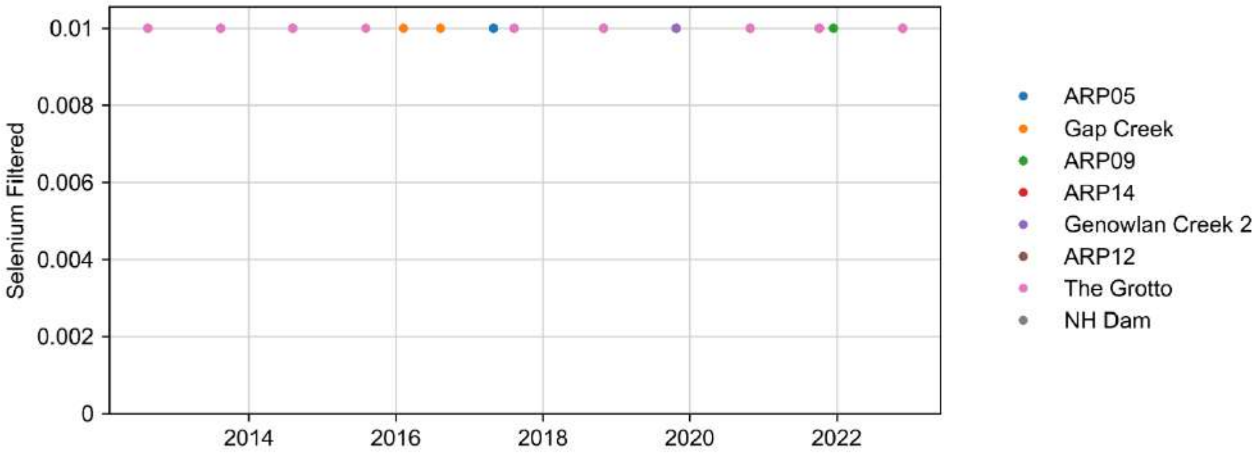

Rubidium Filtered
0.004
0.003
0.002
0.001
0
2014
2016
2018
2020
2022
ARP05
Gap Creek
ARP09
ARP14
Genowlan Creek 2
ARP12
The Grotto
NH Dam


Strontium Filtered
0.04
0.03
0.02
0.01
0
2014
2016
2018
2020
2022
ARP05
Gap Creek
ARP09
ARP14
Genowlan Creek 2
ARP12
The Grotto
NH Dam

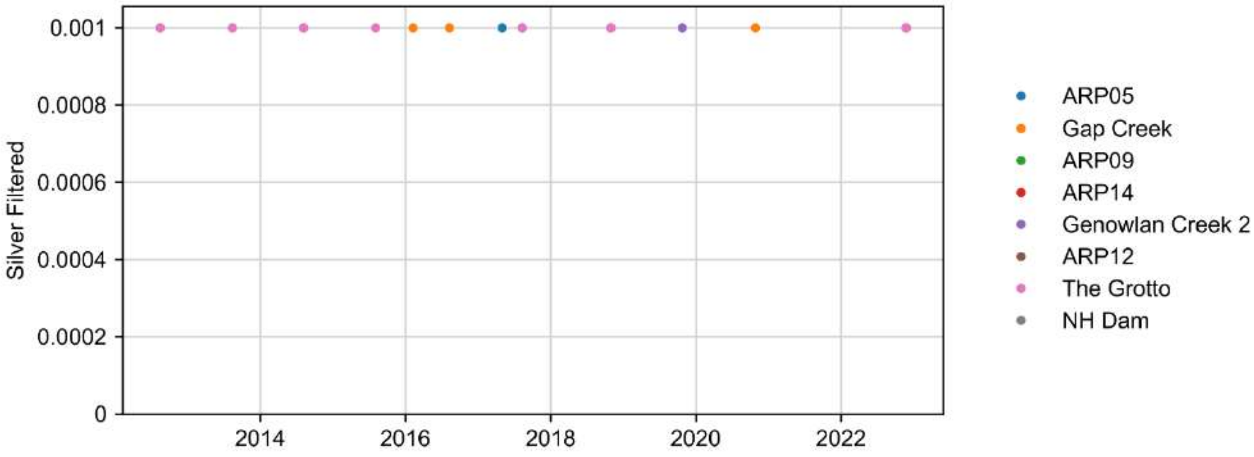

Thorium Filtered
0.001
0.0008
0.0006
0.0004
0.0002
0
2014
2016
2018
2020
2022
ARP05
Gap Creek
ARP09
ARP14
Genowlan Creek 2
ARP12
The Grotto
NH Dam



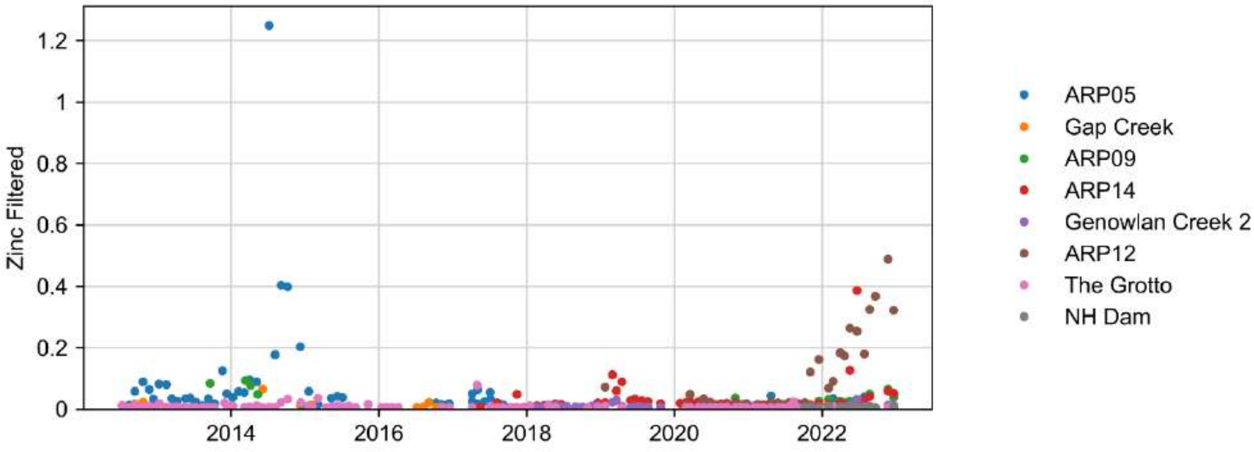
Yttrium Filtered
0.006
0.005
0.004
0.003
0.002
0.001
0
2014
2016
2018
2020
2022
ARP05
Gap Creek
ARP09
ARP14
Genowlan Creek 2
ARP12
The Grotto
NH Dam



Selenium Filtered
0.01
0.008
0.006
0.004
0.002
0
2014
2016
2018
2020
2022
ARP05
Gap Creek
ARP09
ARP14
Genowlan Creek 2
ARP12
The Grotto
NH Dam

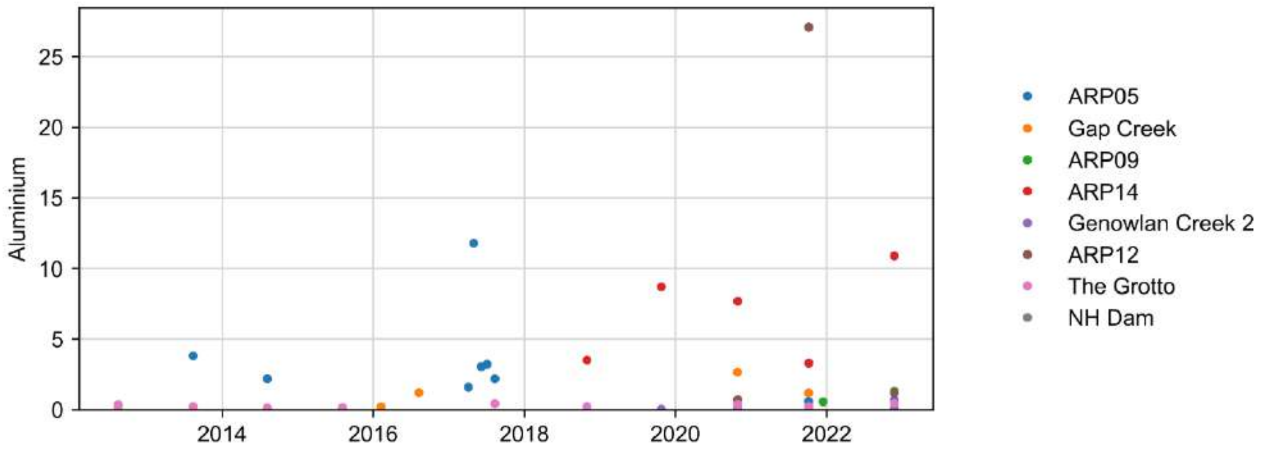


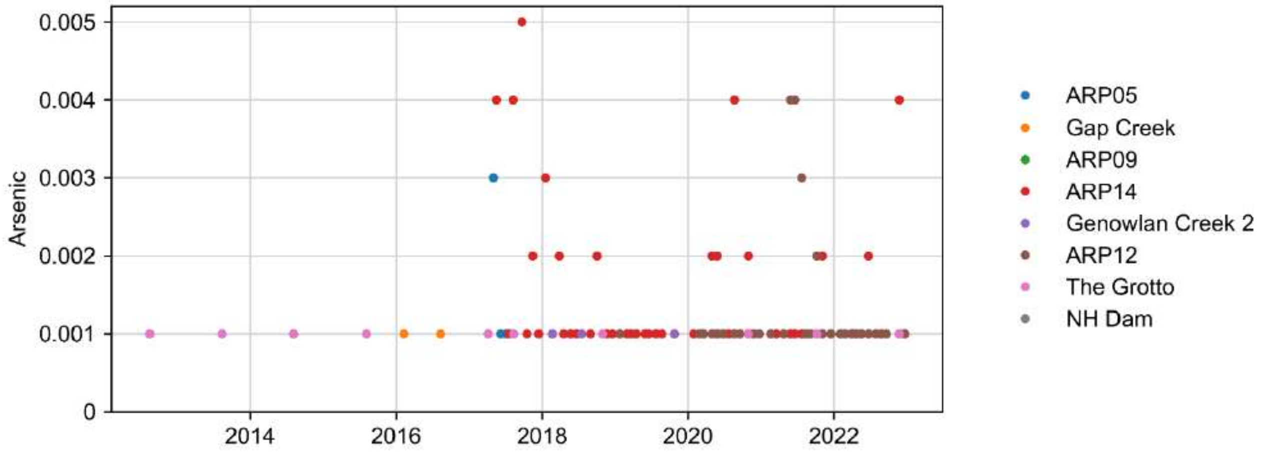
0.001
0.0008
0.0006
0.0004
0.0002
0
Silver Filtered
2014
2016
2018
2020
2022
ARP05
Gap Creek
ARP09
ARP14
Genowlan Creek 2
ARP12
The Grotto
NH Dam

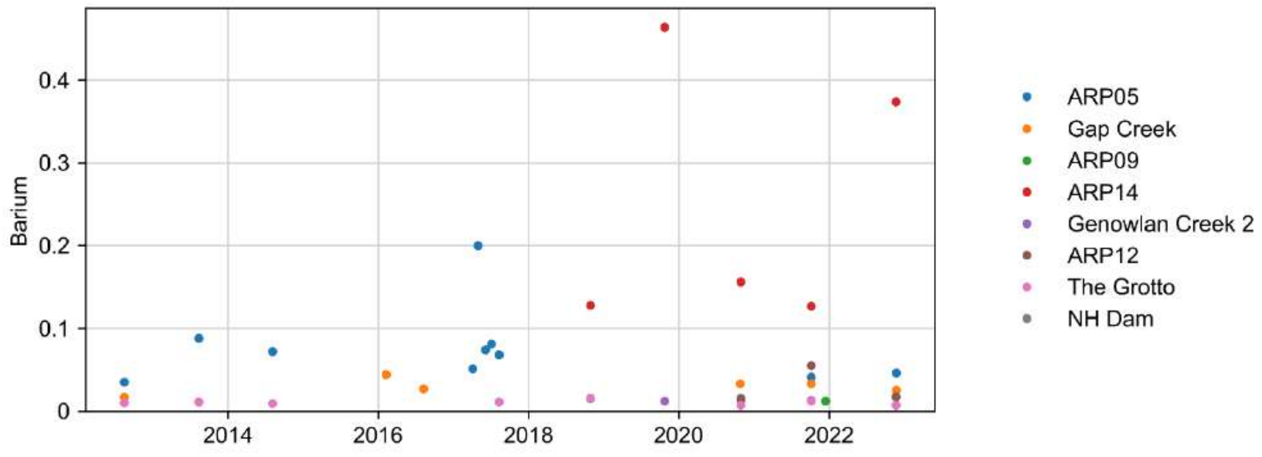


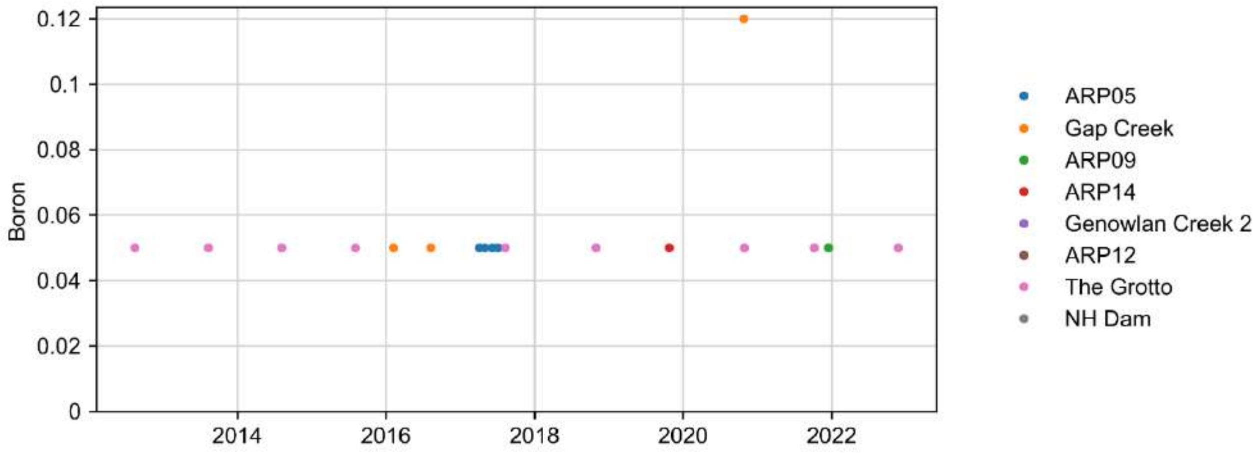
1.2
1
0.8
0.6
0.4
0.2
0
Zinc Filtered
2014
2016
2018
2020
2022
ARP05
Gap Creek
ARP09
ARP14
Genowlan Creek 2
ARP12
The Grotto
NH Dam

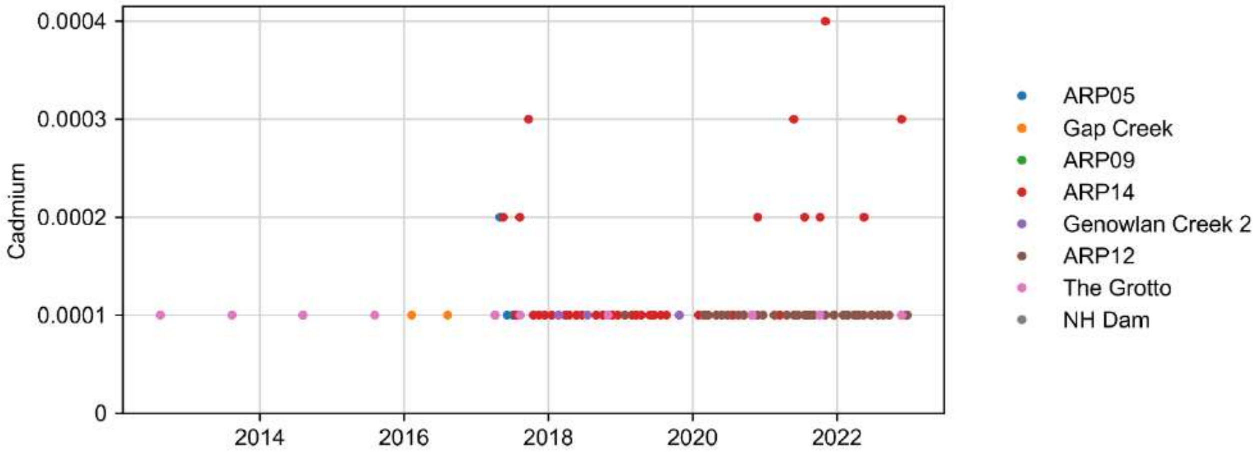
Total metals

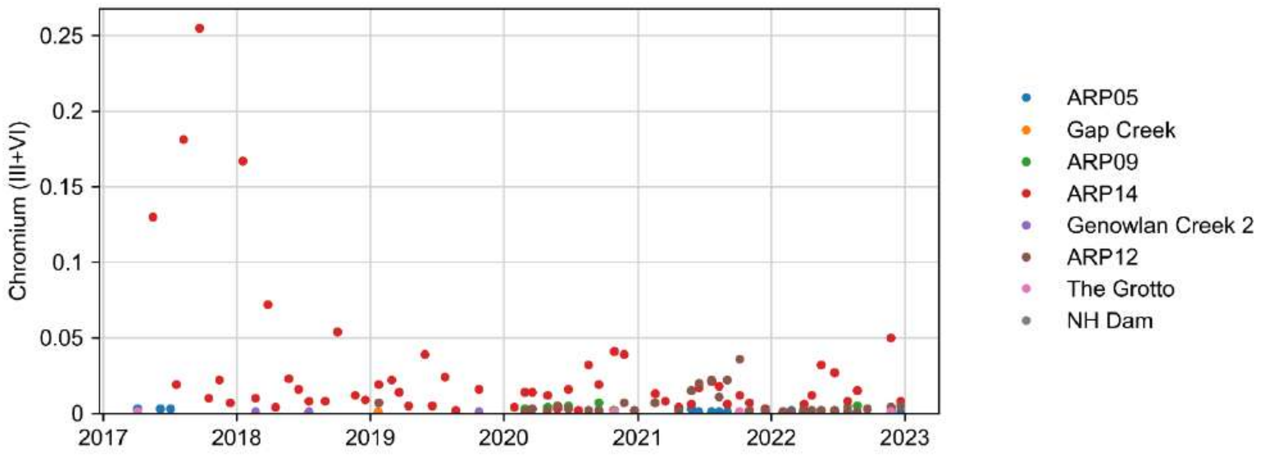


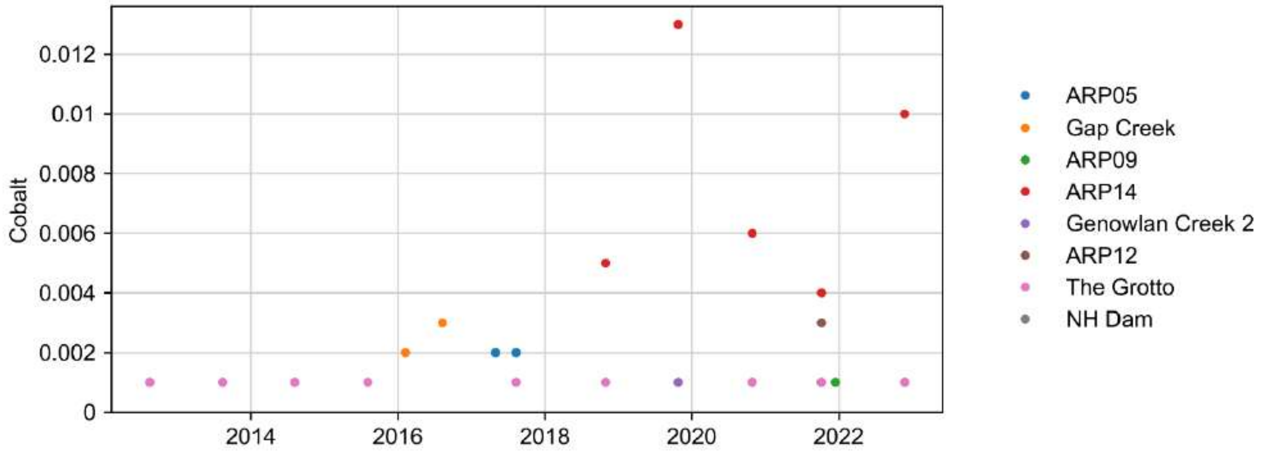


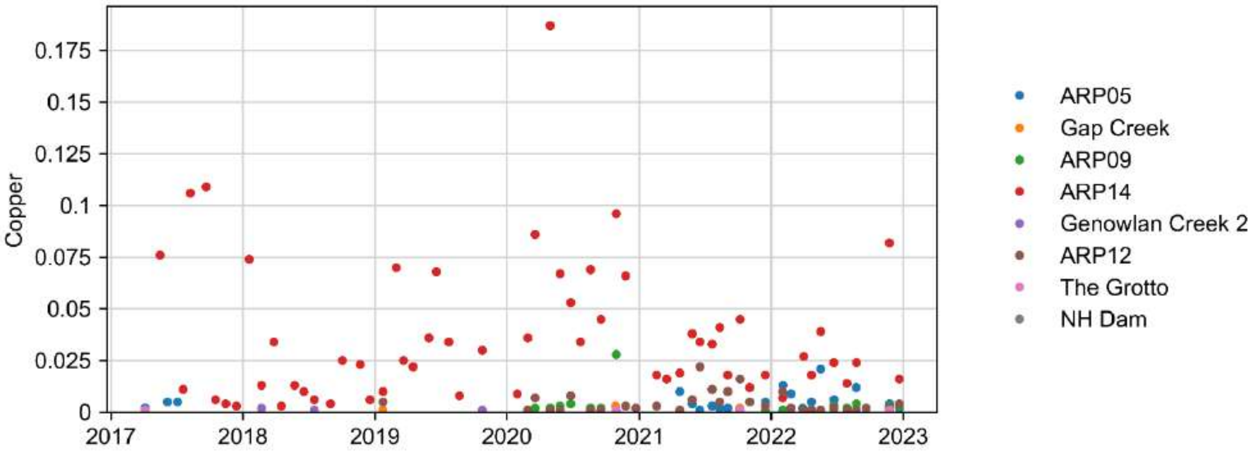


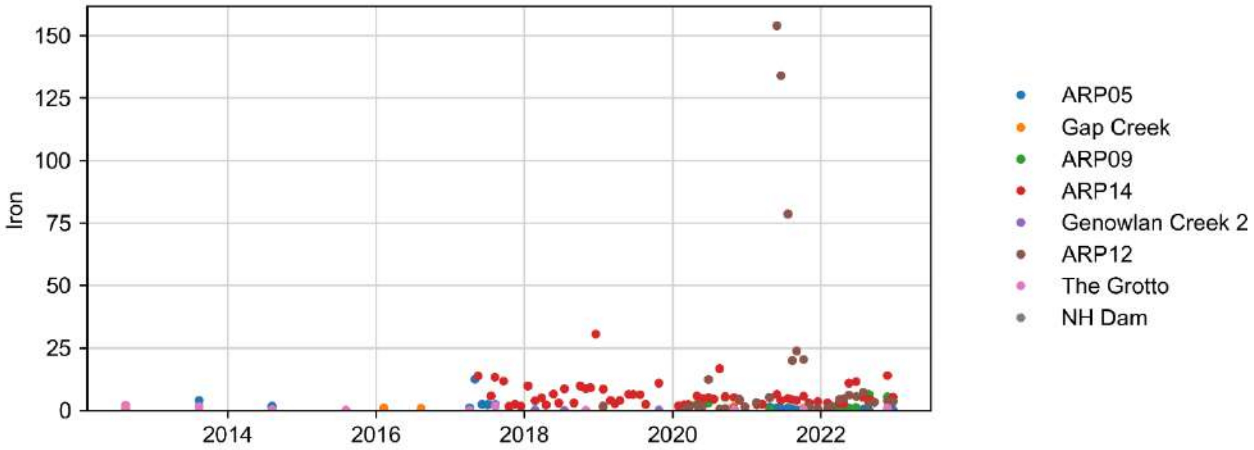

Boron
0.12
0.1
0.08
0.06
0.04
0.02
0
2014
2016
2018
2020
2022
ARP05
Gap Creek
ARP09
ARP14
Genowlan Creek 2
ARP12
The Grotto
NH Dam

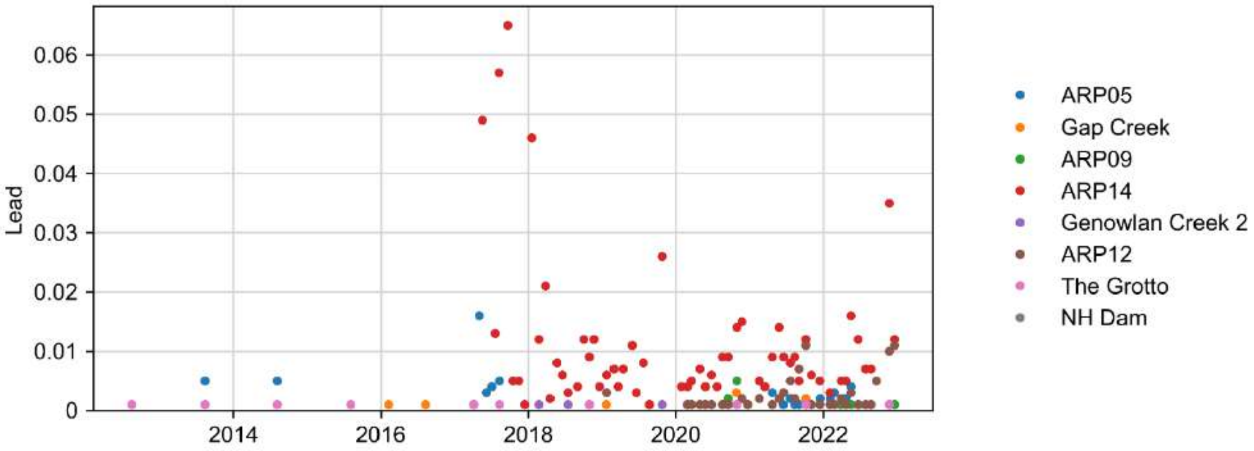

Cadmium
0.0004
0.0003
0.0002
0.0001
0
2014
2016
2018
2020
2022
ARP05
Gap Creek
ARP09
ARP14
Genowlan Creek 2
ARP12
The Grotto
NH Dam

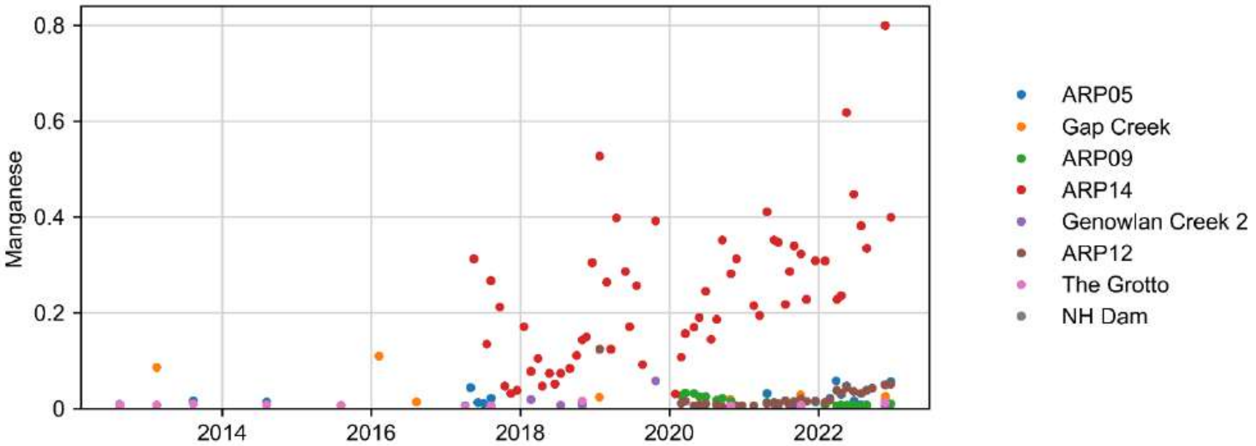

Chromium (III+VI)
0.25
0.2
0.15
0.1
0.05
0
2017
2018
2019
2020
2021
2022
2023
ARP05
Gap Creek
ARP09
ARP14
Genowlan Creek 2
ARP12
The Grotto
NH Dam

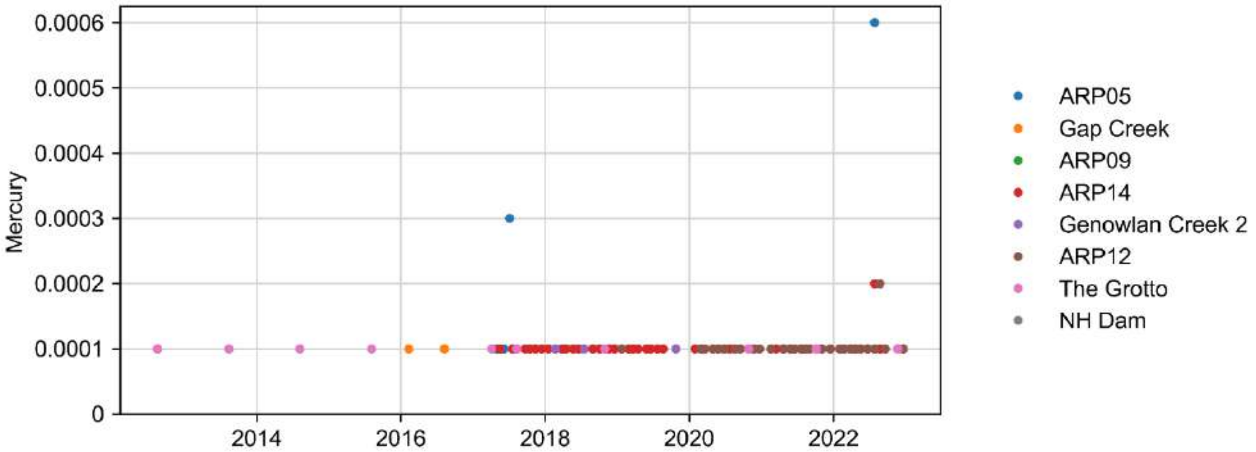

Cobalt
0.012
0.01
0.008
0.006
0.004
0.002
0
2014
2016
2018
2020
2022
ARP05
Gap Creek
ARP09
ARP14
Genowlan Creek 2
ARP12
The Grotto
NH Dam

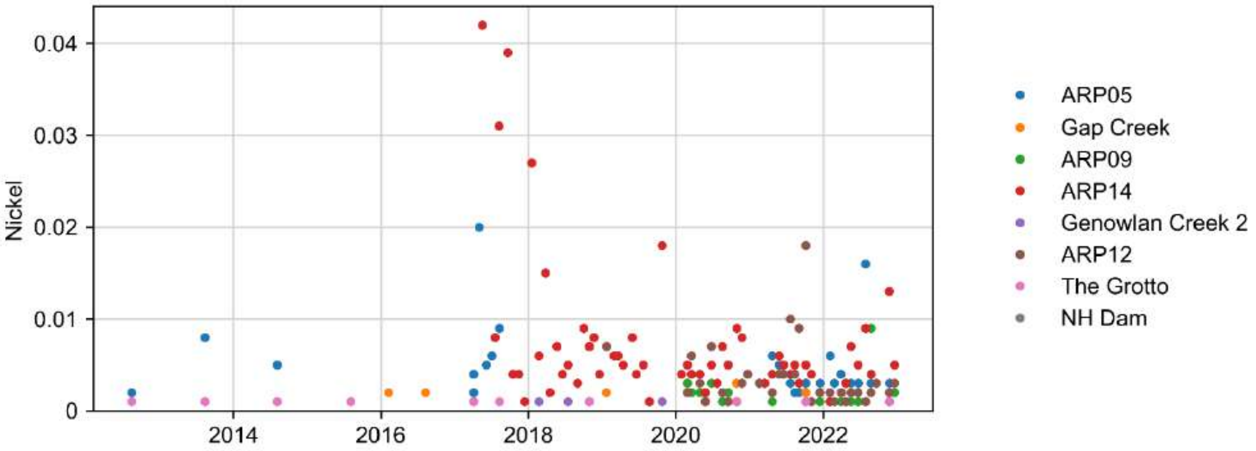

Copper
0.175
0.15
0.125
0.1
0.075
0.05
0.025
0
2017
2018
2019
2020
2021
2022
2023
ARP05
Gap Creek
ARP09
ARP14
Genowlan Creek 2
ARP12
The Grotto
NH Dam

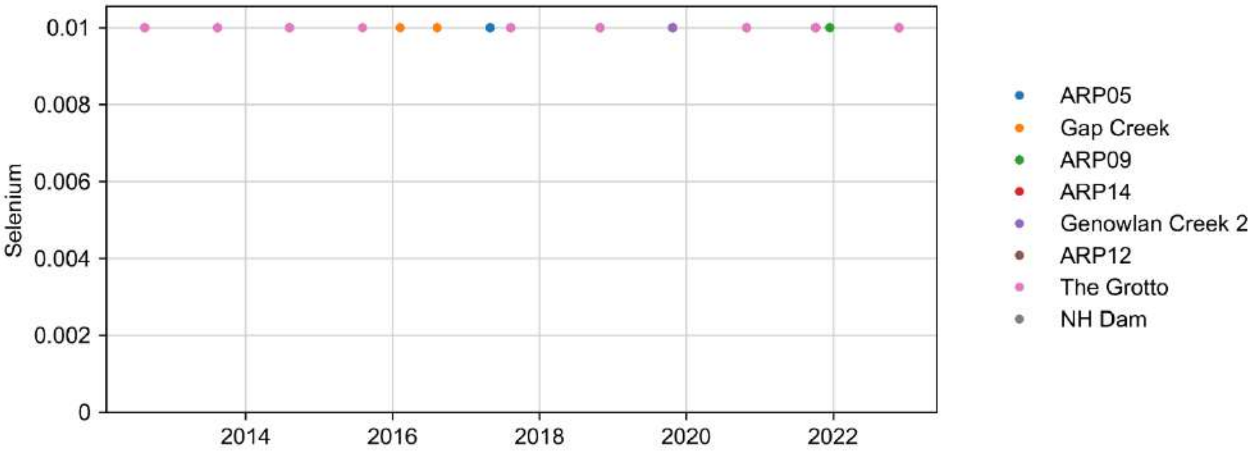

Iron
150
125
100
75
50
25
0
2014
2016
2018
2020
2022
ARP05
Gap Creek
ARP09
ARP14
Genowlan Creek 2
ARP12
The Grotto
NH Dam

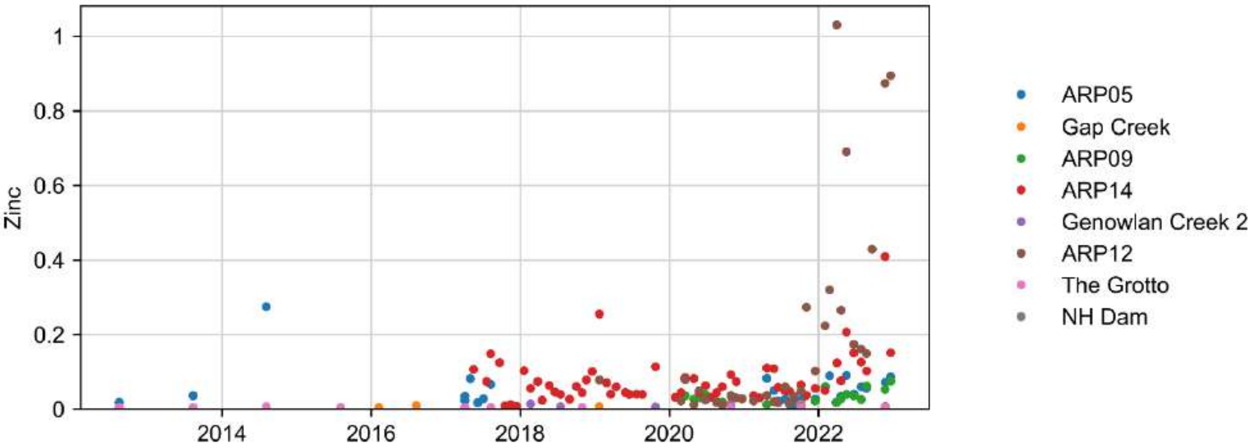

Lead
0.06
0.05
0.04
0.03
0.02
0.01
0
2014
2016
2018
2020
2022
ARP05
Gap Creek
ARP09
ARP14
Genowlan Creek 2
ARP12
The Grotto
NH Dam


Manganese
0.8
0.6
0.4
0.2
0
2014
2016
2018
2020
2022
ARP05
Gap Creek
ARP09
ARP14
Genowlan Creek 2
ARP12
The Grotto
NH Dam

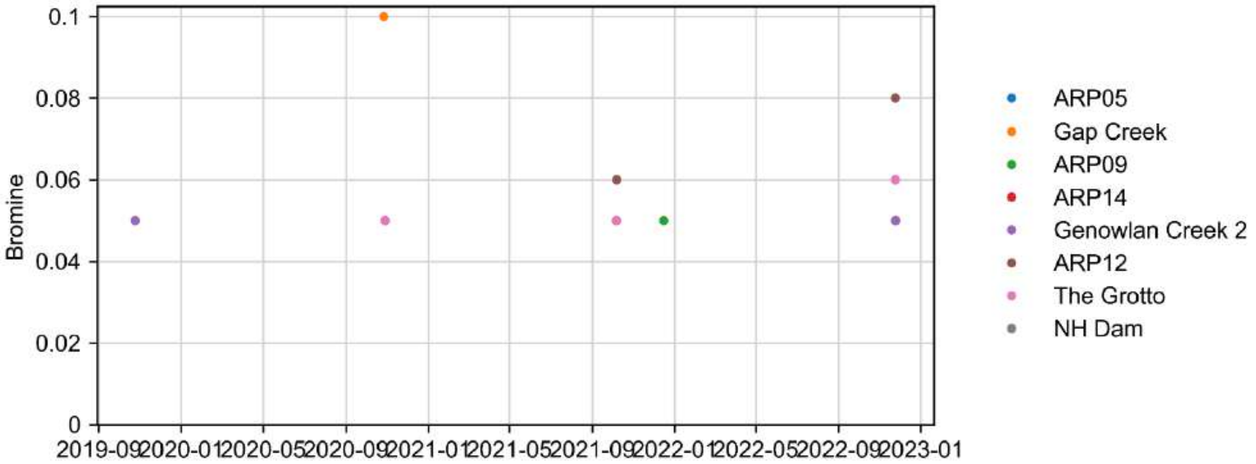

Mercury
0.0006
0.0005
0.0004
0.0003
0.0002
0.0001
0
2014
2016
2018
2020
2022
ARP05
Gap Creek
ARP09
ARP14
Genowlan Creek 2
ARP12
The Grotto
NH Dam

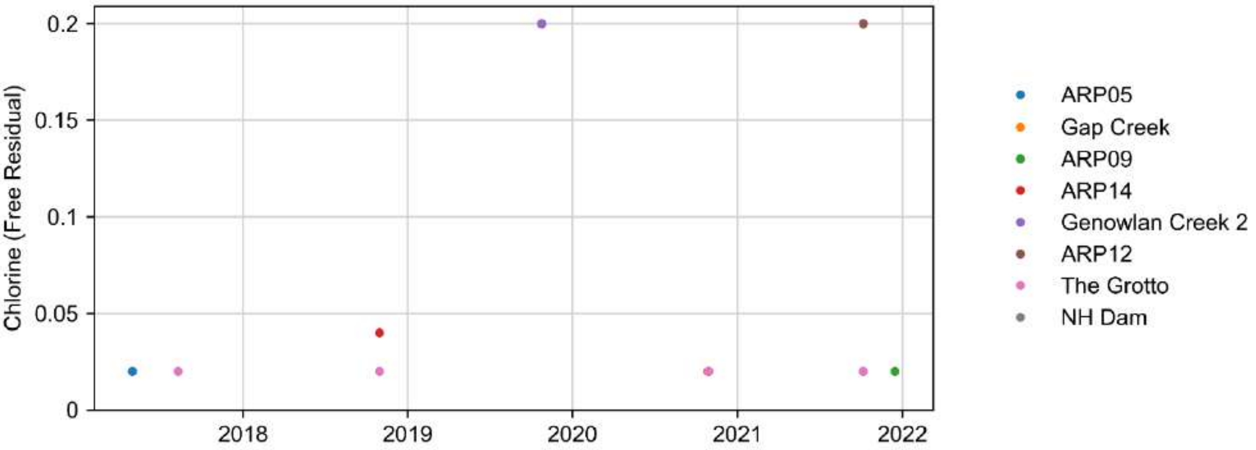

Nickel
0.04
0.03
0.02
0.01
0
2014
2016
2018
2020
2022
ARP05
Gap Creek
ARP09
ARP14
Genowlan Creek 2
ARP12
The Grotto
NH Dam

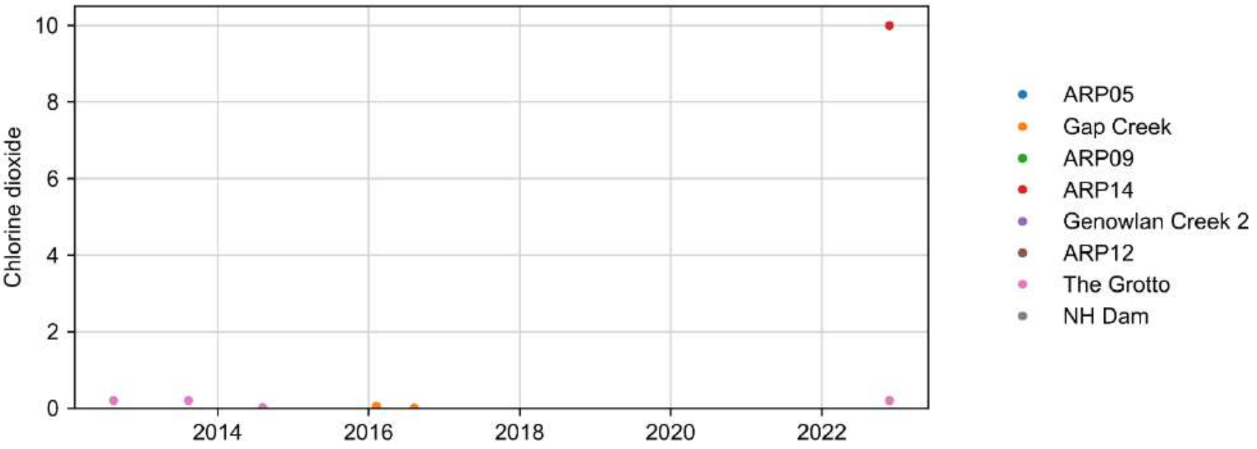

0.01
0.008
0.006
0.004
0.002
0
Selenium
2014
2016
2018
2020
2022
ARP05
Gap Creek
ARP09
ARP14
Genowlan Creek 2
ARP12
The Grotto
NH Dam

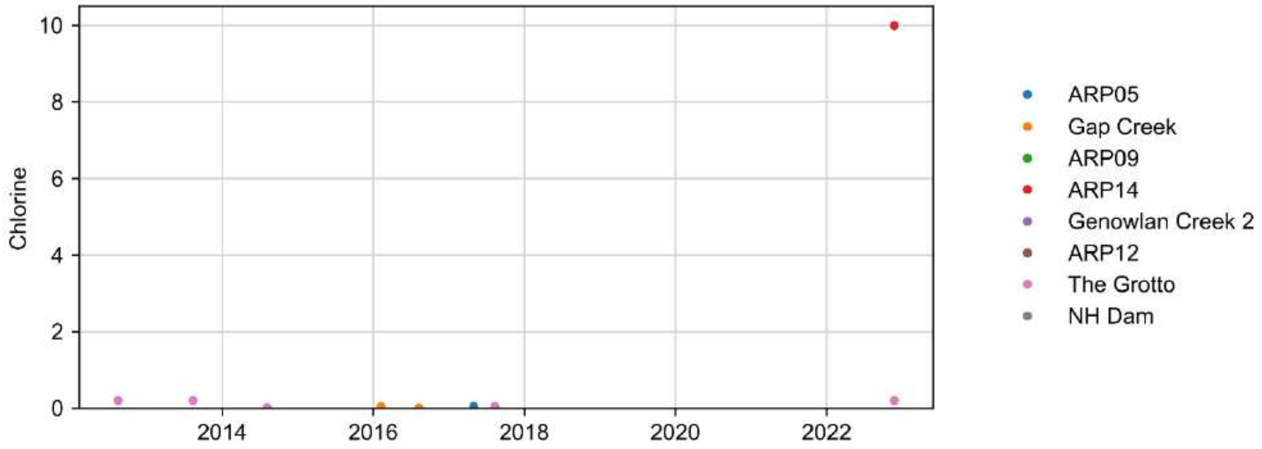

1
0.8
0.6
0.4
0.2
0
Zinc
2014
2016
2018
2020
2022
ARP05
Gap Creek
ARP09
ARP14
Genowlan Creek 2
ARP12
The Grotto
NH Dam

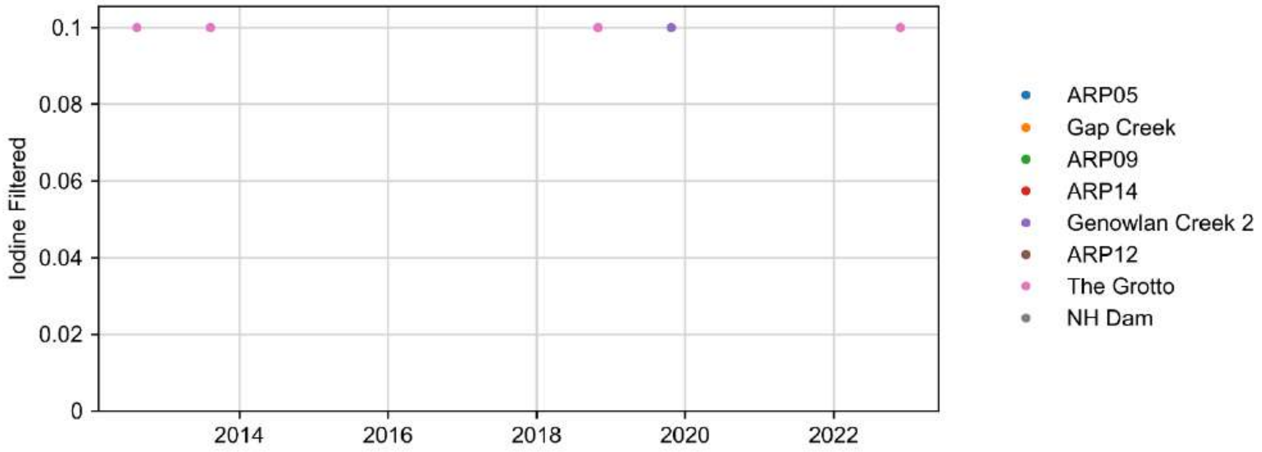
Other

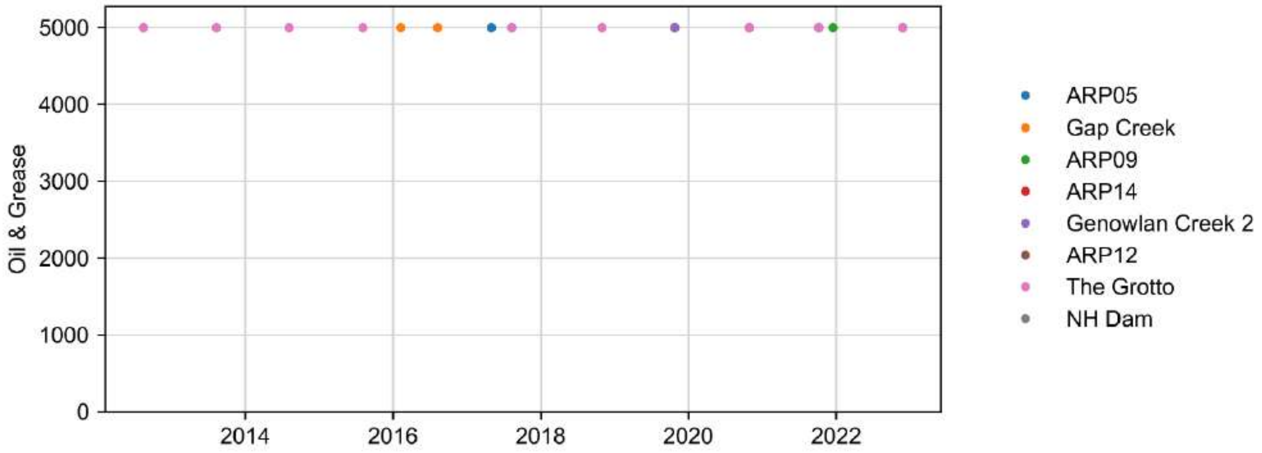

Bromine
0.1
0.08
0.06
0.04
0.02
0
2019-09
2020-01
2020-05
2020-09
2021-01
2021-05
2021-09
2022-01
2022-05
2022-09
2023-01
ARP05
Gap Creek
ARP09
ARP14
Genowlan Creek 2
ARP12
The Grotto
NH Dam

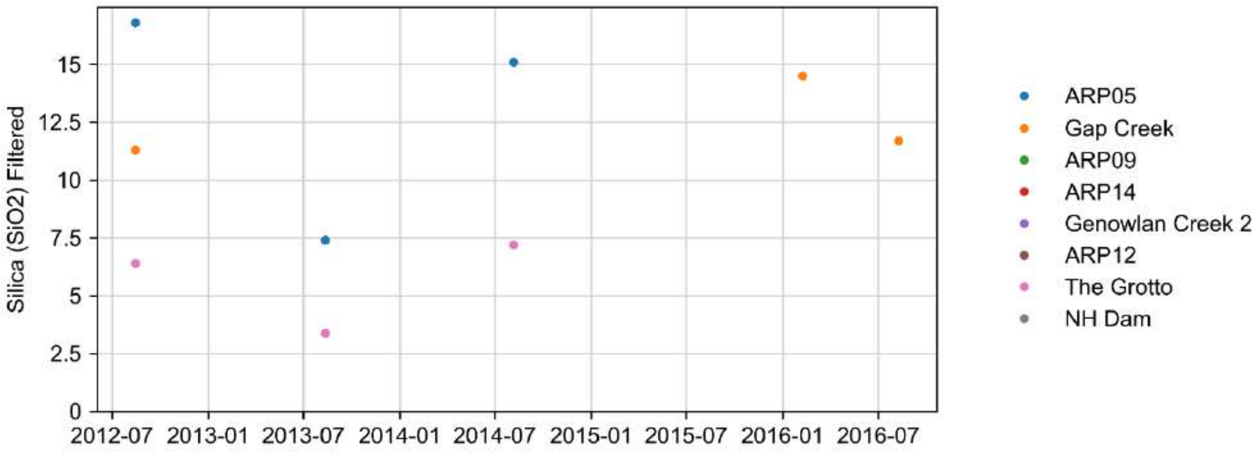

Chlorine (Free Residual)
0.2
0.15
0.1
0.05
0
2018
2019
2020
2021
2022
ARP05
Gap Creek
ARP09
ARP14
Genowlan Creek 2
ARP12
The Grotto
NH Dam

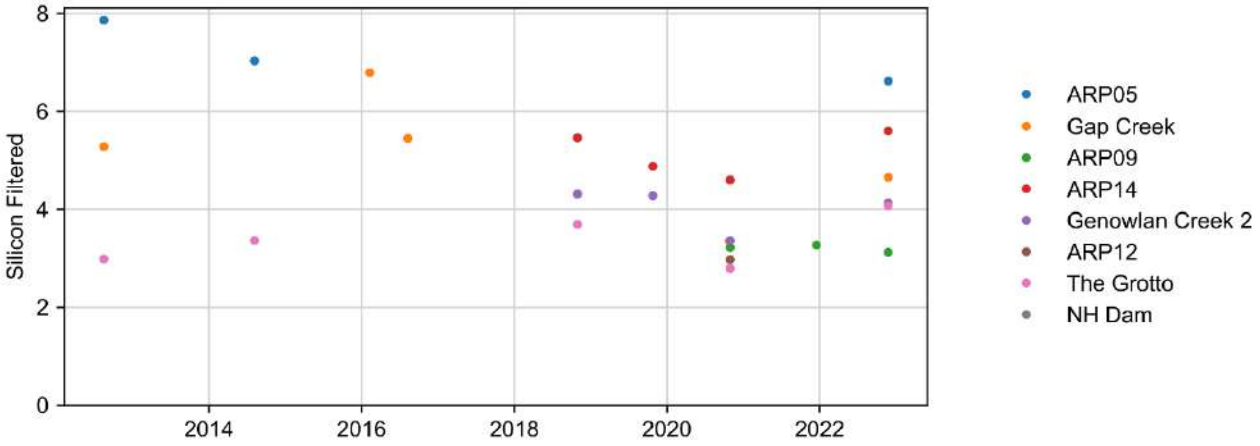

Chlorine dioxide
10
8
6
4
2
0
2014
2016
2018
2020
2022
ARP05
Gap Creek
ARP09
ARP14
Genowlan Creek 2
ARP12
The Grotto
NH Dam


Chlorine
10
8
6
4
2
0
2014
2016
2018
2020
2022
● ARP05
● Gap Creek
● ARP09
● ARP14
● Genowlan Creek 2
● ARP12
● The Grotto
● NH Dam


Iodine Filtered
0.1
0.08
0.06
0.04
0.02
0
2014
2016
2018
2020
2022
● ARP05
● Gap Creek
● ARP09
● ARP14
● Genowlan Creek 2
● ARP12
● The Grotto
● NH Dam

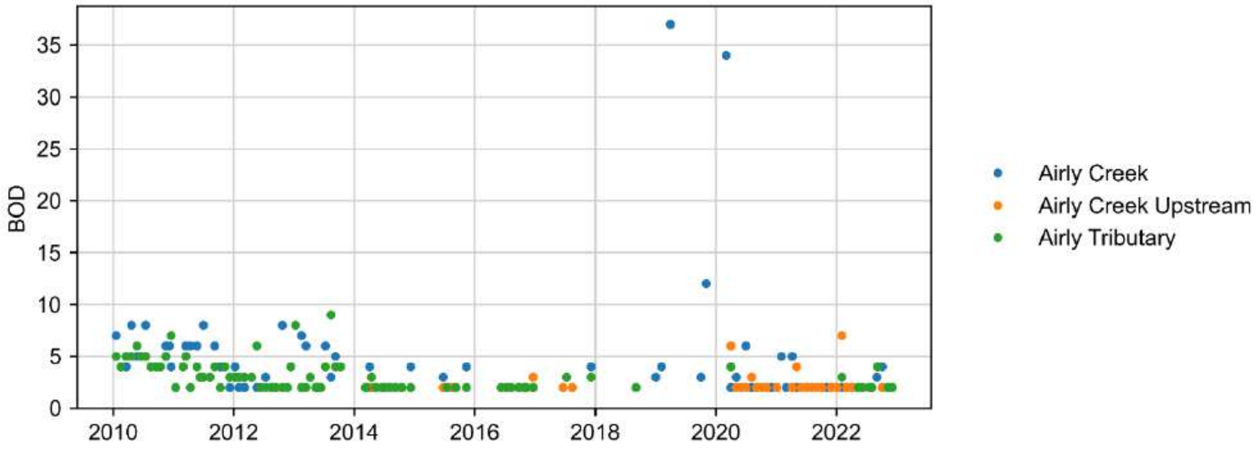

Oil & Grease
5000
4000
3000
2000
1000
0
2014
2016
2018
2020
2022
● ARP05
● Gap Creek
● ARP09
● ARP14
● Genowlan Creek 2
● ARP12
● The Grotto
● NH Dam

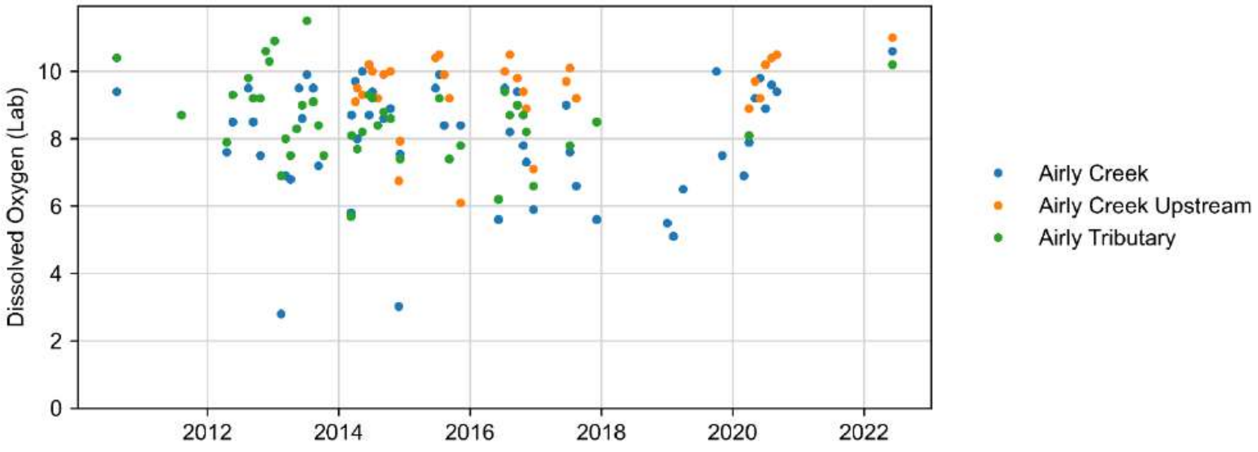

Silica (SiO2) Filtered
15
12.5
10
7.5
5
2.5
0
2012-07
2013-01
2013-07
2014-01
2014-07
2015-01
2015-07
2016-01
2016-07
ARP05
Gap Creek
ARP09
ARP14
Genowlan Creek 2
ARP12
The Grotto
NH Dam

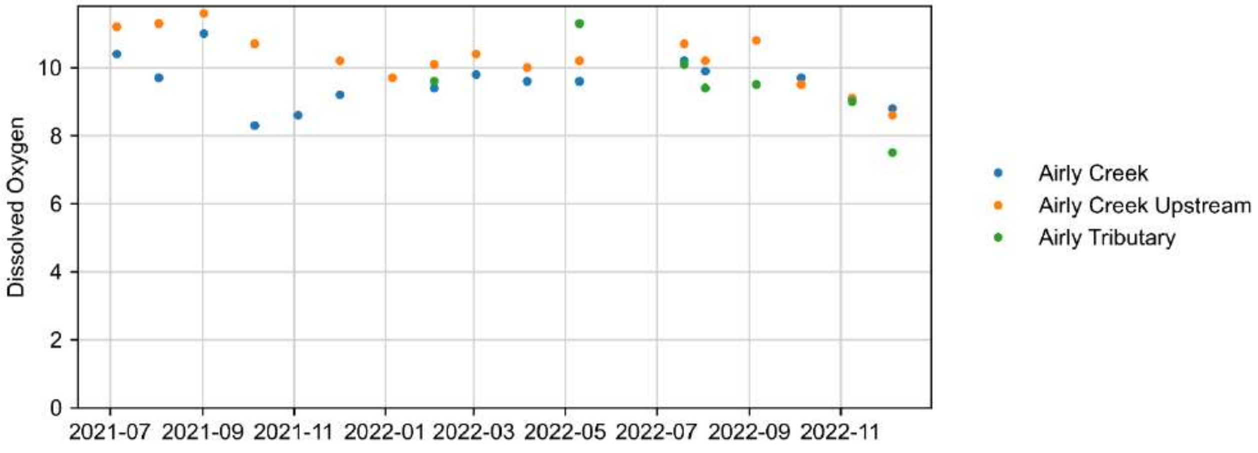

Silicon Filtered
8
6
4
2
0
2014
2016
2018
2020
2022
ARP05
Gap Creek
ARP09
ARP14
Genowlan Creek 2
ARP12
The Grotto
NH Dam

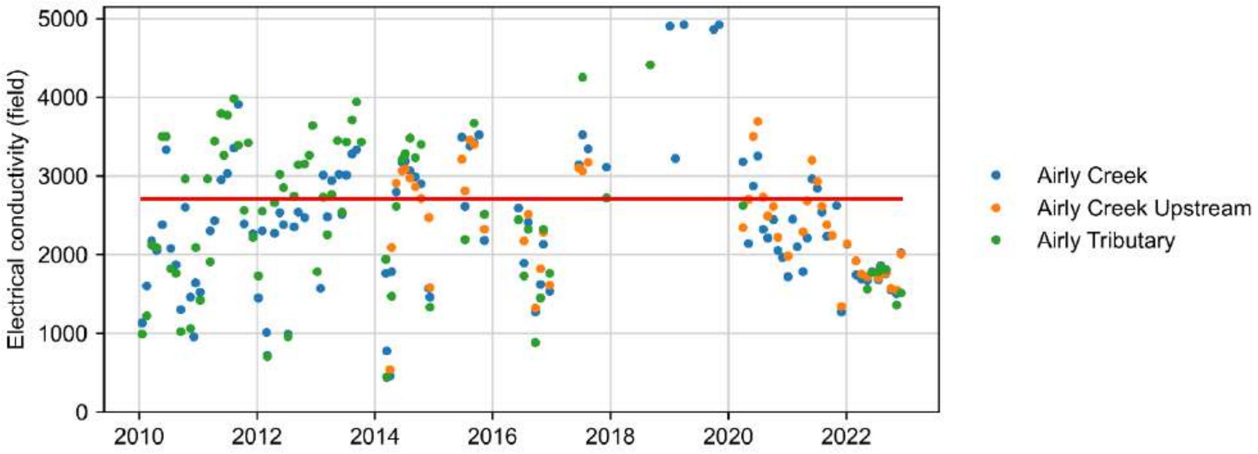
Airly Creek Catchment

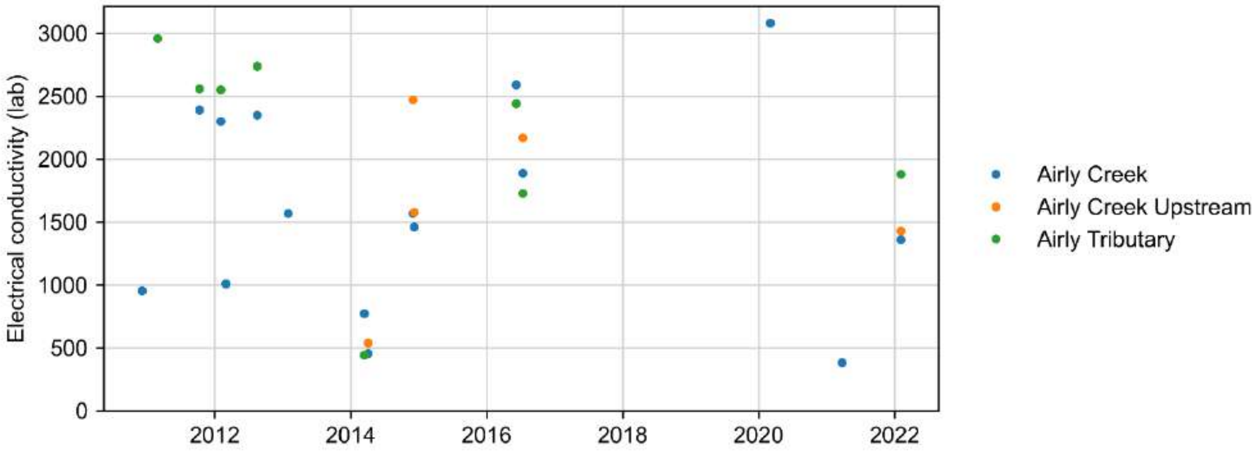
Physicochemical

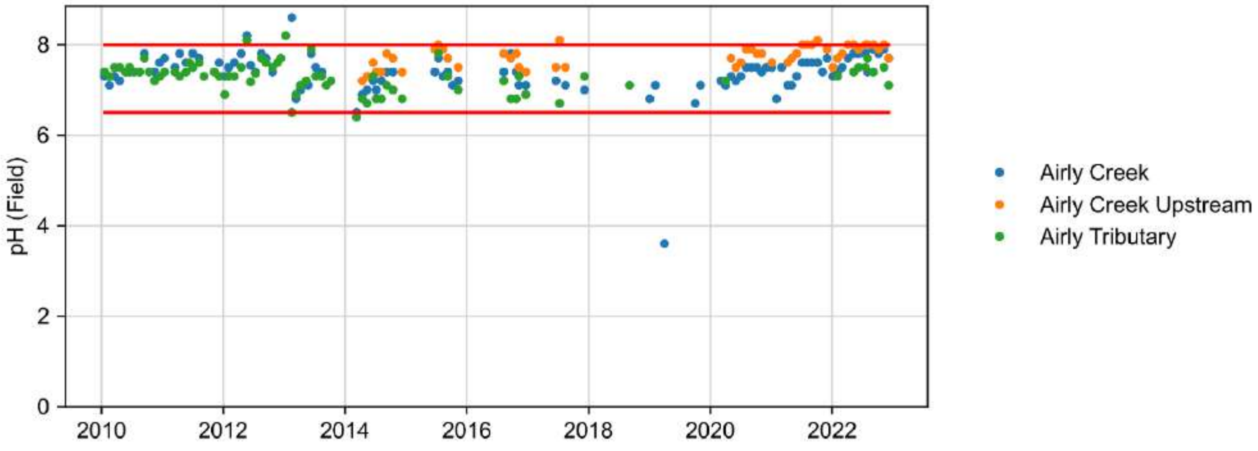


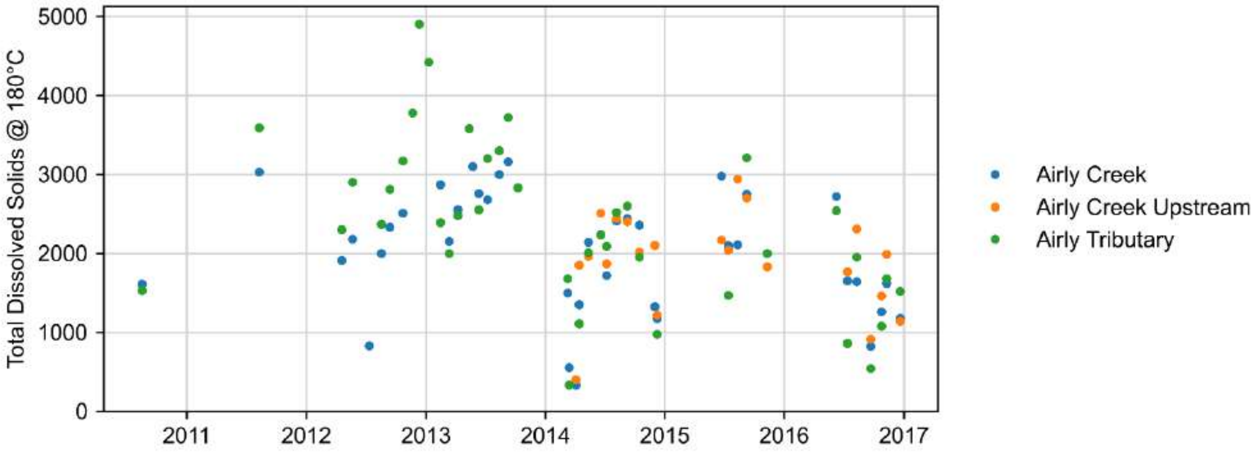




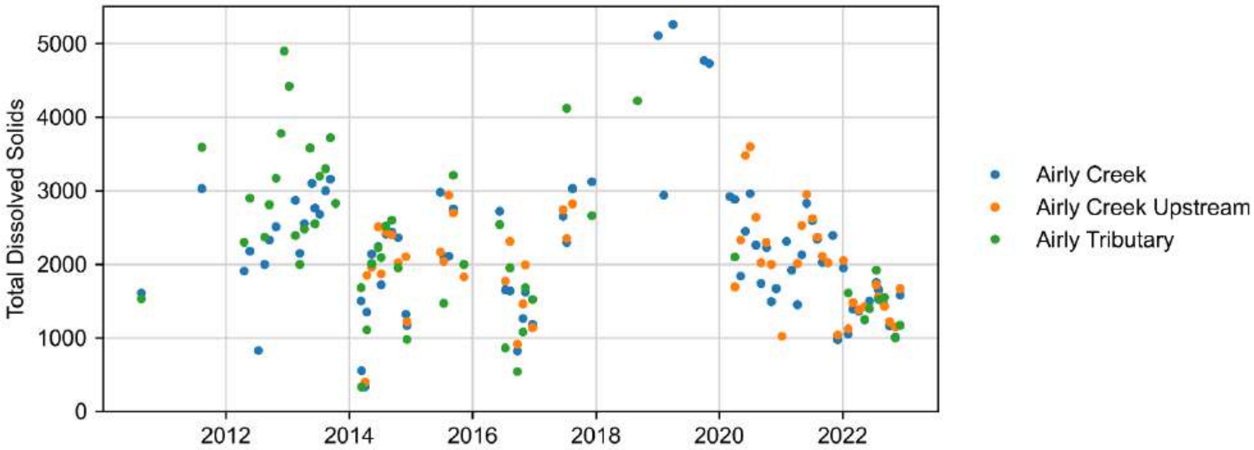

Electrical conductivity (field)
0
1000
2000
3000
4000
5000
2010
2012
2014
2016
2018
2020
2022
Airly Creek
Airly Creek Upstream
Airly Tributary


Electrical conductivity (lab)
0
500
1000
1500
2000
2500
3000
2012
2014
2016
2018
2020
2022
Airly Creek
Airly Creek Upstream
Airly Tributary

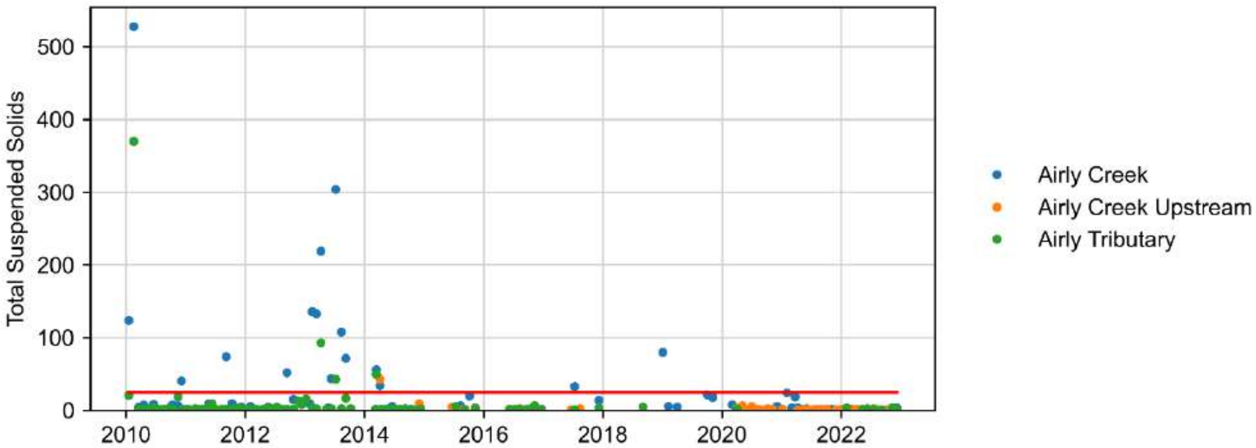

pH (Field)
0
2
4
6
8
2010
2012
2014
2016
2018
2020
2022
Airly Creek
Airly Creek Upstream
Airly Tributary

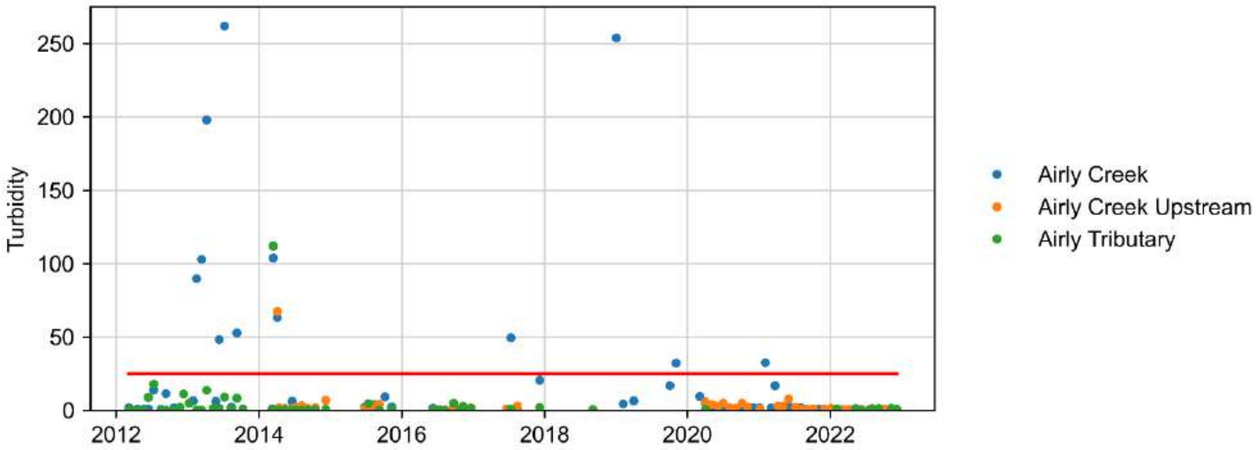


5000
4000
3000
2000
1000
0
Total Dissolved Solids @ 180°C
2011
2012
2013
2014
2015
2016
2017
● Airly Creek
● Airly Creek Upstream
● Airly Tributary

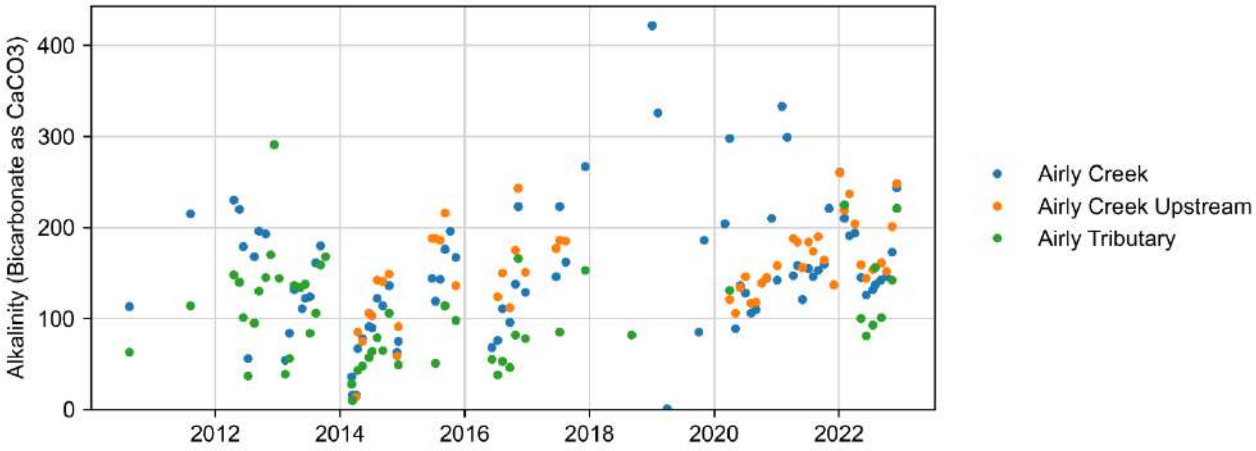


5000
4000
3000
2000
1000
0
Total Dissolved Solids
2012
2014
2016
2018
2020
2022
● Airly Creek
● Airly Creek Upstream
● Airly Tributary

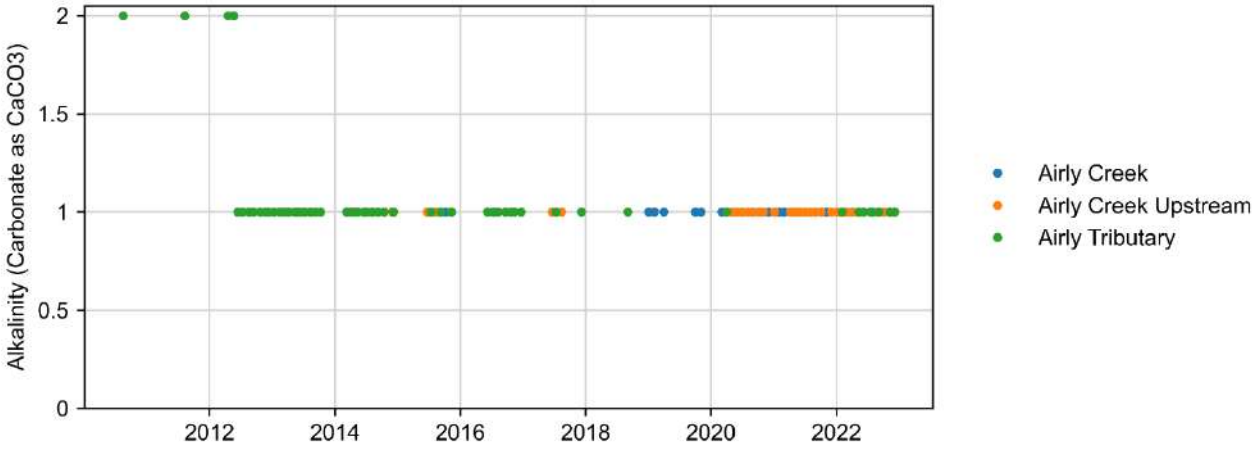

Total Suspended Solids
0
100
200
300
400
500
2010
2012
2014
2016
2018
2020
2022
● Airly Creek
● Airly Creek Upstream
● Airly Tributary


Turbidity
0
50
100
150
200
250
2012
2014
2016
2018
2020
2022
● Airly Creek
● Airly Creek Upstream
● Airly Tributary

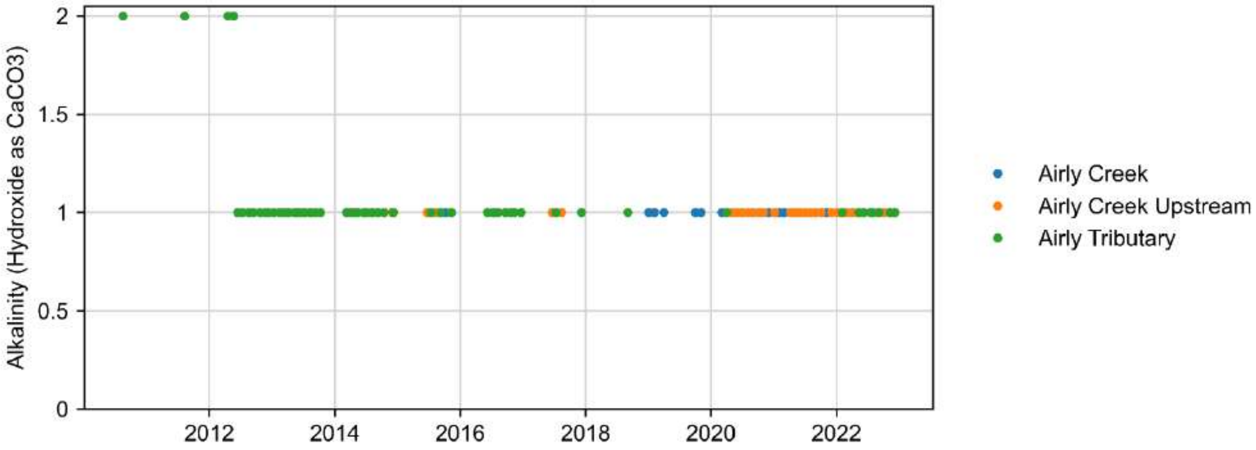
Major ions



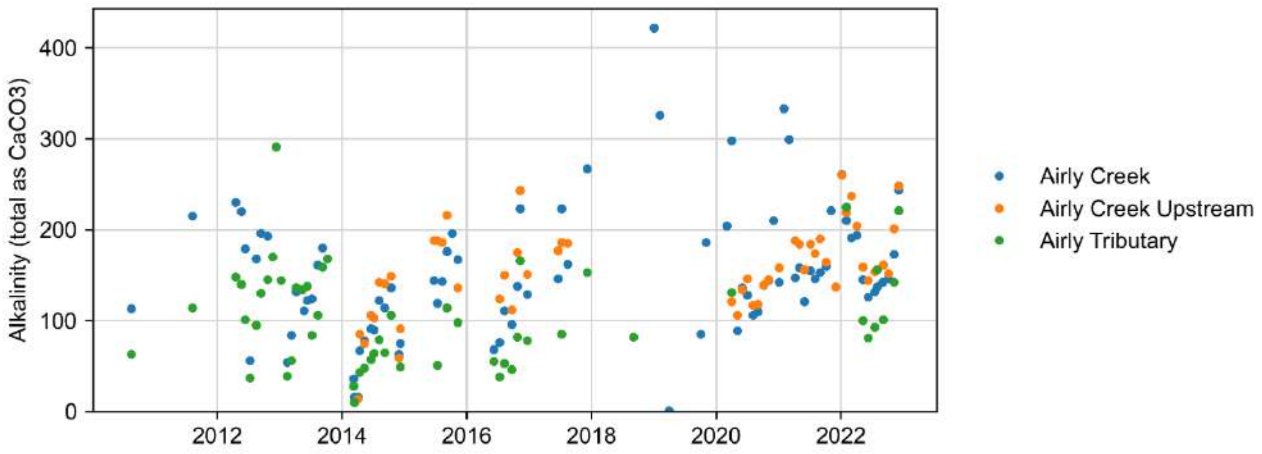
Alkalinity (Bicarbonate as CaCO3)
400
300
200
100
0
2012
2014
2016
2018
2020
2022
Airly Creek
Airly Creek Upstream
Airly Tributary

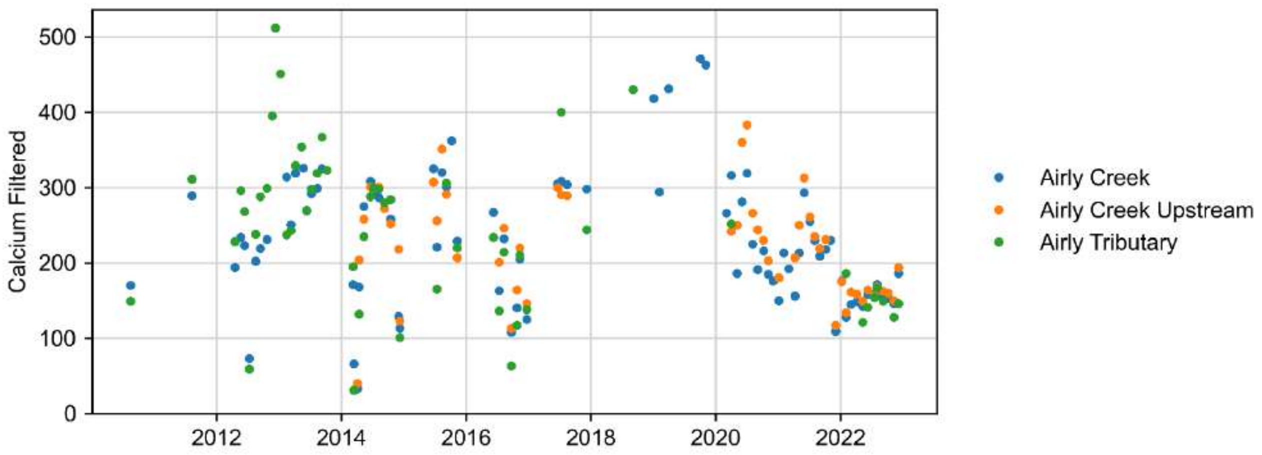


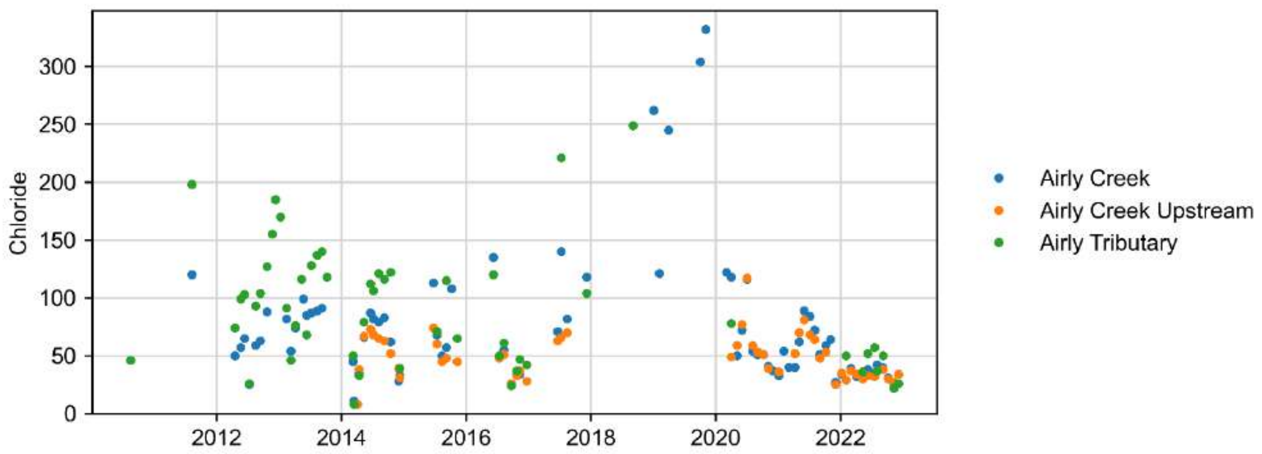
Alkalinity (Carbonate as CaCO3)
2
1.5
1
0.5
0
2012
2014
2016
2018
2020
2022
Airly Creek
Airly Creek Upstream
Airly Tributary

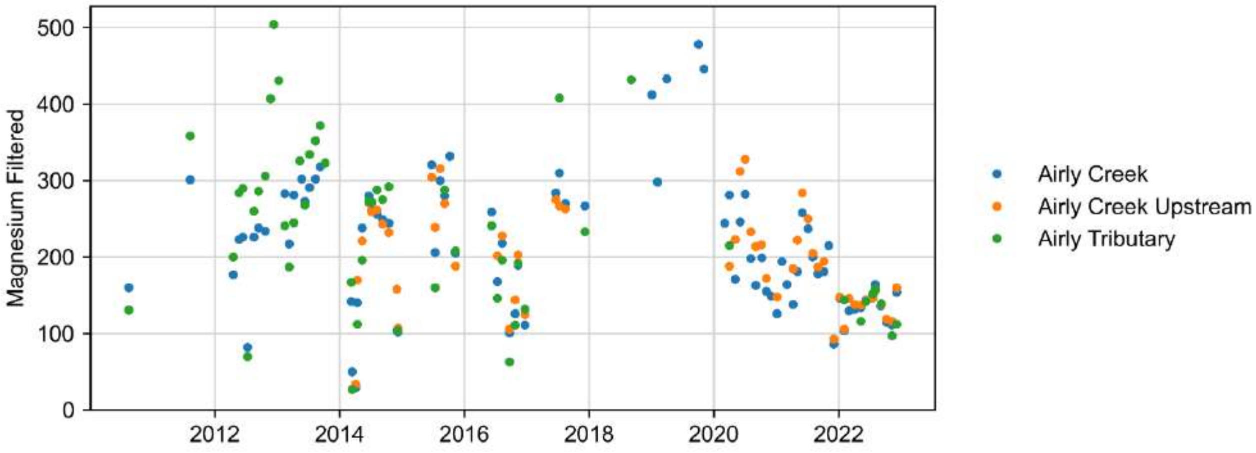


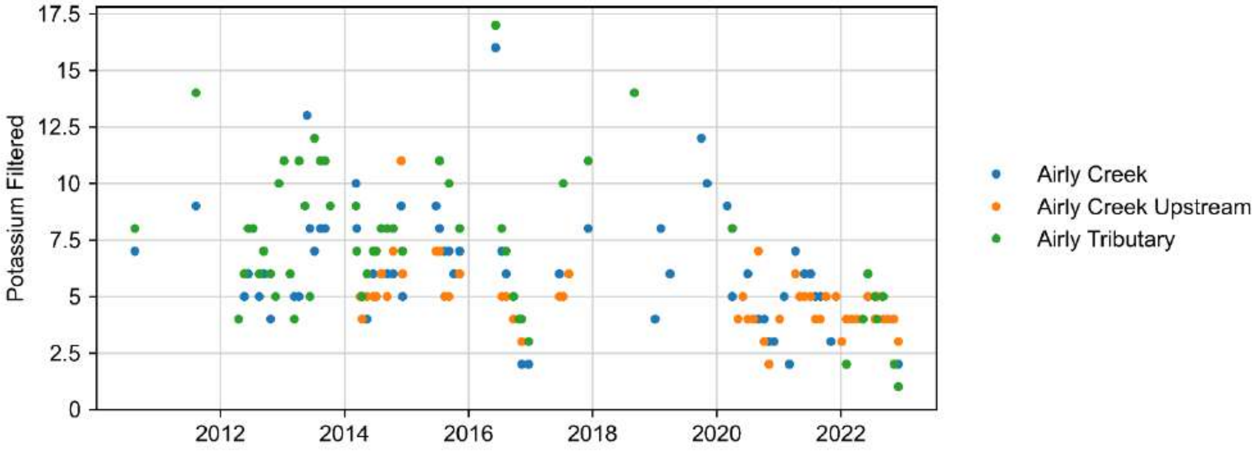
Alkalinity (Hydroxide as CaCO3)
2
1.5
1
0.5
0
2012
2014
2016
2018
2020
2022
Airly Creek
Airly Creek Upstream
Airly Tributary

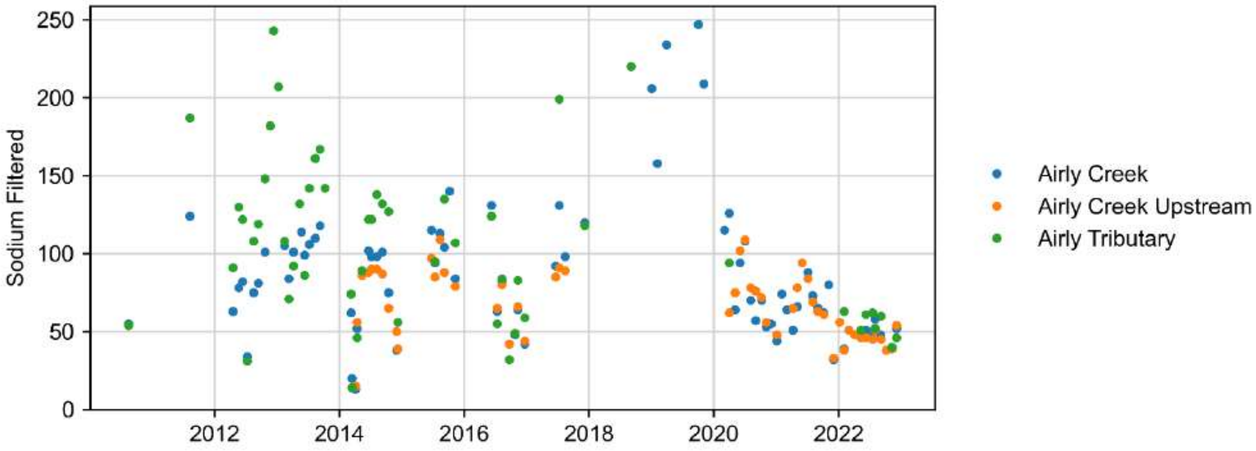

Alkalinity (total as CaCO3)
0
100
200
300
400
2012
2014
2016
2018
2020
2022
Airly Creek
Airly Creek Upstream
Airly Tributary

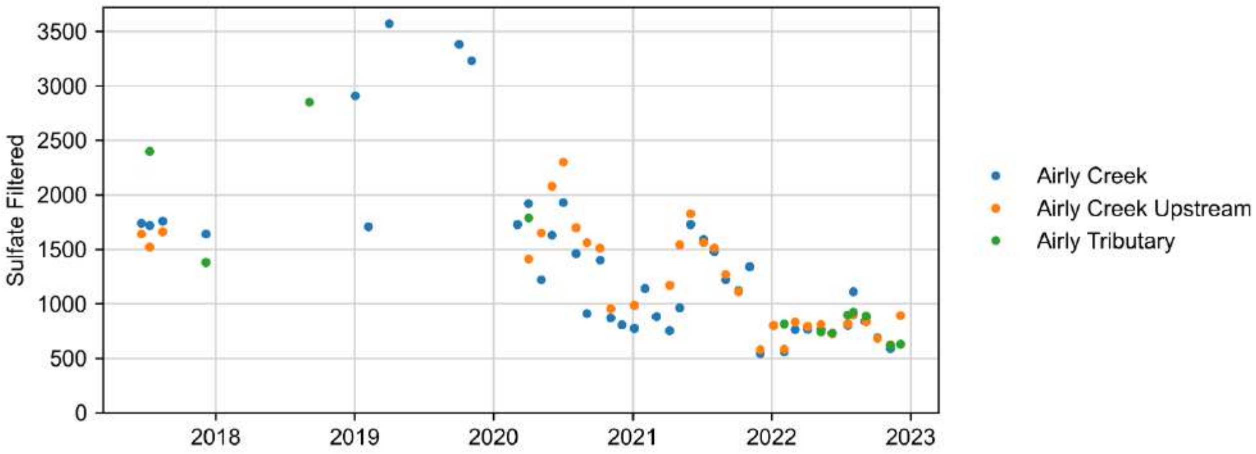

Calcium Filtered
0
100
200
300
400
500
2012
2014
2016
2018
2020
2022
Airly Creek
Airly Creek Upstream
Airly Tributary

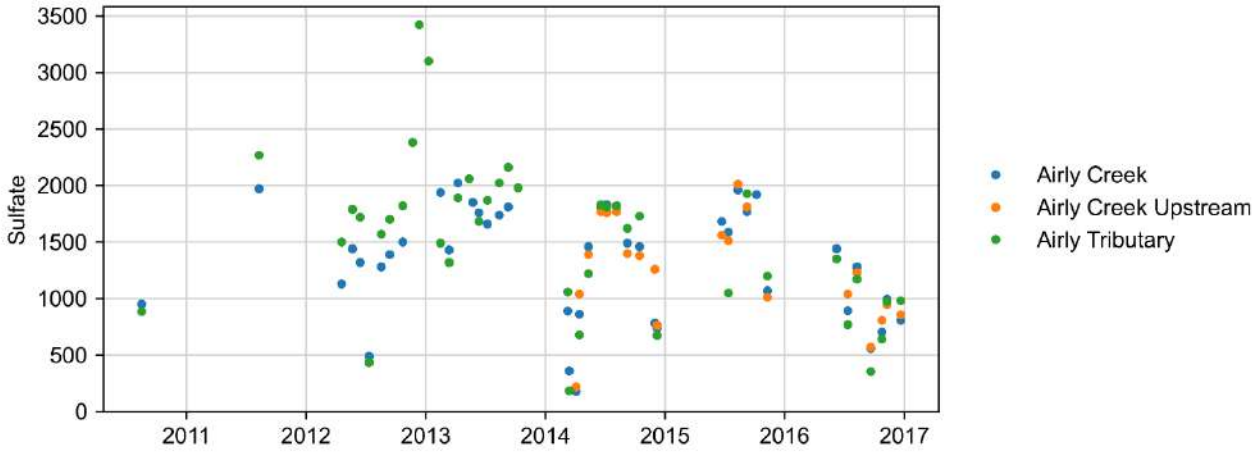

Chloride
0
50
100
150
200
250
300
2012
2014
2016
2018
2020
2022
Airly Creek
Airly Creek Upstream
Airly Tributary


Magnesium Filtered
0
100
200
300
400
500
2012
2014
2016
2018
2020
2022
Airly Creek
Airly Creek Upstream
Airly Tributary

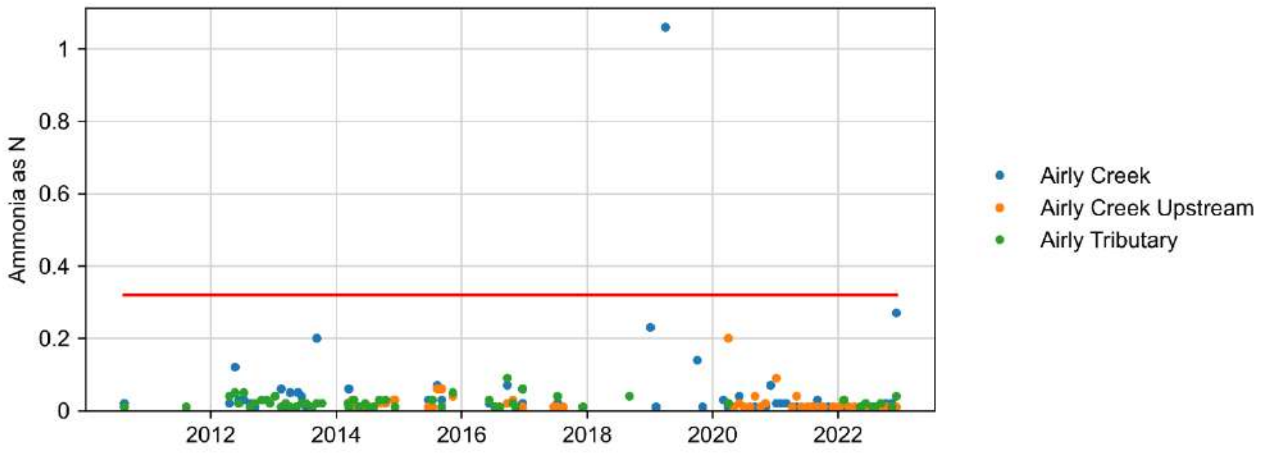

Potassium Filtered
0
2.5
5
7.5
10
12.5
15
17.5
2012
2014
2016
2018
2020
2022
Airly Creek
Airly Creek Upstream
Airly Tributary

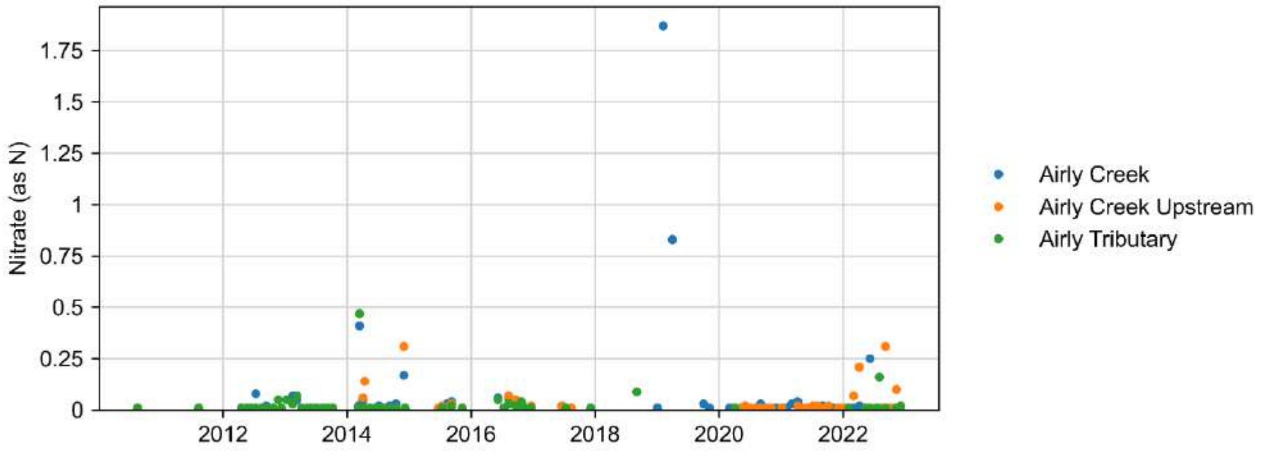

Sodium Filtered
0
50
100
150
200
250
2012
2014
2016
2018
2020
2022
Airly Creek
Airly Creek Upstream
Airly Tributary

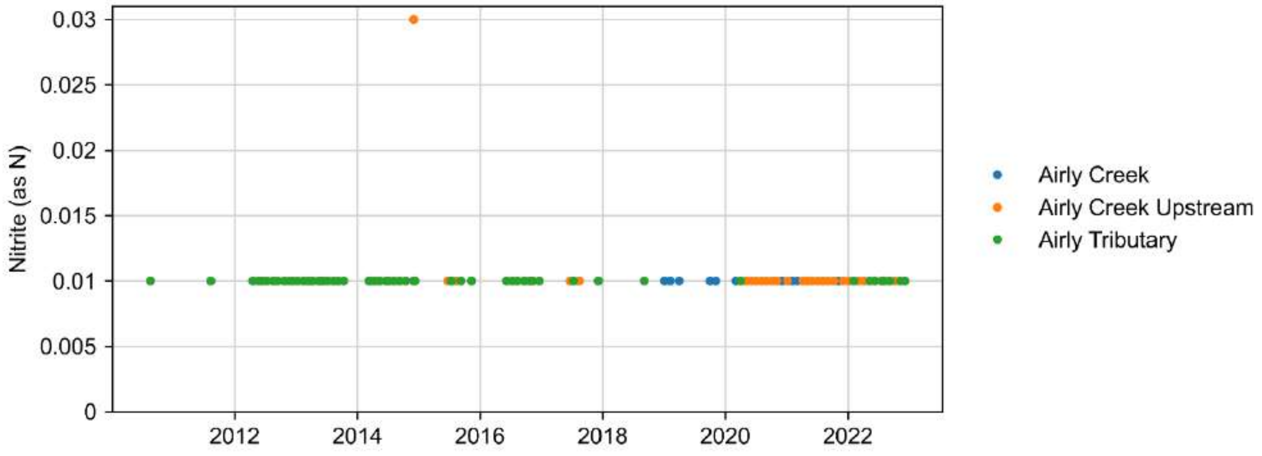

Sulfate Filtered
0
500
1000
1500
2000
2500
3000
3500
2018
2019
2020
2021
2022
2023
● Airly Creek
● Airly Creek Upstream
● Airly Tributary

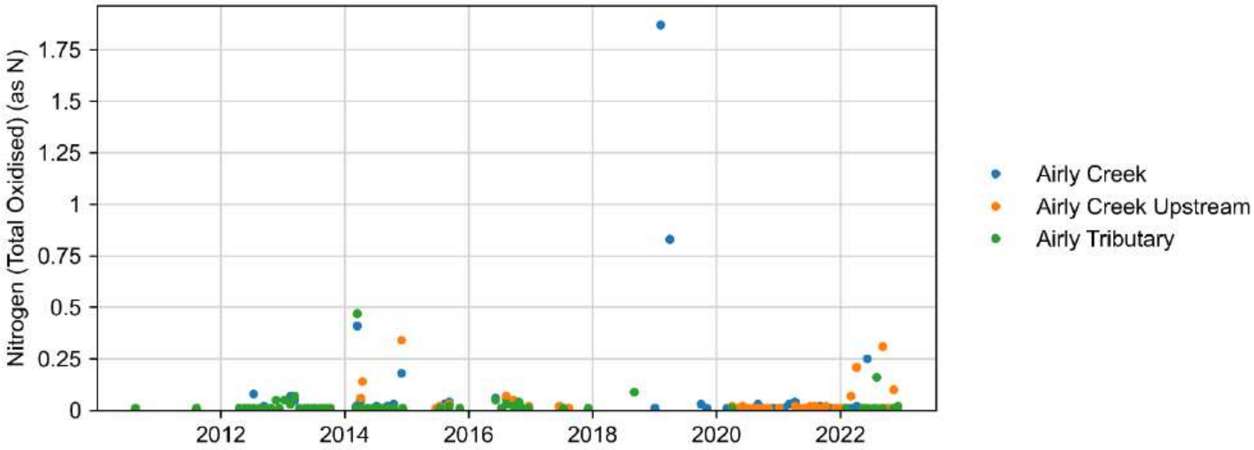

Sulfate
0
500
1000
1500
2000
2500
3000
3500
2011
2012
2013
2014
2015
2016
2017
● Airly Creek
● Airly Creek Upstream
● Airly Tributary

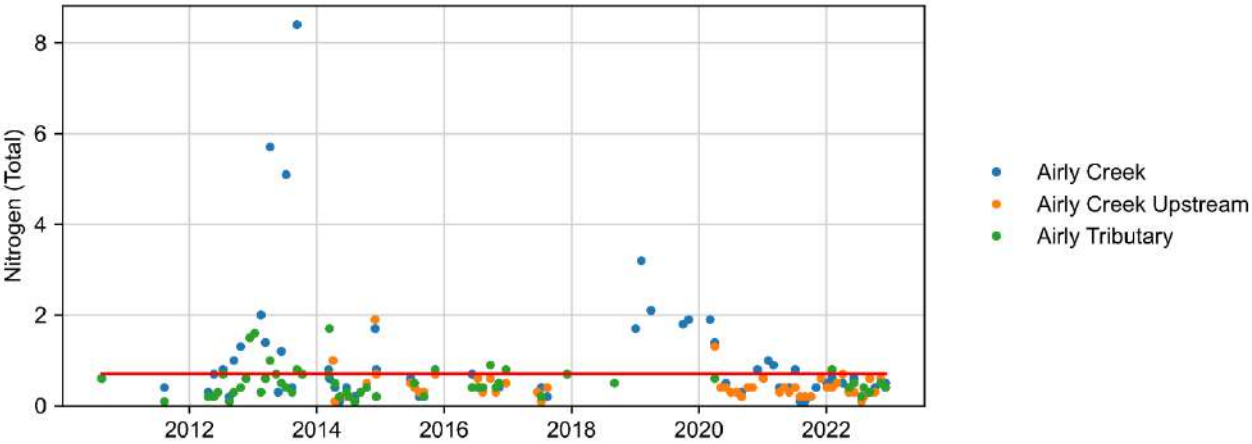
Nutrients

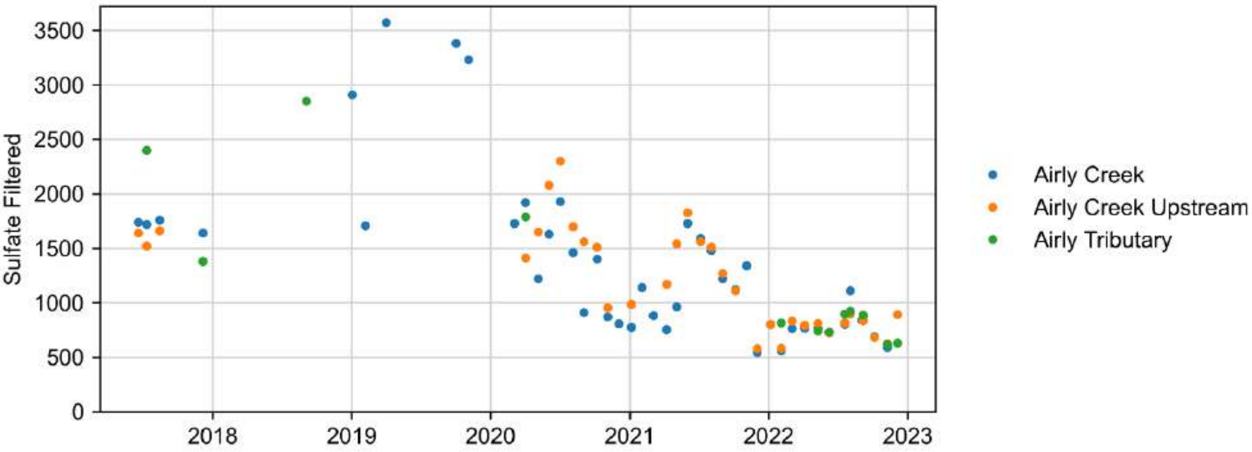

Ammonia as N
1
0.8
0.6
0.4
0.2
0
2012
2014
2016
2018
2020
2022
Airly Creek
Airly Creek Upstream
Airly Tributary

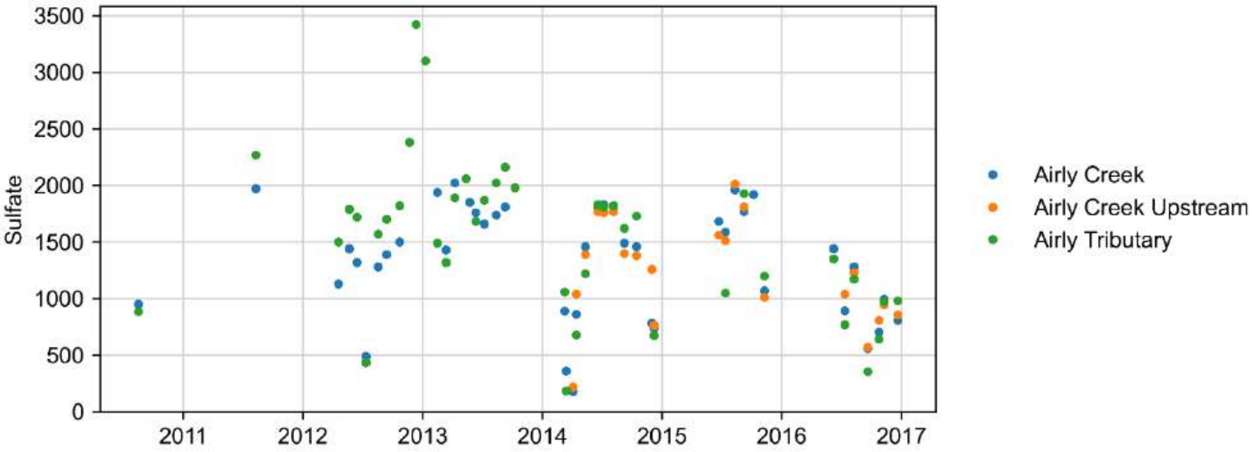

Nitrate (as N)
1.75
1.5
1.25
1
0.75
0.5
0.25
0
2012
2014
2016
2018
2020
2022
Airly Creek
Airly Creek Upstream
Airly Tributary


Nitrite (as N)
0.03
0.025
0.02
0.015
0.01
0.005
0
2012
2014
2016
2018
2020
2022
Airly Creek
Airly Creek Upstream
Airly Tributary

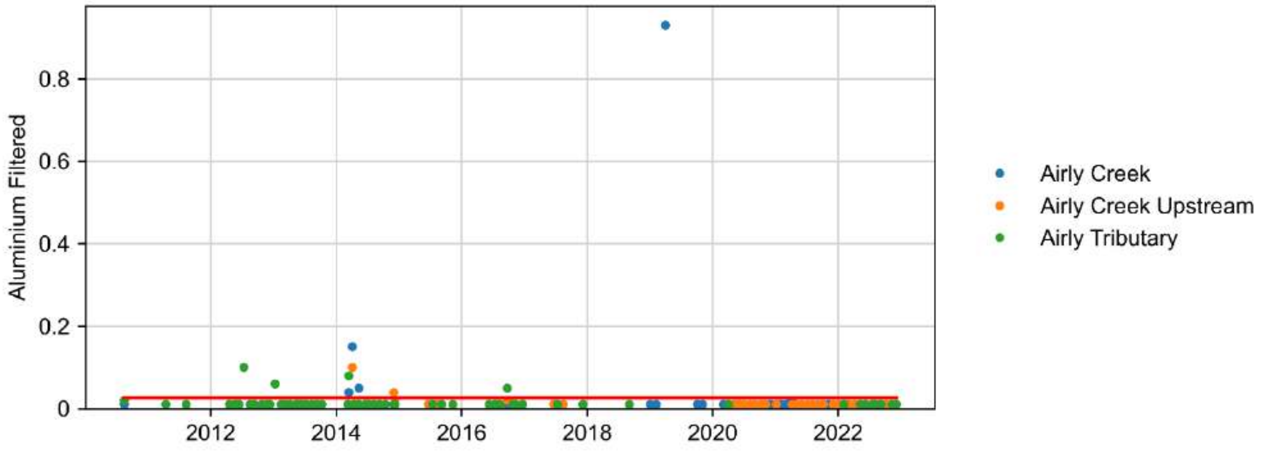

Nitrogen (Total Oxidised) (as N)
1.75
1.5
1.25
1
0.75
0.5
0.25
0
2012
2014
2016
2018
2020
2022
Airly Creek
Airly Creek Upstream
Airly Tributary

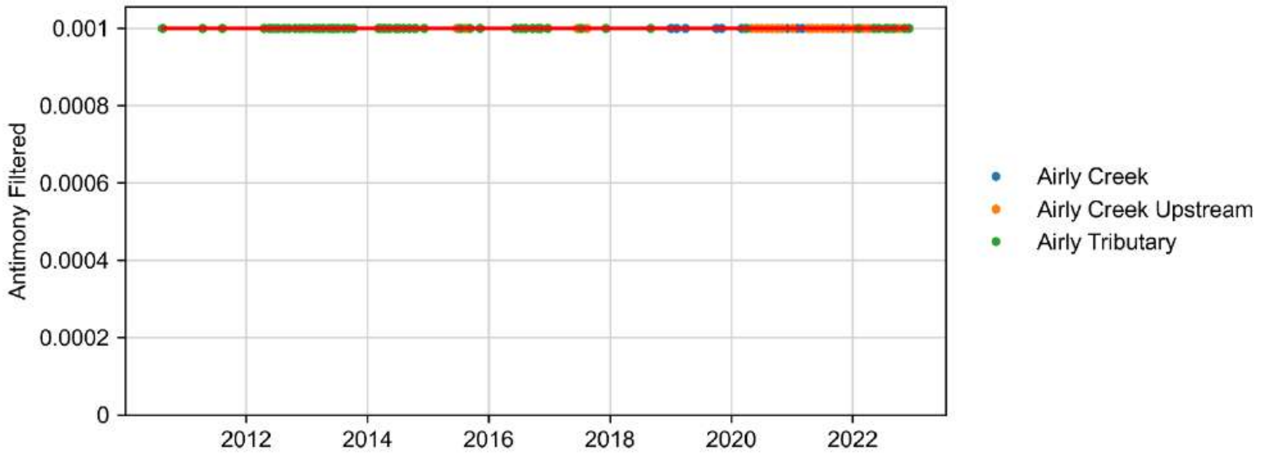

Nitrogen (Total)
8
6
4
2
0
2012
2014
2016
2018
2020
2022
Airly Creek
Airly Creek Upstream
Airly Tributary

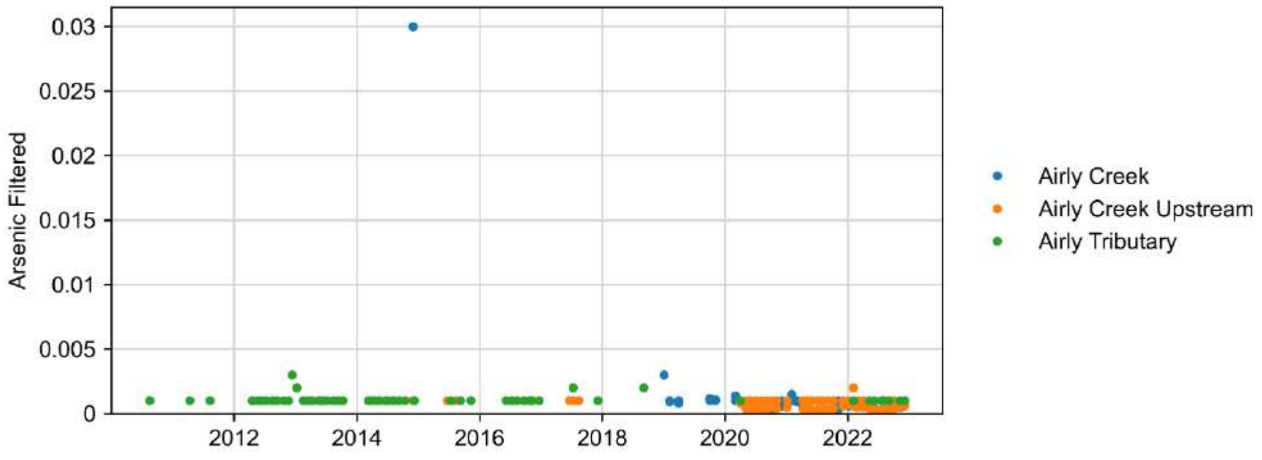

Sulfate Filtered
3500
3000
2500
2000
1500
1000
500
0
2018
2019
2020
2021
2022
2023
Airly Creek
Airly Creek Upstream
Airly Tributary

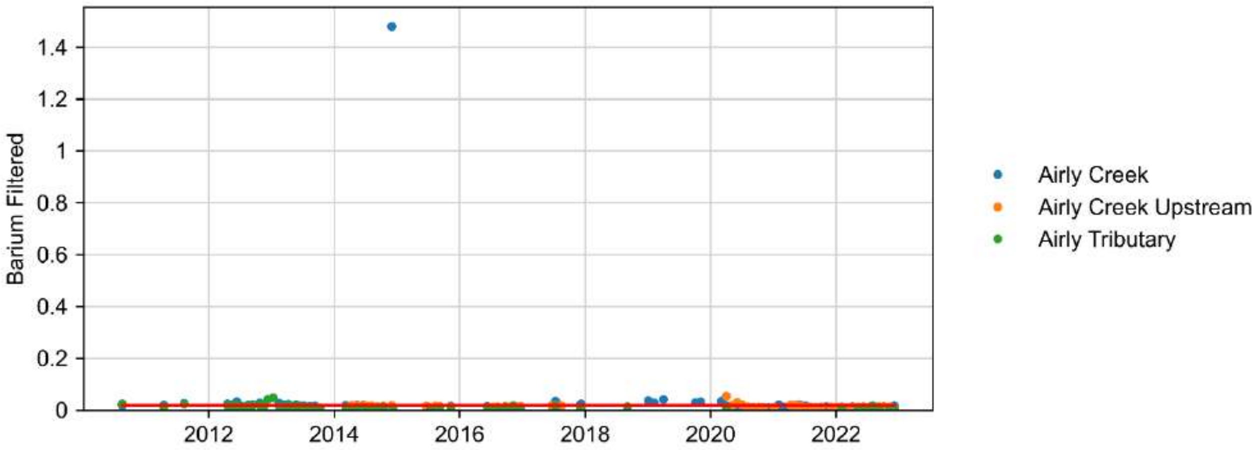

Sulfate
3500
3000
2500
2000
1500
1000
500
0
2011
2012
2013
2014
2015
2016
2017
Airly Creek
Airly Creek Upstream
Airly Tributary

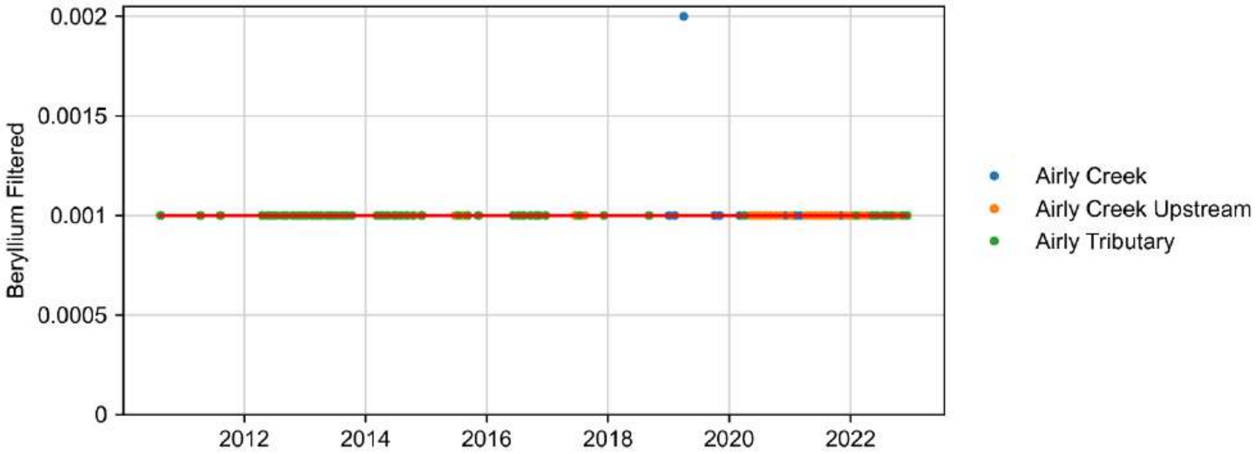
Dissolved metals

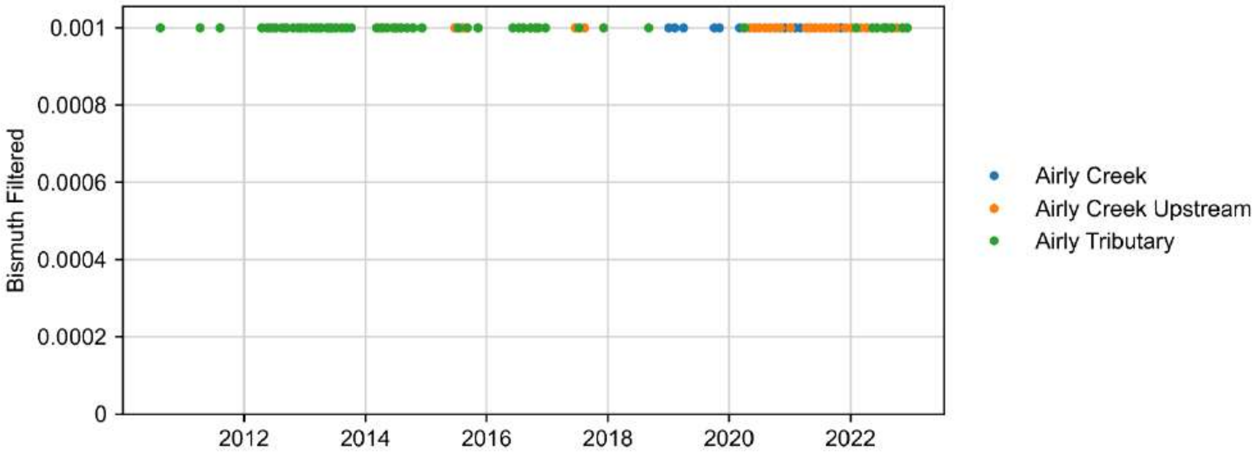


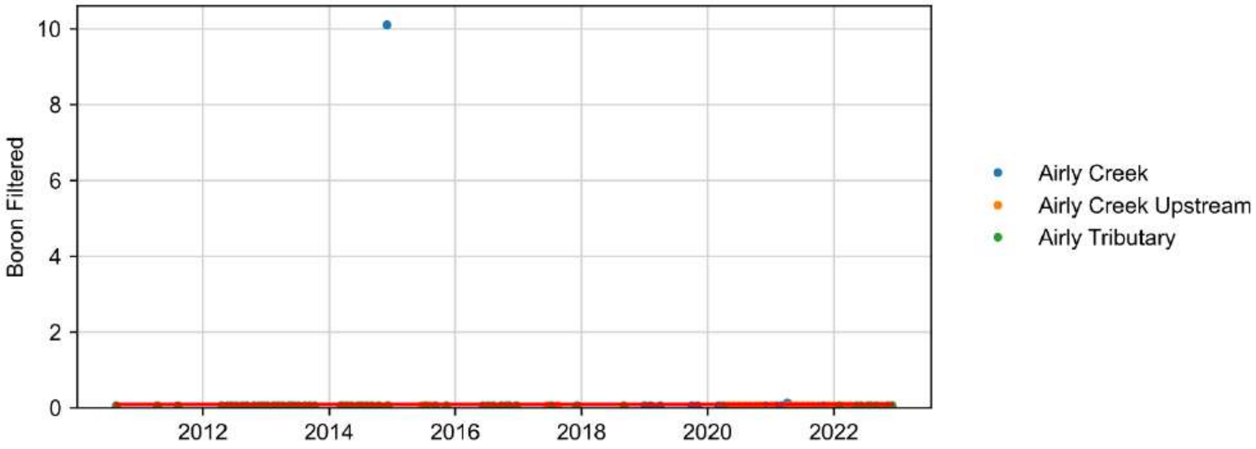




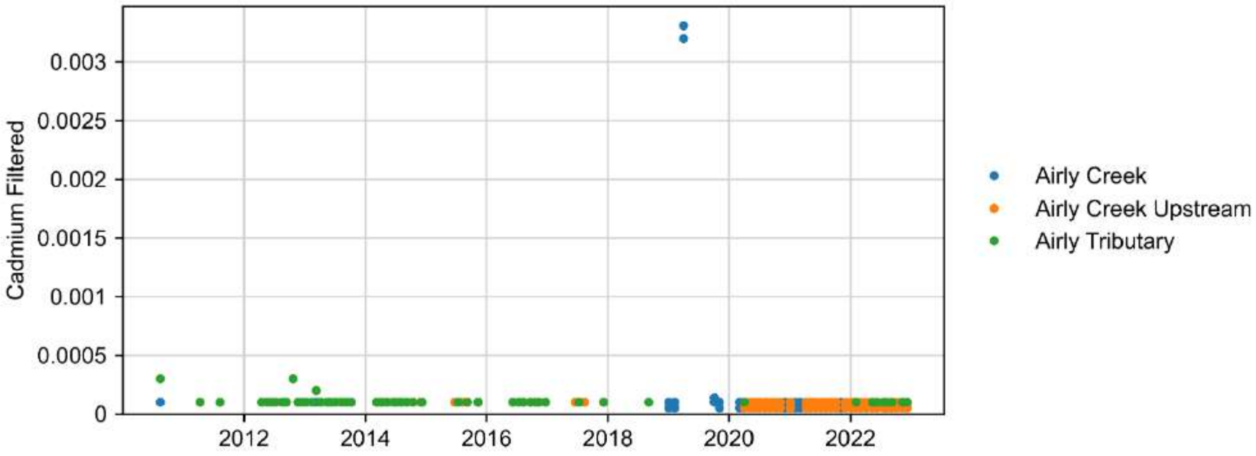

Barium Filtered
1.4
1.2
1
0.8
0.6
0.4
0.2
0
2012
2014
2016
2018
2020
2022
Airly Creek
Airly Creek Upstream
Airly Tributary


Beryllium Filtered
0.002
0.0015
0.001
0.0005
0
2012
2014
2016
2018
2020
2022
Airly Creek
Airly Creek Upstream
Airly Tributary

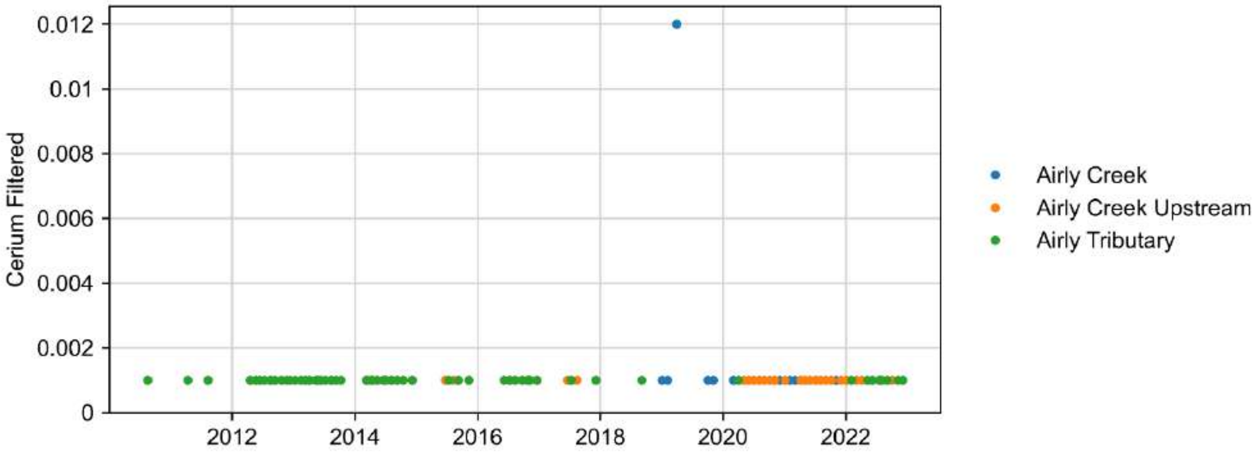

Bismuth Filtered
0.001
0.0008
0.0006
0.0004
0.0002
0
2012
2014
2016
2018
2020
2022
Airly Creek
Airly Creek Upstream
Airly Tributary



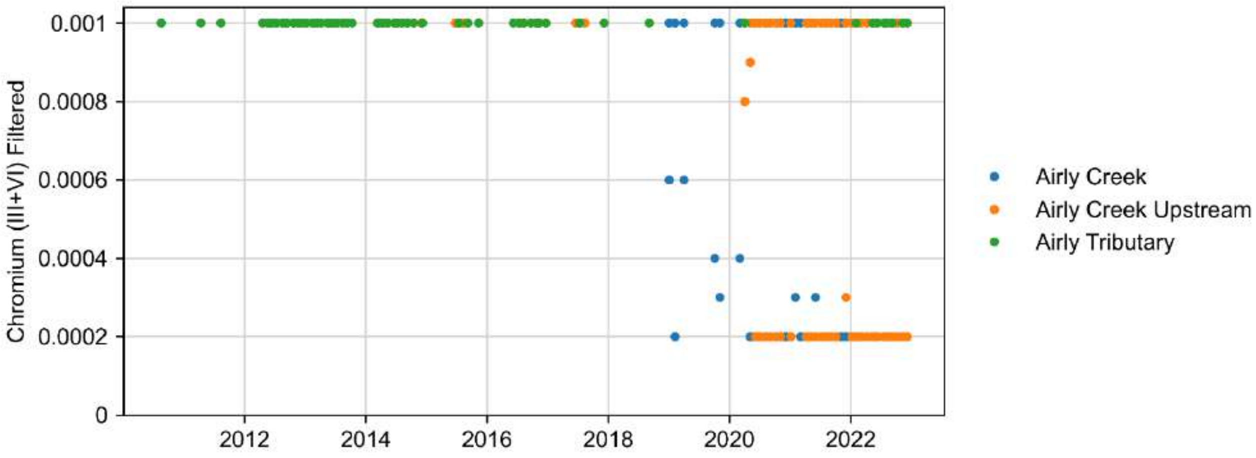
Boron Filtered
10
8
6
4
2
0
2012
2014
2016
2018
2020
2022
● Airly Creek
● Airly Creek Upstream
● Airly Tributary

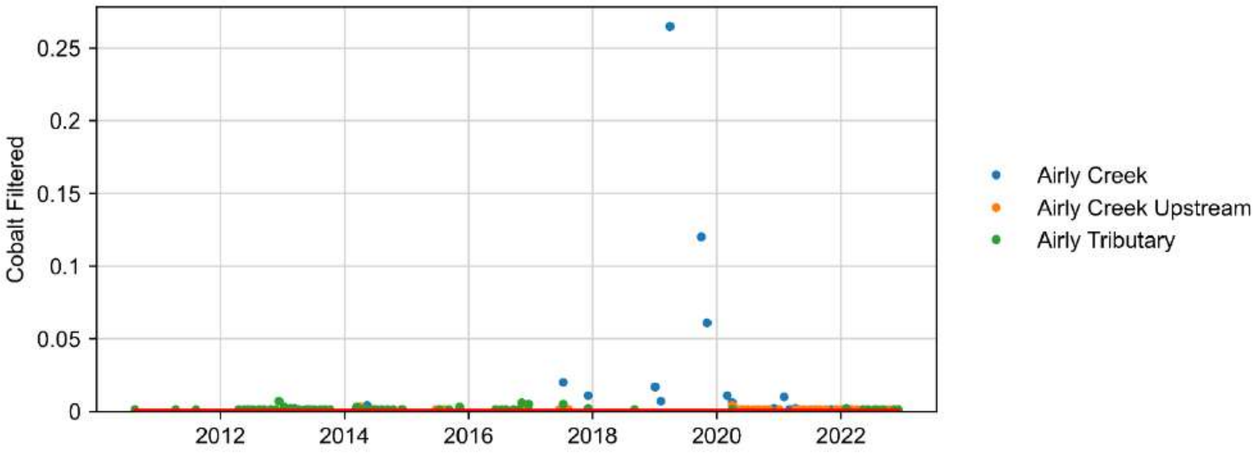


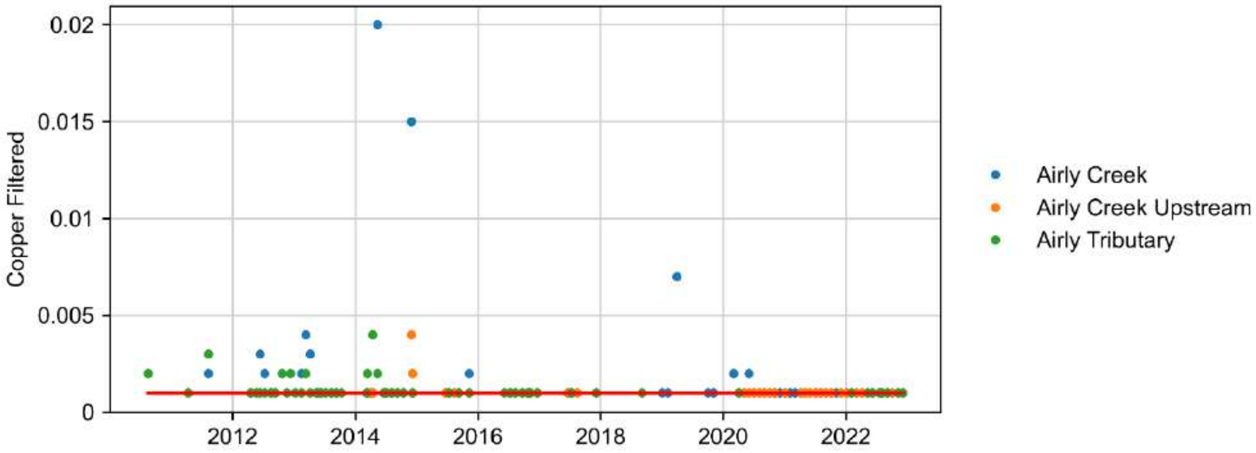
Cadmium Filtered
0.003
0.0025
0.002
0.0015
0.001
0.0005
0
2012
2014
2016
2018
2020
2022
● Airly Creek
● Airly Creek Upstream
● Airly Tributary

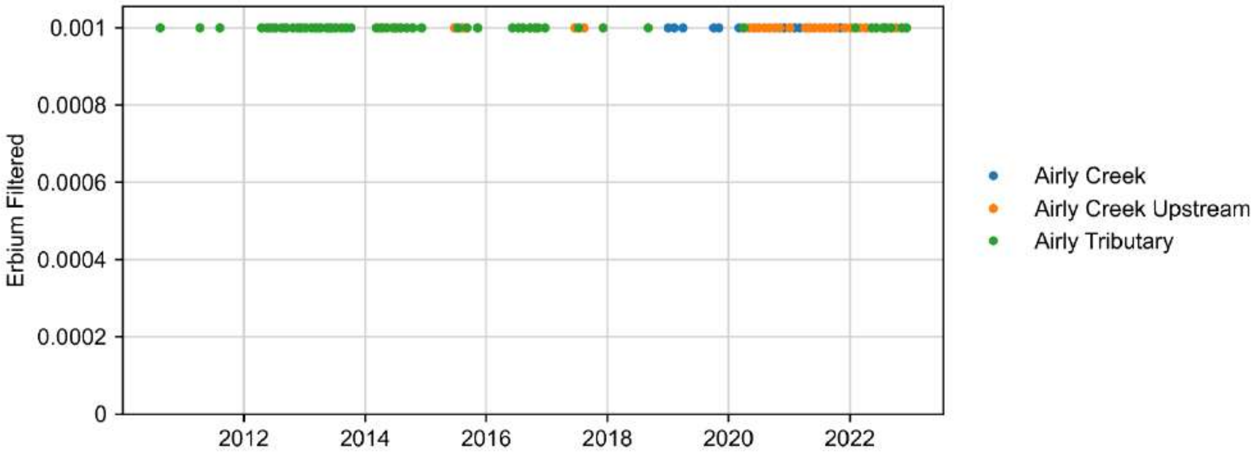


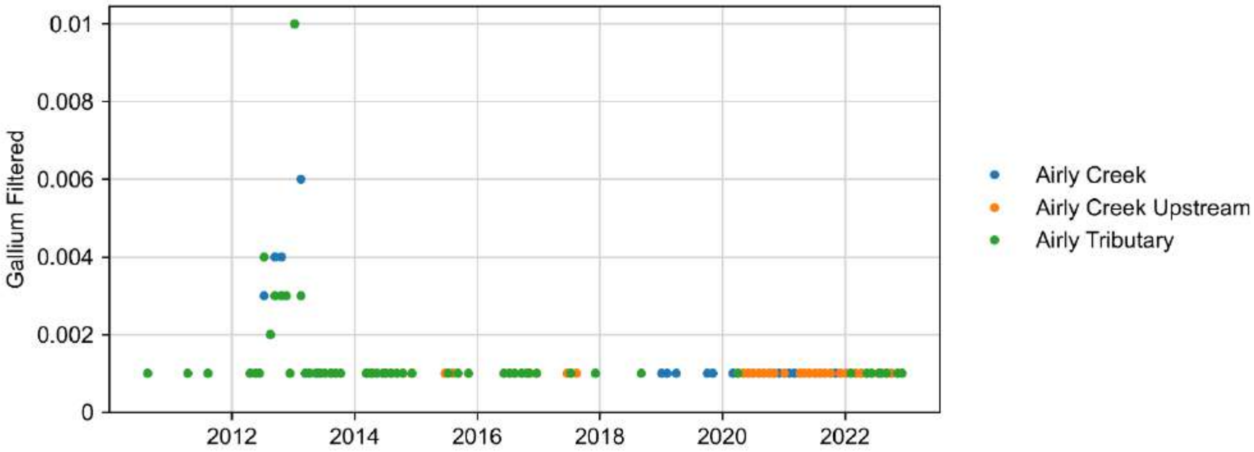
Cerium Filtered
0.012
0.01
0.008
0.006
0.004
0.002
0
2012
2014
2016
2018
2020
2022
● Airly Creek
● Airly Creek Upstream
● Airly Tributary

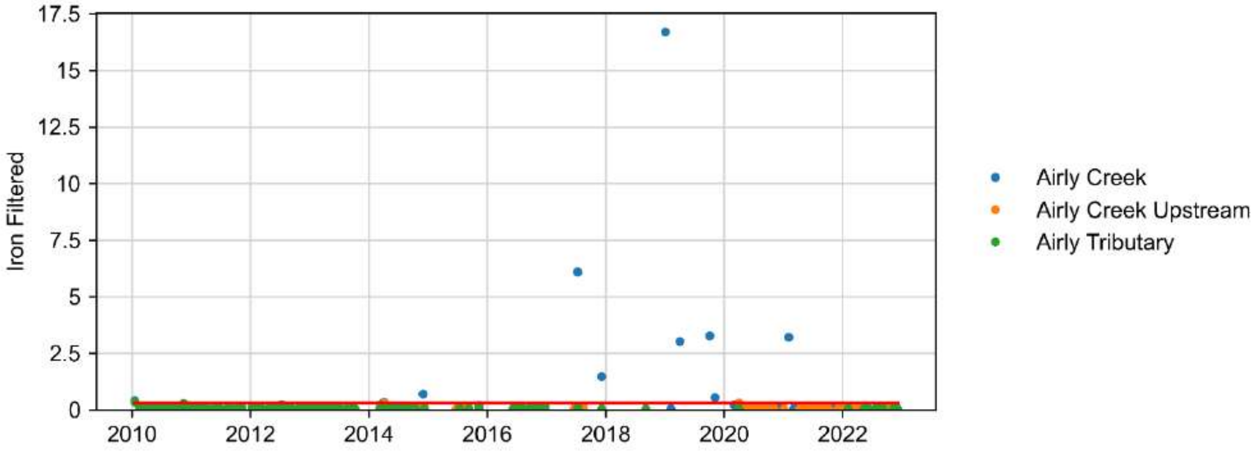

Chromium (III+VI) Filtered
0.001
0.0008
0.0006
0.0004
0.0002
0
2012
2014
2016
2018
2020
2022
Airly Creek
Airly Creek Upstream
Airly Tributary

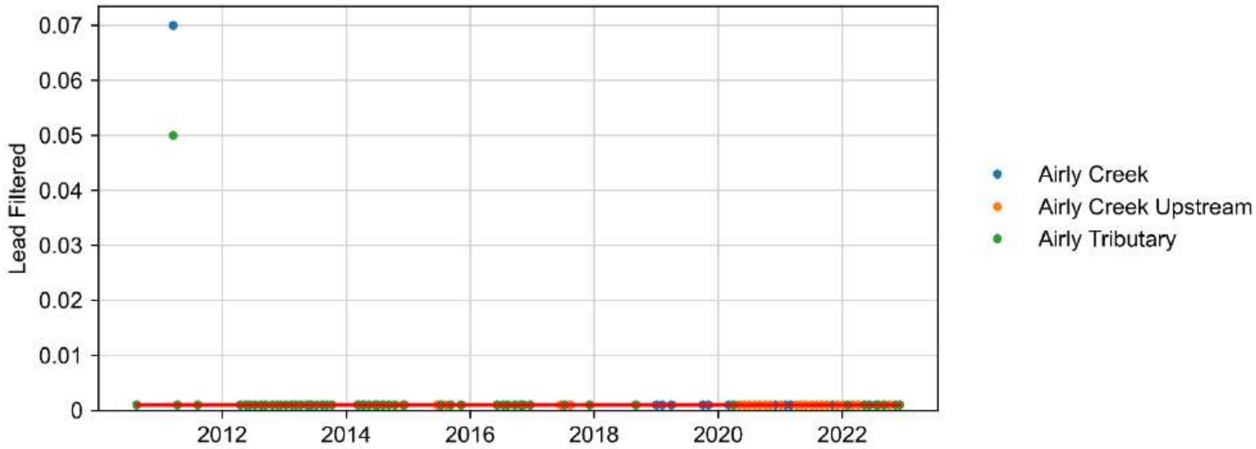

Cobalt Filtered
0.25
0.2
0.15
0.1
0.05
0
2012
2014
2016
2018
2020
2022
Airly Creek
Airly Creek Upstream
Airly Tributary

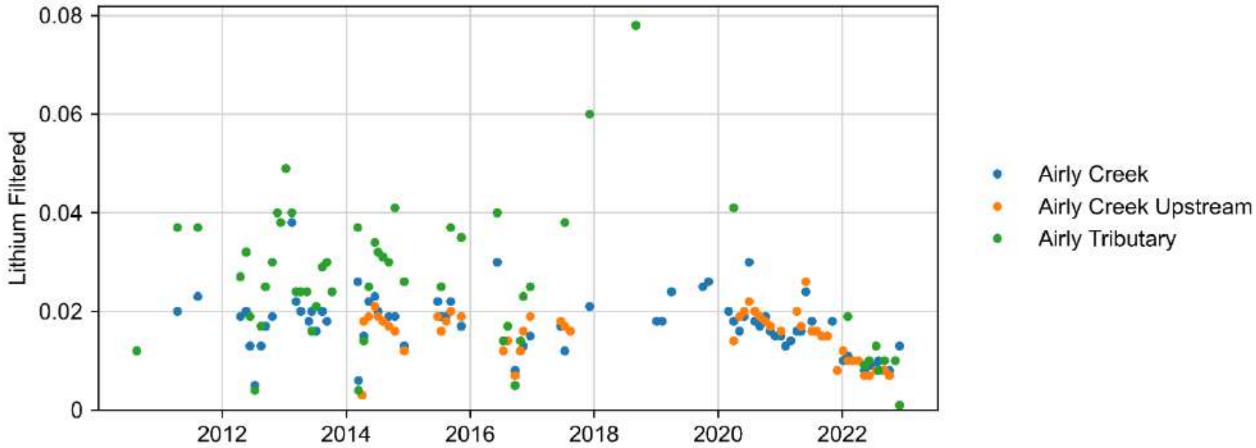

Copper Filtered
0.02
0.015
0.01
0.005
0
2012
2014
2016
2018
2020
2022
Airly Creek
Airly Creek Upstream
Airly Tributary

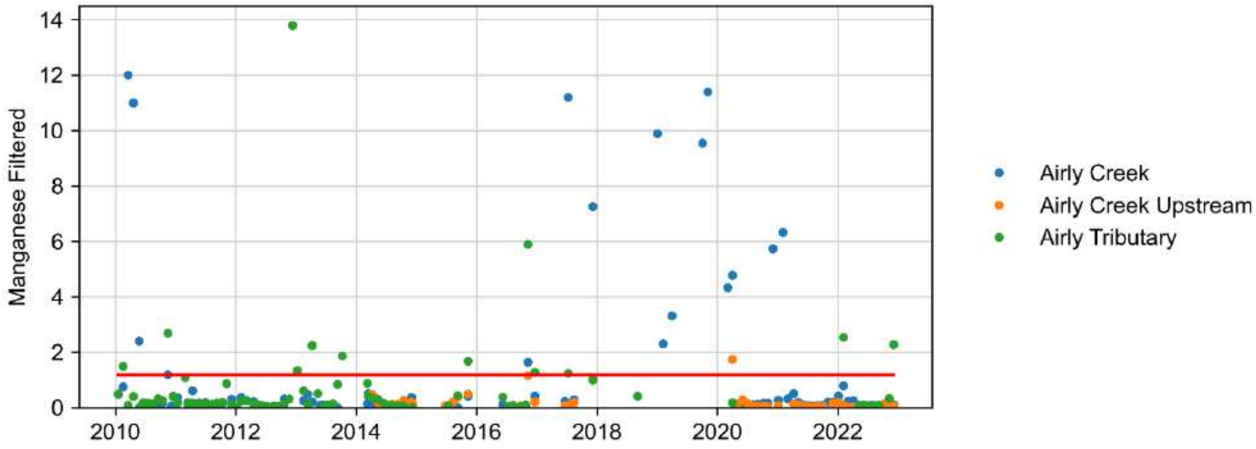

Erbium Filtered
0.001
0.0008
0.0006
0.0004
0.0002
0
2012
2014
2016
2018
2020
2022
Airly Creek
Airly Creek Upstream
Airly Tributary

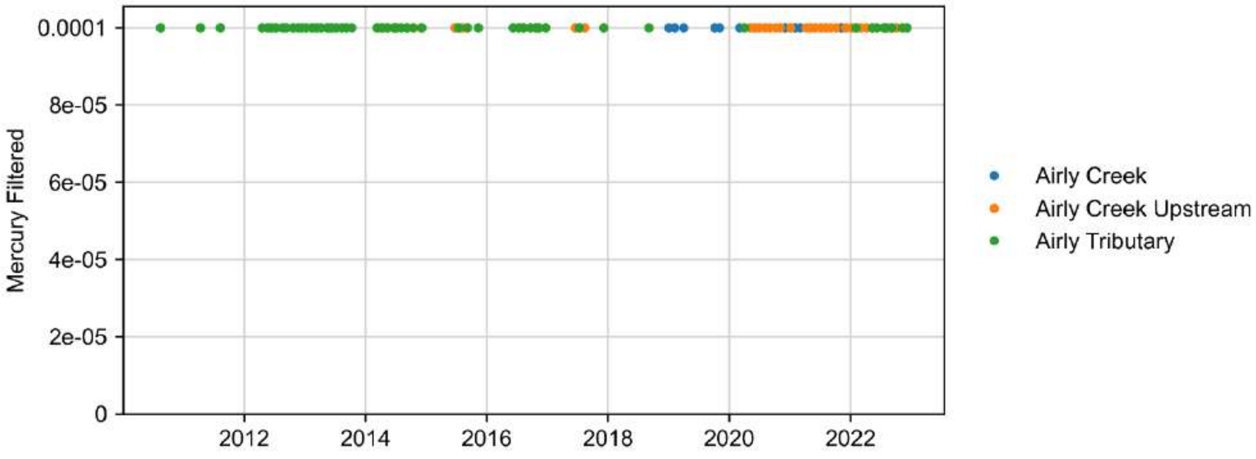

Gallium Filtered
0.01
0.008
0.006
0.004
0.002
0
2012
2014
2016
2018
2020
2022
Airly Creek
Airly Creek Upstream
Airly Tributary

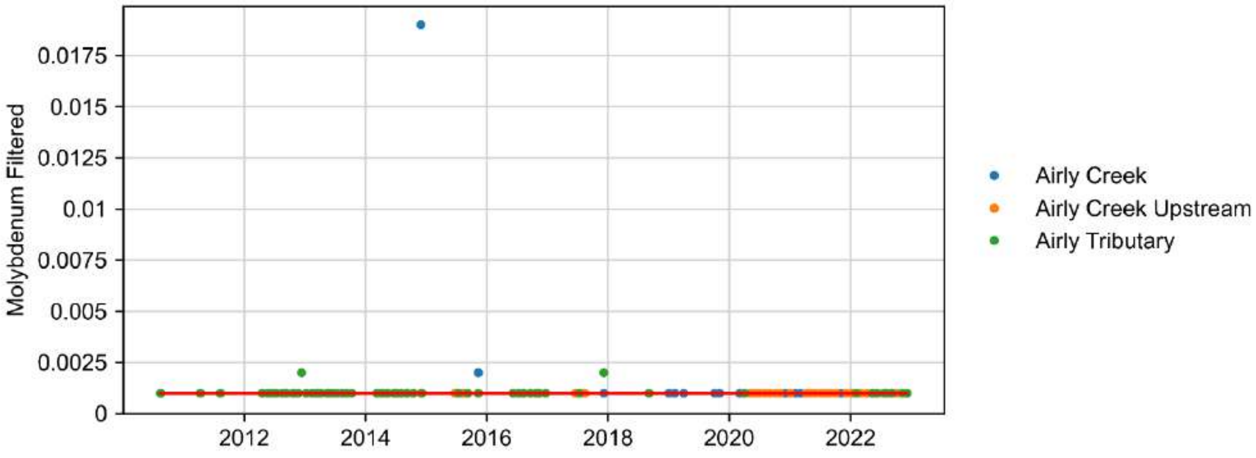

Iron Filtered
17.5
15
12.5
10
7.5
5
2.5
0
2010
2012
2014
2016
2018
2020
2022
Airly Creek
Airly Creek Upstream
Airly Tributary

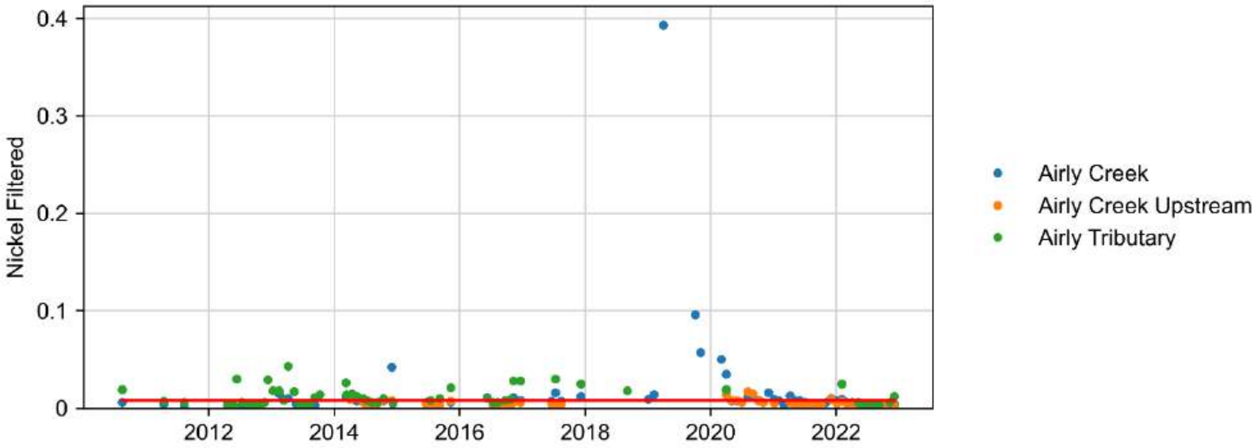

Lead Filtered
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
2012
2014
2016
2018
2020
2022
● Airly Creek
● Airly Creek Upstream
● Airly Tributary

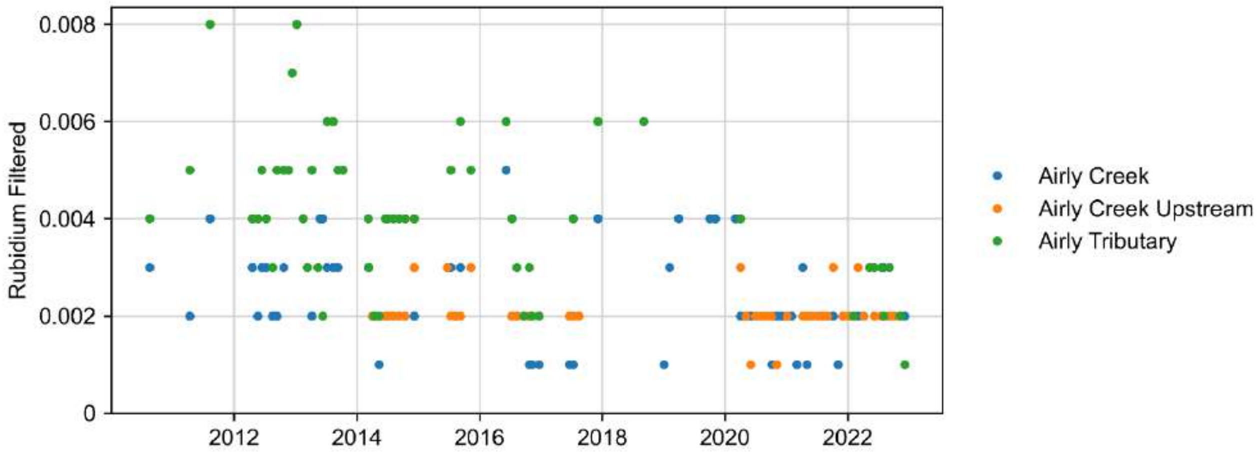

Lithium Filtered
0.08
0.06
0.04
0.02
0
2012
2014
2016
2018
2020
2022
● Airly Creek
● Airly Creek Upstream
● Airly Tributary

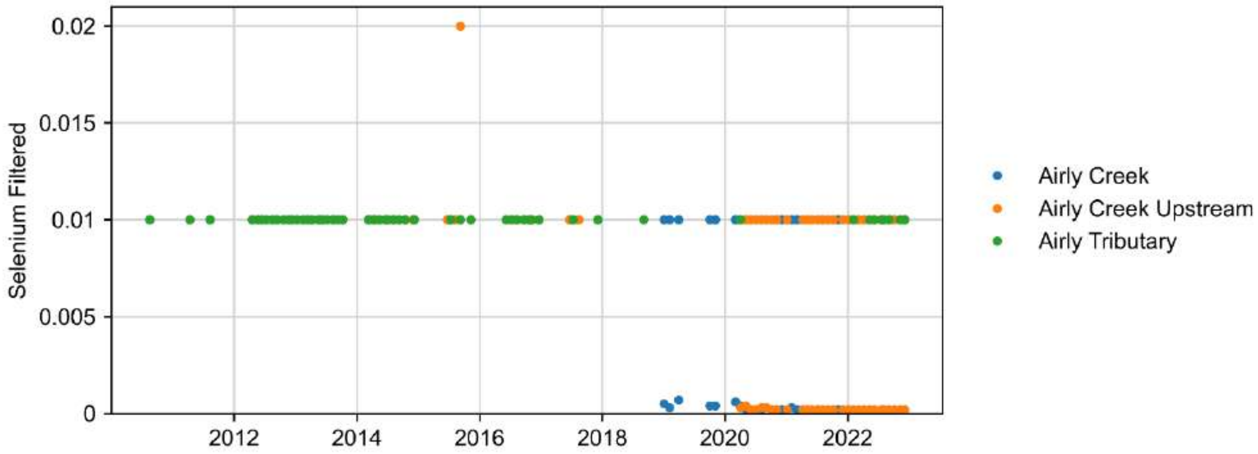

Manganese Filtered
14
12
10
8
6
4
2
0
2010
2012
2014
2016
2018
2020
2022
● Airly Creek
● Airly Creek Upstream
● Airly Tributary

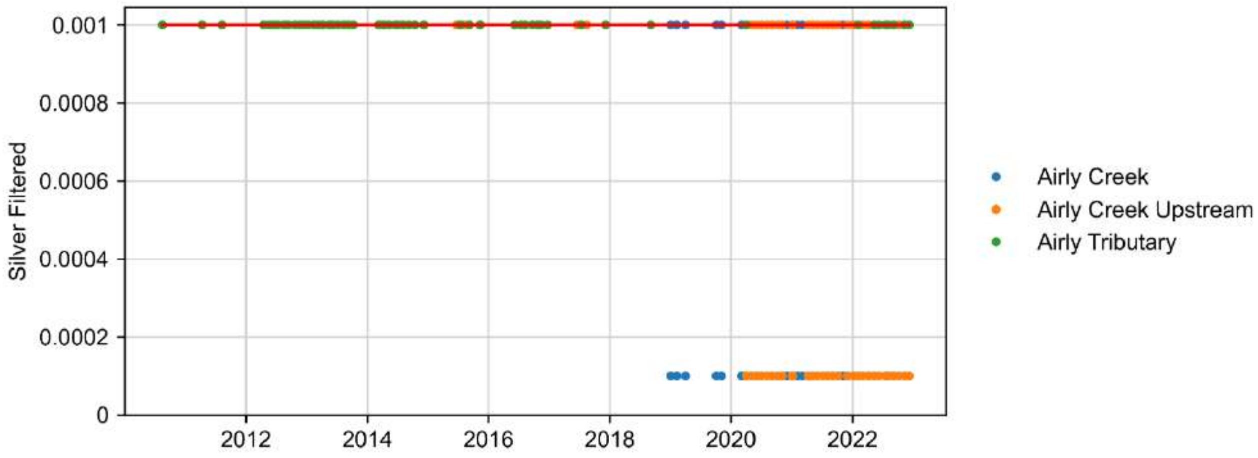

Mercury Filtered
0.0001
8e-05
6e-05
4e-05
2e-05
0
2012
2014
2016
2018
2020
2022
Airly Creek
Airly Creek Upstream
Airly Tributary

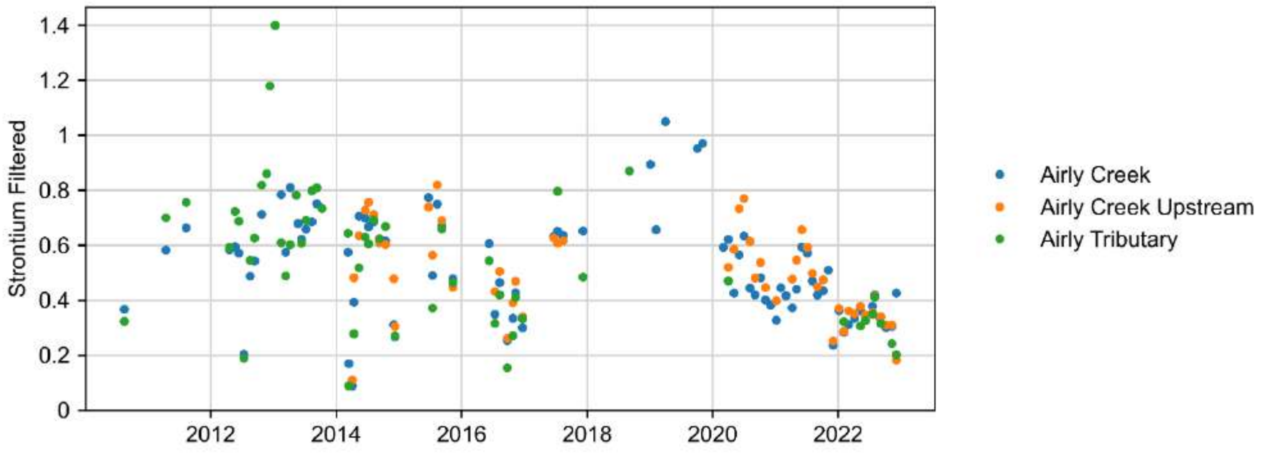

Molybdenum Filtered
0.0175
0.015
0.0125
0.01
0.0075
0.005
0.0025
0
2012
2014
2016
2018
2020
2022
Airly Creek
Airly Creek Upstream
Airly Tributary

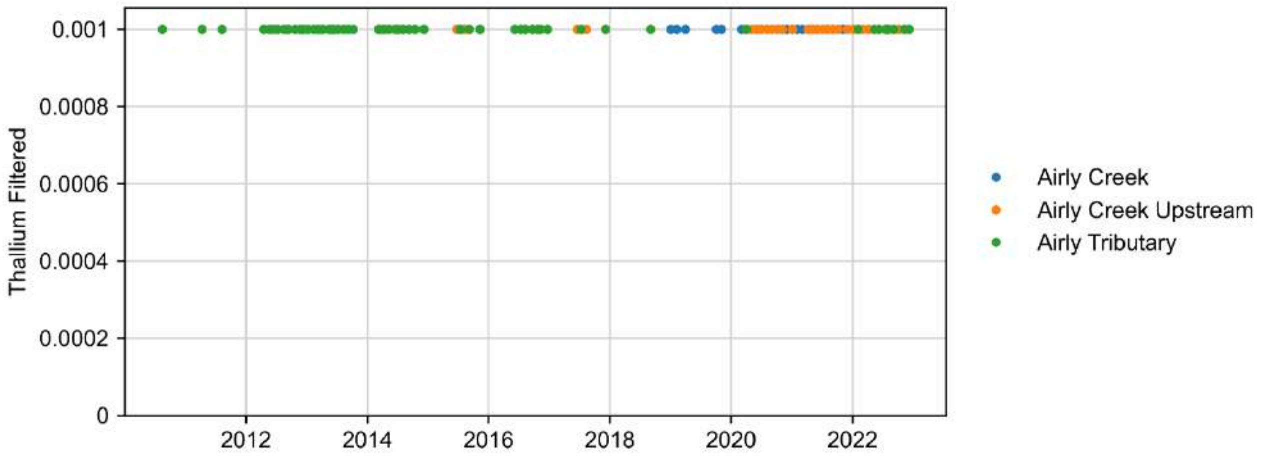

Nickel Filtered
0.4
0.3
0.2
0.1
0
2012
2014
2016
2018
2020
2022
Airly Creek
Airly Creek Upstream
Airly Tributary

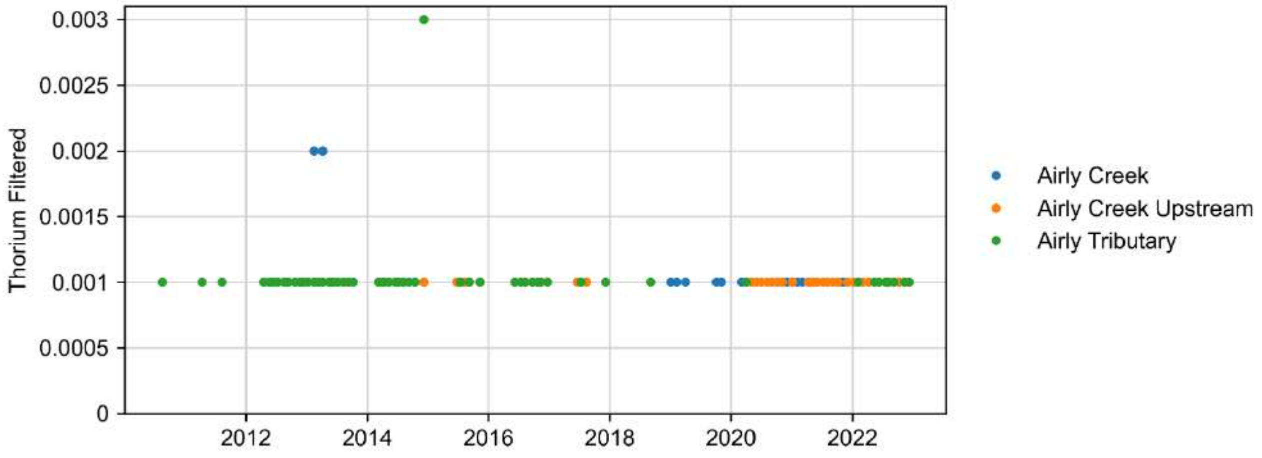

Rubidium Filtered
0.008
0.006
0.004
0.002
0
2012
2014
2016
2018
2020
2022
Airly Creek
Airly Creek Upstream
Airly Tributary

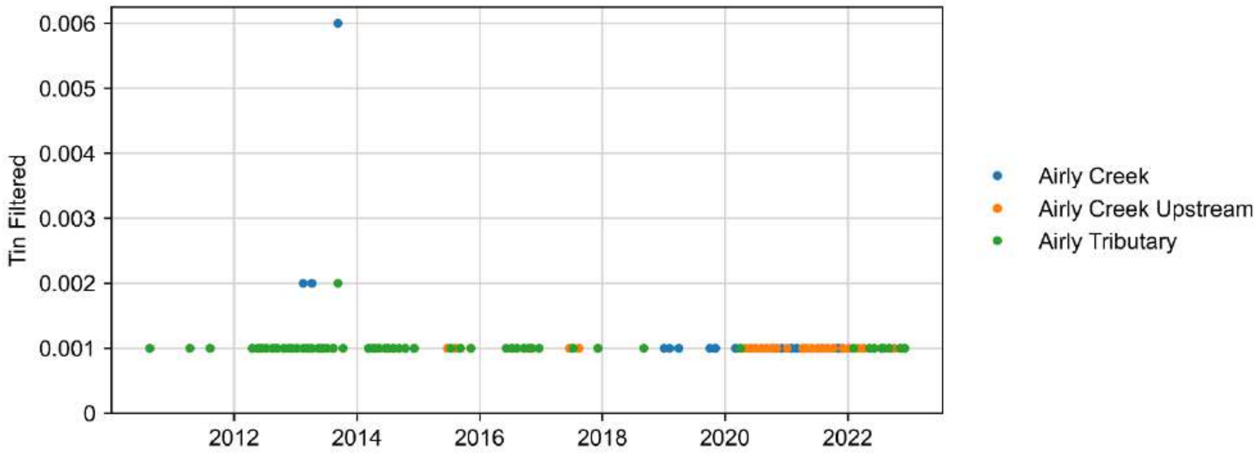

Selenium Filtered
0.02
0.015
0.01
0.005
0
2012
2014
2016
2018
2020
2022
Airly Creek
Airly Creek Upstream
Airly Tributary

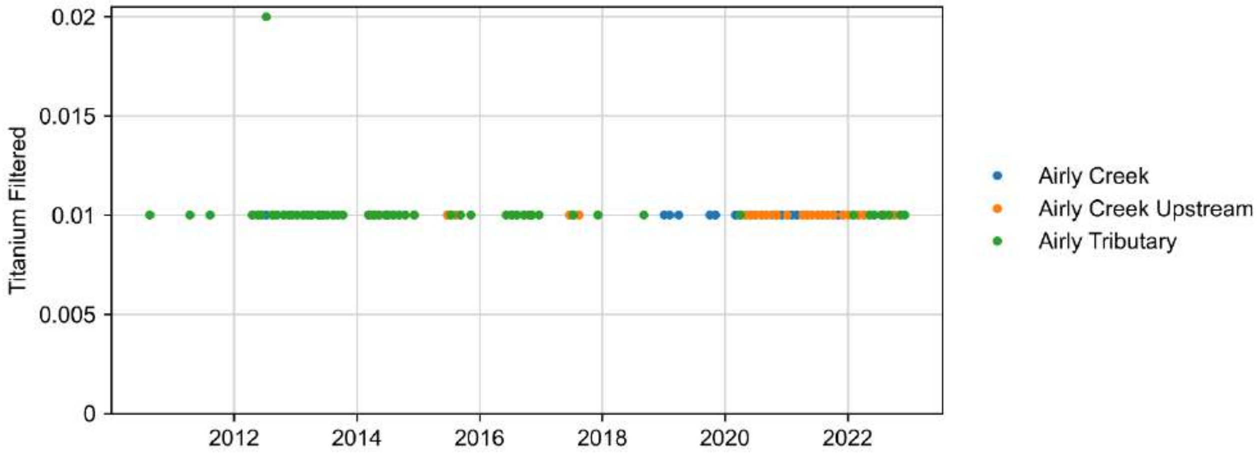

Silver Filtered
0.001
0.0008
0.0006
0.0004
0.0002
0
2012
2014
2016
2018
2020
2022
Airly Creek
Airly Creek Upstream
Airly Tributary

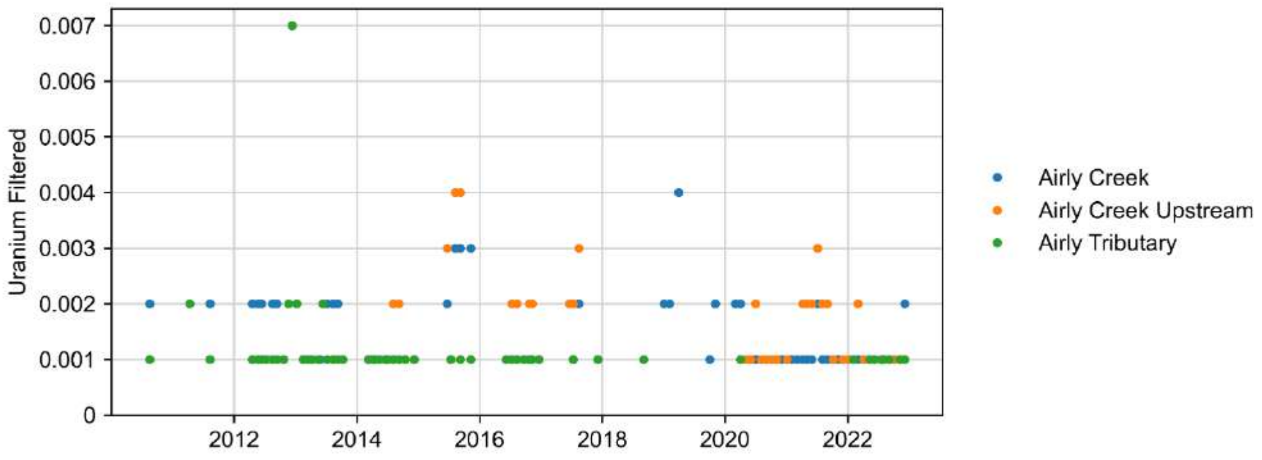

Strontium Filtered
1.4
1.2
1
0.8
0.6
0.4
0.2
0
2012
2014
2016
2018
2020
2022
● Airly Creek
● Airly Creek Upstream
● Airly Tributary

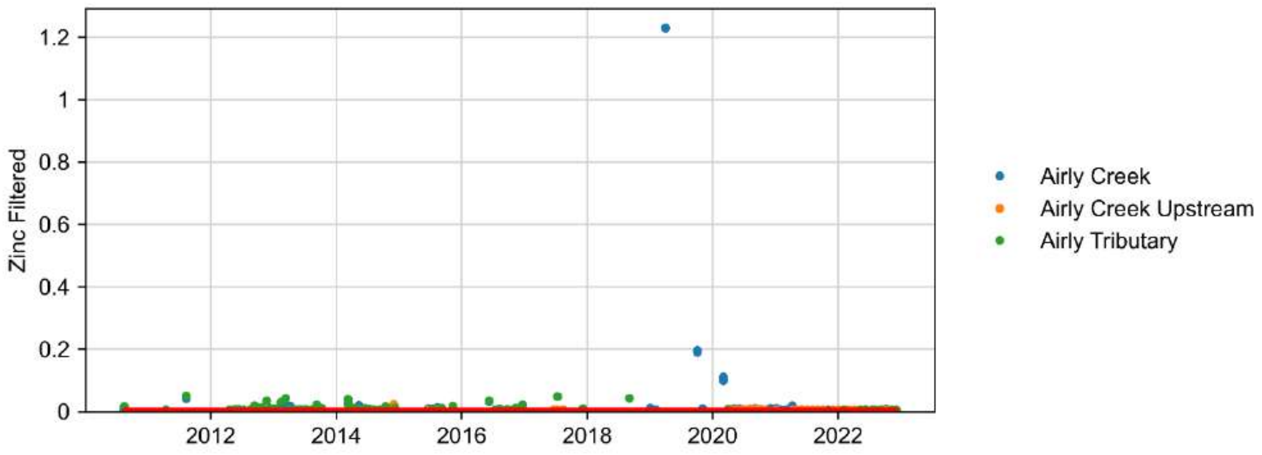

Thallium Filtered
0.001
0.0008
0.0006
0.0004
0.0002
0
2012
2014
2016
2018
2020
2022
● Airly Creek
● Airly Creek Upstream
● Airly Tributary


Thorium Filtered
0.003
0.0025
0.002
0.0015
0.001
0.0005
0
2012
2014
2016
2018
2020
2022
● Airly Creek
● Airly Creek Upstream
● Airly Tributary

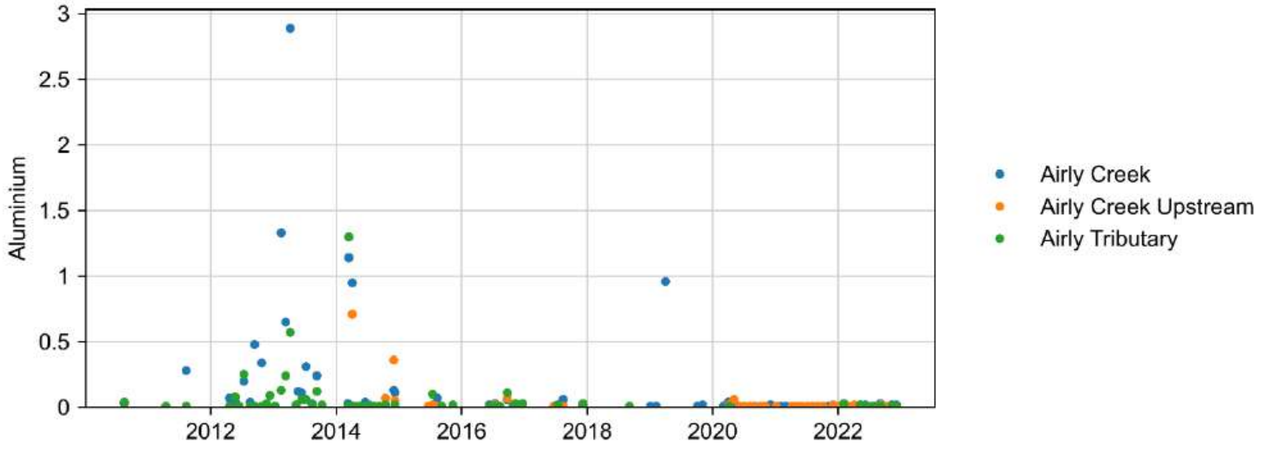

0.006
0.005
0.004
0.003
0.002
0.001
0
Tin Filtered
2012
2014
2016
2018
2020
2022
● Airly Creek
● Airly Creek Upstream
● Airly Tributary

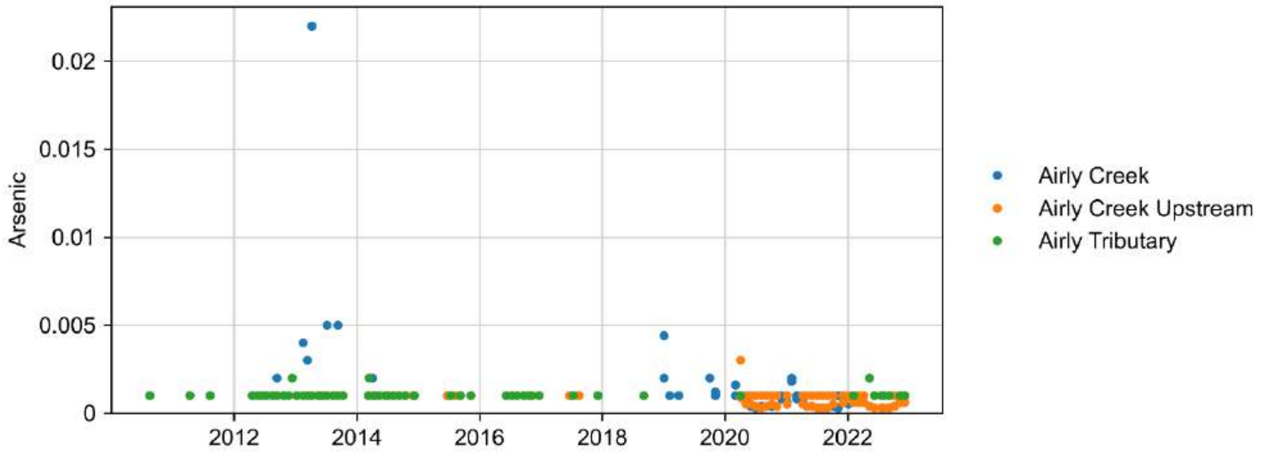

0.02
0.015
0.01
0.005
0
Titanium Filtered
2012
2014
2016
2018
2020
2022
● Airly Creek
● Airly Creek Upstream
● Airly Tributary

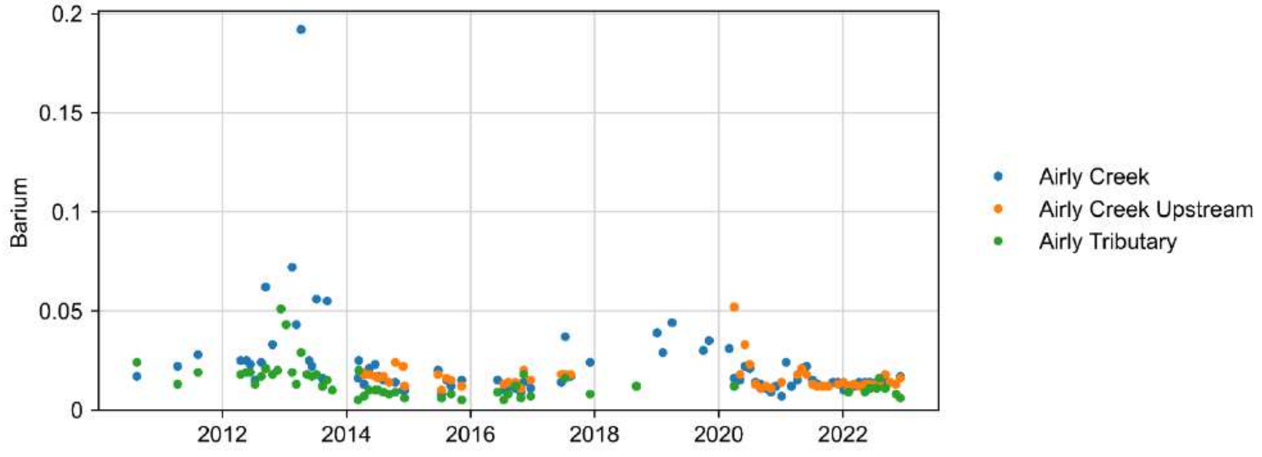

Uranium Filtered
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
2012
2014
2016
2018
2020
2022
Airly Creek
Airly Creek Upstream
Airly Tributary

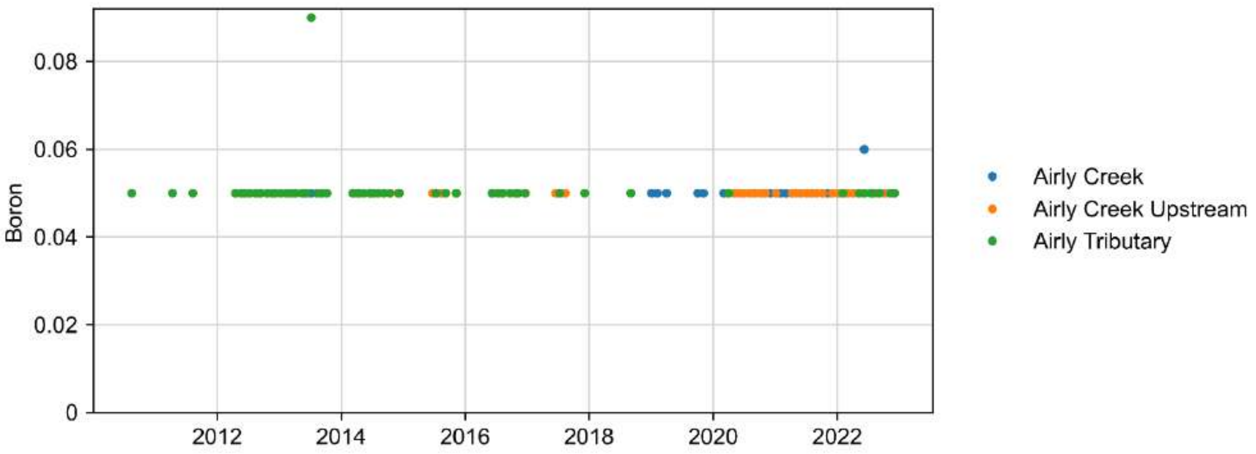

Zinc Filtered
1.2
1
0.8
0.6
0.4
0.2
0
2012
2014
2016
2018
2020
2022
Airly Creek
Airly Creek Upstream
Airly Tributary

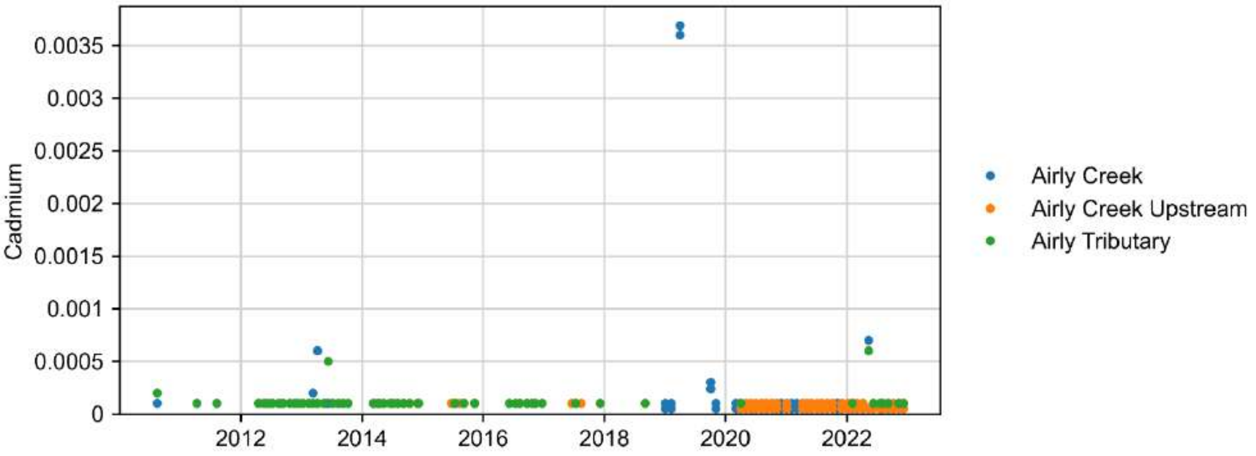
Total metals

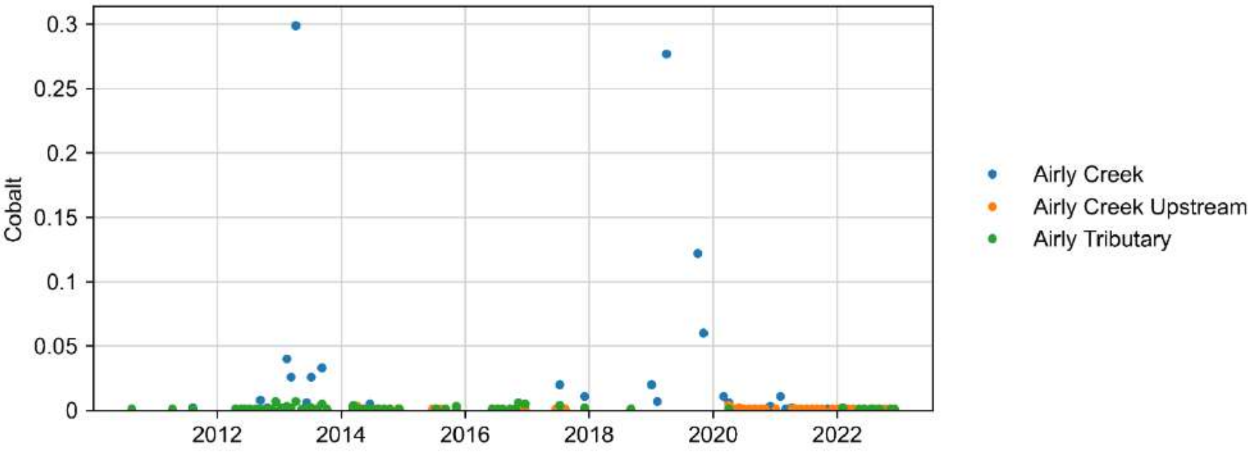


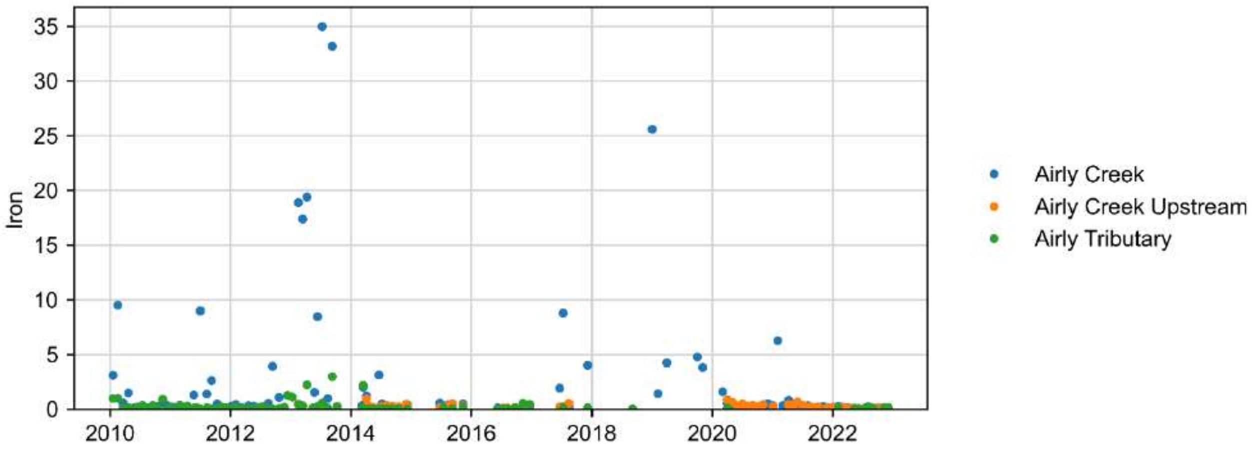


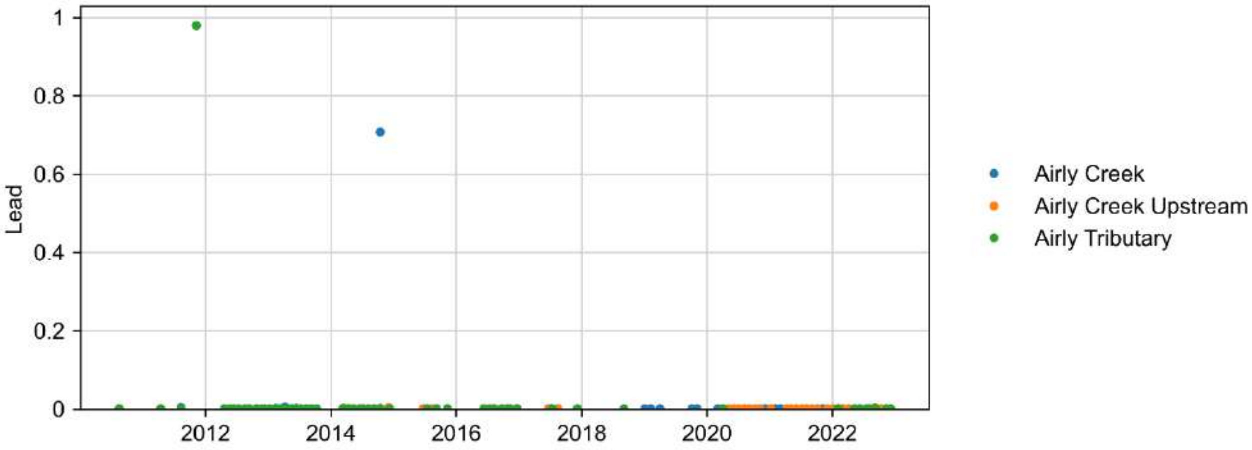


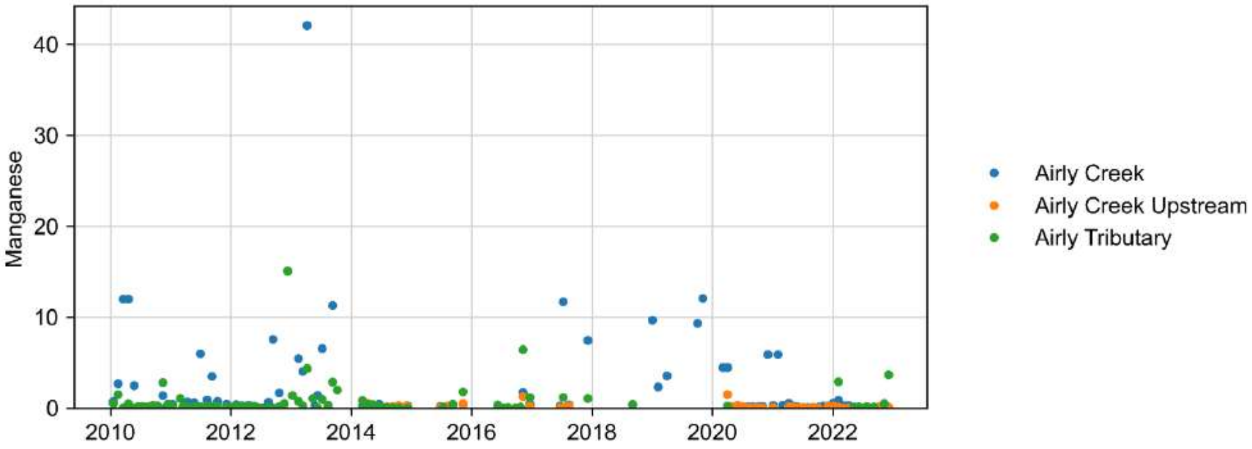

Boron
0.08
0.06
0.04
0.02
0
2012
2014
2016
2018
2020
2022
Airly Creek
Airly Creek Upstream
Airly Tributary

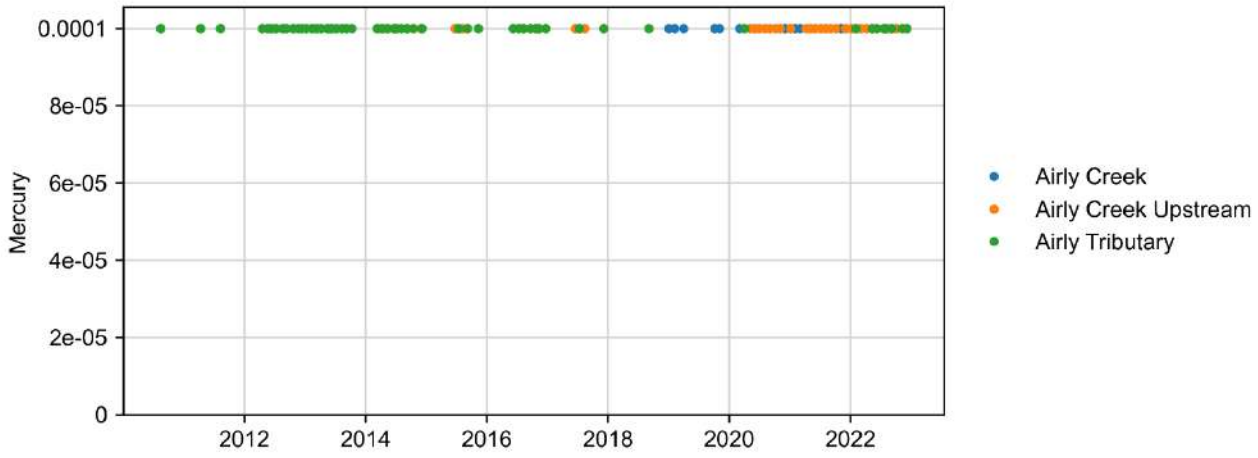

Cadmium
0.0035
0.003
0.0025
0.002
0.0015
0.001
0.0005
0
2012
2014
2016
2018
2020
2022
Airly Creek
Airly Creek Upstream
Airly Tributary

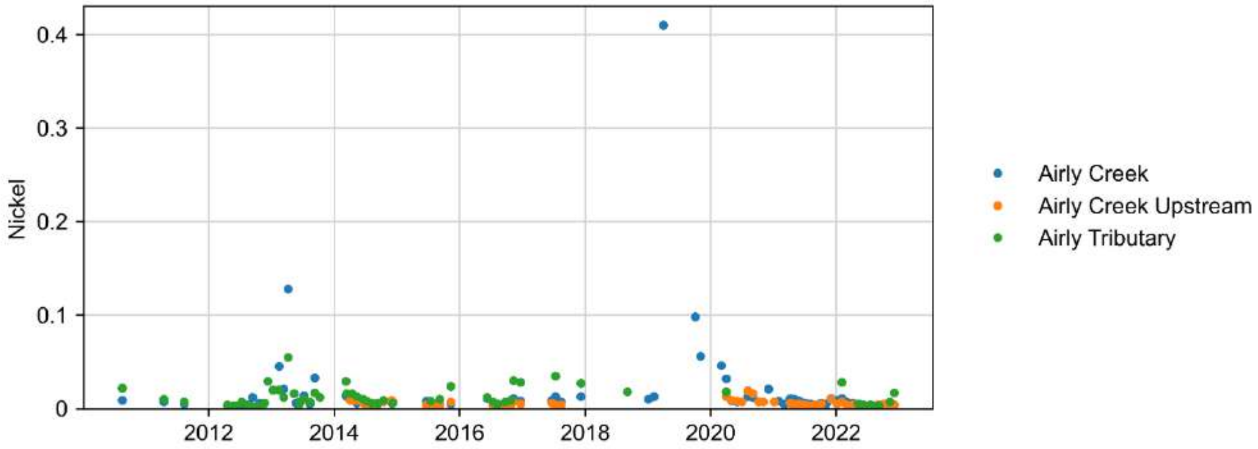

Cobalt
0.3
0.25
0.2
0.15
0.1
0.05
0
2012
2014
2016
2018
2020
2022
Airly Creek
Airly Creek Upstream
Airly Tributary

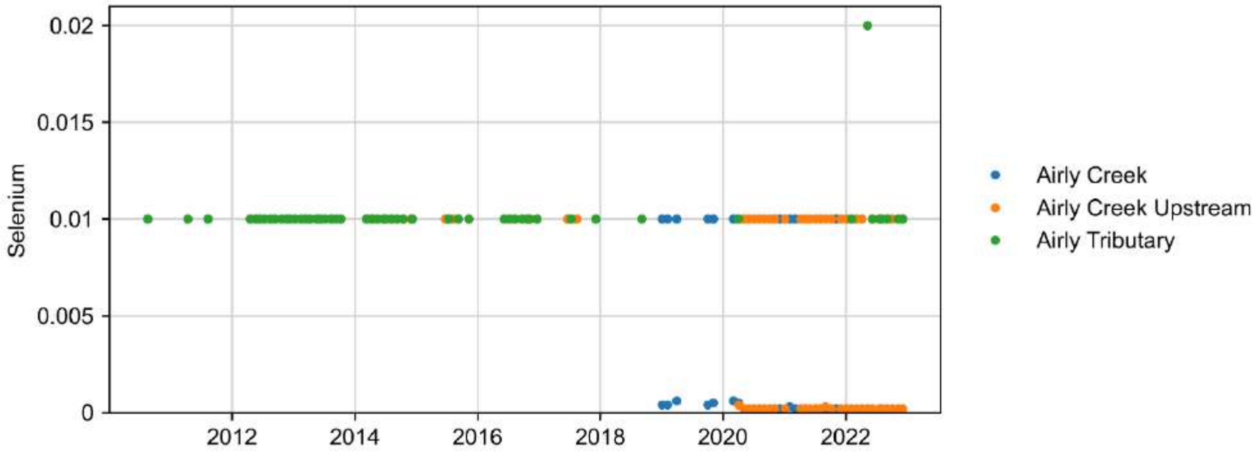

Iron
0
5
10
15
20
25
30
35
2010
2012
2014
2016
2018
2020
2022
● Airly Creek
● Airly Creek Upstream
● Airly Tributary

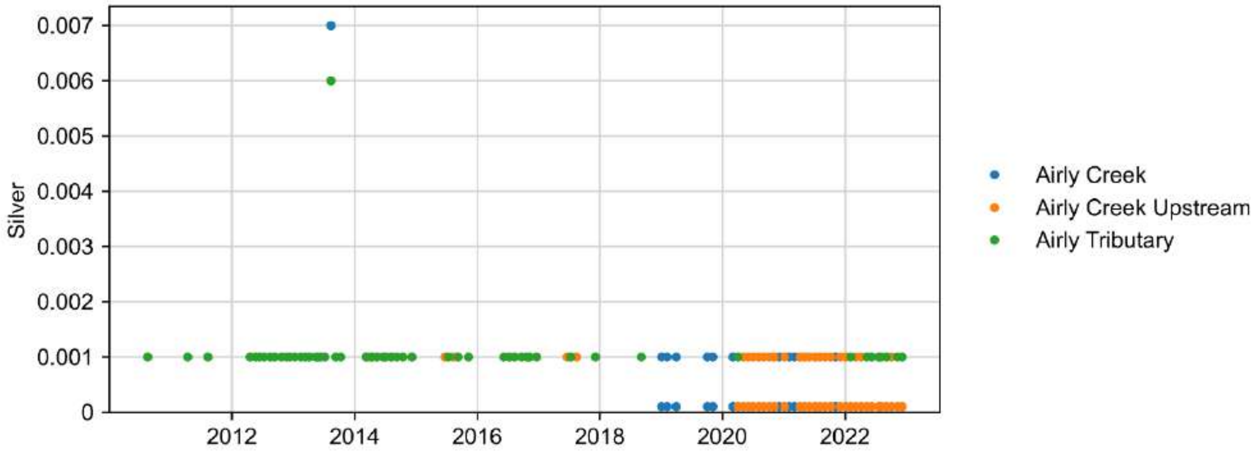

Lead
0
0.2
0.4
0.6
0.8
1
2012
2014
2016
2018
2020
2022
● Airly Creek
● Airly Creek Upstream
● Airly Tributary

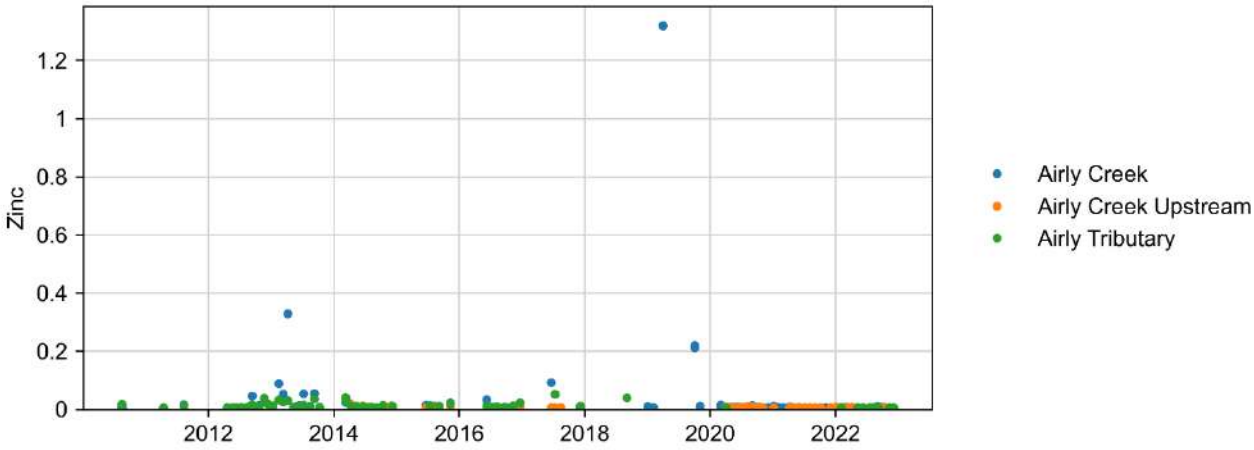

Manganese
0
10
20
30
40
2010
2012
2014
2016
2018
2020
2022
● Airly Creek
● Airly Creek Upstream
● Airly Tributary


Mercury
0.0001
8e-05
6e-05
4e-05
2e-05
0
2012
2014
2016
2018
2020
2022
● Airly Creek
● Airly Creek Upstream
● Airly Tributary

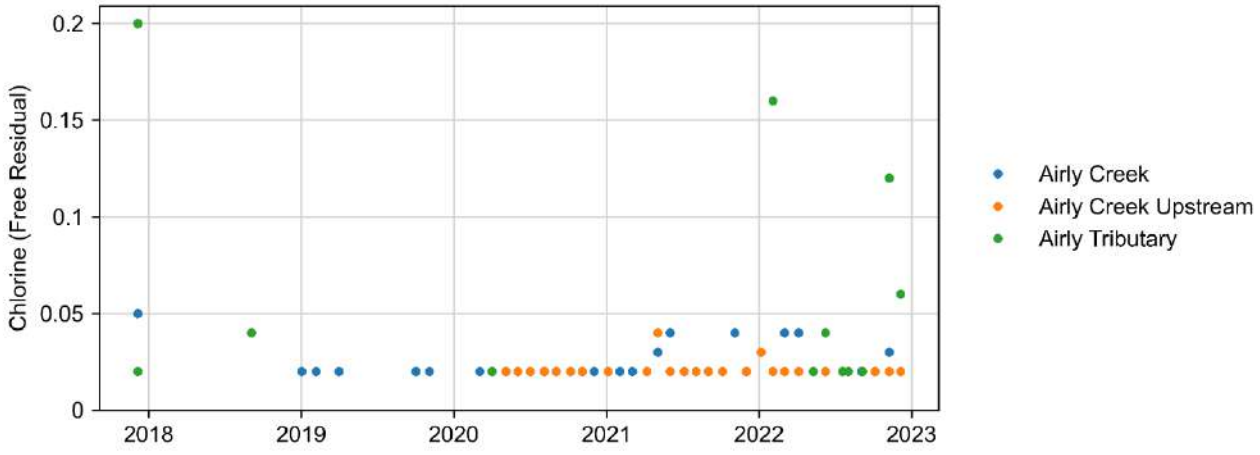

Nickel
0.4
0.3
0.2
0.1
0
2012
2014
2016
2018
2020
2022
● Airly Creek
● Airly Creek Upstream
● Airly Tributary

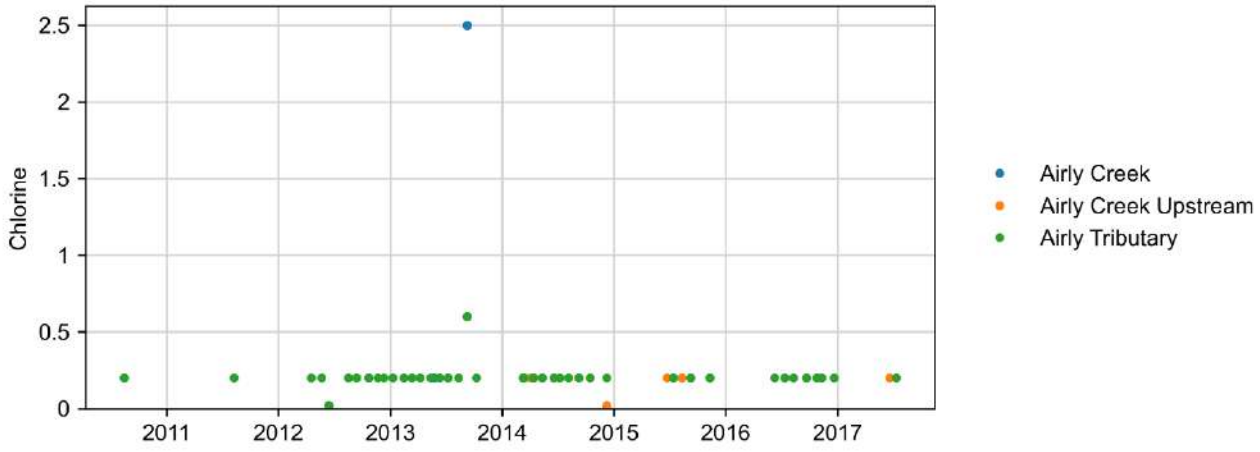

Selenium
0.02
0.015
0.01
0.005
0
2012
2014
2016
2018
2020
2022
● Airly Creek
● Airly Creek Upstream
● Airly Tributary

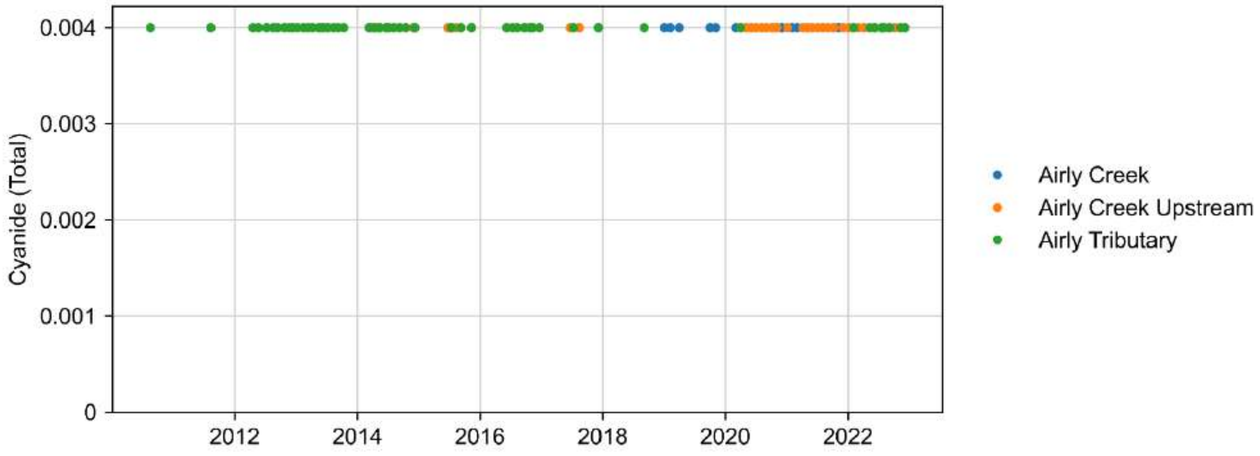

Silver
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
2012
2014
2016
2018
2020
2022
Airly Creek
Airly Creek Upstream
Airly Tributary

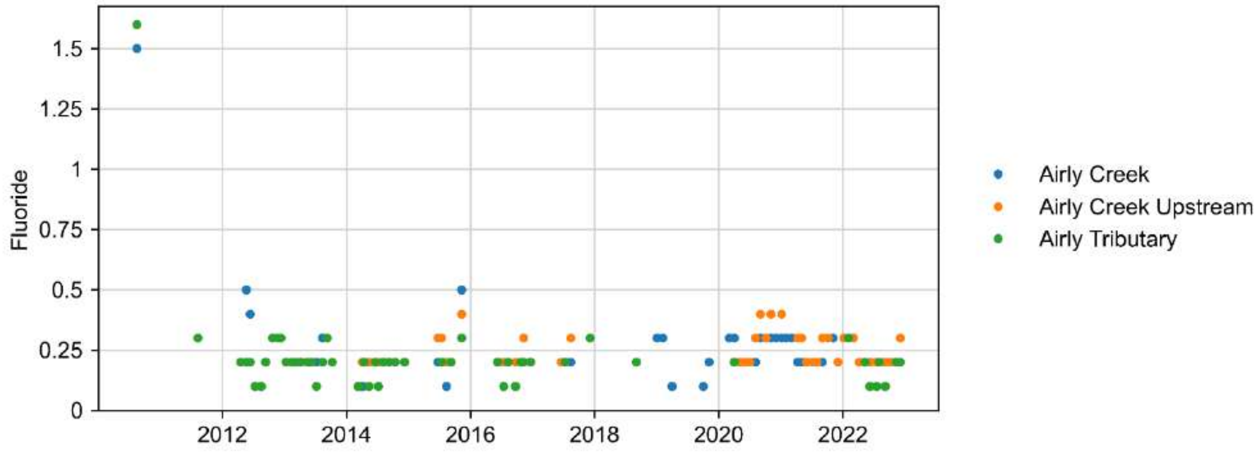

Zinc
1.2
1
0.8
0.6
0.4
0.2
0
2012
2014
2016
2018
2020
2022
Airly Creek
Airly Creek Upstream
Airly Tributary

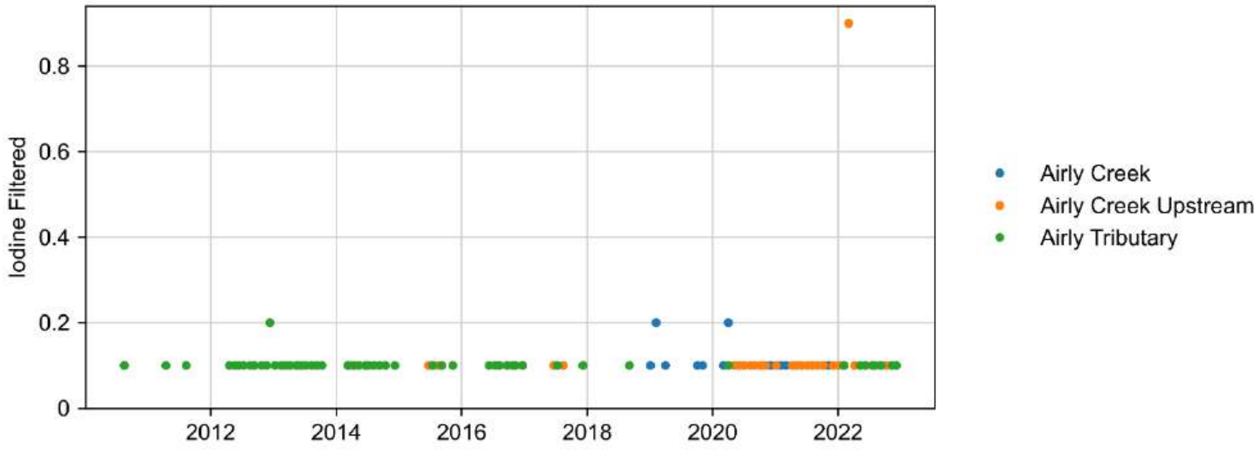
Other

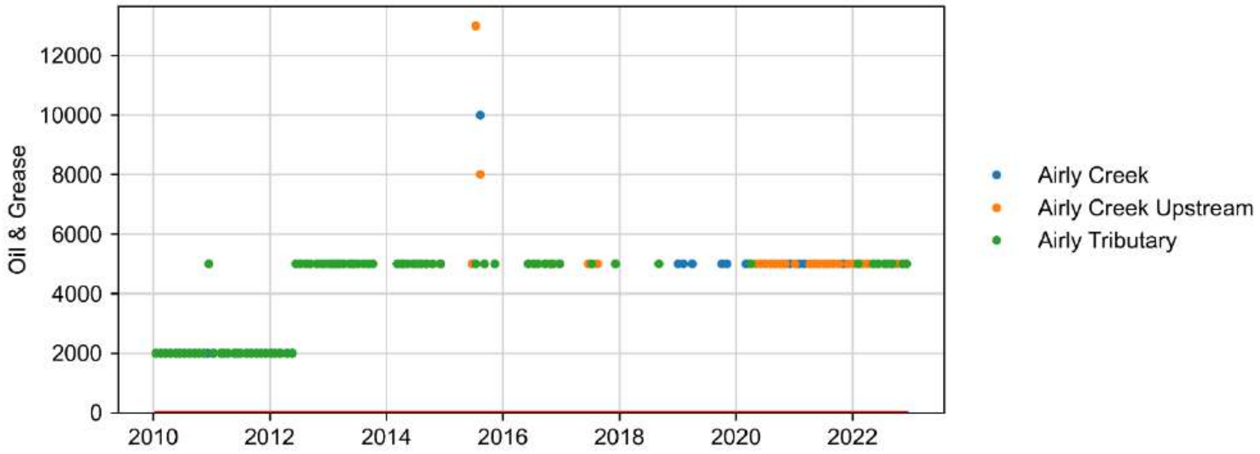

Chlorine (Free Residual)
0.2
0.15
0.1
0.05
0
2018
2019
2020
2021
2022
2023
Airly Creek
Airly Creek Upstream
Airly Tributary

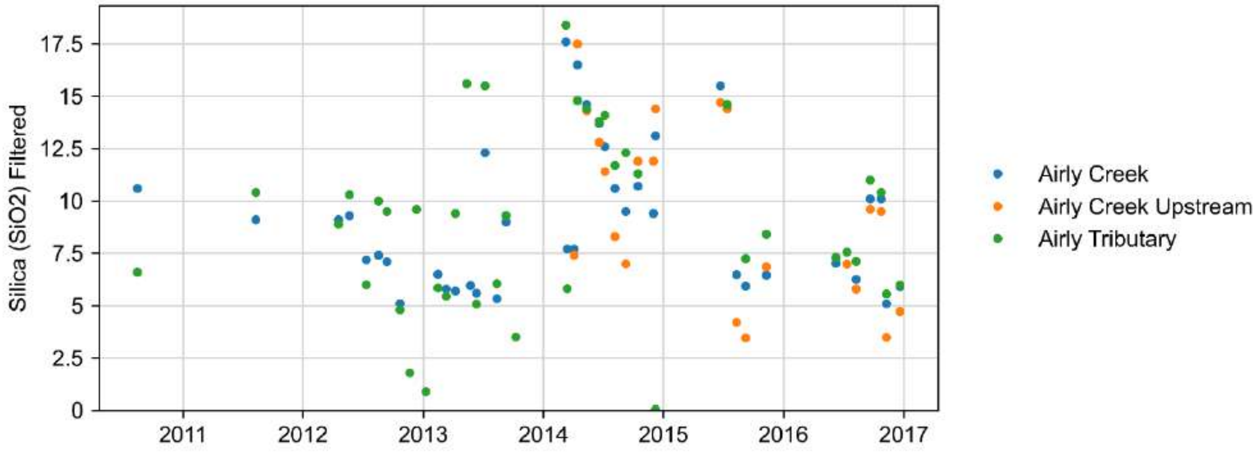

Chlorine
2.5
2
1.5
1
0.5
0
2011
2012
2013
2014
2015
2016
2017
Airly Creek
Airly Creek Upstream
Airly Tributary

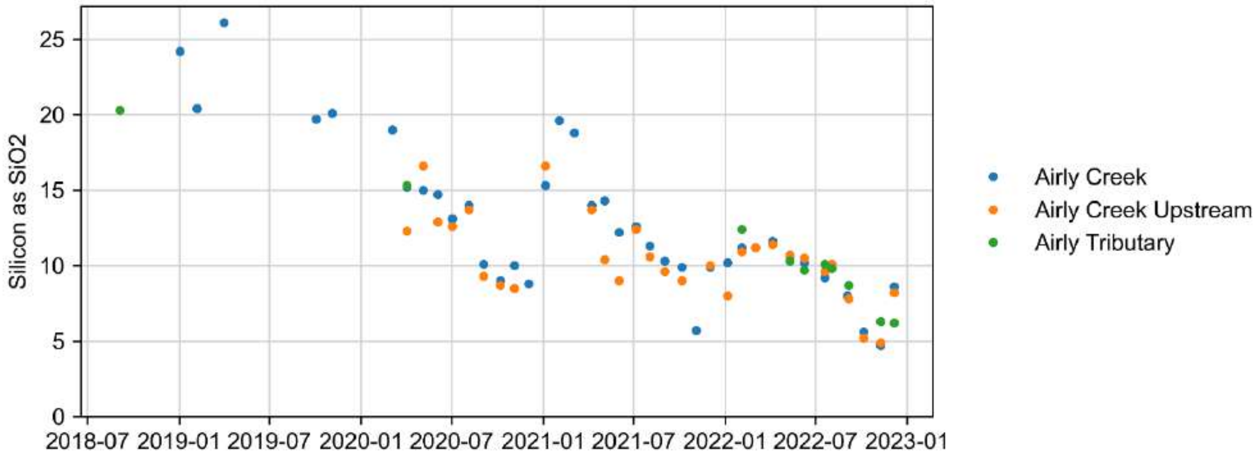

Cyanide (Total)
0.004
0.003
0.002
0.001
0
2012
2014
2016
2018
2020
2022
Airly Creek
Airly Creek Upstream
Airly Tributary

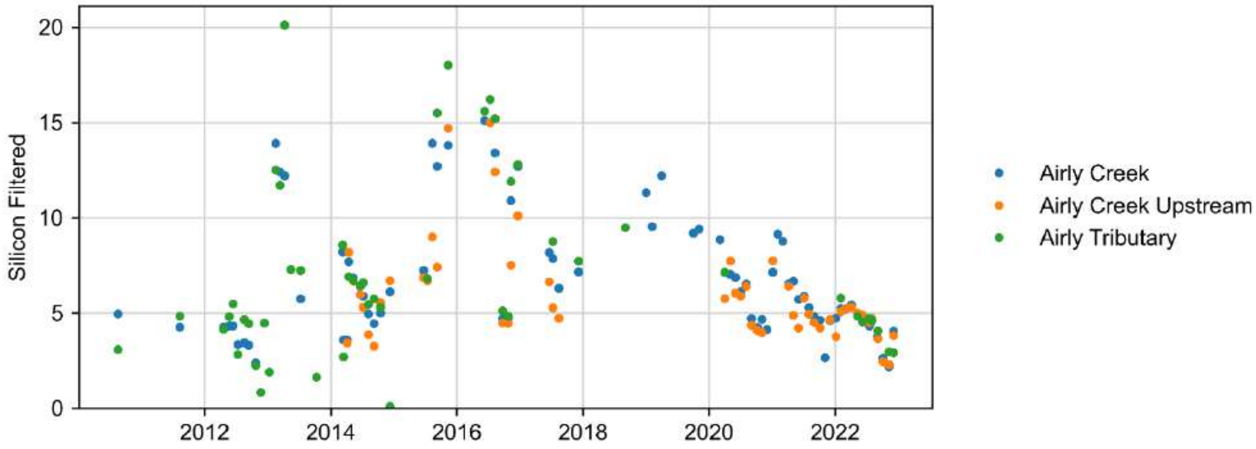

Fluoride
1.5
1.25
1
0.75
0.5
0.25
0
2012
2014
2016
2018
2020
2022
● Airly Creek
● Airly Creek Upstream
● Airly Tributary


Iodine Filtered
0.8
0.6
0.4
0.2
0
2012
2014
2016
2018
2020
2022
● Airly Creek
● Airly Creek Upstream
● Airly Tributary


Oil & Grease
12000
10000
8000
6000
4000
2000
0
2010
2012
2014
2016
2018
2020
2022
● Airly Creek
● Airly Creek Upstream
● Airly Tributary

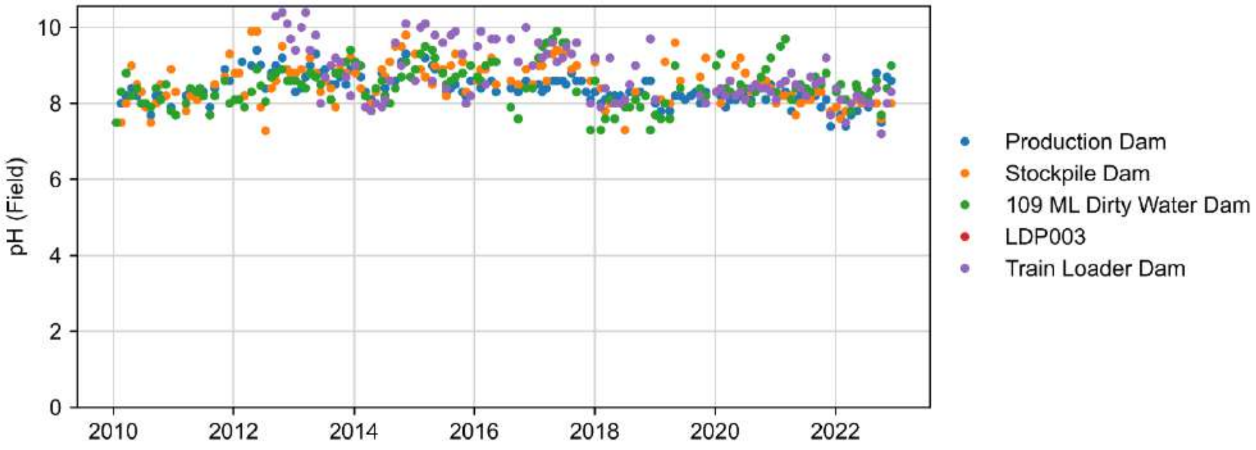

Silica (SiO2) Filtered
0
2.5
5
7.5
10
12.5
15
17.5
2011
2012
2013
2014
2015
2016
2017
● Airly Creek
● Airly Creek Upstream
● Airly Tributary

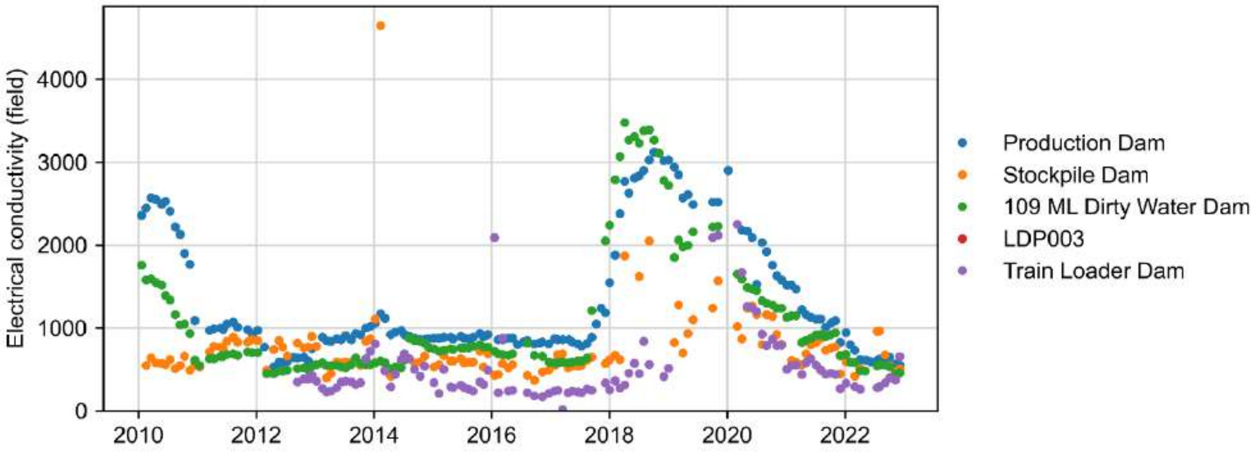

Silicon as SiO2
0
5
10
15
20
25
2018-07
2019-01
2019-07
2020-01
2020-07
2021-01
2021-07
2022-01
2022-07
2023-01
● Airly Creek
● Airly Creek Upstream
● Airly Tributary

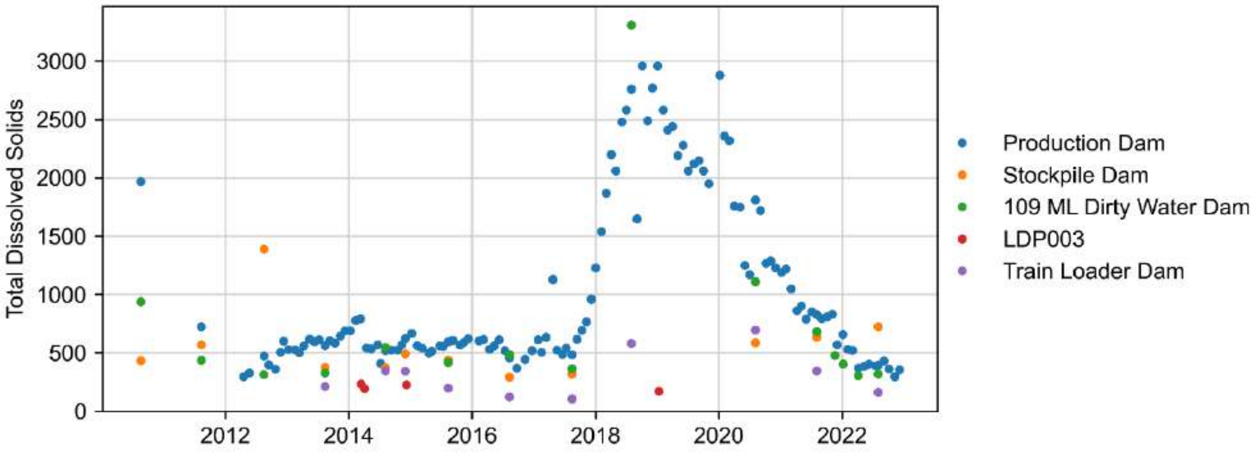

Silicon Filtered
0
5
10
15
20
2012
2014
2016
2018
2020
2022
● Airly Creek
● Airly Creek Upstream
● Airly Tributary

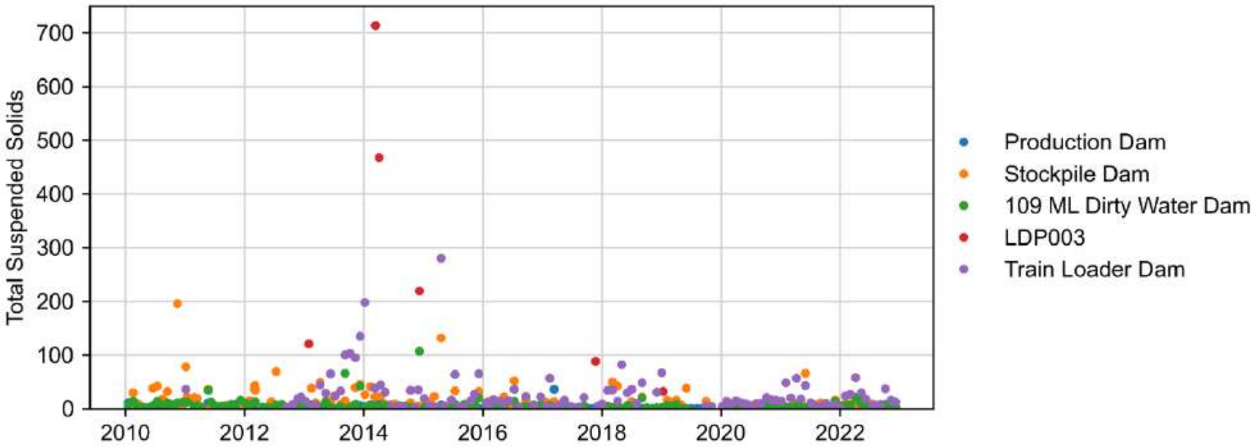
Dam water quality

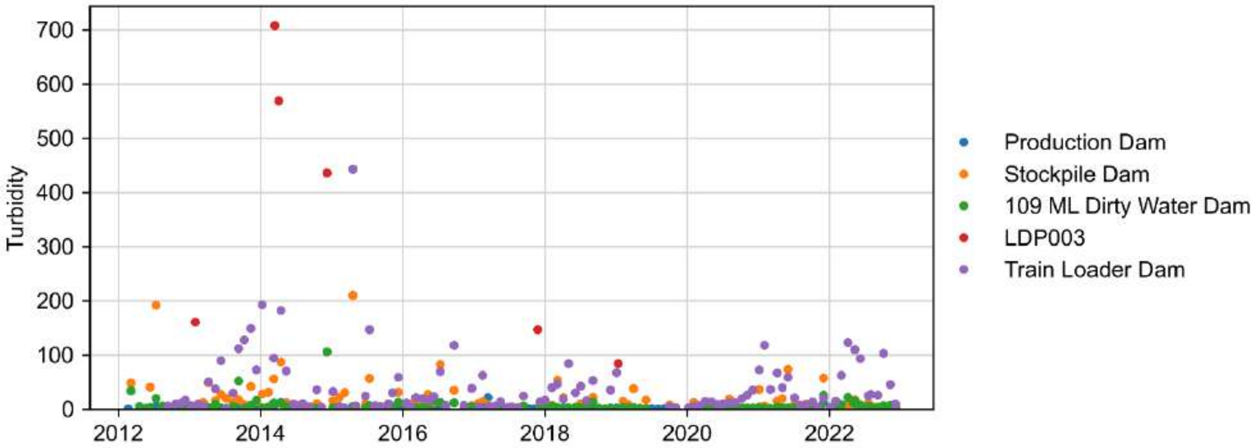
Physiochemical parameters



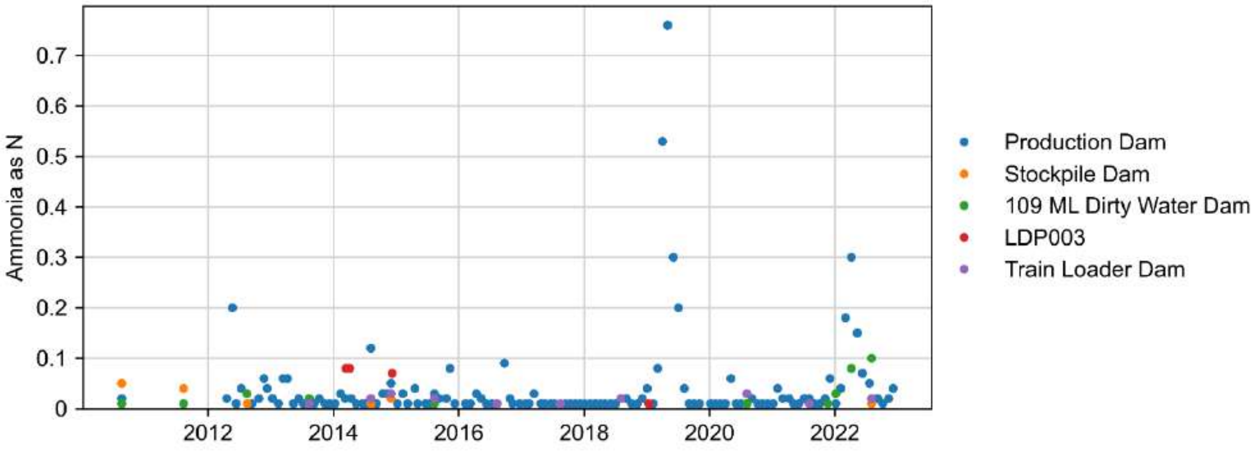


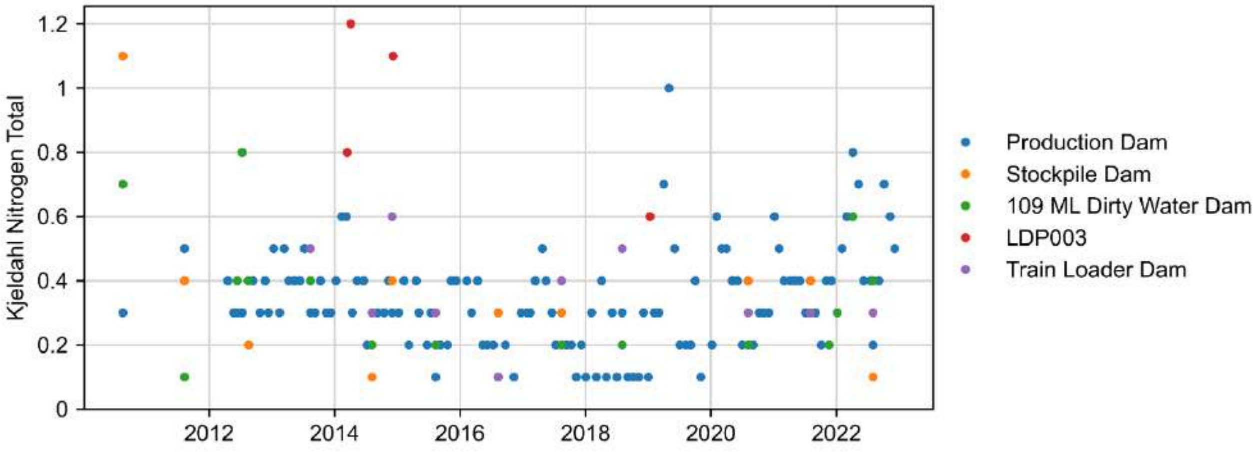


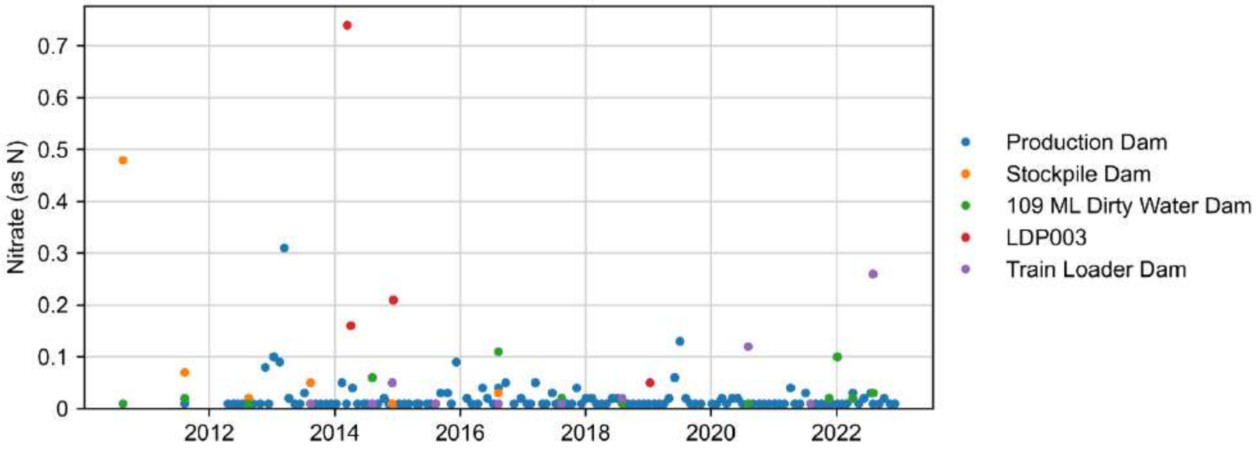

Total Suspended Solids
0
100
200
300
400
500
600
700
2010
2012
2014
2016
2018
2020
2022
Production Dam
Stockpile Dam
109 ML Dirty Water Dam
LDP003
Train Loader Dam

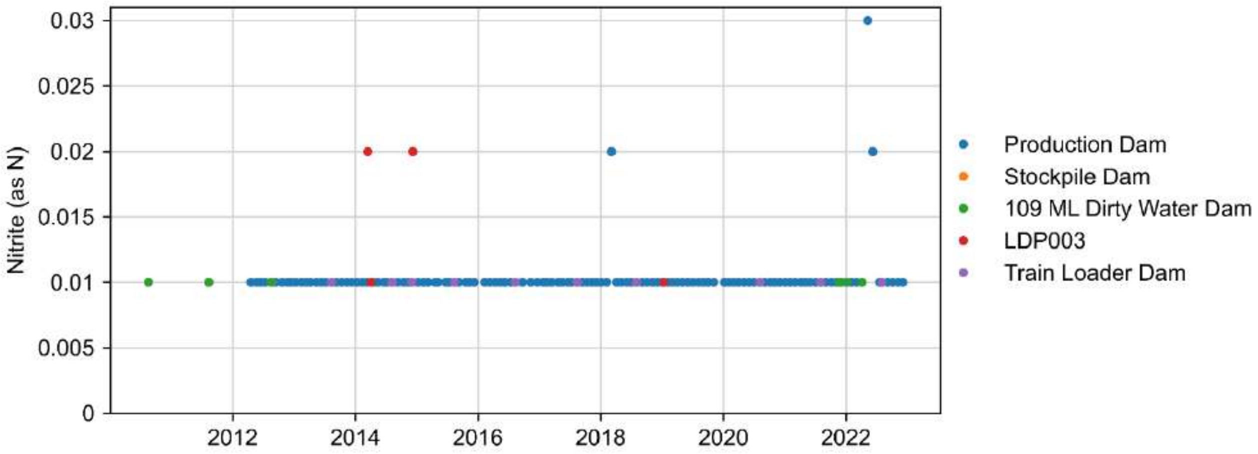

Turbidity
0
100
200
300
400
500
600
700
2012
2014
2016
2018
2020
2022
Production Dam
Stockpile Dam
109 ML Dirty Water Dam
LDP003
Train Loader Dam

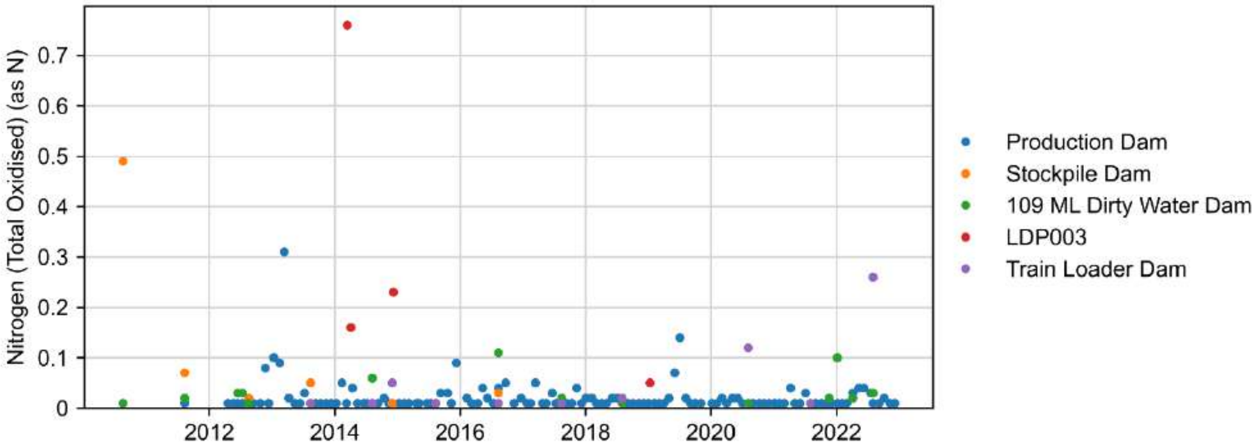
Nutrients

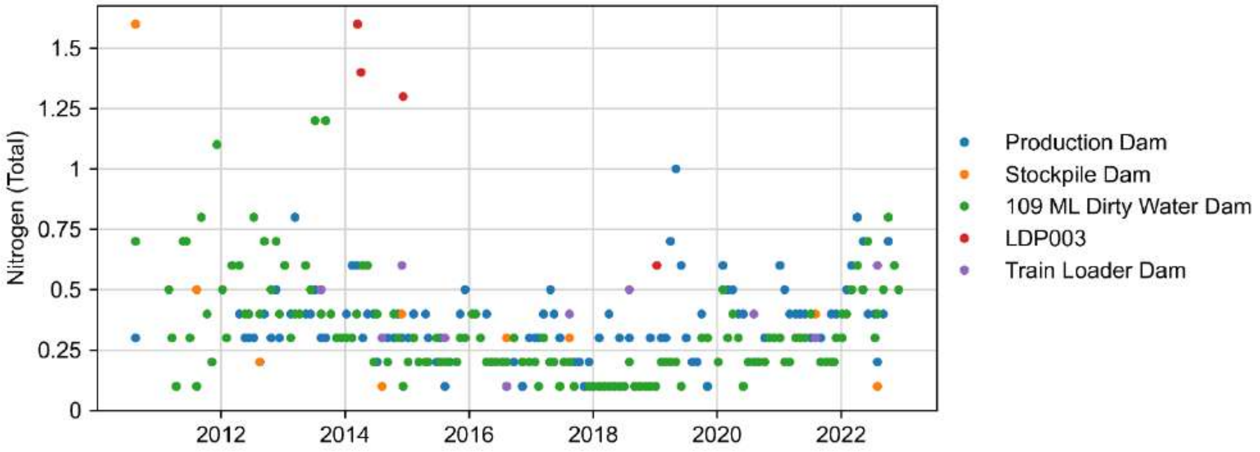

Ammonia as N
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
2012
2014
2016
2018
2020
2022
● Production Dam
● Stockpile Dam
● 109 ML Dirty Water Dam
● LDP003
● Train Loader Dam

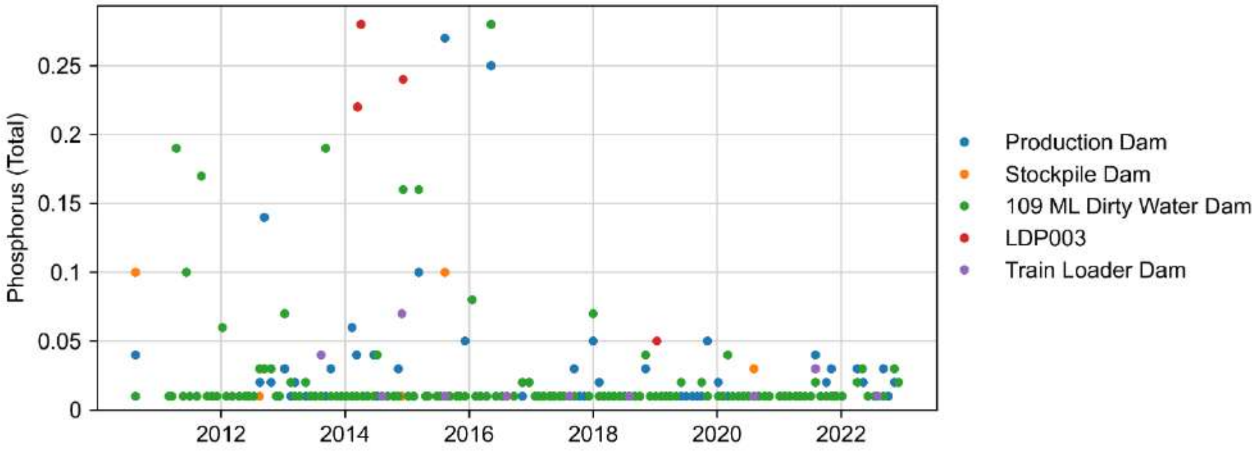

Kjeldahl Nitrogen Total
1.2
1
0.8
0.6
0.4
0.2
0
2012
2014
2016
2018
2020
2022
● Production Dam
● Stockpile Dam
● 109 ML Dirty Water Dam
● LDP003
● Train Loader Dam


Nitrate (as N)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
2012
2014
2016
2018
2020
2022
● Production Dam
● Stockpile Dam
● 109 ML Dirty Water Dam
● LDP003
● Train Loader Dam

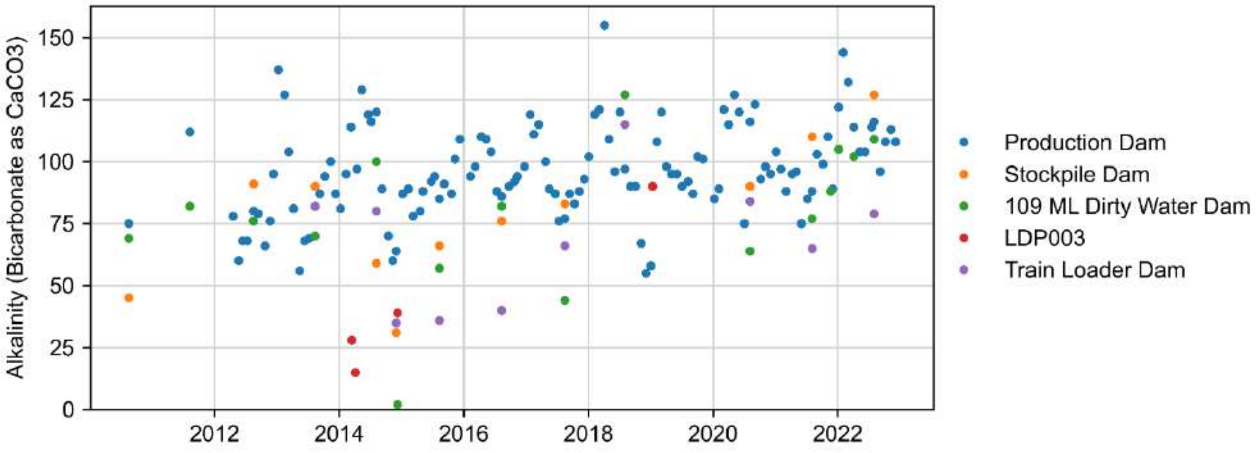

Nitrite (as N)
0.03
0.025
0.02
0.015
0.01
0.005
0
2012
2014
2016
2018
2020
2022
Production Dam
Stockpile Dam
109 ML Dirty Water Dam
LDP003
Train Loader Dam

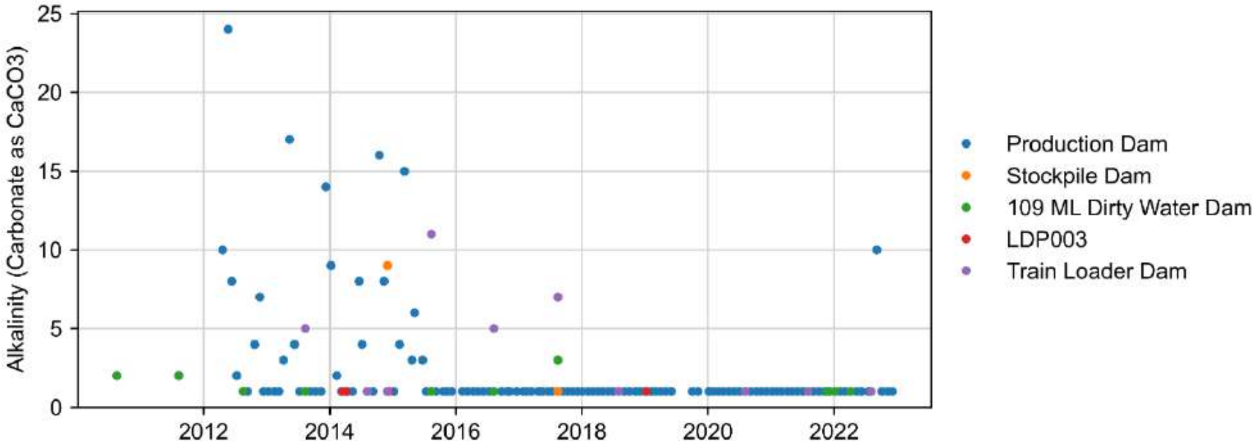

Nitrogen (Total Oxidised) (as N)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
2012
2014
2016
2018
2020
2022
Production Dam
Stockpile Dam
109 ML Dirty Water Dam
LDP003
Train Loader Dam

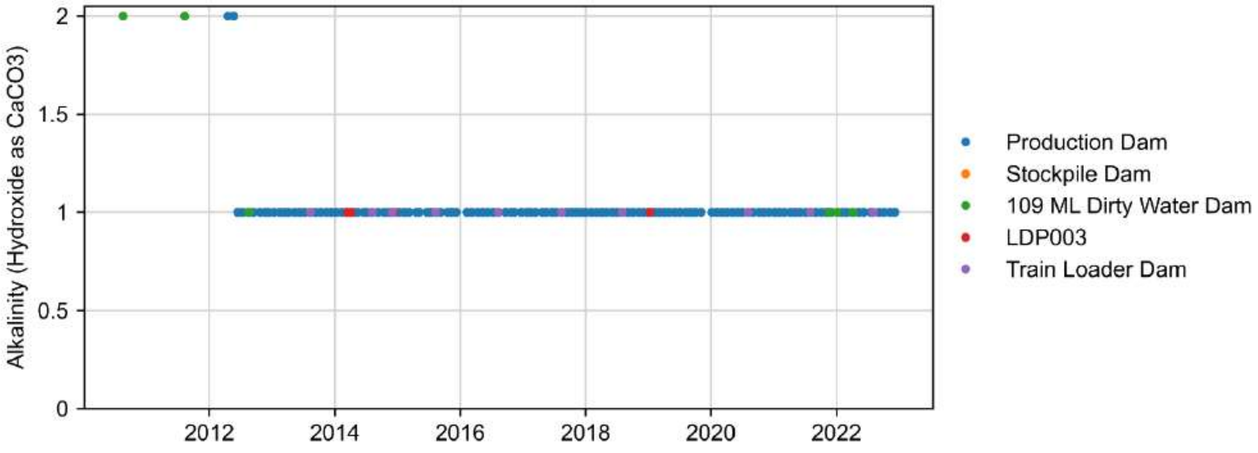

Nitrogen (Total)
0
0.25
0.5
0.75
1
1.25
1.5
2012
2014
2016
2018
2020
2022
Production Dam
Stockpile Dam
109 ML Dirty Water Dam
LDP003
Train Loader Dam

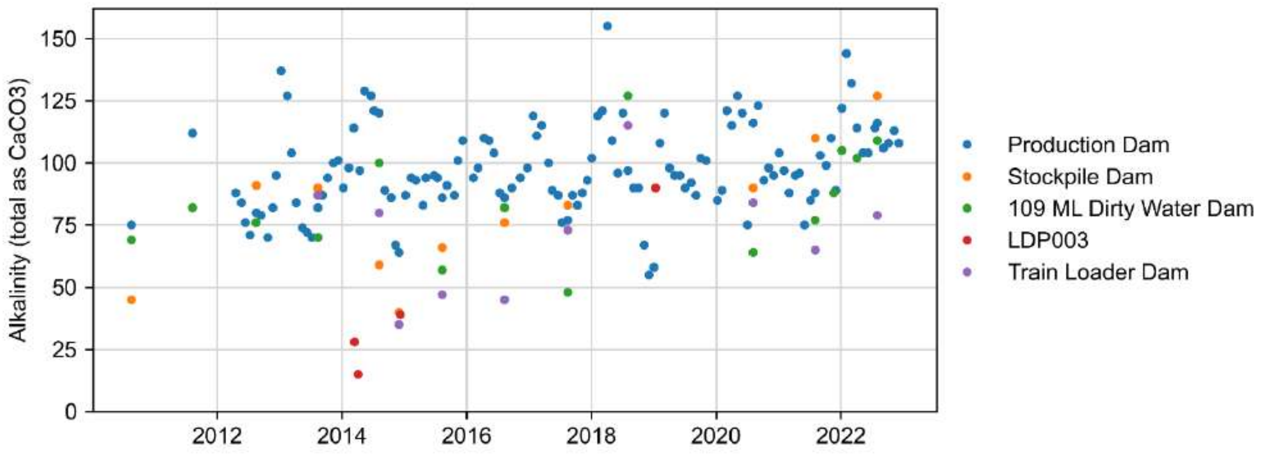

Phosphorus (Total)
0
0.05
0.1
0.15
0.2
0.25
2012
2014
2016
2018
2020
2022
Production Dam
Stockpile Dam
109 ML Dirty Water Dam
LDP003
Train Loader Dam

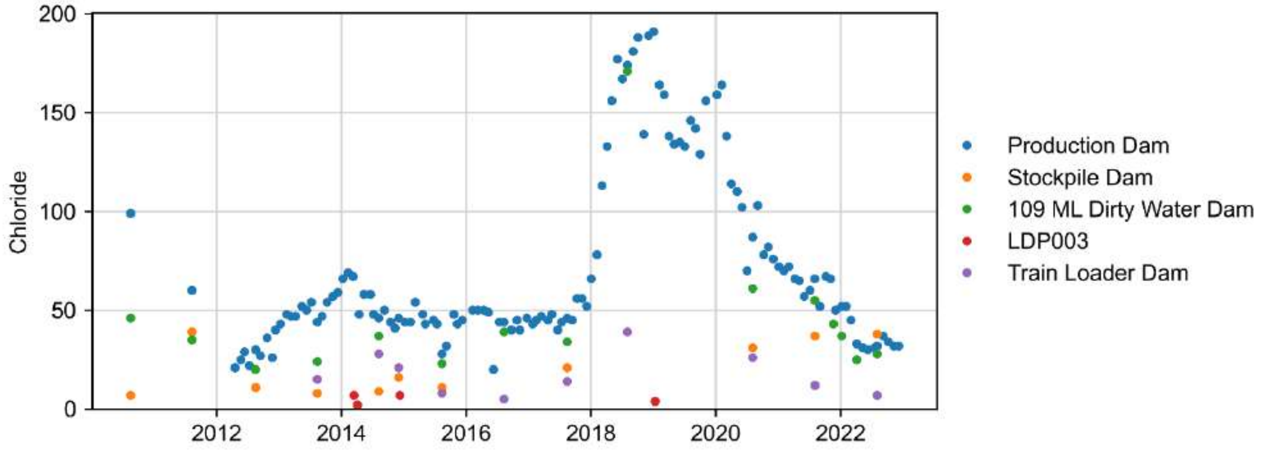
Major ions

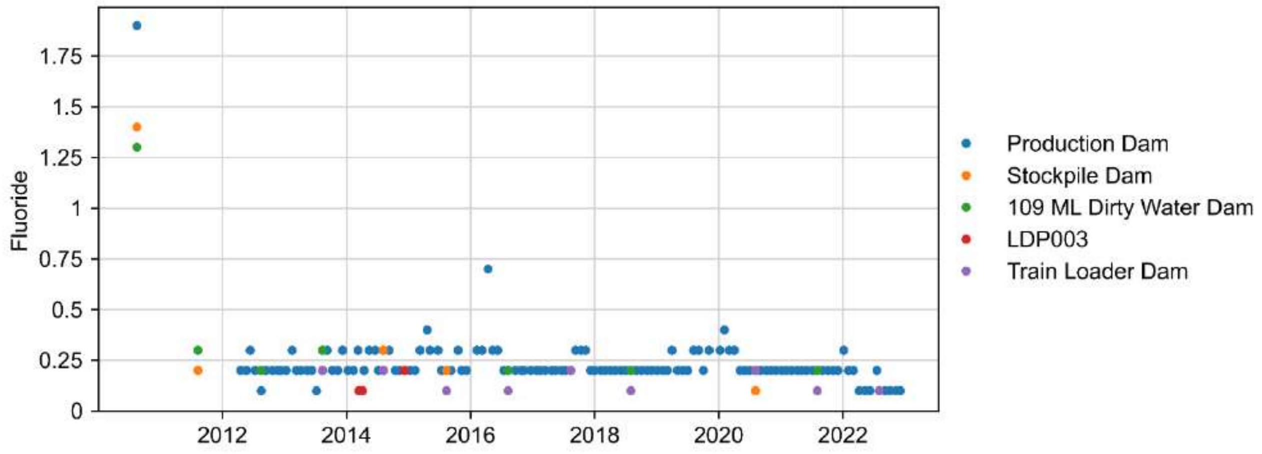

Alkalinity (Bicarbonate as CaCO3)
0
25
50
75
100
125
150
2012
2014
2016
2018
2020
2022
Production Dam
Stockpile Dam
109 ML Dirty Water Dam
LDP003
Train Loader Dam

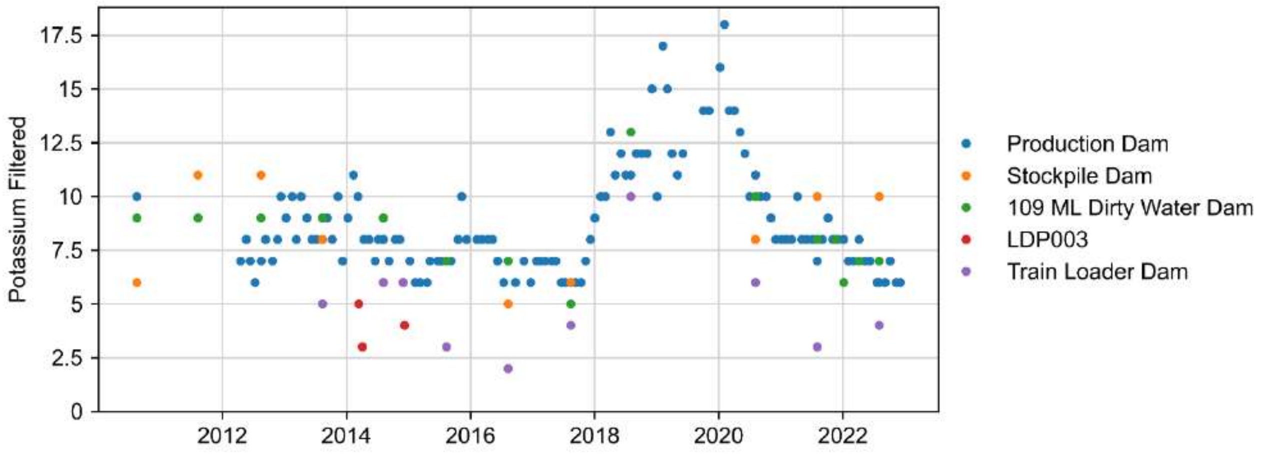

Alkalinity (Carbonate as CaCO3)
0
5
10
15
20
25
2012
2014
2016
2018
2020
2022
Production Dam
Stockpile Dam
109 ML Dirty Water Dam
LDP003
Train Loader Dam

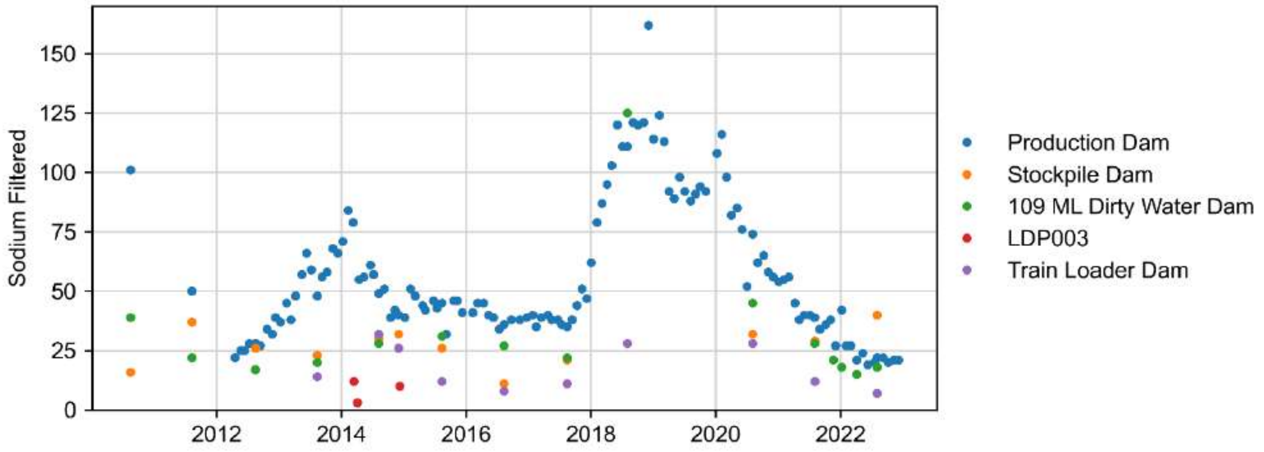

Alkalinity (Hydroxide as CaCO3)
0
0.5
1
1.5
2
2012
2014
2016
2018
2020
2022
Production Dam
Stockpile Dam
109 ML Dirty Water Dam
LDP003
Train Loader Dam

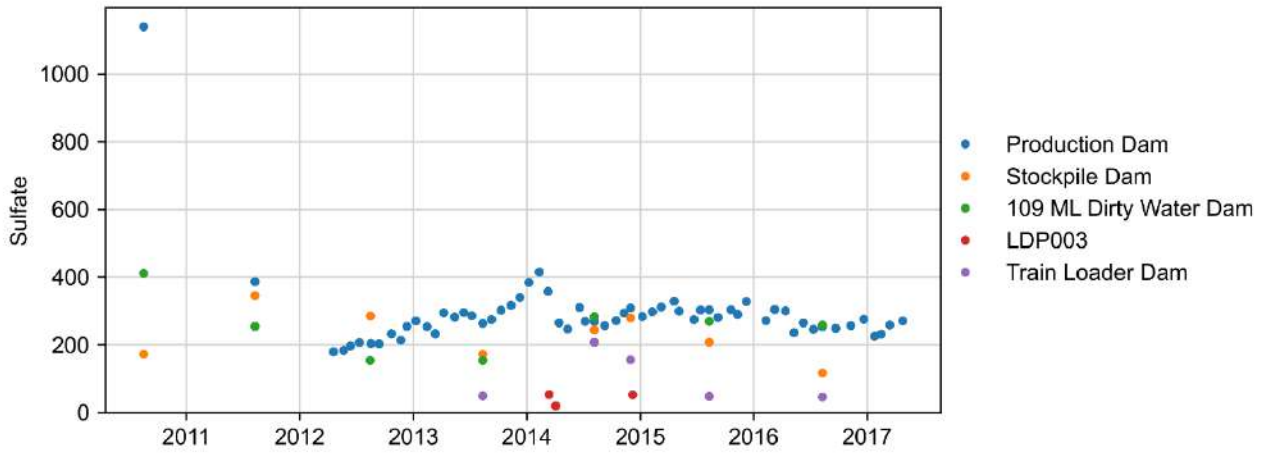

Alkalinity (total as CaCO3)
150
125
100
75
50
25
0
2012
2014
2016
2018
2020
2022
Production Dam
Stockpile Dam
109 ML Dirty Water Dam
LDP003
Train Loader Dam


Chloride
200
150
100
50
0
2012
2014
2016
2018
2020
2022
Production Dam
Stockpile Dam
109 ML Dirty Water Dam
LDP003
Train Loader Dam

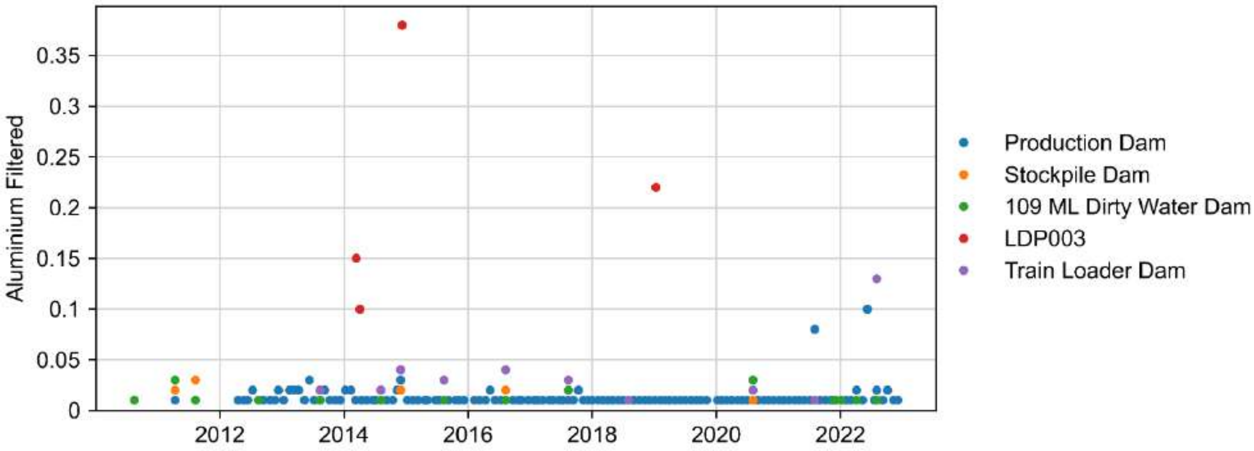

Fluoride
1.75
1.5
1.25
1
0.75
0.5
0.25
0
2012
2014
2016
2018
2020
2022
Production Dam
Stockpile Dam
109 ML Dirty Water Dam
LDP003
Train Loader Dam

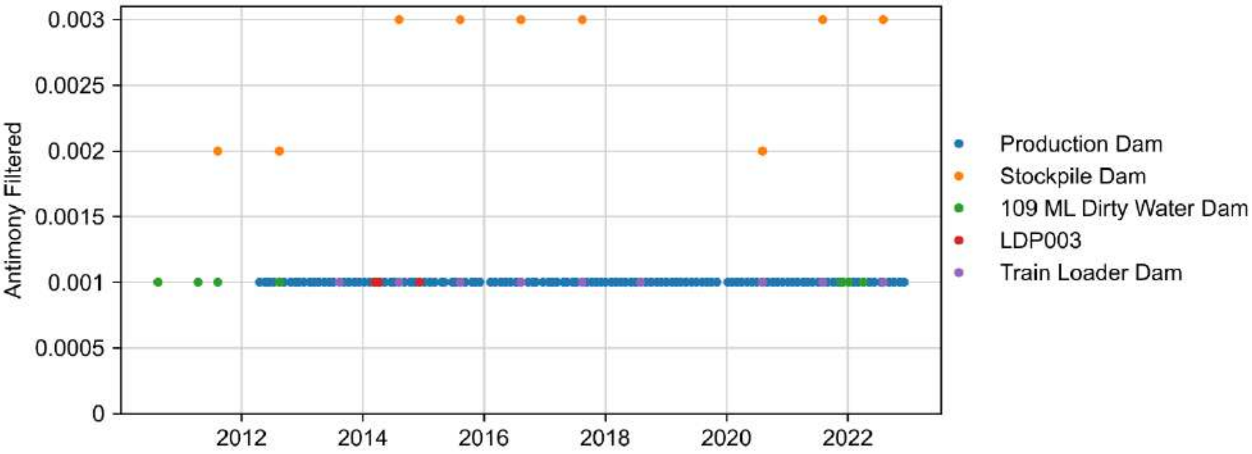

Potassium Filtered
17.5
15
12.5
10
7.5
5
2.5
0
2012
2014
2016
2018
2020
2022
● Production Dam
● Stockpile Dam
● 109 ML Dirty Water Dam
● LDP003
● Train Loader Dam

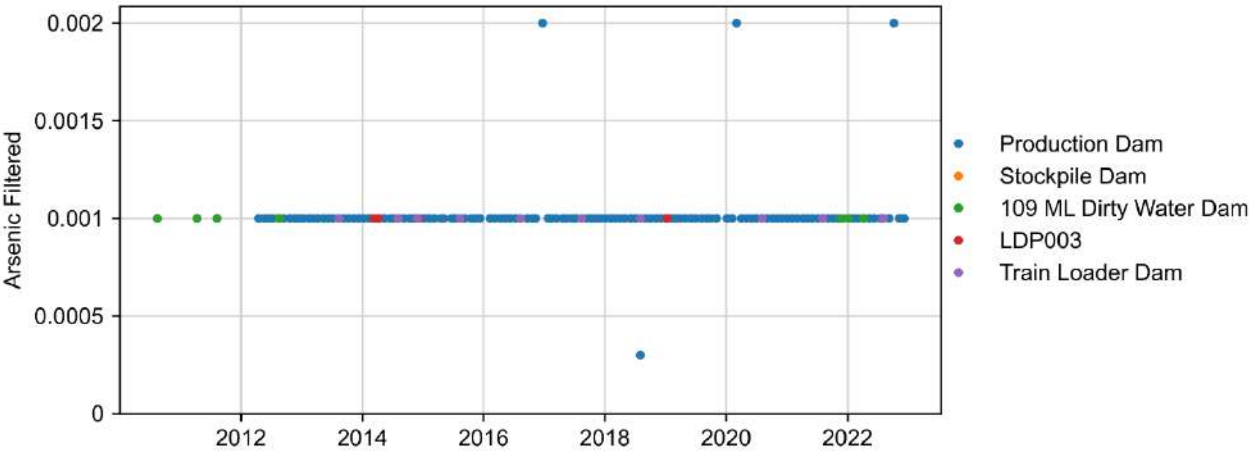

Sodium Filtered
150
125
100
75
50
25
0
2012
2014
2016
2018
2020
2022
● Production Dam
● Stockpile Dam
● 109 ML Dirty Water Dam
● LDP003
● Train Loader Dam

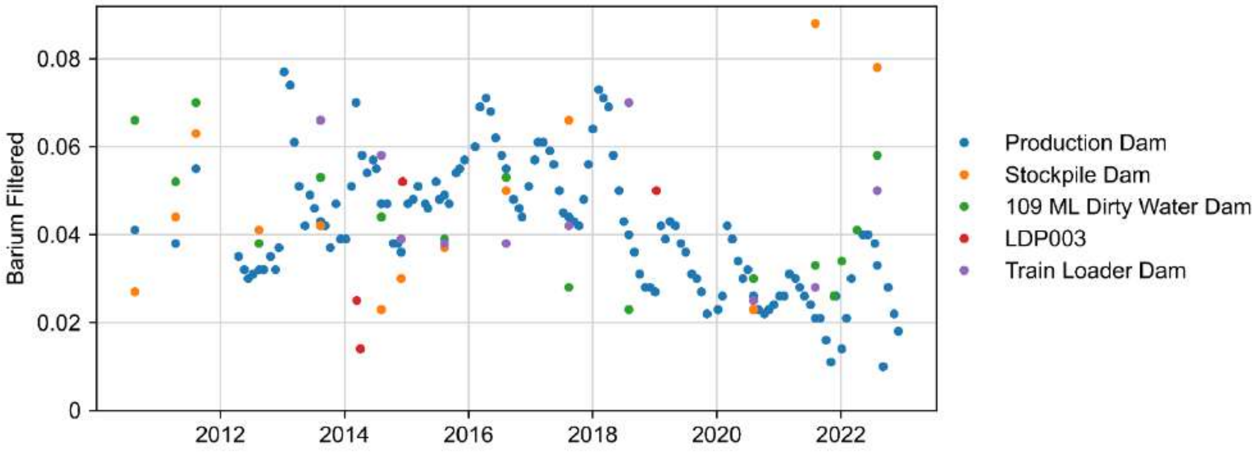

Sulfate
1000
800
600
400
200
0
2011
2012
2013
2014
2015
2016
2017
● Production Dam
● Stockpile Dam
● 109 ML Dirty Water Dam
● LDP003
● Train Loader Dam

Metals (dissolved)

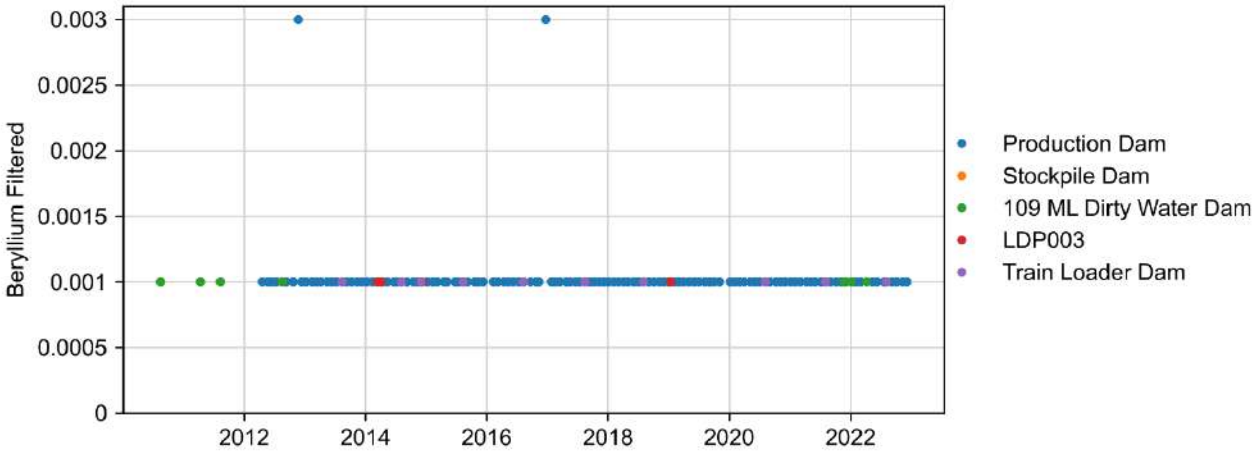




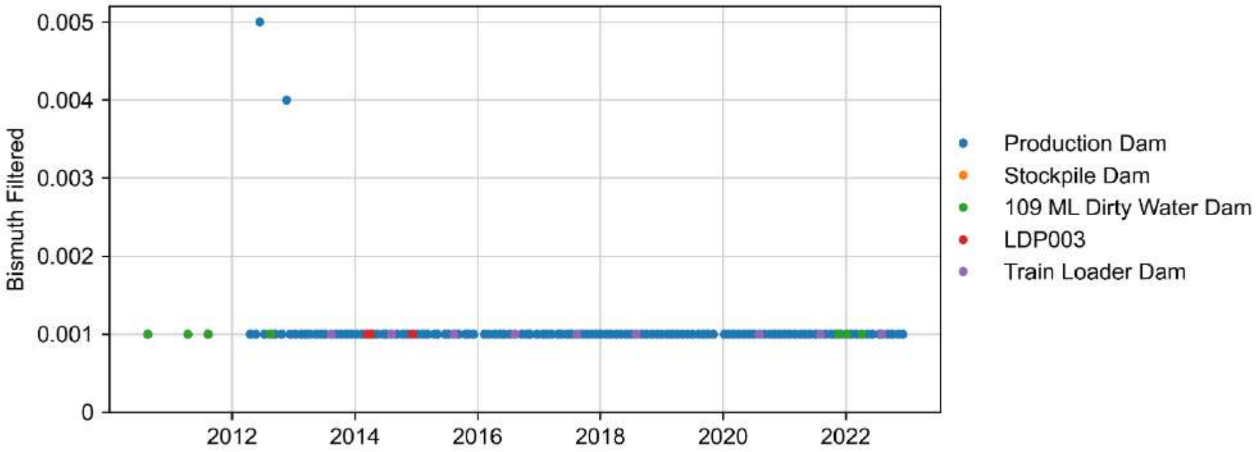




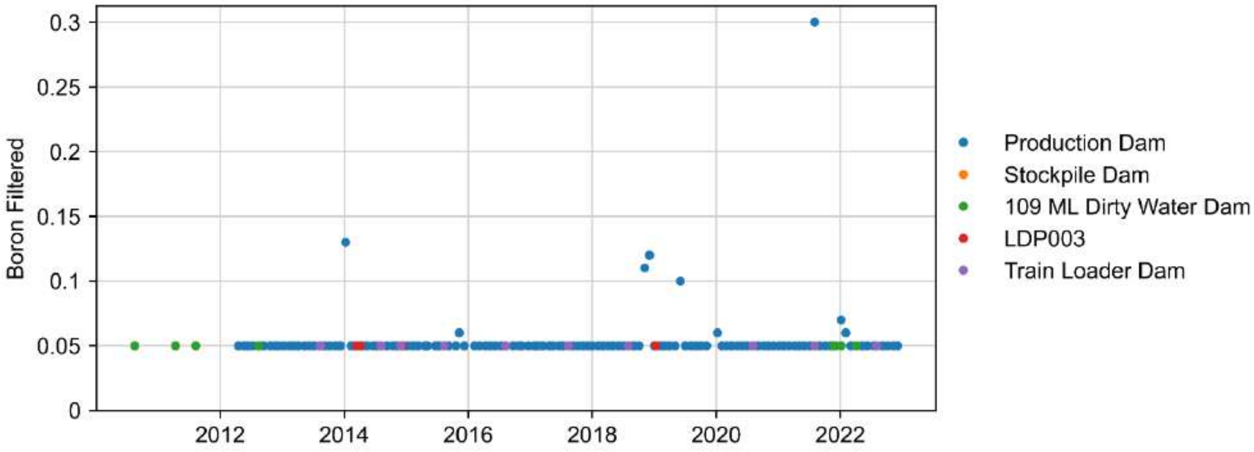
Barium Filtered
0.08
0.06
0.04
0.02
0
2012
2014
2016
2018
2020
2022
● Production Dam
● Stockpile Dam
● 109 ML Dirty Water Dam
● LDP003
● Train Loader Dam

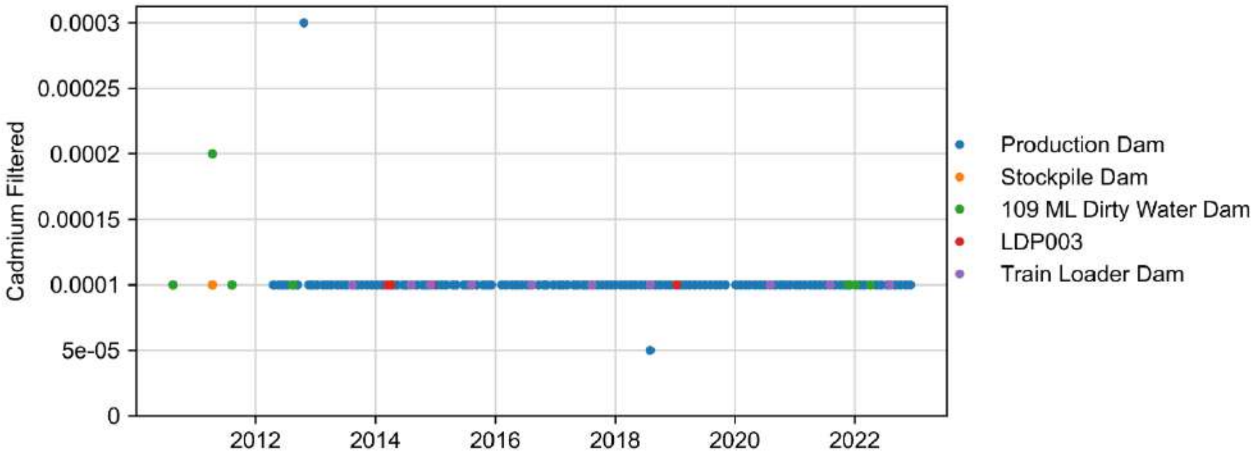


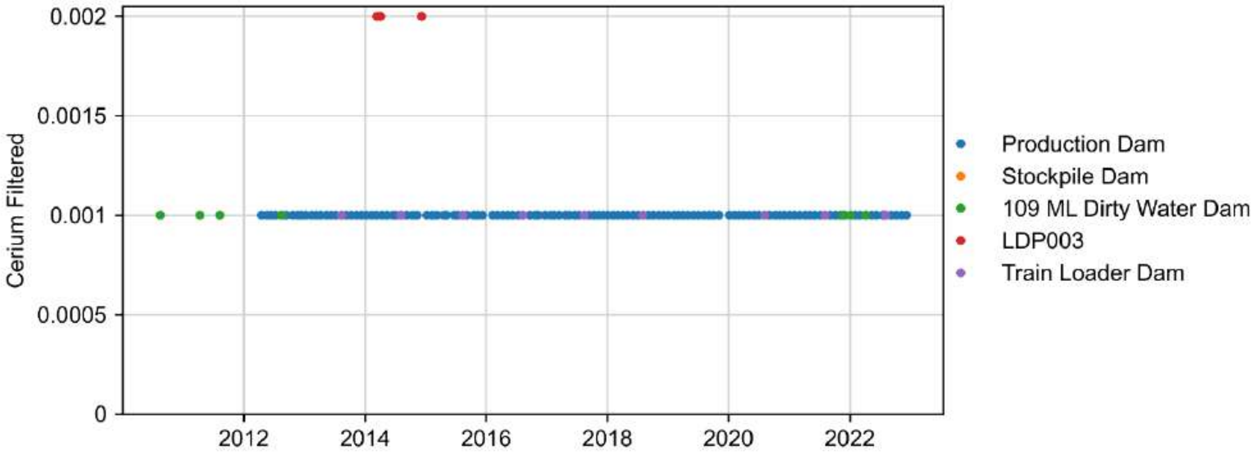
Beryllium Filtered
0.003
0.0025
0.002
0.0015
0.001
0.0005
0
2012
2014
2016
2018
2020
2022
● Production Dam
● Stockpile Dam
● 109 ML Dirty Water Dam
● LDP003
● Train Loader Dam

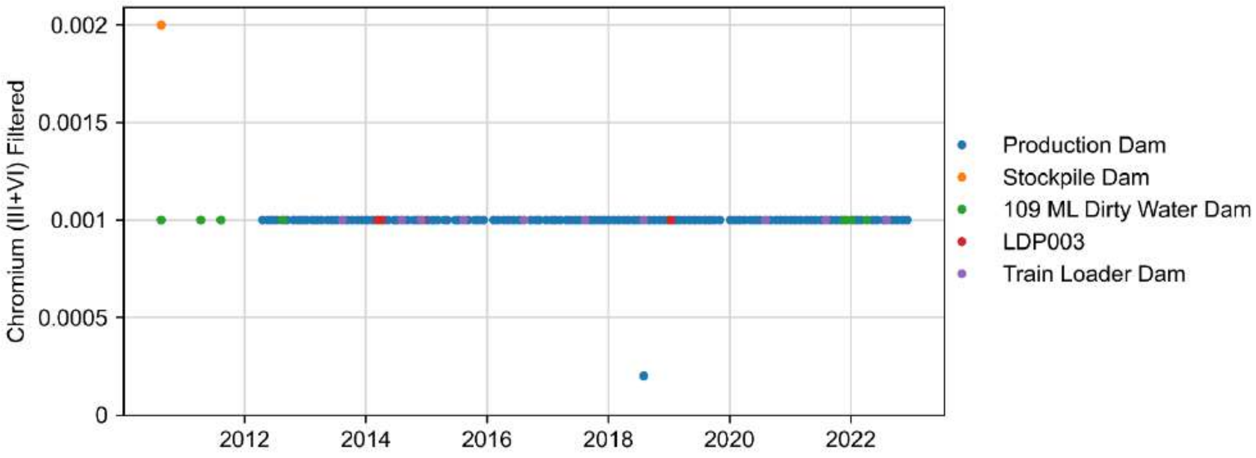


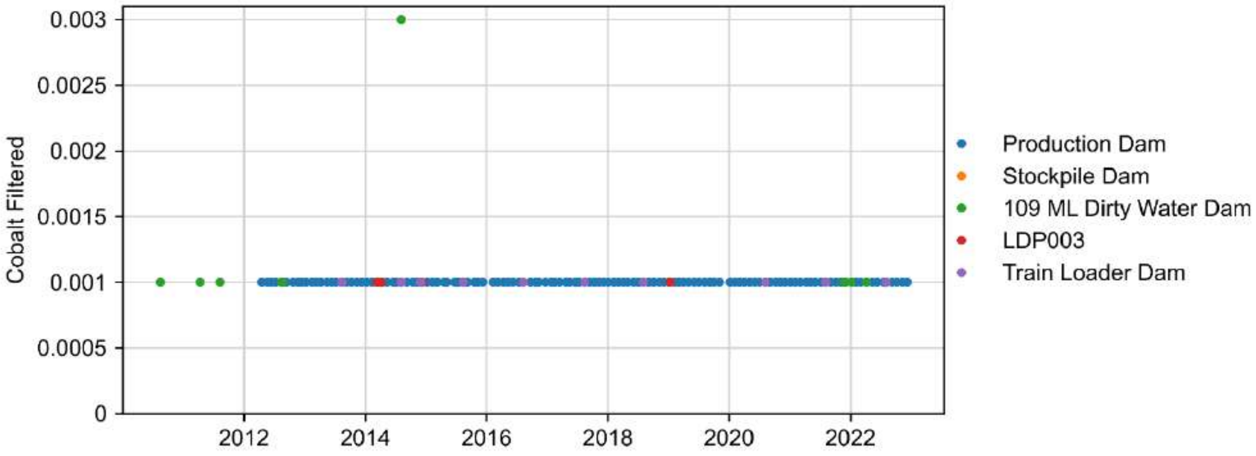
Bismuth Filtered
0.005
0.004
0.003
0.002
0.001
0
2012
2014
2016
2018
2020
2022
● Production Dam
● Stockpile Dam
● 109 ML Dirty Water Dam
● LDP003
● Train Loader Dam

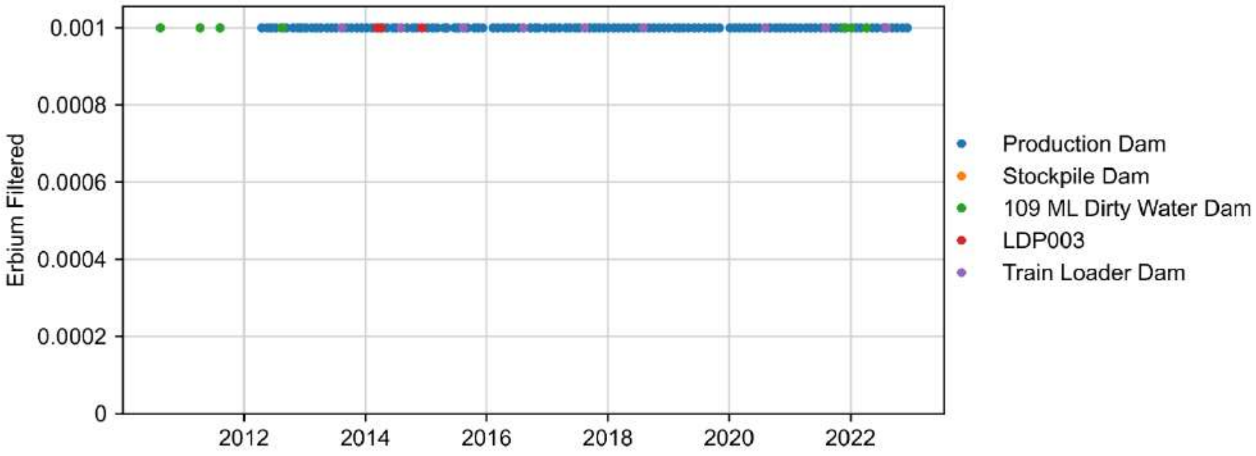

Boron Filtered
0.3
0.25
0.2
0.15
0.1
0.05
0
2012
2014
2016
2018
2020
2022
● Production Dam
● Stockpile Dam
● 109 ML Dirty Water Dam
● LDP003
● Train Loader Dam

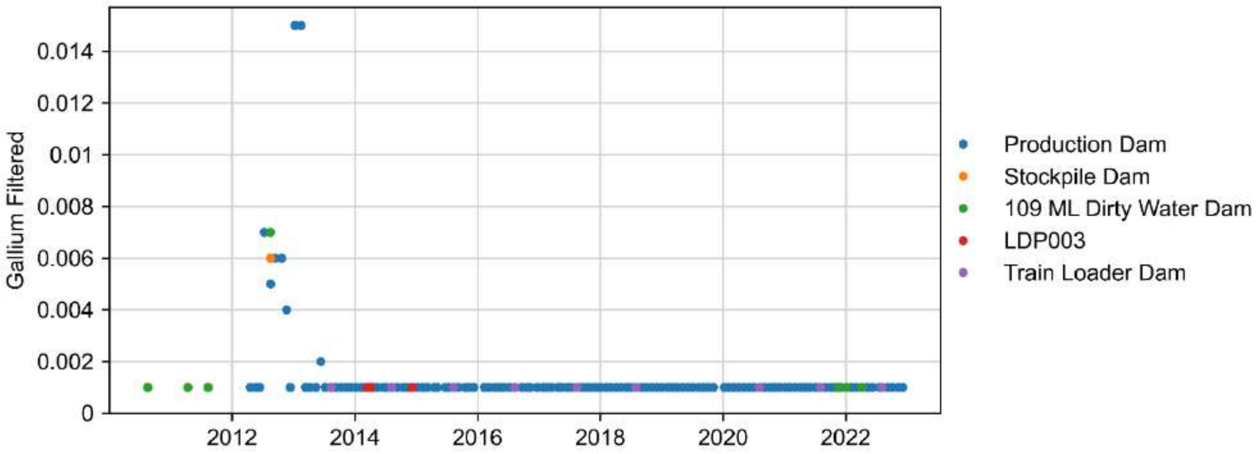

Cadmium Filtered
0.0003
0.00025
0.0002
0.00015
0.0001
5e-05
0
2012
2014
2016
2018
2020
2022
● Production Dam
● Stockpile Dam
● 109 ML Dirty Water Dam
● LDP003
● Train Loader Dam

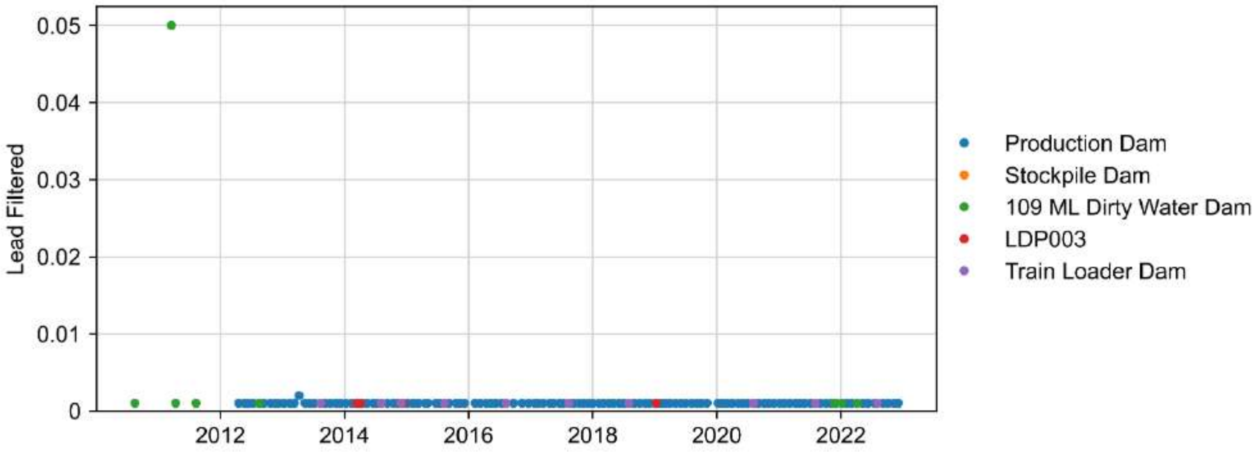

Cerium Filtered
0.002
0.0015
0.001
0.0005
0
2012
2014
2016
2018
2020
2022
● Production Dam
● Stockpile Dam
● 109 ML Dirty Water Dam
● LDP003
● Train Loader Dam

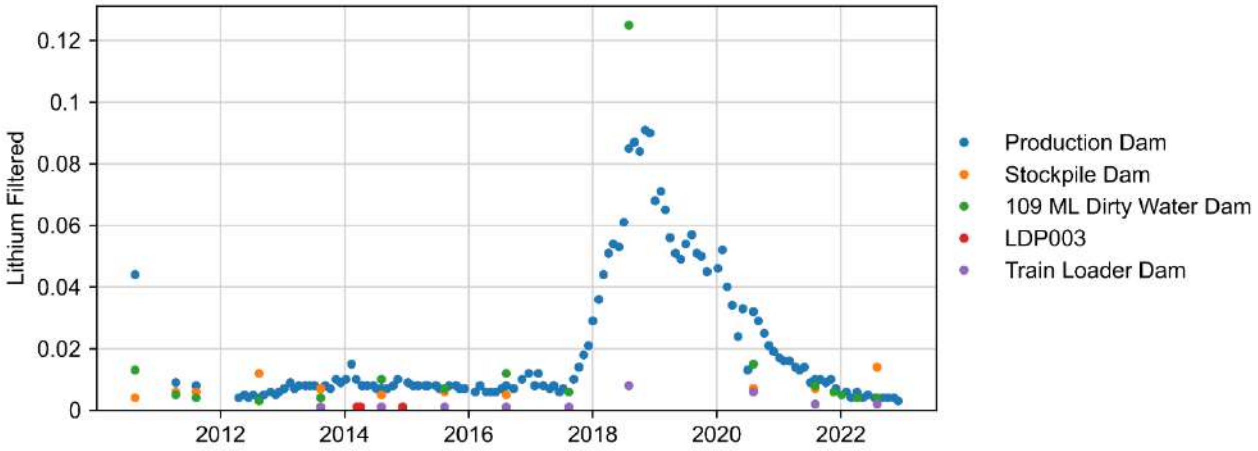

Chromium (III+VI) Filtered
0.002
0.0015
0.001
0.0005
0
2012
2014
2016
2018
2020
2022
Production Dam
Stockpile Dam
109 ML Dirty Water Dam
LDP003
Train Loader Dam

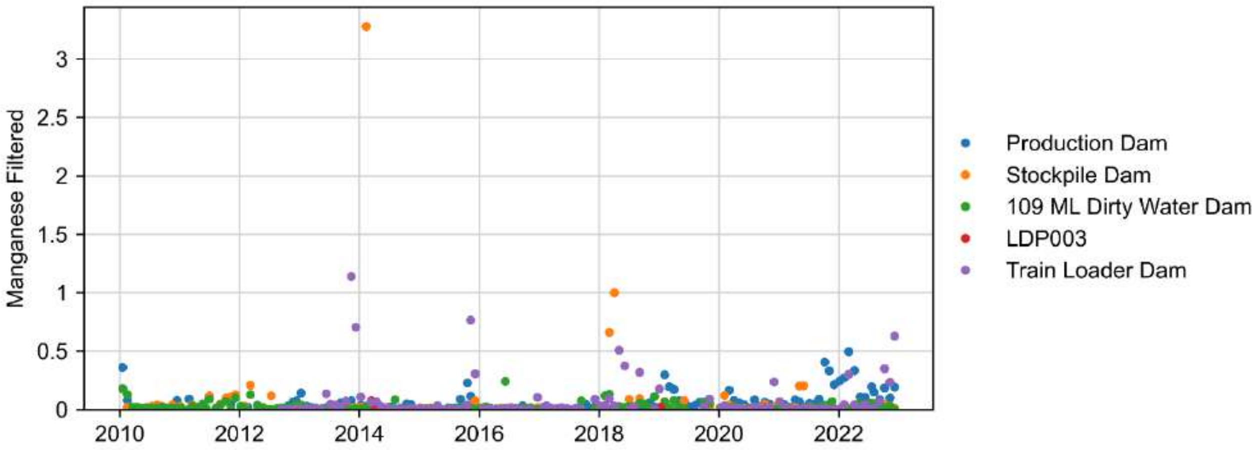

Cobalt Filtered
0.003
0.0025
0.002
0.0015
0.001
0.0005
0
2012
2014
2016
2018
2020
2022
Production Dam
Stockpile Dam
109 ML Dirty Water Dam
LDP003
Train Loader Dam

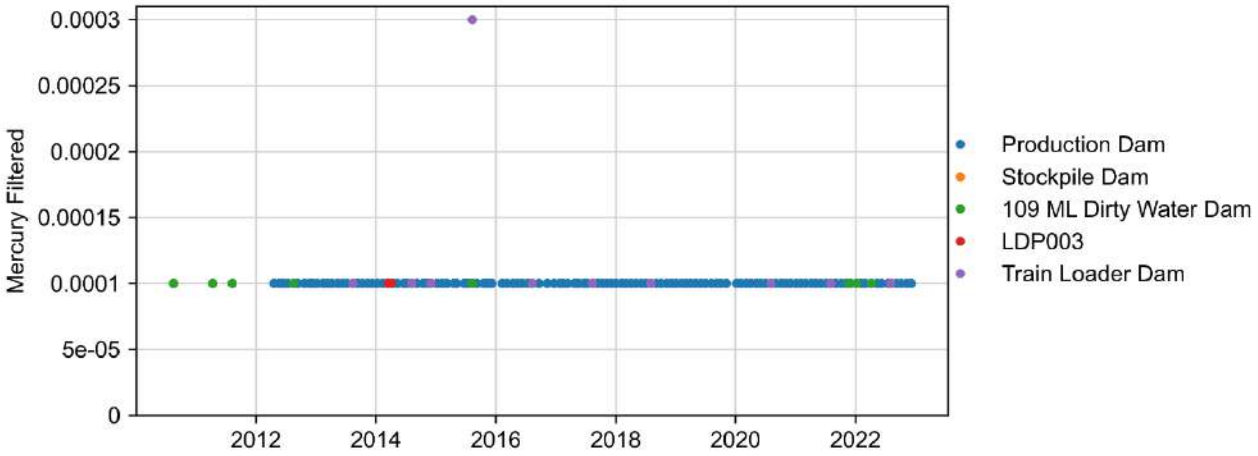

Erbium Filtered
0.001
0.0008
0.0006
0.0004
0.0002
0
2012
2014
2016
2018
2020
2022
Production Dam
Stockpile Dam
109 ML Dirty Water Dam
LDP003
Train Loader Dam

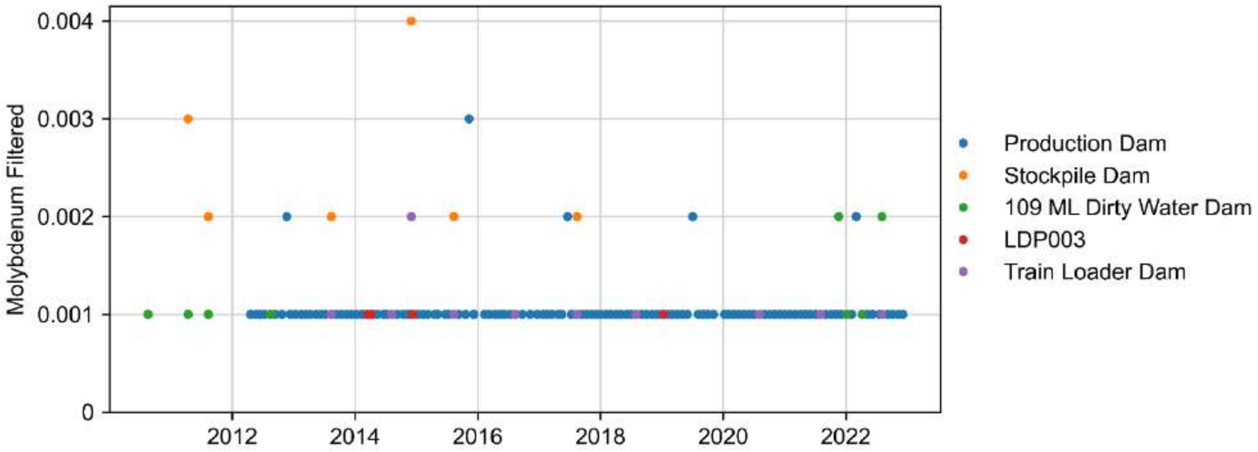

Gallium Filtered
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
2012
2014
2016
2018
2020
2022
Production Dam
Stockpile Dam
109 ML Dirty Water Dam
LDP003
Train Loader Dam

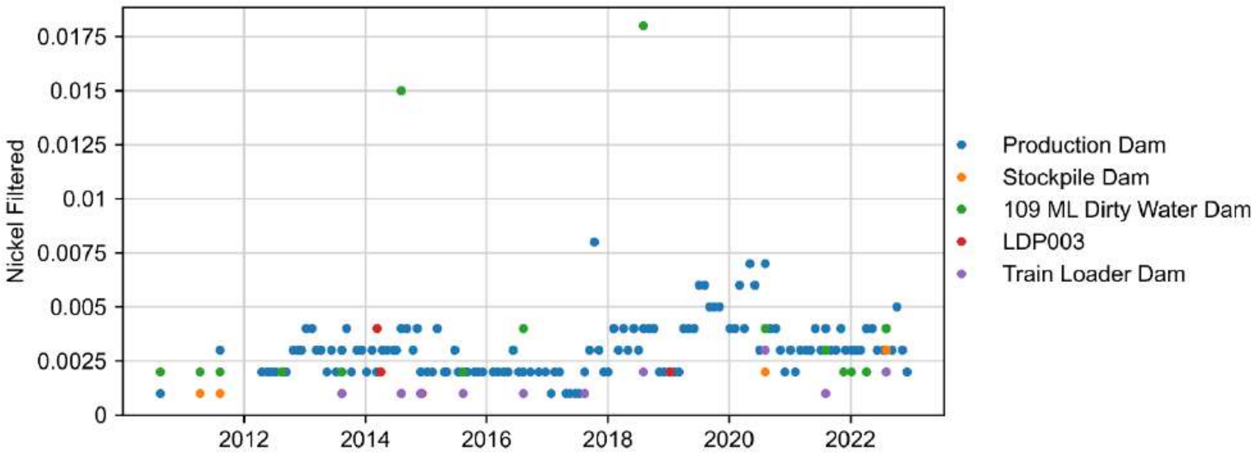

Lead Filtered
0.05
0.04
0.03
0.02
0.01
0
2012
2014
2016
2018
2020
2022
Production Dam
Stockpile Dam
109 ML Dirty Water Dam
LDP003
Train Loader Dam

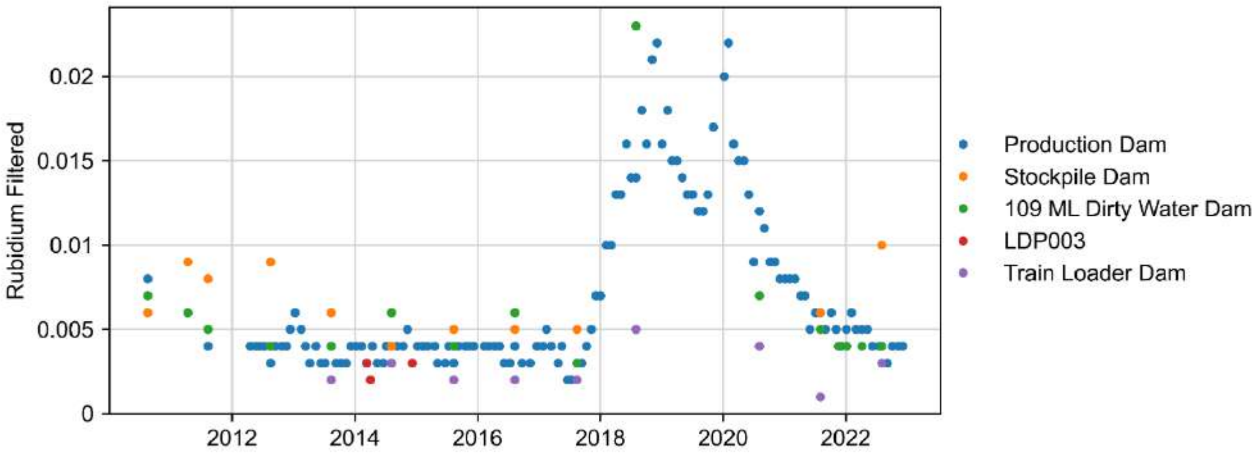

Lithium Filtered
0.12
0.1
0.08
0.06
0.04
0.02
0
2012
2014
2016
2018
2020
2022
Production Dam
Stockpile Dam
109 ML Dirty Water Dam
LDP003
Train Loader Dam

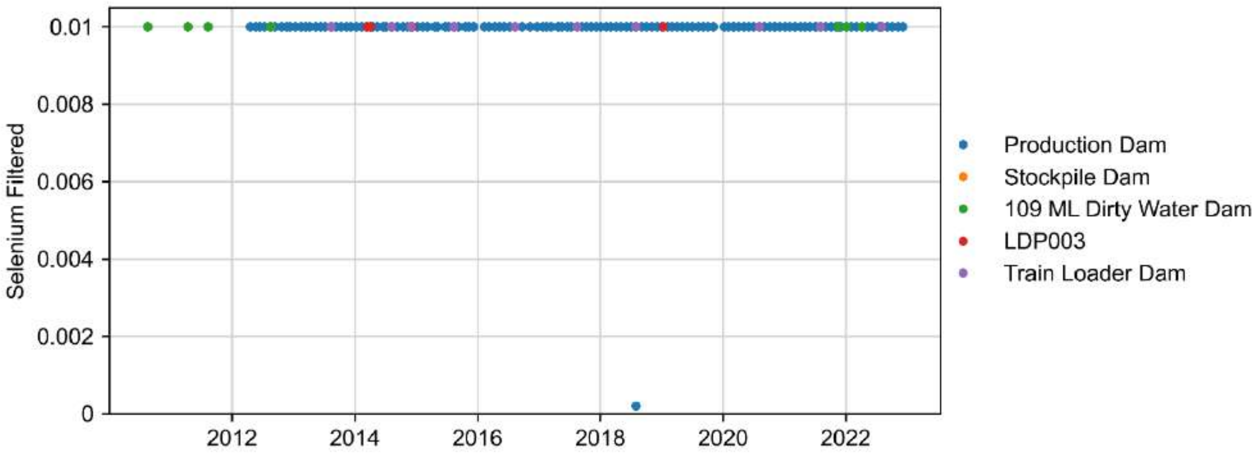

Manganese Filtered
0
0.5
1
1.5
2
2.5
3
2010
2012
2014
2016
2018
2020
2022
Production Dam
Stockpile Dam
109 ML Dirty Water Dam
LDP003
Train Loader Dam

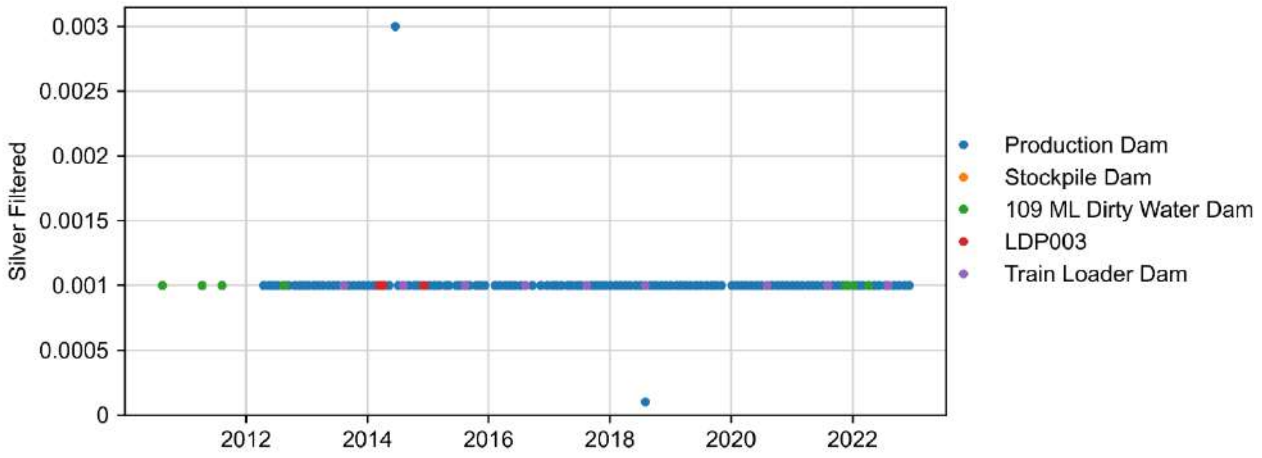

Mercury Filtered
0
5e-05
0.0001
0.00015
0.0002
0.00025
0.0003
2012
2014
2016
2018
2020
2022
Production Dam
Stockpile Dam
109 ML Dirty Water Dam
LDP003
Train Loader Dam

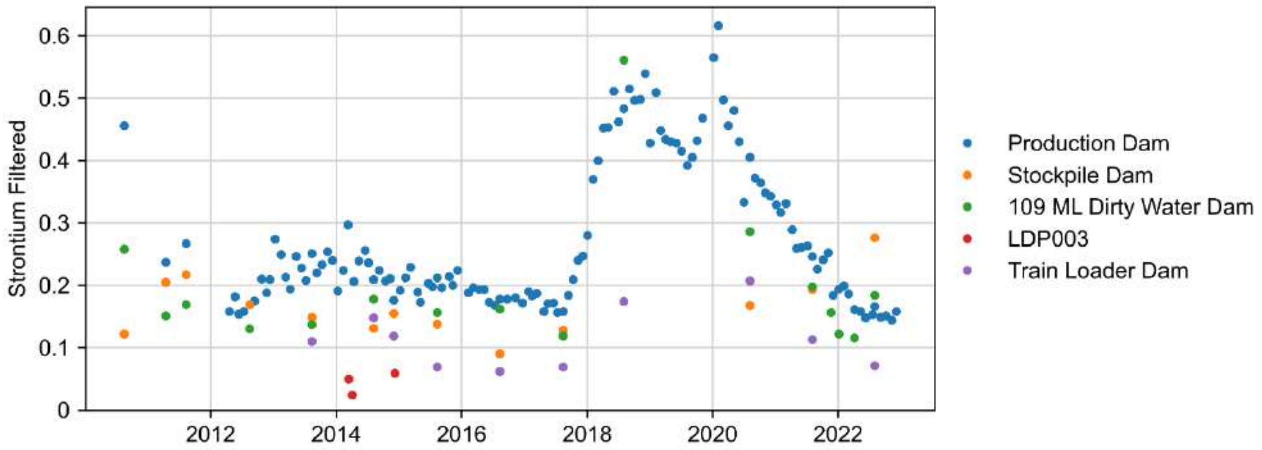

Molybdenum Filtered
0
0.001
0.002
0.003
0.004
2012
2014
2016
2018
2020
2022
Production Dam
Stockpile Dam
109 ML Dirty Water Dam
LDP003
Train Loader Dam

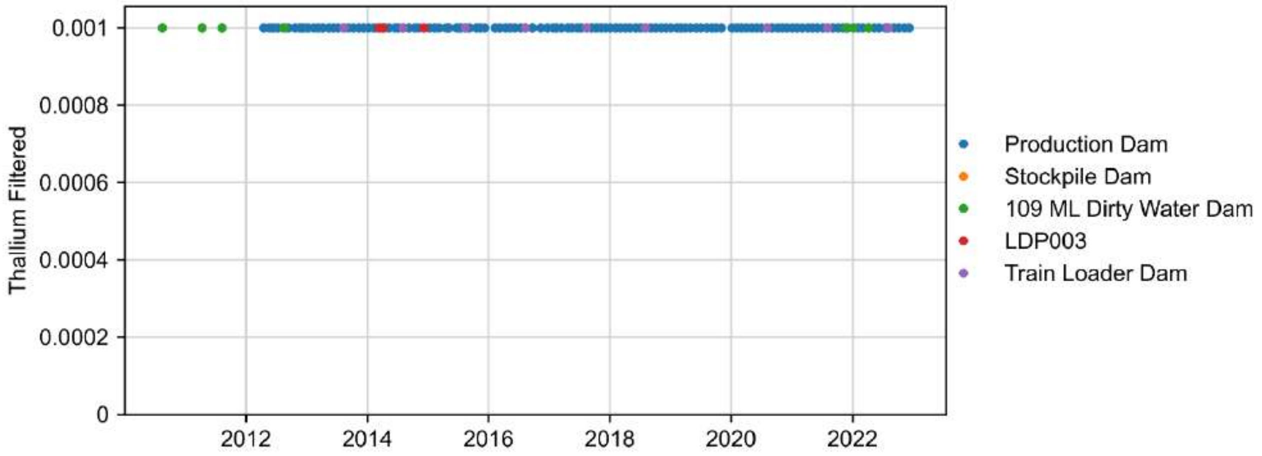

Nickel Filtered
0.0175
0.015
0.0125
0.01
0.0075
0.005
0.0025
0
2012
2014
2016
2018
2020
2022
Production Dam
Stockpile Dam
109 ML Dirty Water Dam
LDP003
Train Loader Dam

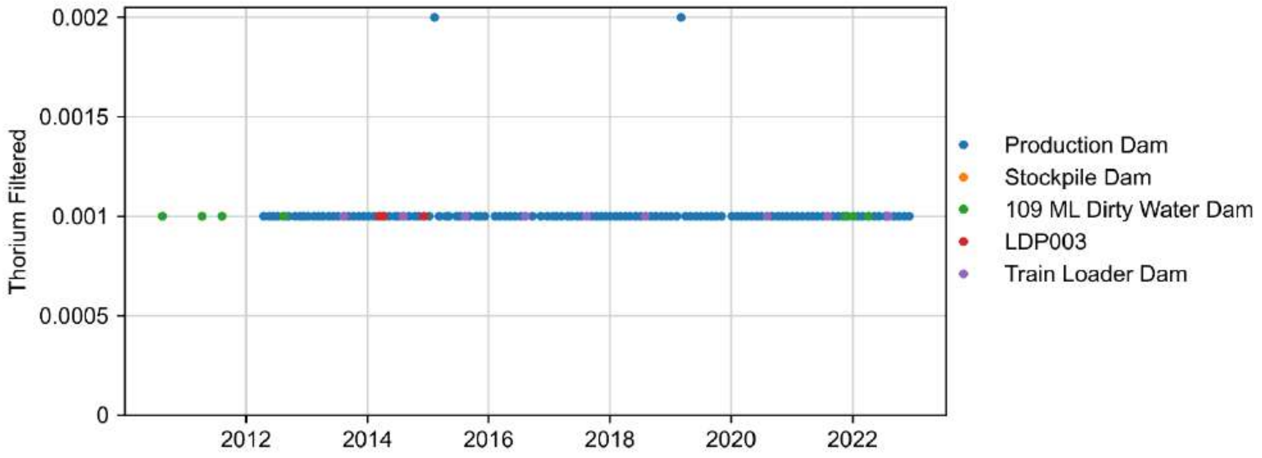

Rubidium Filtered
0.02
0.015
0.01
0.005
0
2012
2014
2016
2018
2020
2022
Production Dam
Stockpile Dam
109 ML Dirty Water Dam
LDP003
Train Loader Dam

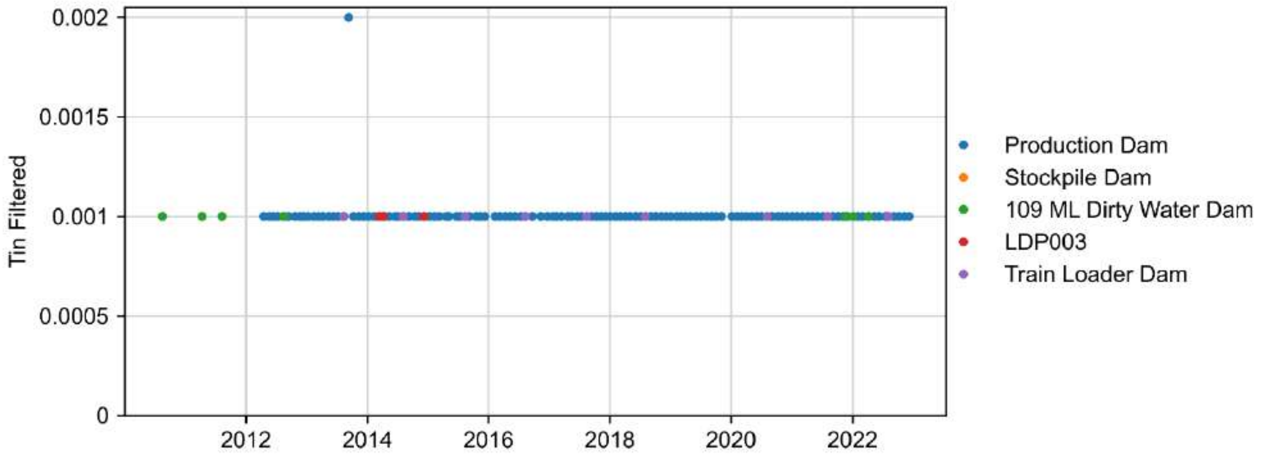

Selenium Filtered
0.01
0.008
0.006
0.004
0.002
0
2012
2014
2016
2018
2020
2022
Production Dam
Stockpile Dam
109 ML Dirty Water Dam
LDP003
Train Loader Dam

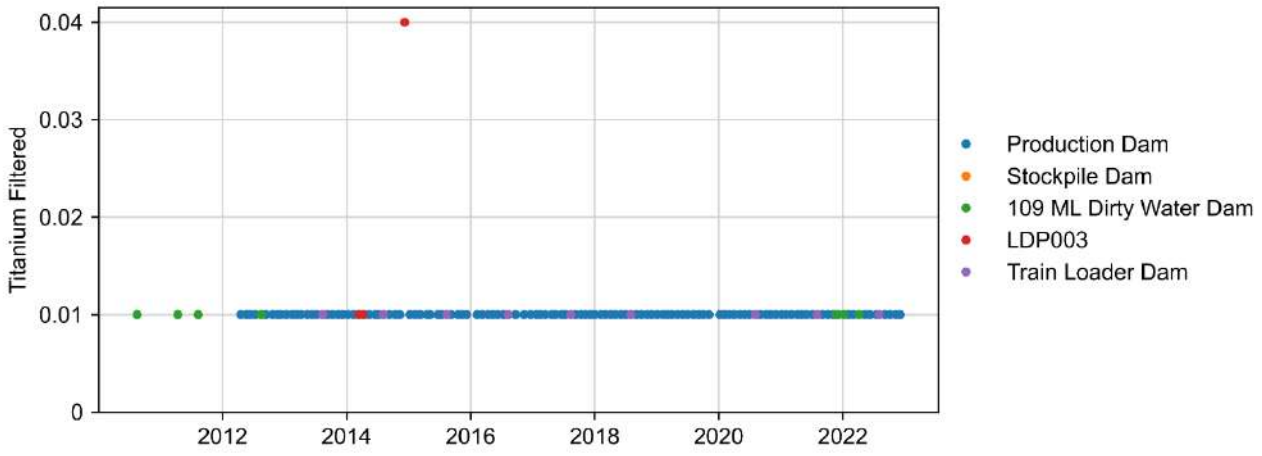

Silver Filtered
0.003
0.0025
0.002
0.0015
0.001
0.0005
0
2012
2014
2016
2018
2020
2022
Production Dam
Stockpile Dam
109 ML Dirty Water Dam
LDP003
Train Loader Dam

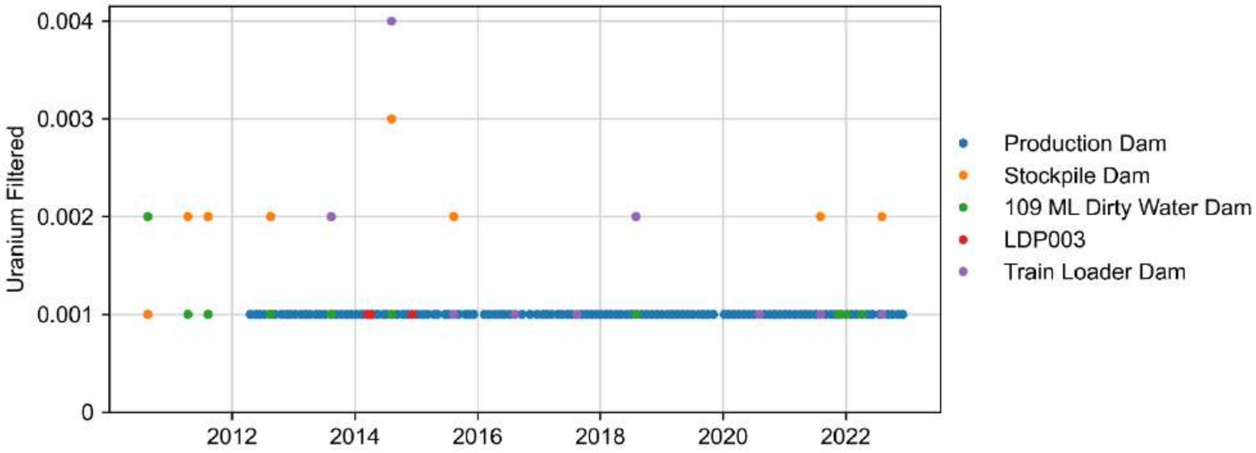

Strontium Filtered
0.6
0.5
0.4
0.3
0.2
0.1
0
2012
2014
2016
2018
2020
2022
Production Dam
Stockpile Dam
109 ML Dirty Water Dam
LDP003
Train Loader Dam

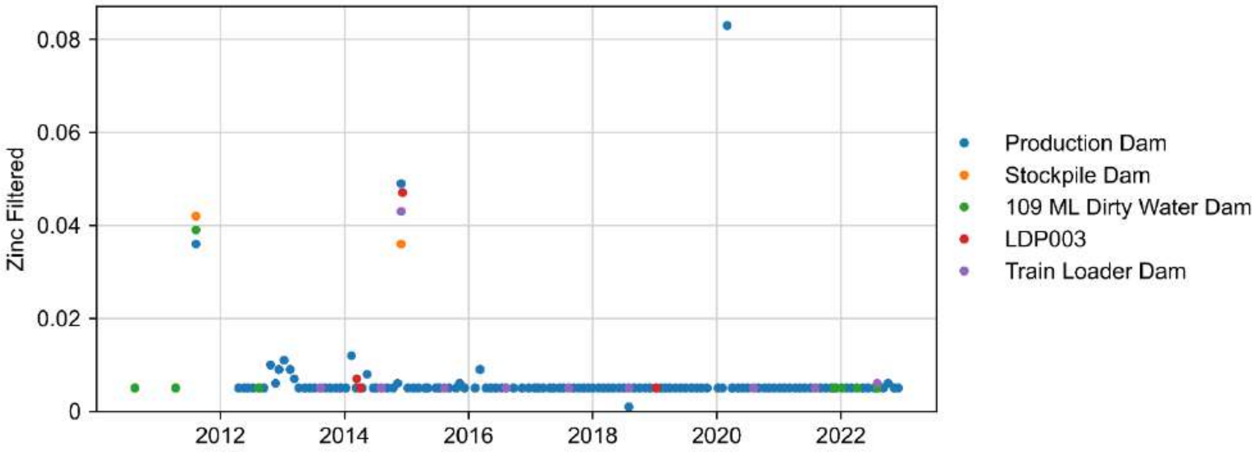

Thallium Filtered
0.001
0.0008
0.0006
0.0004
0.0002
0
2012
2014
2016
2018
2020
2022
Production Dam
Stockpile Dam
109 ML Dirty Water Dam
LDP003
Train Loader Dam


Thorium Filtered
0.002
0.0015
0.001
0.0005
0
2012
2014
2016
2018
2020
2022
Production Dam
Stockpile Dam
109 ML Dirty Water Dam
LDP003
Train Loader Dam

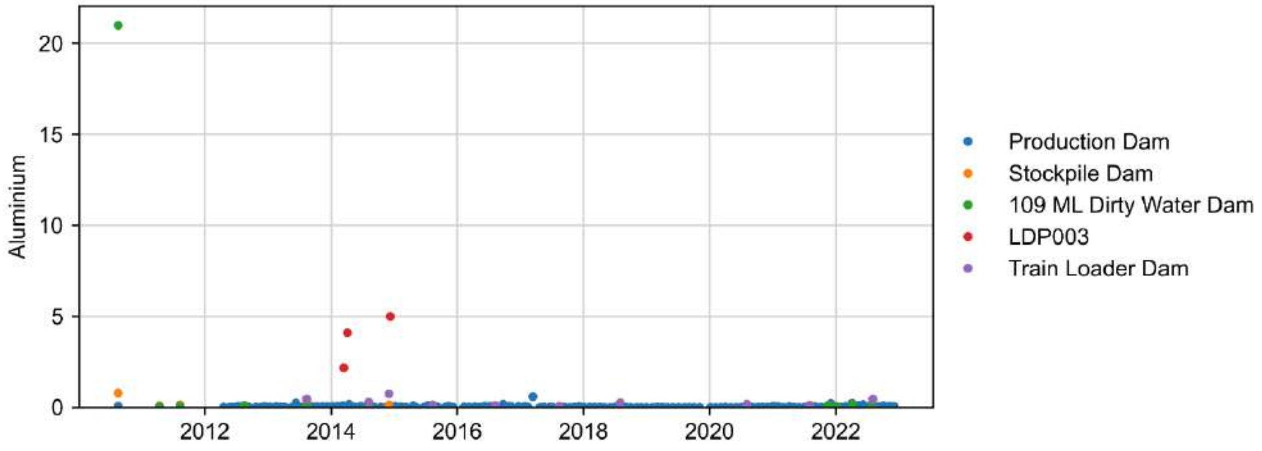

Tin Filtered
0.002
0.0015
0.001
0.0005
0
2012
2014
2016
2018
2020
2022
Production Dam
Stockpile Dam
109 ML Dirty Water Dam
LDP003
Train Loader Dam

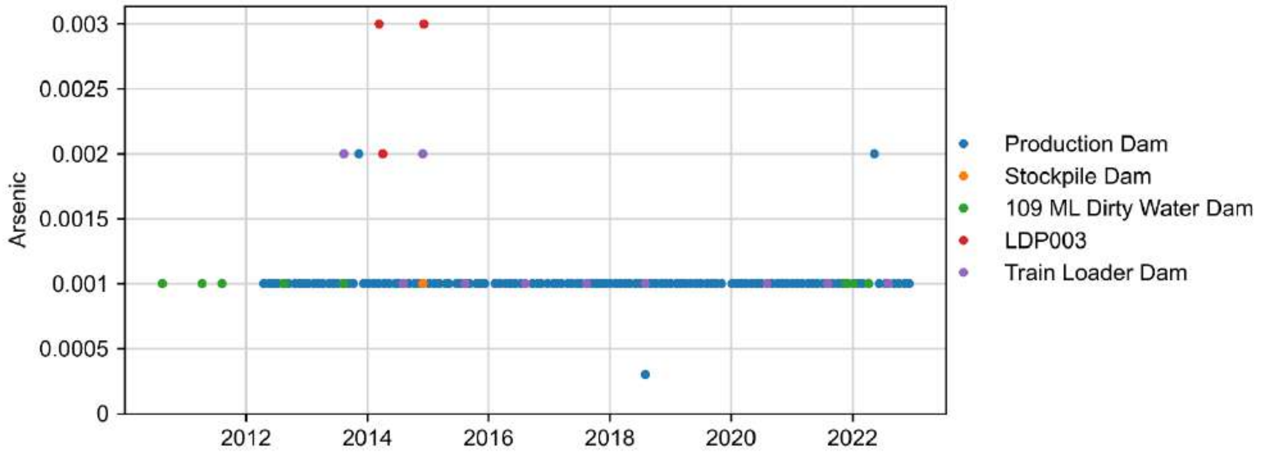

Titanium Filtered
0.04
0.03
0.02
0.01
0
2012
2014
2016
2018
2020
2022
Production Dam
Stockpile Dam
109 ML Dirty Water Dam
LDP003
Train Loader Dam

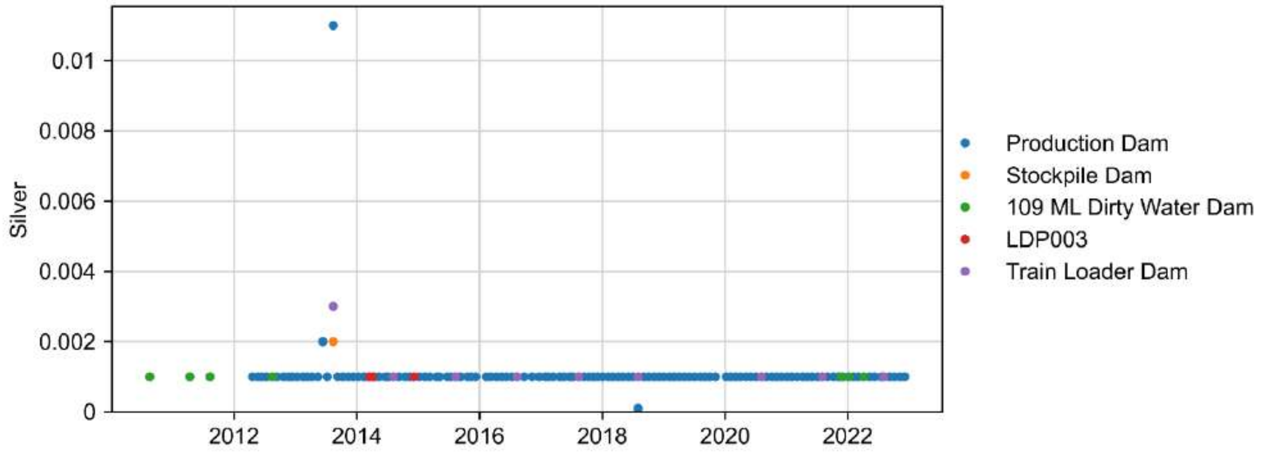

Uranium Filtered
0.004
0.003
0.002
0.001
0
2012
2014
2016
2018
2020
2022
Production Dam
Stockpile Dam
109 ML Dirty Water Dam
LDP003
Train Loader Dam

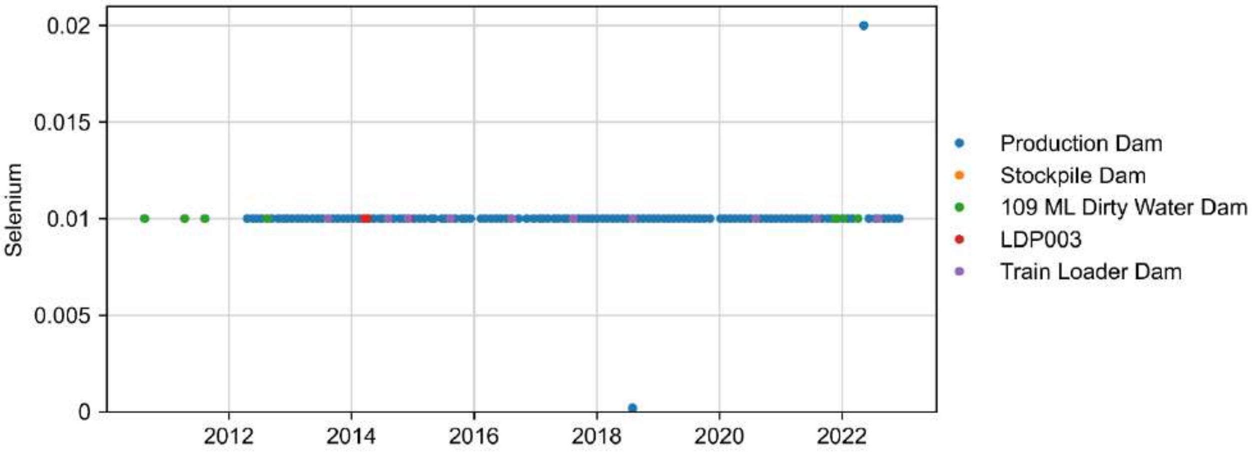

Zinc Filtered
0.08
0.06
0.04
0.02
0
2012
2014
2016
2018
2020
2022
Production Dam
Stockpile Dam
109 ML Dirty Water Dam
LDP003
Train Loader Dam

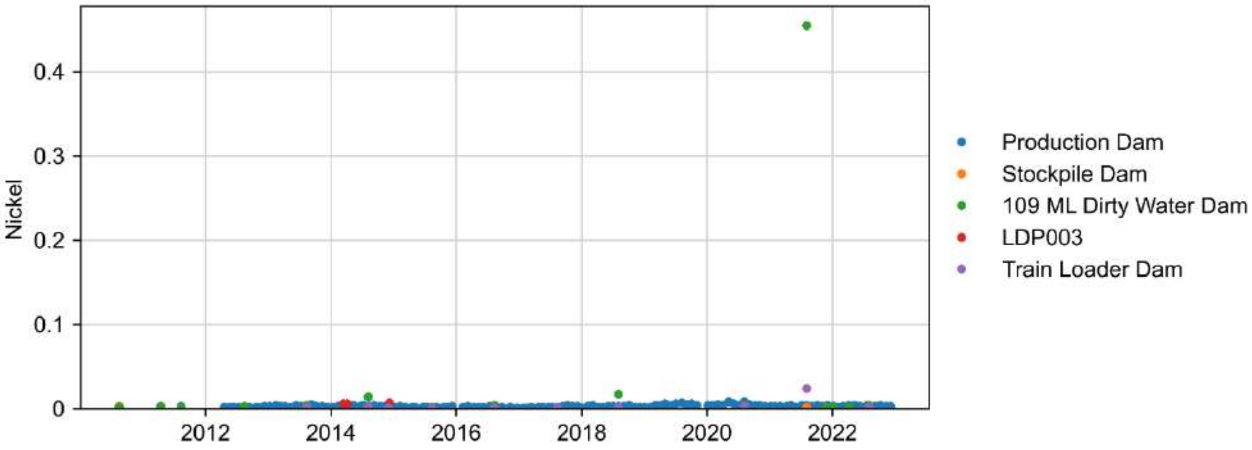
Total Metals

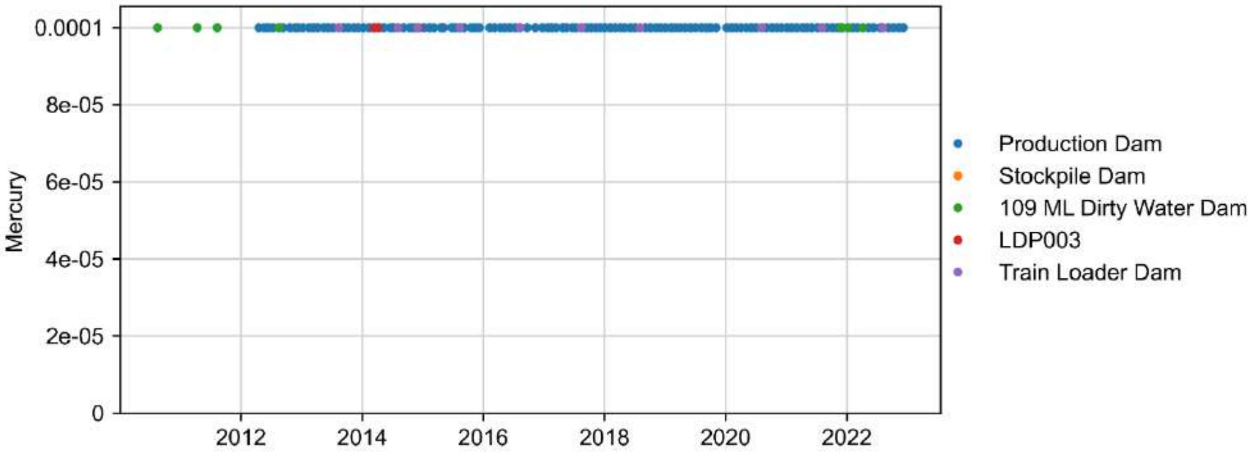


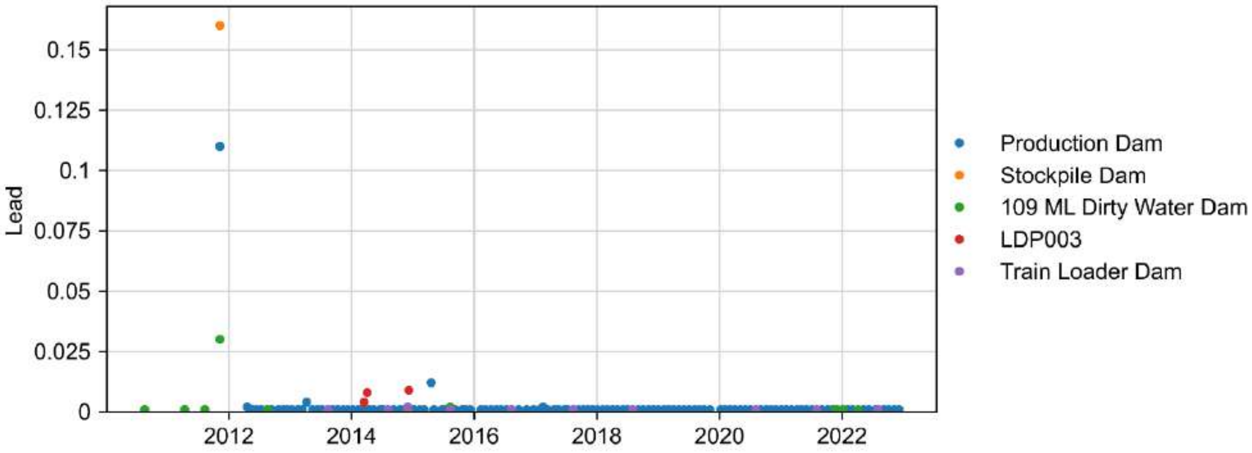


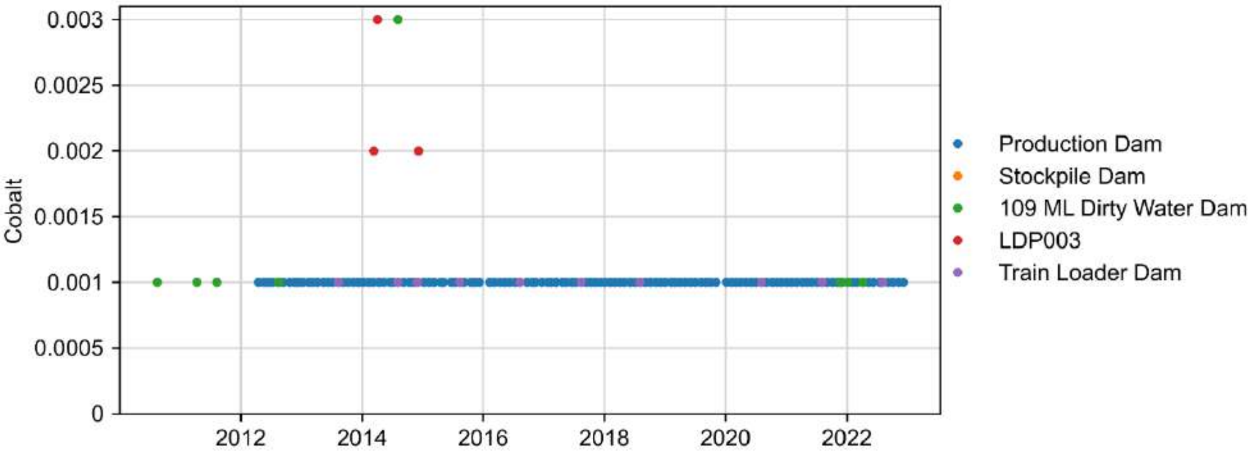


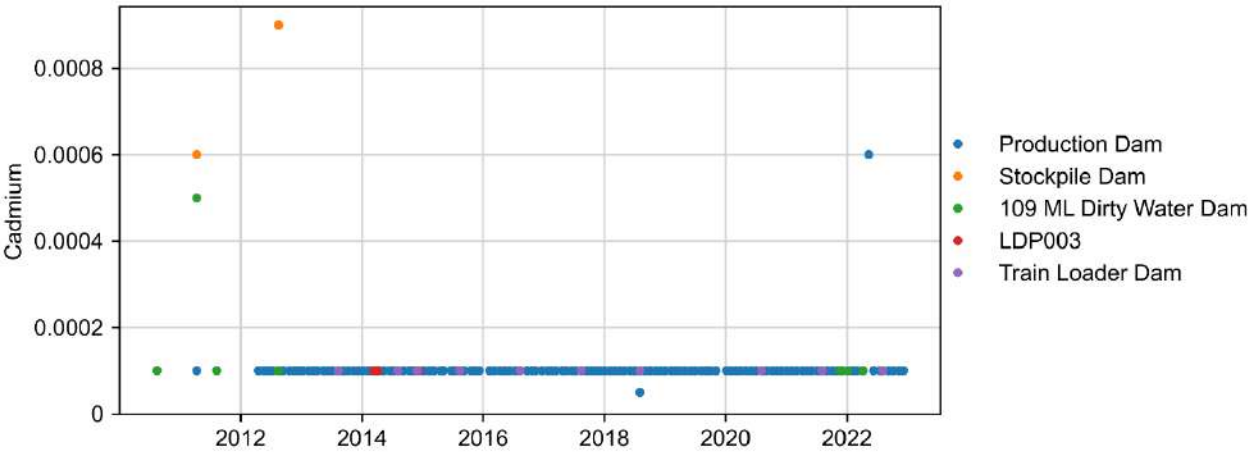

Selenium
0.02
0.015
0.01
0.005
0
2012
2014
2016
2018
2020
2022
● Production Dam
● Stockpile Dam
● 109 ML Dirty Water Dam
● LDP003
● Train Loader Dam

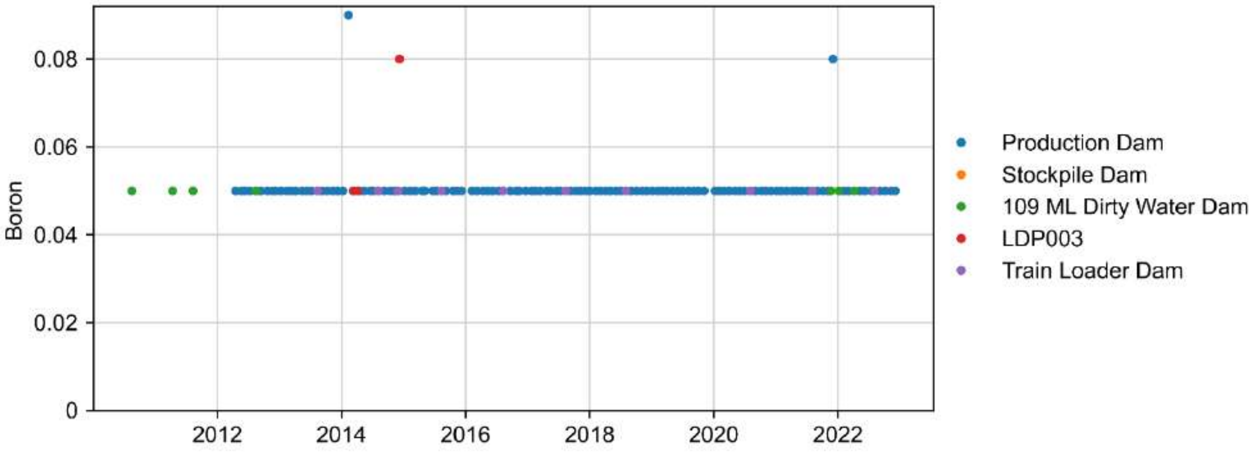

Nickel
0.4
0.3
0.2
0.1
0
2012
2014
2016
2018
2020
2022
● Production Dam
● Stockpile Dam
● 109 ML Dirty Water Dam
● LDP003
● Train Loader Dam

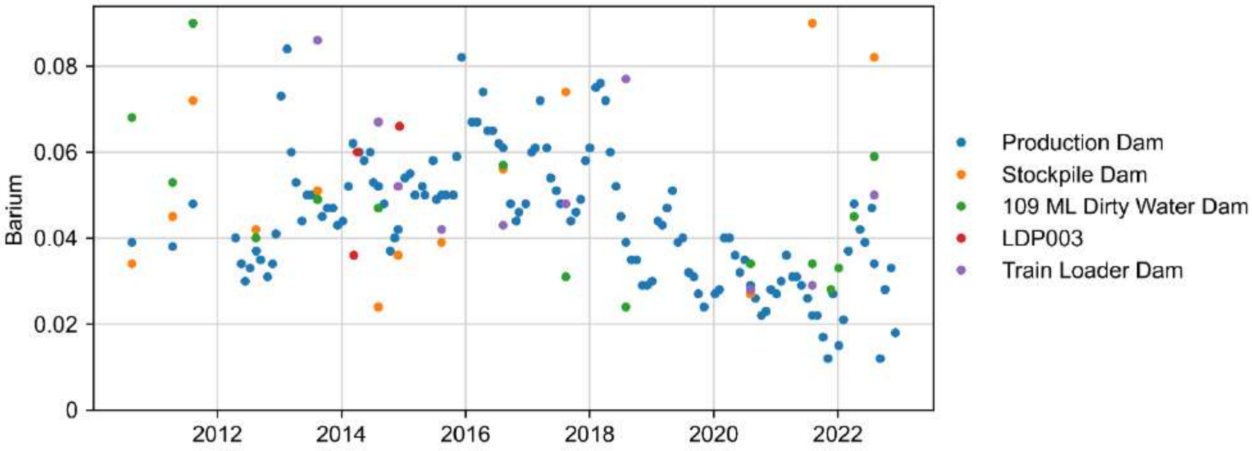

Mercury
0.0001
8e-05
6e-05
4e-05
2e-05
0
2012
2014
2016
2018
2020
2022
● Production Dam
● Stockpile Dam
● 109 ML Dirty Water Dam
● LDP003
● Train Loader Dam

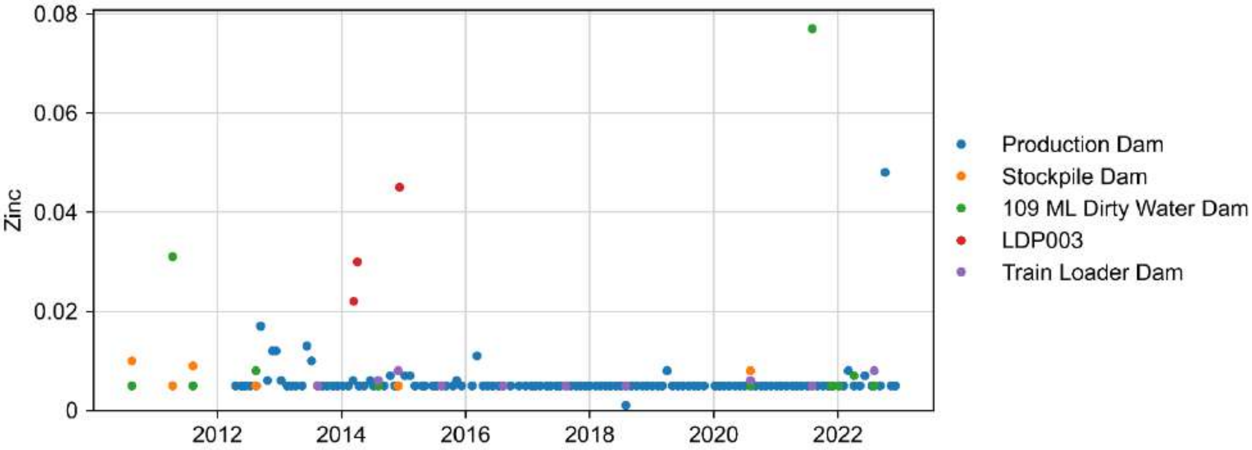

Lead
0.15
0.125
0.1
0.075
0.05
0.025
0
2012
2014
2016
2018
2020
2022
Production Dam
Stockpile Dam
109 ML Dirty Water Dam
LDP003
Train Loader Dam


Cobalt
0.003
0.0025
0.002
0.0015
0.001
0.0005
0
2012
2014
2016
2018
2020
2022
Production Dam
Stockpile Dam
109 ML Dirty Water Dam
LDP003
Train Loader Dam

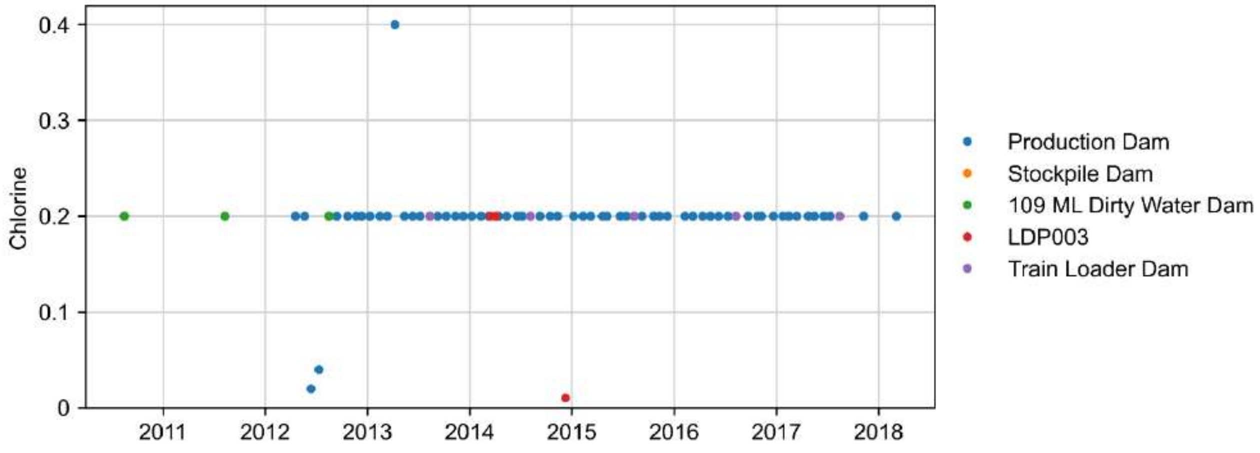

Cadmium
0.0008
0.0006
0.0004
0.0002
0
2012
2014
2016
2018
2020
2022
Production Dam
Stockpile Dam
109 ML Dirty Water Dam
LDP003
Train Loader Dam


Boron
0.08
0.06
0.04
0.02
0
2012
2014
2016
2018
2020
2022
Production Dam
Stockpile Dam
109 ML Dirty Water Dam
LDP003
Train Loader Dam

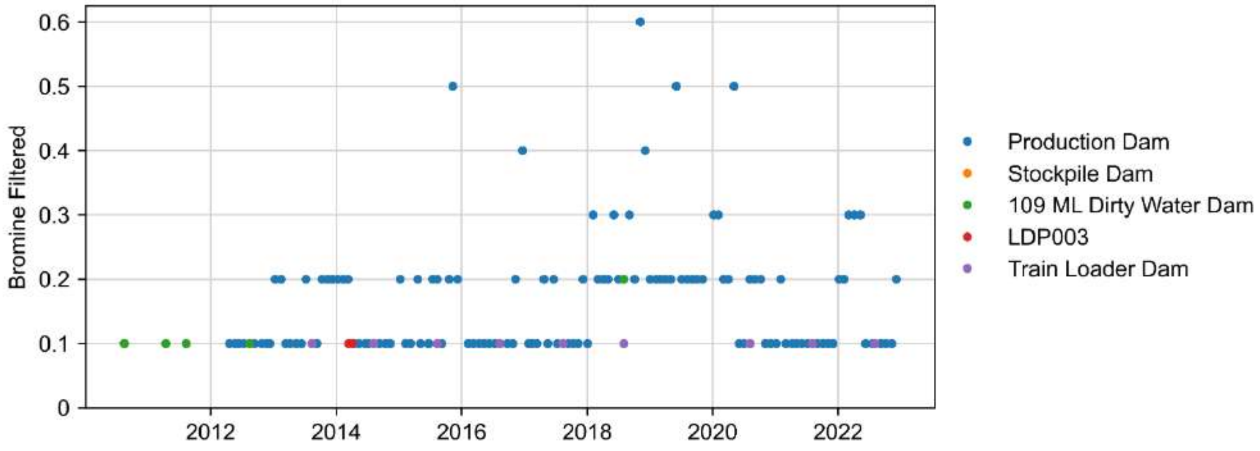

Barium
0.08
0.06
0.04
0.02
0
2012
2014
2016
2018
2020
2022
Production Dam
Stockpile Dam
109 ML Dirty Water Dam
LDP003
Train Loader Dam


Zinc
0.08
0.06
0.04
0.02
0
2012
2014
2016
2018
2020
2022
Production Dam
Stockpile Dam
109 ML Dirty Water Dam
LDP003
Train Loader Dam

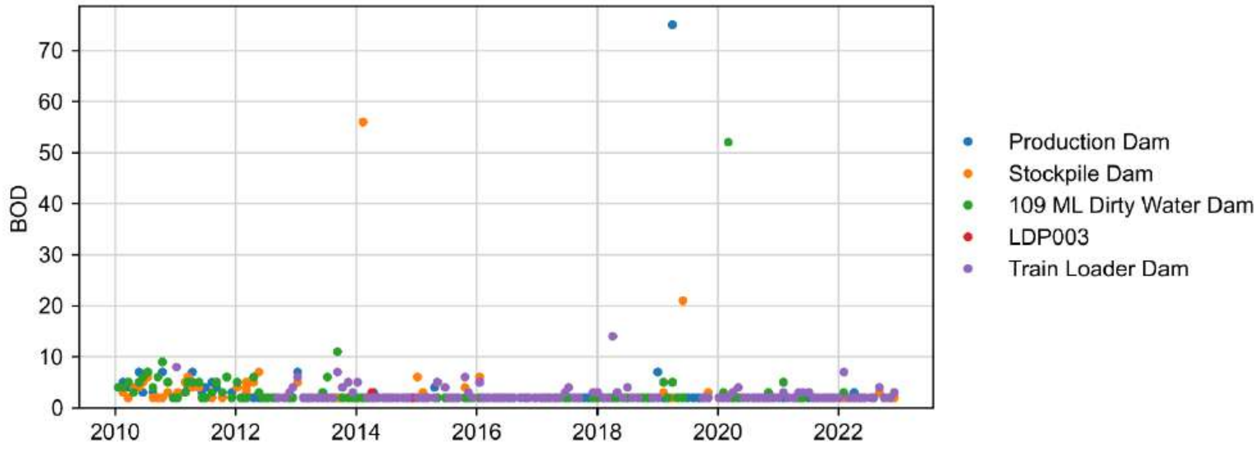
Other



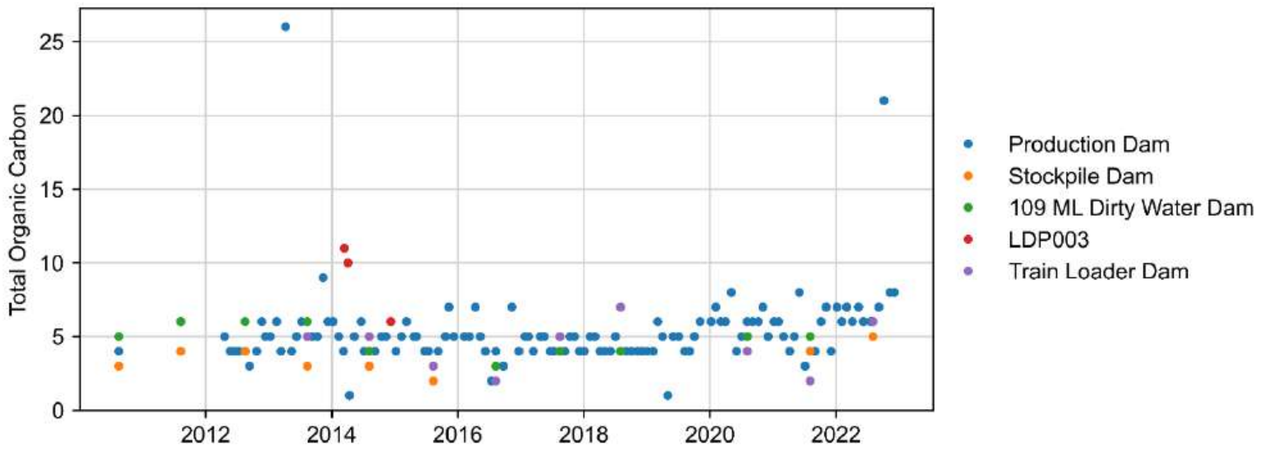
0.4
0.3
0.2
0.1
0
Chlorine
2011
2012
2013
2014
2015
2016
2017
2018
Production Dam
Stockpile Dam
109 ML Dirty Water Dam
LDP003
Train Loader Dam



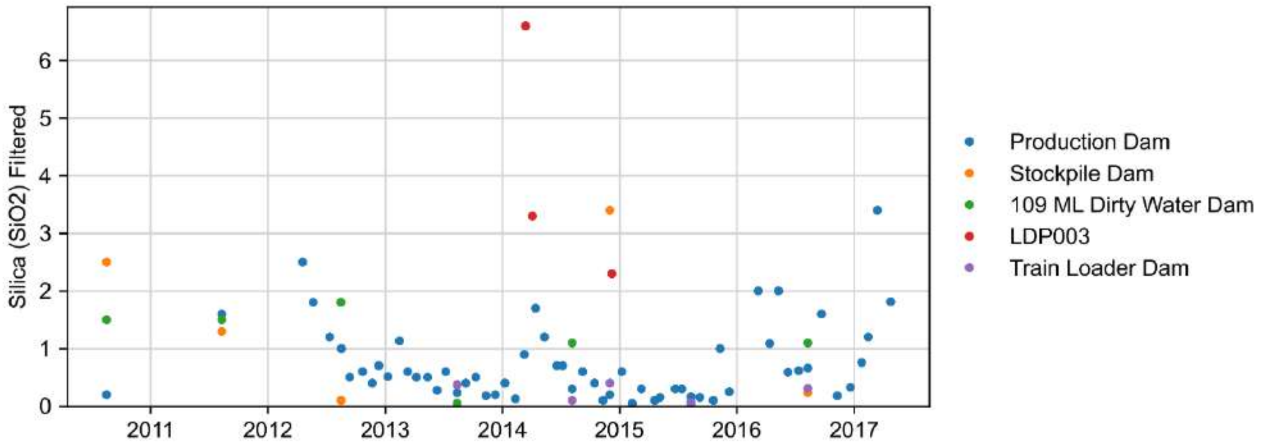
0.6
0.5
0.4
0.3
0.2
0.1
0
Bromine Filtered
2012
2014
2016
2018
2020
2022
Production Dam
Stockpile Dam
109 ML Dirty Water Dam
LDP003
Train Loader Dam



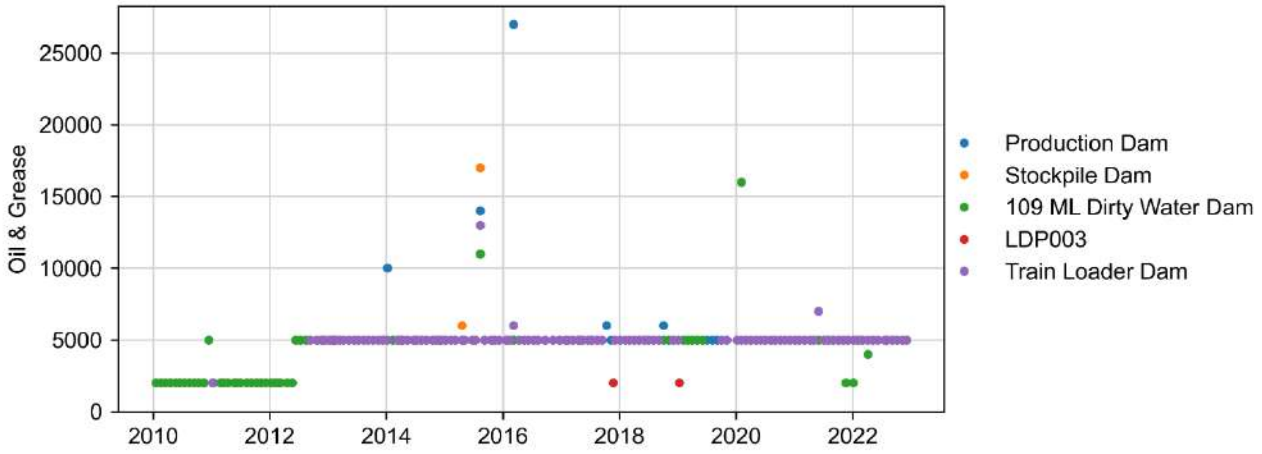
70
60
50
40
30
20
10
0
BOD
2010
2012
2014
2016
2018
2020
2022
Production Dam
Stockpile Dam
109 ML Dirty Water Dam
LDP003
Train Loader Dam



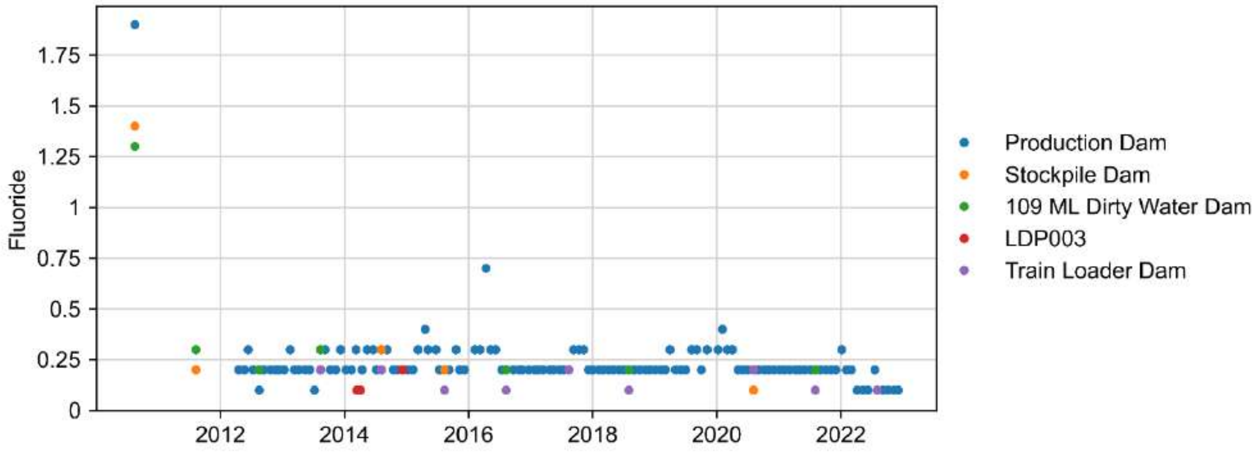
Total Organic Carbon
0
5
10
15
20
25
2012
2014
2016
2018
2020
2022
Production Dam
Stockpile Dam
109 ML Dirty Water Dam
LDP003
Train Loader Dam



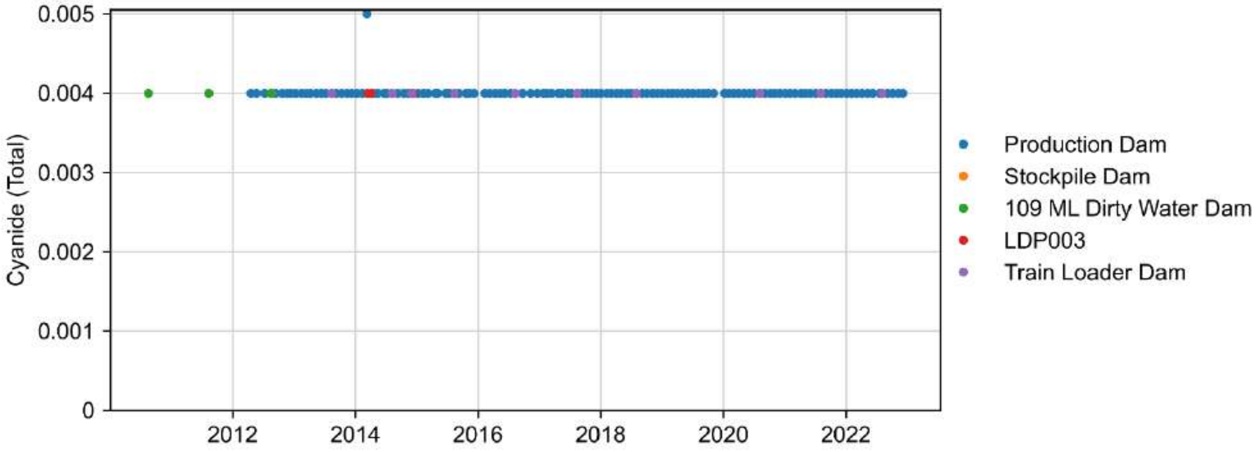
Silica (SiO2) Filtered
0
1
2
3
4
5
6
2011
2012
2013
2014
2015
2016
2017
Production Dam
Stockpile Dam
109 ML Dirty Water Dam
LDP003
Train Loader Dam



Oil & Grease
0
5000
10000
15000
20000
25000
2010
2012
2014
2016
2018
2020
2022
Production Dam
Stockpile Dam
109 ML Dirty Water Dam
LDP003
Train Loader Dam



Fluoride
1.75
1.5
1.25
1
0.75
0.5
0.25
0
2012
2014
2016
2018
2020
2022
● Production Dam
● Stockpile Dam
● 109 ML Dirty Water Dam
● LDP003
● Train Loader Dam



Cyanide (Total)
0.005
0.004
0.003
0.002
0.001
0
2012
2014
2016
2018
2020
2022
● Production Dam
● Stockpile Dam
● 109 ML Dirty Water Dam
● LDP003
● Train Loader Dam

Appendix C

SSGV and DGV summary

Surface water

Table C.1 Airly creek SSGV summary

Parameter	Units	Trigger Values (WMP ((GHD, 2021)	Maximum observed Concentration		
			2022		
			Airly Creek	Airly Creek Upstream	Airly Tributary
Physiochemical Parameters					
EC	µS/cm	2709	2020	2140	2240
pH	pH units	6.5 – 8.0	7.7-7.9	8	7.4-7.9
TSS	mg/L	25	4	3	9
Turbidity	NTU	25	1.6	1.6	3.5
Nutrients					
Ammonia	mg/L	0.32	0.27	0.02	0.04
Total nitrogen	mg/L	0.7	0.6	0.7	1.2
Total phosphorus	mg/L	0.056	0.04	0.03	0.05
Dissolved metals					
Aluminium	mg/L	0.027	0.01	0.01	0.01
Antimony	mg/L	0.001	0.001	0.001	0.001
Barium	mg/L	0.017	0.016	0.014	0.016
Beryllium	mg/L	0.001	0.001	0.001	0.001
Boron	mg/L	0.09	0.05	0.05	0.05
Cobalt	mg/L	0.001	0.001	0.001	0.002
Copper	mg/L	0.001	0.001	0.001	0.001
Iron	mg/L	0.3	0.15	0.05	0.25
Lead	mg/L	0.001	0.001	0.001	0.001
Manganese	mg/L	1.2	0.8	0.192	2.54
Molybdenum	mg/L	0.001	0.001	0.001	0.001
Nickel	mg/L	0.008	0.009	0.007	0.025
Silver	mg/L	0.001	0.0001	0.0001	0.0001
Zinc	mg/L	0.0076	0.008	0.005	0.014
Other					
Oil and grease	mg/L	5	5	5	5

Parameter	Units	Gap Creek	
		Trigger value (WMP (GHD, 2021))	Maximum Observed concentration 2022
Physiochemical parameters			
EC	µS/cm	178	137.9
pH	pH units	6.2 - 7.2	6.35-8.31
TDS	mg/L	130	90
Dissolved metals			
Arsenic	mg/L	0.001	0.001

Parameter	Units	Gap Creek	
		Trigger value (WMP (GHD, 2021))	Maximum Observed concentration 2022
Cadmium	mg/L	0.0001	0.0001
Chromium	mg/L	0.001	0.001
Copper	mg/L	0.002	0.005
Iron	mg/L	0.39	0.53
Lead	mg/L	0.001	0.001
Manganese	mg/L	0.053	0.037
Mercury	mg/L	0.0001	0.0001
Nickel	mg/L	0.002	0.003
Zinc	mg/L	0.014	0.008

Parameter	Units	Genowlan Creek 2	
		Trigger value (WMP (GHD, 2021))	Maximum Observed concentration 2022
Physiochemical parameters			
EC	µS/cm	52	59
pH	pH units	5.6 - 6.6	6.32-7.69
Dissolved metals			
Arsenic	mg/L	0.001	0.001
Cadmium	mg/L	0.0001	0.0001
Chromium	mg/L	0.001	0.002
Copper	mg/L	0.001	0.003
Iron	mg/L	0.06	0.05
Lead	mg/L	0.001	0.001
Manganese	mg/L	0.014	0.007
Mercury	mg/L	0.0001	0.0001
Nickel	mg/L	0.002	0.002
Zinc	mg/L	0.012	0.032

Parameter	Units	The Grotto	
		Trigger value (WMP (GHD, 2021))	Maximum Observed concentration 2022
Physiochemical parameters			
EC	µS/cm	60	64.3
pH	pH units	5.4 - 6.1	5.86-7.81
TDS	mg/L	56	40
Dissolved metals			
Arsenic	mg/L	0.001	0.002
Cadmium	mg/L	0.0001	0.0002

Parameter	Units	The Grotto	
		Trigger value (WMP (GHD, 2021))	Maximum Observed concentration 2022
Chromium	mg/L	0.001	0.002
Copper	mg/L	0.001	0.004
Iron	mg/L	0.51	0.59
Lead	mg/L	0.001	0.002
Manganese	mg/L	0.01	0.017
Mercury	mg/L	0.0001	0.0001
Nickel	mg/L	0.001	0.002
Zinc	mg/L	0.011	0.009

Groundwater

Parameter	Units	Village Spring	
		Trigger value	Maximum observed concentration
		(WMP (GHD, 2021))	2022
Physicochemical parameters			
EC	µS/cm	487	493.3
pH	pH units	7.8-8.3	6.49-7.96
TDS	mg/L	300	18
TSS	mg/L	16	18
Dissolved metals			
Arsenic	mg/L	0.001	0.001
Cadmium	mg/L	0.0001	0.0001
Chromium	mg/L	0.001	0.001
Copper	mg/L	0.001	0.002
Iron	mg/L	0.05	0.05
Lead	mg/L	0.001	0.001
Manganese	mg/L	0.004	0.002
Mercury	mg/L	0.0001	0.0001
Nickel	mg/L	0.004	0.012
Zinc	mg/L	0.026	0.037

Parameter	Units	ARP05	
		Trigger value	Maximum observed concentration
		(WMP (GHD, 2021))	2022
Physicochemical parameters			
EC	µS/cm	148	162.8
pH	pH units	5.8 – 6.0	5.9-7.6
TDS	mg/L	164	95

Parameter	Units	ARP05	
		Trigger value	Maximum observed concentration
		(WMP (GHD, 2021))	2022
Dissolved metals			
Arsenic	mg/L	0.001	0.001
Cadmium	mg/L	0.0001	0.0001
Chromium	mg/L	0.001	0.001
Copper	mg/L	0.002	0.008
Iron	mg/L	0.07	0.15
Lead	mg/L	0.001	0.001
Manganese	mg/L	0.009	0.014
Mercury	mg/L	0.0001	0.0001
Nickel	mg/L	0.003	0.011
Zinc	mg/L	0.086	0.063

Parameter	Units	ARP08SP	
		Default Guideline Value (ANZECC 2000)	Maximum observed concentration
			2022
Physicochemical parameters			
EC	µS/cm	350	6449
pH	pH units	6.5 – 9.0	12.59
TDS	mg/L	NA	3710
Dissolved metals			
Arsenic	mg/L	0.001	0.001
Cadmium	mg/L	0.00006	0.0001
Chromium	mg/L	0.00001	0.001
Copper	mg/L	0.001	0.014
Iron	mg/L	0.3	0.05
Lead	mg/L	0.001	0.002
Manganese	mg/L	1.2	0.002
Mercury	mg/L	0.00006	0.0001
Nickel	mg/L	0.008	0.005
Zinc	mg/L	0.0024	0.082

Parameter	Units	ARP09	
		Default Guideline Value (ANZECC 2000)	Maximum observed concentration
			2022
Physicochemical parameters			
EC	µS/cm	350	40.9
pH	pH units	6.5 – 9.0	4.73-6.40
TDS	mg/L	NA	27
Dissolved metals			
Arsenic	mg/L	0.001	0.001
Cadmium	mg/L	0.00006	0.0001
Chromium	mg/L	0.00001	0.002
Copper	mg/L	0.001	0.005
Iron	mg/L	0.3	2.62
Lead	mg/L	0.001	0.001
Manganese	mg/L	1.2	0.012
Mercury	mg/L	0.00006	0.0001
Nickel	mg/L	0.008	0.006
Zinc	mg/L	0.0024	0.056

Parameter	Units	ARP11	
		Trigger value	Maximum observed concentration
		(WMP (GHD, 2021))	2022
Physicochemical parameters			
EC	µS/cm	1760	1588
pH	pH units	6.6–7.2	6.47-6.73
TDS	mg/L	1170	1060
TSS	mg/L	–	-
Dissolved metals			
Arsenic	mg/L	0.002	0.002
Cadmium	mg/L	0.0001	0.0001
Chromium	mg/L	0.001	0.002
Copper	mg/L	0.002	0.005
Iron	mg/L	1.14	0.68
Lead	mg/L	0.001	0.001
Manganese	mg/L	0.343	0.279
Mercury	mg/L	0.0001	0.0001
Nickel	mg/L	0.006	0.01
Zinc	mg/L	0.016	0.049

Parameter	**Units**	**ARP13SP**	
		Trigger value	**Maximum observed concentration**
		(WMP (GHD, 2021))	**2022**
Physicochemical parameters			
EC	µS/cm	760	601
pH	pH units	6.7 – 7.2	6.2-6.98
TDS	mg/L	463	393
Dissolved metals			
Arsenic	mg/L	0.002	0.001
Cadmium	mg/L	0.0001	0.0001
Chromium	mg/L	0.001	0.001
Copper	mg/L	0.002	0.005
Iron	mg/L	1.28	0.11
Lead	mg/L	0.001	0.001
Manganese	mg/L	0.31	0.15
Mercury	mg/L	0.0001	0.0001
Nickel	mg/L	0.003	0.013
Zinc	mg/L	0.033	0.086

Parameter	**Units**	**SPP15SP**	
		Trigger value	**Maximum observed concentration**
		(WMP (GHD, 2021))	**2022**
Physicochemical parameters			
EC	µS/cm	109	193.5
pH	pH units	5.9 – 7.5	4.97-7.18
TDS	mg/L	71	64
Dissolved metals			
Arsenic	mg/L	0.001	0.001
Cadmium	mg/L	0.0001	0.0001
Chromium	mg/L	0.001	0.001
Copper	mg/L	0.001	0.002
Iron	mg/L	1.54	0.22
Lead	mg/L	0.003	0.001
Manganese	mg/L	0.282	0.174
Mercury	mg/L	0.0001	0.0001
Nickel	mg/L	0.011	0.008
Zinc	mg/L	0.067	0.086

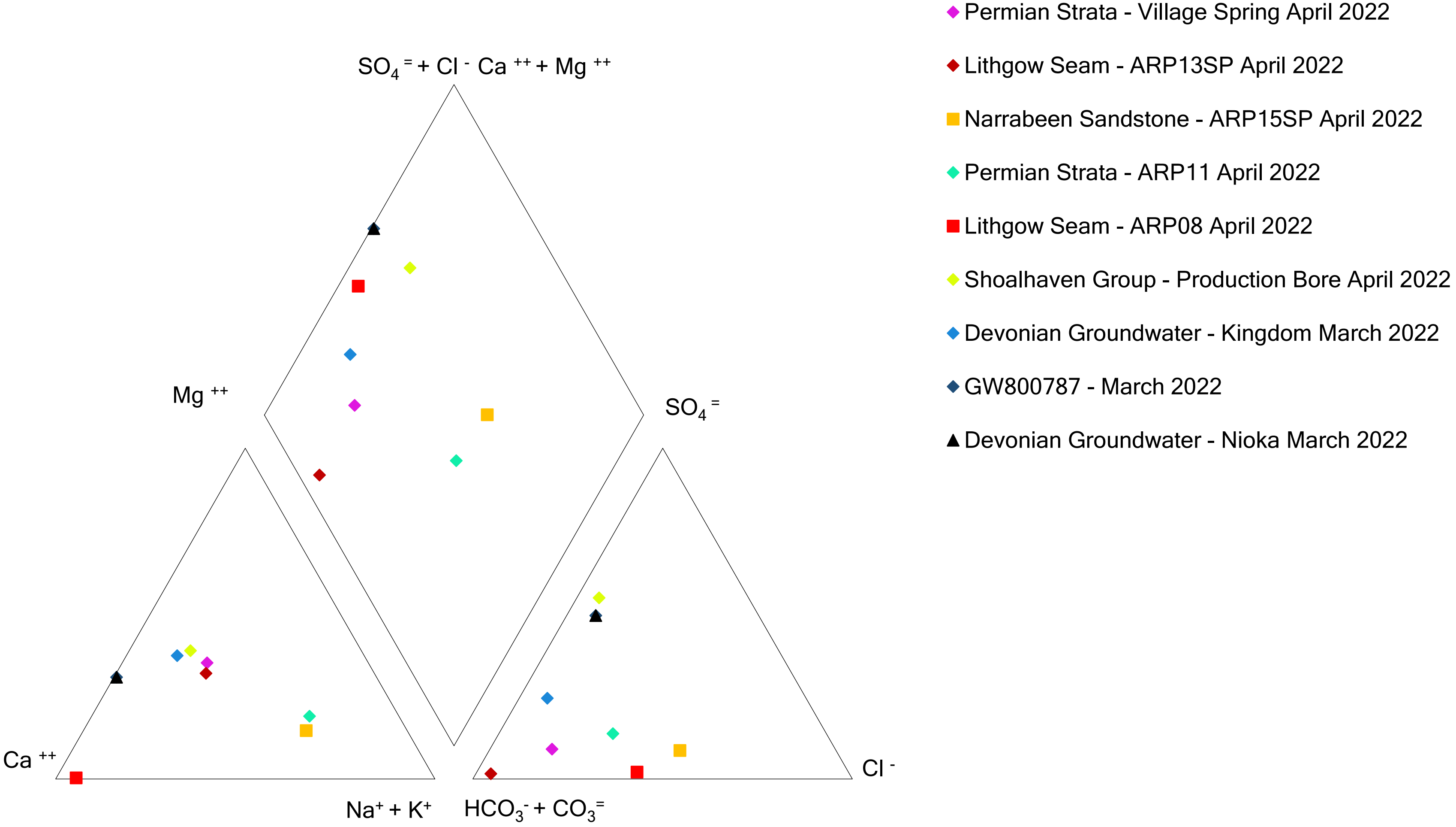
Table C.2 Landholder bores

Parameter	Units	Default Guideline Value (ANZECC 2000)	Nioka	Kingdom	GW800787
			Maximum observed concentration		
			2022		
Physicochemical parameters					
EC	µS/cm	350	1562	1116	766
pH	pH units	6.5 – 9.0	7.12	6.96	7.35
Dissolved metals					
Aluminium	mg/L	0.055	0.01	0.01	0.01
Arsenic	mg/L	0.001	0.001	0.001	0.001
Boron	mg/L	0.94	0.05	0.05	0.05
Cadmium	mg/L	0.00006	0.0001	0.0001	0.0001
Chromium	mg/L	0.000011	0.001	0.001	0.001
Copper	mg/L	0.001	0.003	0.01	0.001
Iron	mg/L	0.3	0.05	0.05	0.31
Lead	mg/L	0.001	0.001	0.001	0.001
Manganese	mg/L	1.2	0.002	0.001	0.037
Mercury	mg/L	0.000061	0.0001	-	-
Nickel	mg/L	0.008	0.006	0.001	0.012
Zinc	mg/L	0.00241	0.101	0.015	0.022

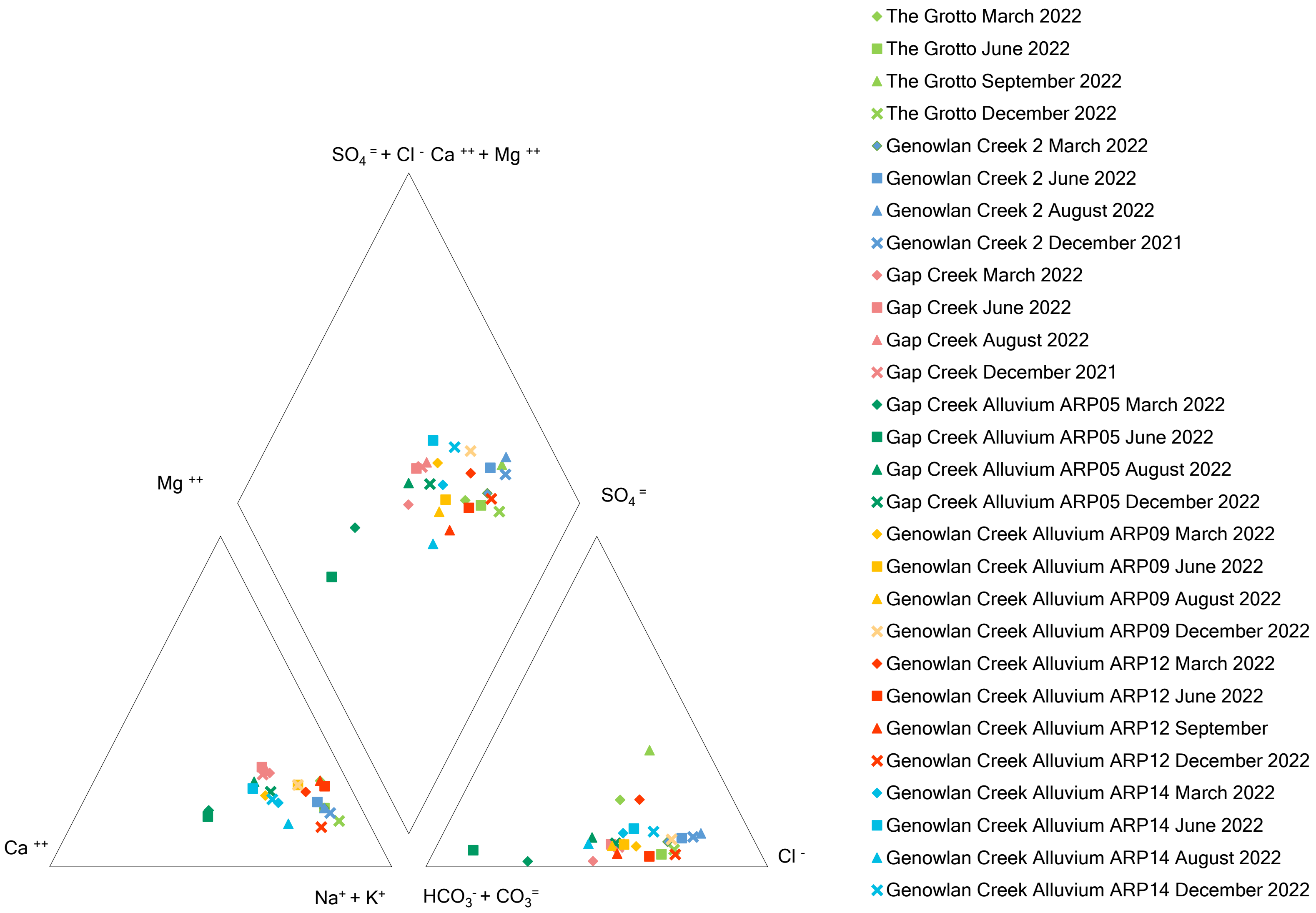
Appendix D

Piper Charts

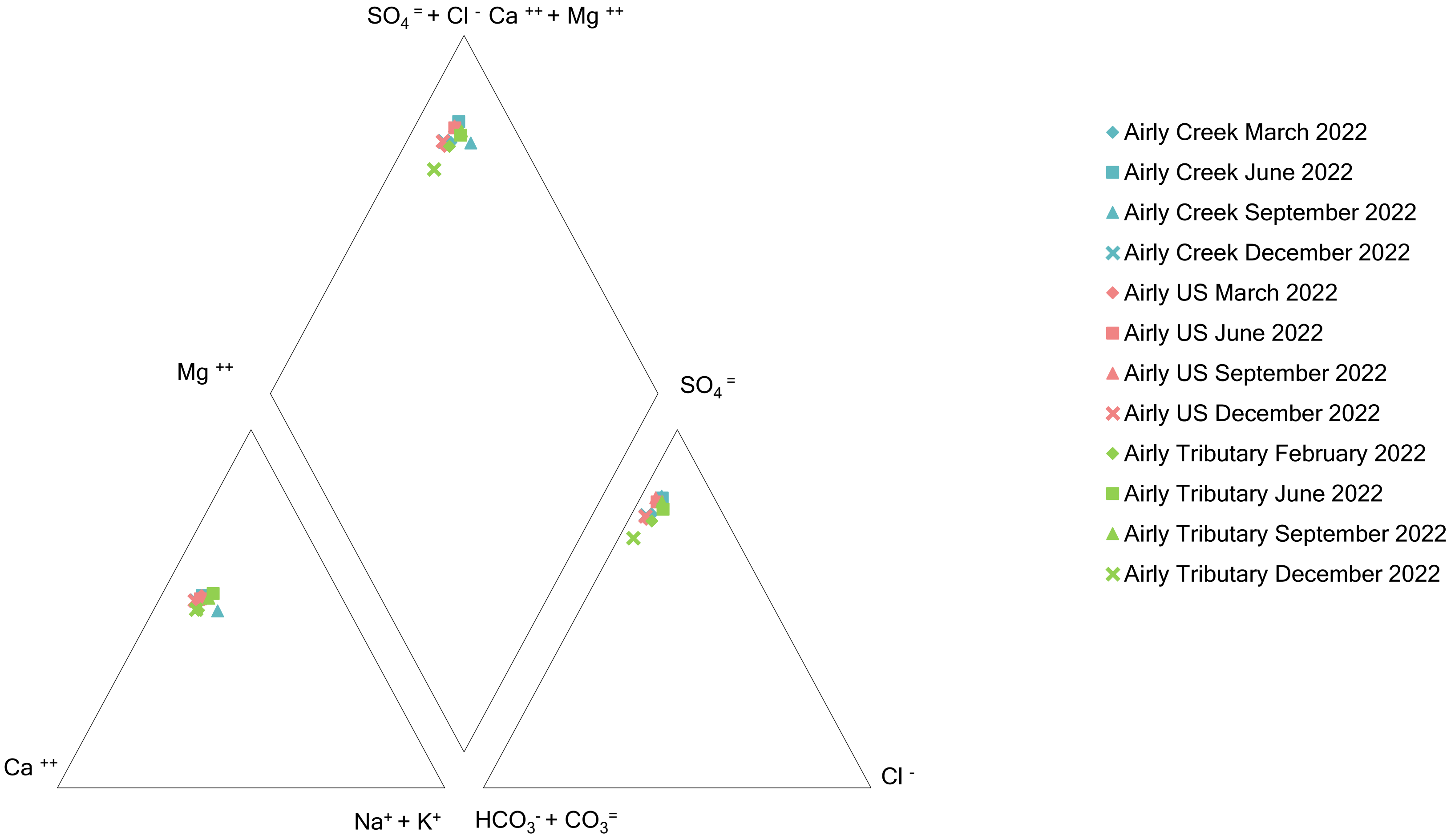
Permian and Fractured Rock Groundwater



Genowlan Creek and alluvial bores



Airly Creek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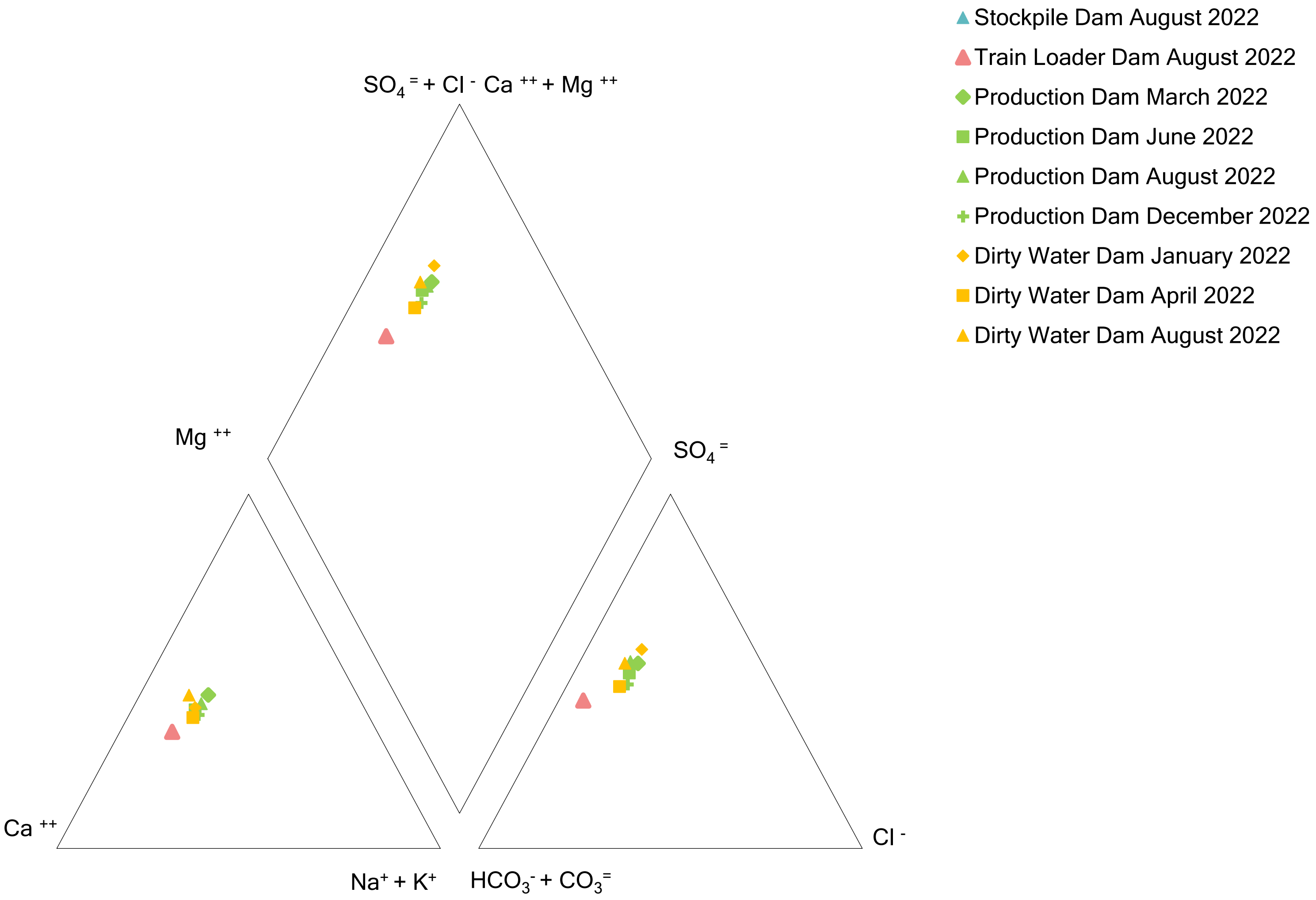
Mg ++
SO4 =
Ca ++
Cl -
Na+ + K+
HCO3- + CO3=
Airly Creek March 2022
Airly Creek June 2022
Airly Creek September 2022
Airly Creek December 2022
Airly US March 2022
Airly US June 2022
Airly US September 2022
Airly US December 2022
Airly Tributary February 2022
Airly Tributary June 2022
Airly Tributary September 2022
Airly Tributary December 2022

Surface dam storages



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→ The Power of Commitment

Appendix 7: Airly Mine Watercourse Stability Monitoring Report

Airly Mine

Watercourse stability monitoring report

Centennial Airly Pty Ltd

03 March 2023

→ **The Power of Commitment**

Project name	Airly aquatic ecology, stygofauna and geomorphology 2022
Document title	Airly Mine | Watercourse stability monitoring report
Project number	12570462
File name	12570462-REP-Airly 2022 watercourse stability monitoring report.docx

Status Code	**Revision**	**Author**	**Reviewer**		**Approved for issue**		
			Name	**Signature**	**Name**	**Signature**	**Date**
S4	0	A Harvey	T Tinkler	T.G.Till	Z Lagerroth		03/03/23

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→ **The Power of Commitment**

Statement of compliance

Overarching Review

Statement of Compliance Question	Statement of Compliance Answer
Were all conditions of SSD_5581 and the Airly Mine Water Management Plan relating to geomorphology complied with?	Yes – There were no non-compliances relating to watercourse geomorphology or watercourse stability in the 2022 reporting period

Details of Non-Compliances

Relevant Approval	Condition #	Condition summary	Compliance Status	Comment	Reference # addressed in Annual Review
NA			Compliant		

Development consent SSD-5581 (Modification 2) conditions relating to surface waters

Condition	Condition description	Compliant	Relevant section of this document
Water management performance measures			
Water discharge to Airly Creek			
Schedule 4 12.	Negligible environmental consequences for water quality (i.e.. protection to 99% of all species in accordance with ANZECC guidelines) and flow in Airly Creek where it enters the Gardens of Stone National Park and Greater Blue Mountains World Heritage Area	Yes	NA Refer to Aquatic Ecology 2022 Annual Report (GHD 2023a) and 2022 Annual Water Monitoring Report (GHD 2023b)
Gap and Genowlan Creeks			
Schedule 4 12.	No greater impact than predicted in the EIS for water, flow and quality	Yes	NA Refer to Aquatic Ecology 2022 Annual Report (GHD 2023a) and 2022 Annual Water Monitoring Report (GHD 2023b)
Aquatic and riparian ecosystems			
Schedule 4 12.	Maintain or improve baseline channel stability	Yes	Refer to Section 3
	Develop site-specific water quality objectives in accordance with ANZECC Guidelines and Using the ANZECC Guidelines and Water Quality Objectives in NSW procedures (DECC 2006) or its latest version	Yes	NA Refer to Site Specific Guideline Values document (GHD 2018). Also refer to Section 6 of WMP (GHD 2023c, not yet approved)
Water management plan			
Schedule 4 13.	Prior to carrying out any development under this consent, unless the Secretary agrees otherwise, the Applicant must prepare a Water Management Plan for the development to the satisfaction of the Secretary. This plan must:		
Schedule 4 13. (a)	Be prepared in consultation with the DoEE, EPA and the Water Division, by suitably qualified and experienced person/s whose appointment has been approved by the Secretary.	Yes	NA Refer to Appendix A and Appendix B of WMP (GHD 2023c)
Schedule 4 13. (b)	Include detailed performance criteria and describe measures to ensure that the Applicant complies with the Water Management Performance Measures (see Table 6).	Yes	NA Refer to Table 1-3 and Section 6 of WMP (GHD 2023c)

Condition	Condition description	Compliant	Relevant section of this document
Site water balance			
Schedule 4 13. (c) (i)	Details of sources and security of water supply, including contingency supply for future reporting periods.	Yes	NA Refer to Section 3.1 and Section 3.5.1 of the WMP (GHD 2023c)
	Details of water use and management on site.	Yes	NA Refer to Section 3 of WMP (GHD 2023c) and 2022 Annual Water Monitoring Report (GHD 2023b)
	Details of any off-site water discharges.	Yes	NA Refer to Section 3.5.2 of WMP (GHD 2023c) and 2022 Annual Water Monitoring Report (GHD 2023b)
	Reporting procedures, including the preparation of a site water balance for each calendar year.	Yes	NA Refer to 2022 Annual Water Monitoring Report (GHD 2023b) and Section 7.4 of WMP (GHD 2023c)
	Investigates and implements all reasonable and feasible measures to minimise water use on site.	Yes	NA Refer to Section 3.5.1 of WMP (GHD 2023c)
Surface water management plan			
Schedule 4 13. (c) (ii)	Detailed baseline data on water flows and quality in the watercourses that could potentially be affected by the development, including, but not limited to Gap, Genowlan and Airly Creeks.	Yes	NA Refer to Aquatic Ecology 2022 Annual Report (GHD 2023a) and 2022 Annual Water Monitoring Report (GHD 2023b). Also refer to Section 5.1 of WMP (GHD 2023c)
	Continuous flow monitoring at Airly village spring and the Grotto.	Yes	NA Refer to WMP (GHD 2023c) and 2022 Annual Water Monitoring Report (GHD 2023b)
	Provisions for the recalculation of site-specific trigger values in relation to water discharges to Airly Creek once a minimum of two years data is obtained from the Airly Creek 'U/S' monitoring location in accordance with ANZECC guidelines.	Yes	NA Refer to Site Specific Guideline Values document (GHD 2018) and Section 6.1.1 of WMP (GHD 2023c)
	The provision and implementation of adaptive management measures to ensure that subsequent water discharges to Airly Creek comply with the recalculated site-specific trigger values derived from the Airly Creek 'U/S' monitoring location.	Yes	NA Refer to TARPs in Appendix E of the WMP (GHD 2023c)
	A detailed description of the water management system, including the: – Clean water diversion systems – Erosion and sediment controls (mine water system); and – Mine water management systems	Yes	NA Refer to Section 3.2 and Section 3.3 of WMP (GHD 2023c)
	Detailed objectives and performance criteria, including trigger levels for investigating any potentially adverse impacts associated with the development for:		
	Downstream surface water quality	Yes	NA Refer to Section 6 of WMP (GHD 2023c) and 2022 Annual Water Monitoring Report (GHD 2023b)

Condition	Condition description	Compliant	Relevant section of this document
	Downstream water users, including with respect to any subsidence-related flow reductions in Gap and Genowlan Creeks.	Yes	NA Refer to Section 6 of WMP (GHD 2023c)
	Stream and riparian vegetation health in Gap, Genowlan and Airly Creeks within and immediately outside of the site.	Yes	NA Performance criteria for instream health outlined in Table 1.1 Refer to Aquatic Ecology 2022 Annual Report (GHD 2023a) Riparian vegetation assessment outlined in Airly Site specific Biodiversity Management Plan (BMP)
	A program to monitor and report on:		
	Effectiveness of the mine water management system.	Yes	NA Refer to Section 4 of the WMP (GHD 2023c)
	Surface water flows, quality and geomorphology of the watercourses potentially affected by the development within and immediately outside of the site.	Yes	Refer Section 3. Monitoring program for surface water flows, quality and geomorphology outlined in Section 4 of WMP (GHD 2023c) Monitoring results for water quality and flow addressed in the 2022 Annual Water Monitoring Report (GHD 2023b) and Aquatic Ecology 2022 Annual Report (GHD 2023a)
Schedule 4 13. (c) (ii)	The performance measures listed in Table 6 including, but not limited to event-based monitoring of the hydrology, quality, ecotoxicology and chemical composition of water in Airly Creek under discharge conditions at points 5 and 6, or as otherwise determined in consultation with the EPA, to ensure that protection is provided to 99% of all species in the Gardens of Stone National Park and Greater Blue Mountains World Heritage Area in accordance with ANZECC guidelines.	Yes	NA Refer to Section 4 and Appendix E of WMP (GHD 2023c) and 2022 Annual Water Monitoring Report (GHD 2023b)
	Reporting procedures for the results of the monitoring program.	Yes	NA Refer to Section 7.1 of WMP (GHD 2023c) and Regional WMP (GHD 2016)
	A plan to respond to any exceedances of performance measures, and repair, mitigate and/or offset any adverse surface water impacts of the development, including measures to provide compensatory water supply to any affected downstream water user.	Yes	NA Refer to Section 6.3 and Appendix E of WMP (GHD 2023c)

NA – not applicable to this report

Statement of commitments relating to geomorphology (GHD 2023c)

Commitment	Compliant	Relevant section of this document
Monitor geomorphic conditions of third order streams approximately every two years	Yes	Section 3.2

Stream health performance criteria relating to geomorphology (GHD 2023c)

Aspect	Criteria	Compliant	Relevant section of this document
Geomorphic condition and watercourse stability (required every two years)			
Bed and bank stability	Negligible environmental consequences to bed and bank stability for Gap and Genowlan Creeks. Maintain or improve baseline channel stability.	Yes, no changes to watercourse stability for Gap and Genowlan Creek were identified.	Section 4
Incisional processes and instabilities	Occurrence of erosional processes does not occur as a result of subsidence.	Yes, no changes to erosional processes potentially related to subsidence were identified.	
Stream gradient	Change in stream gradient does not vary beyond predictions of subsidence modelling.	NA, refer to Subsidence Monitoring Report.	
Watercourse subsidence	No connective cracking between the surface and underground workings. Subsidence does not vary beyond predictions of modelling.	Yes, no connective cracking was identified based on visual inspection of watercourses. Refer to Subsidence Monitoring Report for subsidence monitoring.	

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1. Introduction

1.1 Background

Airly Mine is an underground coal mine located near Capertee, approximately 40 km northwest of Lithgow, owned by Centennial Airly Pty Ltd (Centennial), as shown in Figure 1.1. Airly Mine was granted Development Consent (SSD-5581) for the extension of its underground coal mine on 15 December 2016. Development consent SSD-5581 has been modified twice to amend the wording of the development consent to remove restrictions on mining (Modification 1) and to allow the receipt of up to 170 ML/year of water from Charbon Colliery by rail.

Airly Mine currently has approval to extract up to 1.8 million tonnes per annum (Mtpa) of run of mine (ROM) coal from the Lithgow Seam using mining methods that incorporate extraction by first workings, partial pillar extraction or panel and pillar mining. ROM and product coal is transported off site by rail for the export and domestic markets.

SSD-5581 required the development of a water management plan (WMP), including a program to monitor and report on the “geomorphology of the watercourses potentially affected by the development within and immediately outside of the site”. Airly Mine’s WMP (GHD 2023c) states that watercourse stability monitoring is undertaken on third order streams within and immediately outside the site boundary (subject to access requirements), as shown in Figure 1.2, every two years.

1.2 Purpose of this report

The purpose of this report is to document the outcomes of the watercourse stability monitoring for 2022 to support the Annual Review for Airly Mine.

1.3 Scope and limitations

The scope of this report is to present the results of the watercourse stability monitoring undertaken at Airly Mine during autumn (21 February 2022) and spring 2022 (22 to 24 November 2022) and assess against the relevant develop consent conditions (refer to Section 1.4).

This report: has been prepared by GHD for Centennial Airly Pty Ltd and may only be used and relied on by Centennial Airly Pty Ltd for the purpose agreed between GHD and Centennial Airly Pty Ltd as set out in Section 1.2 of this report.

GHD otherwise disclaims responsibility to any person other than Centennial Airly Pty Ltd arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

1.4 Development consent conditions

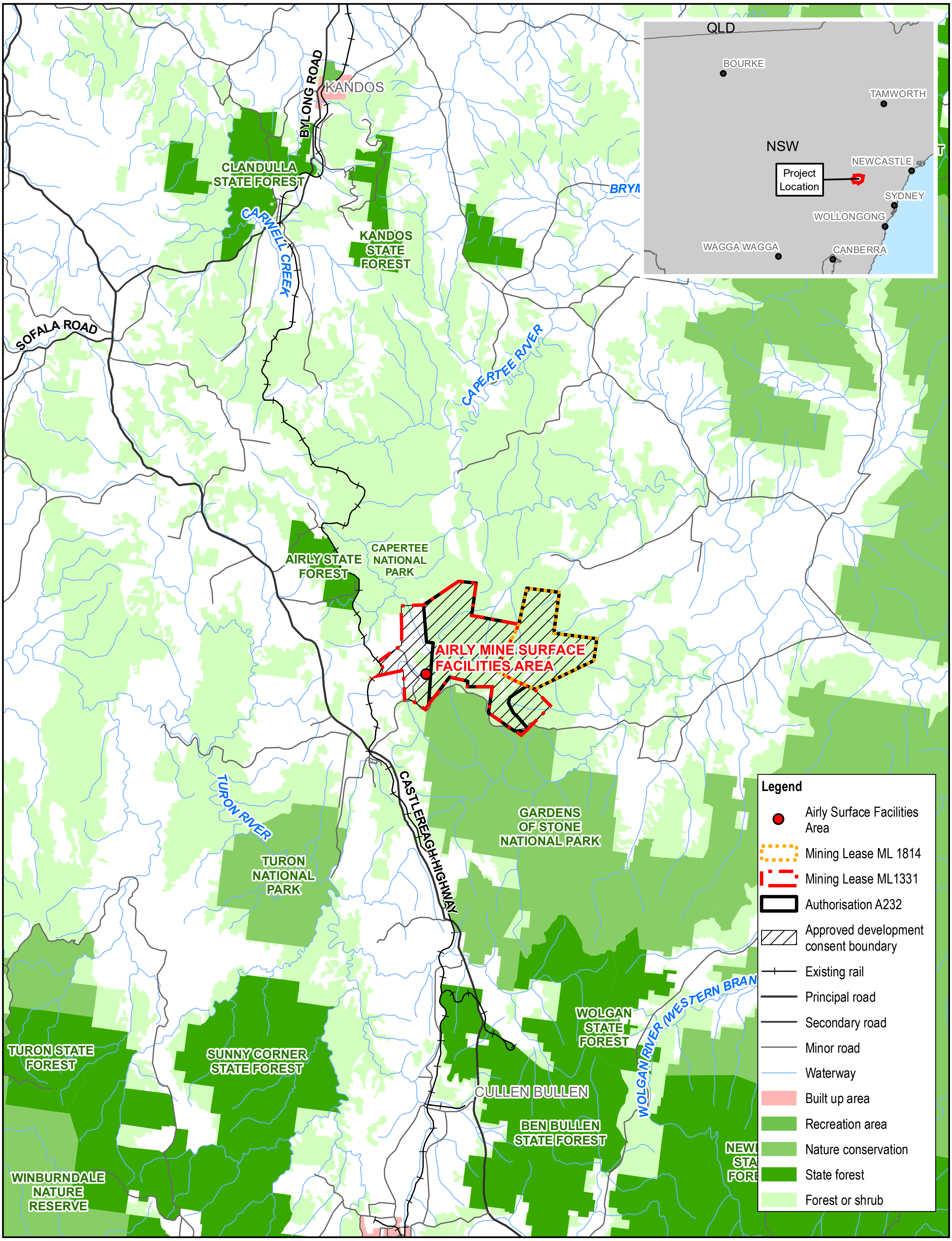
Airly Mine has development consent under Section 89E of the Environmental Planning & Assessment Act 1979 for the extension of the mine (approved 15 December 2016).

Stream health performance criteria related to geomorphic condition and watercourse stability in waterways surrounding Airly Mine have been outlined in the Airly Mine WMP (GHD 2023c) and are displayed in Table 1.1. These criteria have been developed to assess whether the impacts as a result of mining operations are greater than those predicted by the EIS and approved by development consent SSD-5581.

Table 1.1 Stream health performance criteria from Airly Mine Water Management Plan

Aspect	Criteria
Geomorphic condition and watercourse stability (required every two years)	
Bed and bank stability	Negligible environmental consequences to bed and bank stability for Gap and Genowlan Creeks. Maintain or improve baseline channel stability.
Incisional processes and instabilities	Occurrence of erosional processes does not occur as a result of subsidence.
Stream gradient	Change in stream gradient does not vary beyond predictions of subsidence modelling.
Watercourse subsidence	No connective cracking between the surface and underground workings. Subsidence does not vary beyond predictions of modelling.

The visual inspection methodology for the assessment does not include quantitative measurements of stream gradient.



Paper Size ISO A4

0 1 2 3 4 5

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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GHD

Centennial Airly Pty Ltd
Airly Mine
Watercourse Stability Monitoring Report

Project No.	**12570462**
Revision No.	**0**
Date	**14 Feb 2023**

Site location

FIGURE 1.1

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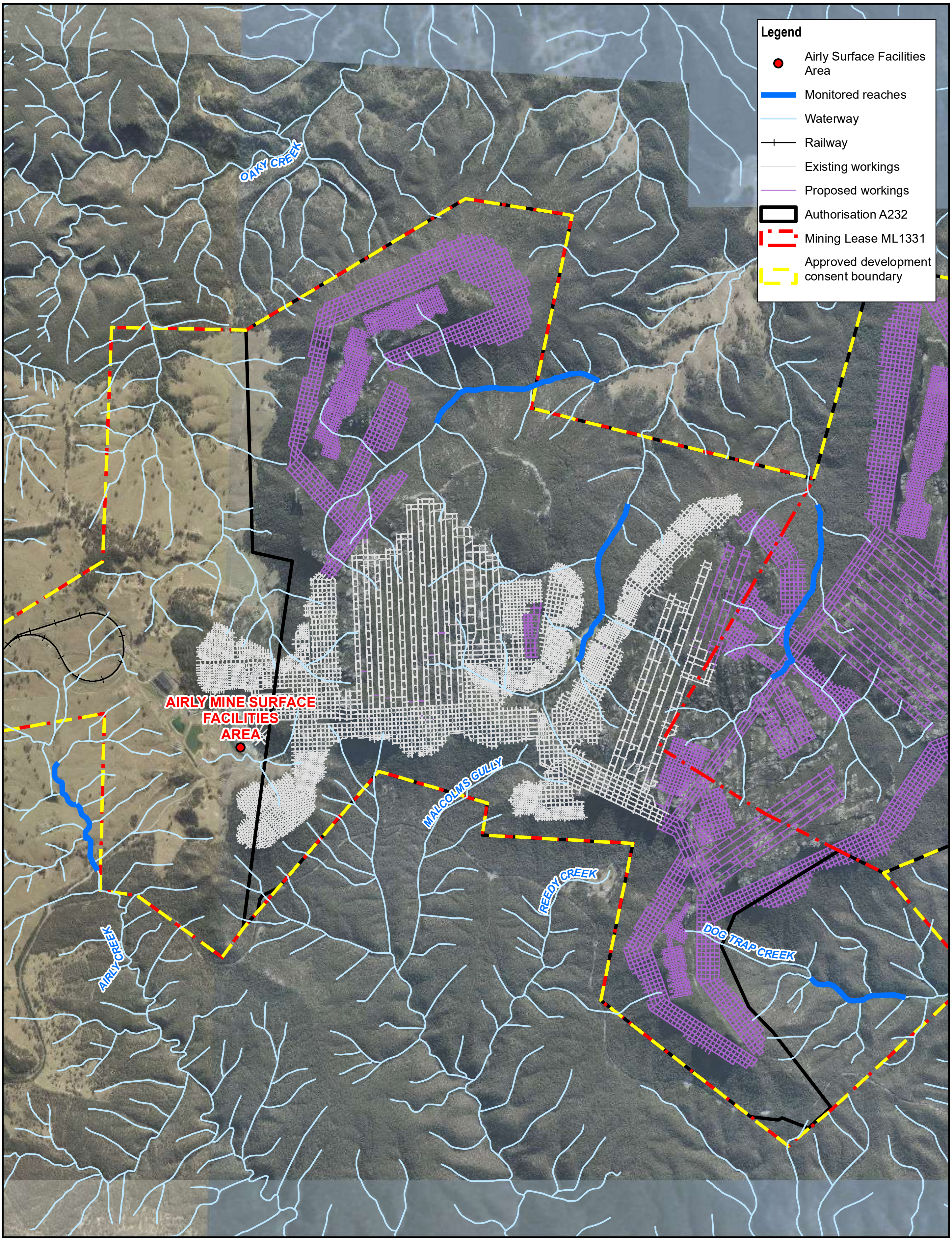

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

Centennial Airly Pty Ltd
Airly Mine
Watercourse Stability Monitoring Report

Project No.	12570462
Revision No.	0
Date	14 Feb 2023

Watercourse stability monitoring locations

FIGURE 1.2

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Print date: 14 Feb 2023 - 09:52

Data source: © Department of Customer Service 2020. Created by: fmackay

2. Methodology

2.1 Watercourse stability inspections

Watercourse stability inspections were undertaken on two separate occasions during 2022. Inspections of the east and west Gap Creek reaches occurred in summer (21 February 2022), while inspections of Airly Creek (22 November 2022), Genowlan Creek (23 November 2022) and Dog Trap Creek (24 November 2022) occurred in spring.

Following the 2018 inspection, the extents of inspected reaches were refined, as shown in Figure 1.2. Inspected reaches during 2020 and 2022 focused on third order streams in proximity to existing or future mining areas.

Visual monitoring of the watercourses was carried out by suitably qualified professionals to identify any instabilities that could form as a result of mining operations and general geomorphic condition, including:

- Degree of valley confinement and bedrock influences
- Presence and continuity of a channel
- Channel planform (number of channels and sinuosity)
- Channel and floodplain geomorphic features
- Nature of channel and floodplain sediments
- Presence of head cuts and other instabilities
- Riparian vegetation associations
- Bed and bank stability (extent and severity of erosion)
- Geomorphic features (such as bars, pools, riffles and benches)
- Evidence of channel lateral migrations, expansion, incision and/or straightening
- Evidence of excessive sediment deposition
- Evidence of geomorphic recovery from past disturbances
- Evidence of connective cracking (loss of streamflow, surface discontinuities not associated with bedrock channel)

The results of this monitoring were compared with the baseline data collected during the Airly Mine Extension Project (GHD 2014) and the 2020 monitoring (GHD 2020).

2.2 River Styles assessment

The River Styles® framework (Brierley and Fryirs 2005) is a river characterisation process that allows interpretation of river form and behaviour from which appropriate management approaches can be formulated. The first level of assessment places a waterway reach into one of three river style groups based on valley setting and channel continuity as shown in Figure 2.1. Further characterisation is determined based on the identification of key geomorphic units, channel substrate and channel form. These attributes provide the basis for interpretation of stream behaviour, condition and recovery potential. The river style of a stream that exists at any one point within a valley is dependent upon a large number of physical factors upstream, downstream and adjacent to the point of assessment.

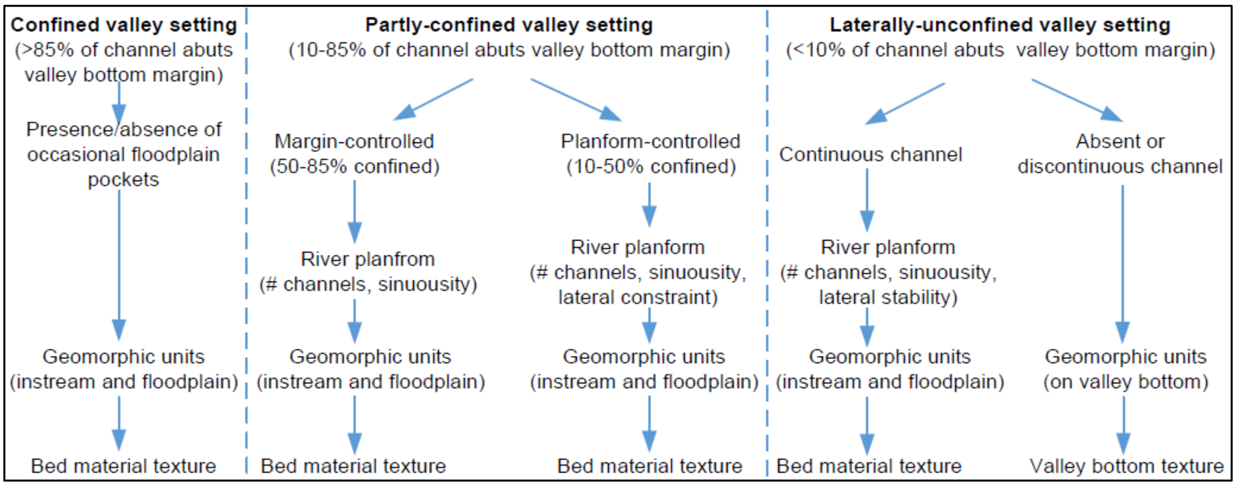


Figure 2.1 The River styles procedural tree (adapted from Brierly and Fryirs 2005)

2.3 Geomorphic condition assessment

The inspection included the categorisation of geomorphic condition following the methods of Outhet and Cook (2004), and Brierley and Fryirs (2005), which are detailed briefly below. This categorisation provides an indication of the degree of alteration that reaches within the tributaries have experienced, and the likely response of these reaches to changes in flow rates and durations.

Outhet and Cook (2004) describe a rapid method of condition assessment that frames geomorphic condition in the context of natural and human induced variability to divide stream condition into three broad categories:

- Good (generally natural and intact)
- Moderate (noticeably impacted by human disturbances)
- Poor (degraded)

This method combines the observation of physical features and their interactions with a set of defined characteristics/criteria. The method considers the floodplain and its features in conjunction with the instream channel features as well as an assessment of the role and condition of vegetation for maintaining the condition of river styles.

The characteristics of each of these categories of geomorphic condition, as described by Outhet and Cook (2004), are outlined in Table 2.1. These condition categories align with the geomorphic condition definitions in Brierley and Fryirs (2005), also presented in Table 2.1.

Table 2.1 Geomorphic condition categories

Geomorphic condition	Outhet and Cook (2004)	Brierly and Fryirs (2005)
Good	River character and behaviour is similar to the pre-development state presenting a high potential for ecological diversity. Minimal alteration to catchment controls such as sediment supply and the hydrological regime allowing fast recovery from any natural disturbance. Relatively intact and effective vegetation coverage dominated by native species, giving resistance to natural disturbance and accelerated erosion.	River character and behaviour are appropriate for the River Style given the valley setting and within-catchment position. Geomorphic structures are in the right place and operating as expected for the River Style. These reaches have near-natural potential for ecological diversity and associated vegetation associations.

Geomorphic condition	Outhet and Cook (2004)	Brierly and Fryirs (2005)
Moderate	Localised degradation of river character and behaviour, typically marked by modified patterns of geomorphic units. Patchy effective vegetation coverage allowing some localised accelerated erosion.	Certain characteristics are out-of-balance or inappropriate for the River Style. Localised degradation of river character and behaviour is typically marked by modified patterns of geomorphic units. Key geomorphic structures are in the wrong places. Locally anomalous processes are occurring. In general, these reaches have poor vegetation associations and/or cover.
Poor	Abnormal or accelerated geomorphic instability (reaches are prone to accelerated and/or inappropriate patterns or rates of planform change and/or bank and bed erosion). Excessively high volumes of sediment inputs which blanket the bed, reducing flow diversity. Absent or geomorphologically ineffective coverage by vegetation (allowing most locations to have accelerated rates of erosion).	River character is divergent from the natural reference condition. Abnormal or accelerated geomorphic behaviour occurs. Key geomorphic units are located inappropriately along the reach, and processes are out-of-balance or anomalous. These reaches generally have low levels of bank vegetation and/or are weed infested. If fundamental threshold conditions are breached, irreversible geomorphic change would transform the reach into a new River Style.

3. Results

3.1 River Styles assessment

The River Styles of each of the assessed creek reaches are discussed below and are consistent with the those identified within the baseline assessment prepared for the Airly Mine Extension Project (GHD 2014). The River Styles of each of the assessed creek reaches are shown on Figure 3.1. No changes to River Styles have been observed within any of the assessed reaches.

3.1.1 Airly Creek

The River Style of the assessed reach of Airly Creek is laterally unconfined, discontinuous channel, valley fill. These systems are characterised by a relatively flat, featureless valley floor surface that lacks a continuous, well-defined channel. Valley fill systems typically act as long term sediment accumulation zones, as any material eroded within the catchment is generally not transported through the reach. Degradation of valley fill systems most commonly occurs through incisional processes such that a continuous channel forms within the valley fill sediments.

3.1.2 Gap Creek

The assessed reaches of Gap Creek (east and west) contain the following River Styles:

- Confined, bedrock margin controlled, occasional floodplain pockets
- Partly confined, continuous channel, channelised fill

The steep gradient sections of both arms of Gap Creek are bedrock dominated, with limited deposits of sediment within the channel. These confined reaches are geomorphically stable reaches that are subject to very slow rates of change due to the high degree of bedrock confinement. Small floodplain pockets composed primarily of sand were observed in flatter sections of these reaches. The generally steep gradients but small catchment areas mean that the larger grained materials in the catchments are moved only in rare, high magnitude rainfall events.

The upper reach of Gap Creek – east arm was partly confined, with channelised fill and a flatter bed grade. The upper parts were vegetated, with evidence of bank instability close to the pre-existing stock dam.

A small section of the downstream extent of the west arm of Gap Creek had a flatter bed grade, with evidence of sediment deposition. The bed load in this section of the creek was dominated by sand and gravels.

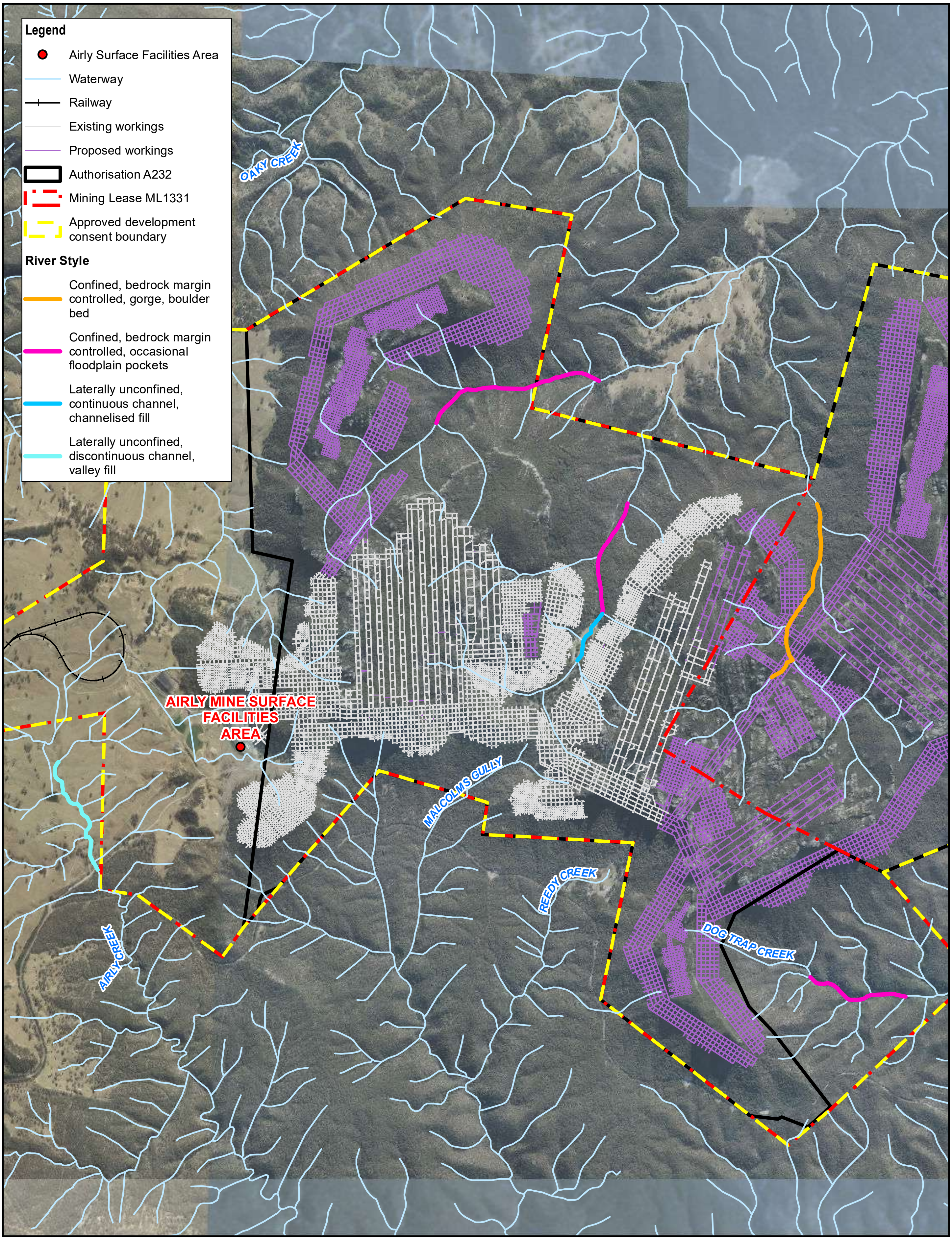
3.1.3 Genowlan Creek

The steep gradient, upstream section of Genowlan Creek is bedrock dominated, with no floodplain present. Due to the steep valley margins, this reach has been classified as a gorge, with the dominant bed material size being boulders.

Further downstream, small floodplain pockets were observed, resulting in the River Style: confined, bedrock margin controlled, occasional floodplain pockets.

3.1.4 Dog Trap Creek

The assessed reach of Dog Trap Creek is of the River Style: confined, bedrock margin controlled, occasional floodplain pockets. The substrate of the creek is dominated by cobble, with finer grained sediments (sand and silt) observed in the exposed banks where concave bank erosion into the floodplain is occurring.



Paper Size ISO A4

0 0.3 0.6 0.9 1.2

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

GHD

Centennial Airly Pty Ltd
Airly Mine
Watercourse Stability Monitoring Report

River Styles of assessed reaches

Project No.	12570462
Revision No.	0
Date	14 Feb 2023

FIGURE 3.1

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Print date: 14 Feb 2023 - 09:52

Data source: © Department of Customer Service 2020. Created by: fmackay

3.2 Geomorphic condition assessment

Geomorphic condition in each of the assessed creek reaches and photo locations are presented in Figure 3.2 and discussed below.

3.2.1 Airly Creek

Site photographs and the results of the geomorphic condition assessment for Airly Creek are presented in Table 3.1.

Table 3.1 Site photos and geomorphic condition notes for Airly Creek

Photo location	2020	2022	Notes on geomorphic condition
1			Photo location 1 is representative of the downstream extent of the assessed reach of Airly Creek, looking upstream. In most of the assessed reach there is no continuous channel with occurrence of several pools and areas of ponding. At this location in 2020, there was presence of a shallow pool with dense *Typha sp.* coverage. Riparian vegetation is dominated by exotic grasses. In 2022, macrophyte coverage increased obscuring the defined ponded area observed in 2020. This portion of the reach is in moderate condition.

Photo location	2020	2022	Notes on geomorphic condition
2			Photo location 2 shows a headcut in Airly Creek, which has been armoured by imported rock. This armouring has been largely effective in mitigating scouring in the exposed area of valley fill sediments, though some migration of the headcut has occurred and bypass of the armouring has resulted in small headcuts developing adjacent to the armouring. In 2022, minimal migration of this headcut was observed at photo location 2, with rock armouring largely remaining in place. Increases in instream vegetation growth are also noted in 2022. This headcut marks the downstream extent of the poor condition reach.

3.2.2 Gap Creek – east arm

Site photographs and the results of the geomorphic condition assessment for Gap Creek – east arm are presented in Table 3.2.

Table 3.2 Site photos and geomorphic condition notes for Gap Creek – east arm

Photo Location	2020	2022	Geomorphic condition comparison
3			Photo location 3 shows the upstream extent of the east arm of Gap Creek. This section of the creek has been channelised into the narrow valley of fine grained sediments. Though there was no active headcut observed during any monitoring event in this area this reach was in poor condition due to accelerated bank erosion and poor coverage of effective vegetation. Despite increased coverage of grasses in 2020 and 2022, the banks remain in poor condition in this area.
4			Photo location 4 in 2020 shows bank erosion (approximately 0.5 m deep) at the incised and widened channel of the creek. In 2022, the headcut was not observable due to high water level and increased vegetation growth along the bank.

Photo Location	2020	2022	Geomorphic condition comparison
5			Photo location 5 in 2020 was taken looking downstream at the incised and widened channel of the creek, showing scattered cobbles within a bed of fine sand and shows the dam at the end of the channelised reach. The dam appears to capture the majority of the flows in the small catchment, only overtopping towards the left valley margin as a result of rainfall events. In 2022 photo location 5 was taken looking upstream along the dam embankment noting a high creek and dam water level with no visible sediment accumulation. Vegetation growth has also increased on the embankment and is stabilised by trees.
6		Not accessible	Photo location 6 was taken looking downstream in 2020, just below the dam wall. The steep slopes and boulders are evident. This reach is in good condition. In 2022 this location was not photographed due to surface water flow limiting access.

Photo Location	2020	2022	Geomorphic condition comparison
7			Photo location 7 shows the large boulders present in much of this reach which has resulted in a small, forced pool with cobble substrate. The reach in this location is in good condition. Similar behaviour was observed in both 2020 and 2022.
8			Photo location 8 shows the east arm of Gap Creek in an area of lesser gradient facing downstream, where a small pocket of floodplain is observed on the right bank. Increased water is present in 2022, though the floodplain is utilised with minimal alteration to sediment.

3.2.3 Gap Creek – west arm

Site photographs and the results of the geomorphic condition assessment for Gap Creek – west arm are presented in Table 3.3.

Table 3.3 Site photos and geomorphic condition notes for Gap Creek – west arm

Photo Location	2020	2022	Geomorphic condition comparison
9			Photo location 9 shows the upstream extent of the assessed reach of the west arm. The gradient of the watercourse in this area is lower than that of downstream areas (such as that shown by Photo location 10) allowing for some sand to accumulate in the bed and pockets of floodplain.
10			Some sections of the west arm of Gap Creek have bedrock substrate with step pools, as shown at Photo location 10. Such reaches are geomorphically stable and subject to only very slow rates of change. Subsidence in such areas has the potential to result in surface cracking in the bedrock substrate, however this was not observed at Photo Location 10 during any visit.

Photo Location	2020	2022	Geomorphic condition comparison
11			Photo location 11 shows the downstream extent of the bedrock confined reach of the west arm, with coarse sediment deposition in the foreground of the photo. The stream flow transitions to subsurface at this location. Slight changes observed between 2020 and 2022 include silty sand deposited at the base of the bedrock in 2022. Flowing water was observed in both 2020 and 2022 following secondary extraction in the contributing catchment.
12			Photo location 12 shows areas of the downstream extent of the assessed reach of the west arm of Gap Creek in 2020 and 2022. Despite exotic grasses covering the bed and some clearing of riparian vegetation having occurred, this reach is in good condition. There is evidence of recent sediment deposition. No surface water has been observed in this part of the watercourse, far downstream from mining, likely due to low flows occurring as subsurface flow through the alluvium, with the transition shown at Photo Location 9.

3.2.4 Genowlan Creek

Site photographs and the results of the geomorphic condition assessment for Genowlan Creek are presented in Table 3.4.

Table 3.4 Site photos and geomorphic condition notes for Genowlan Creek

Photo location	2020	2022	Notes on geomorphic condition
13			Photo location 13 shows the V notch weir and flow gauge installed in the upper part of the inspected reach of Genowlan Creek.
14			Photo location 14 in 2020 was taken looking downstream from the southern extent of the Genowlan Creek reach. There are various small pools formed within the bedrock confined boulder substrate, as shown in the upstream facing photo in 2022. This reach is in good condition.

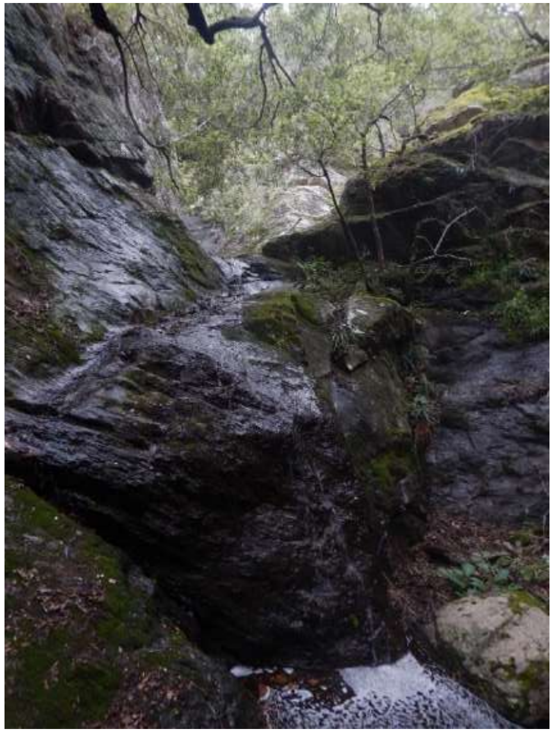
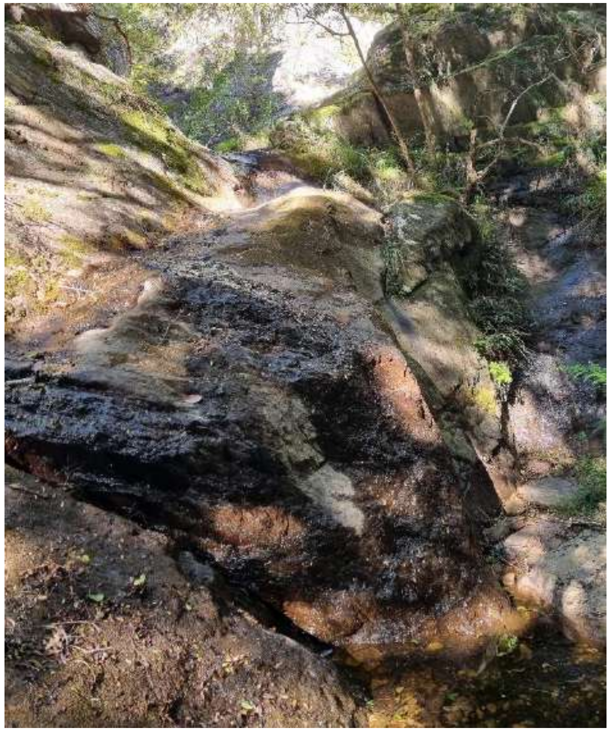
Photo location	2020	2022	Notes on geomorphic condition
15			Photo location 15 shows the bedrock margins and boulder substrate which dominates much of Genowlan Creek.
16			The large boulders present in Genowlan Creek create steps in the creek profile, as shown at Photo location 16. Some instream ponding and cascading is evident in areas with presence of large boulders.

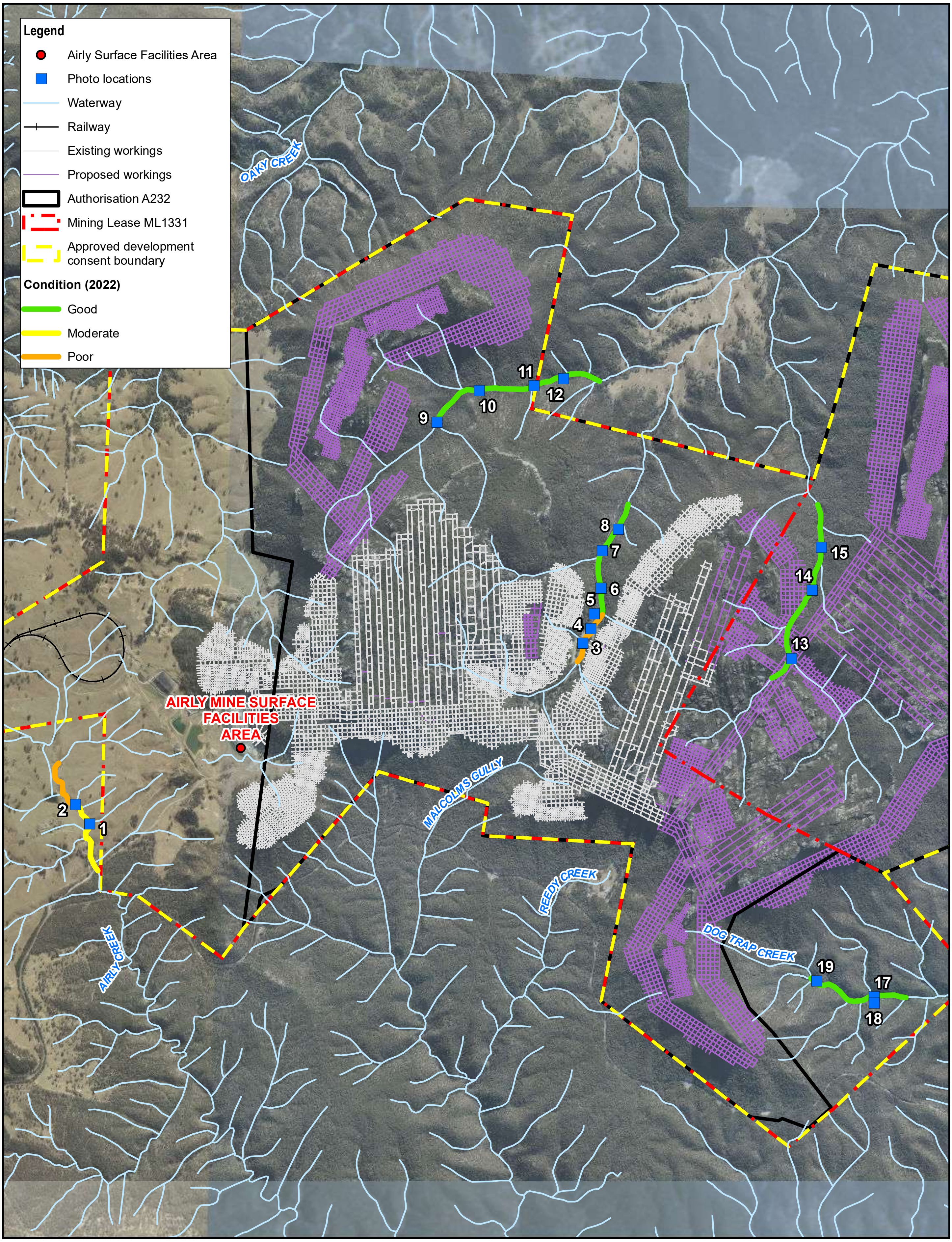
3.2.5 Dog Trap Creek

Site photographs and the results of the geomorphic condition assessment for Dog Trap Creek are presented in Table 3.5.

Table 3.5 Site photos and geomorphic condition notes for Dog Trap Creek

Photo location	2020	2022	Notes on geomorphic condition
17			Photo 17 was taken looking upstream at the eastern (upstream) extent of the Dog Trap Creek reach. The bedrock margins of the creek are shown. The entire reach is in good condition.
18			Photo location 18 shows a floodplain pocket to the right of the photo. Similar floodplain pockets are observed in the downstream portion of the reach.

Photo location	2020	2022	Notes on geomorphic condition
19			Photo location 19 shows an area of outcropping bedrock that forms a cascade/waterfall during flows. Upstream of this location, several small pools and steps which form small cascades are observed.



Paper Size ISO A4

0 0.3 0.6 0.9 1.2

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

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GHD

Centennial Airly Pty Ltd
Airly Mine
Watercourse Stability Monitoring Report

Geomorphic condition of the assessed reaches

Project No.	12570462
Revision No.	0
Date	14 Feb 2023

FIGURE 3.2

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Data source: © Department of Customer Service 2020. Created by: fmackay

4. Conclusions

Watercourse stability monitoring was undertaken at Airly Mine on 21 February and 22 to 24 November 2022. The findings of the assessment were:

- Geomorphic condition in Airly Creek was mostly moderate, though poor condition reaches were identified, associated with active headcuts. Between 2020 and 2022 monitoring events, minimal migration of the headcut has been observed located adjacent to instream rock armouring (which has largely remained in place).
- Geomorphic condition in Gap, Genowlan and Dog Trap Creeks was good, with the exception of an upstream section of Gap Creek where land clearing (unrelated to mining activities) has resulted in the channelisation of a narrow valley of fine-grained sediments. Apart from that poor condition reach, Gap, Genowlan and Dog Trap Creeks are characterised by confined, bedrock-controlled valley settings, which are geomorphologically stable and subject to only slow rates of change (and as such are considered to be low risk). The potential impacts of subsidence on confined, bedrock-controlled valley settings would most likely be observable in areas of bedrock outcropping in the substrate, where any cracks would be evident during inspections. No change was observed in the bedrock confined, upstream portions of the reaches and no evidence of subsidence and subsidence related impacted were observed.
- Overall, based on the visual assessment undertaken, there is no evidence of exceedances of the stream health performance criteria for geomorphic condition and watercourse stability, as presented in the WMP (GHD 2023c).

The next site inspections to assess geomorphic condition and watercourse stability will be undertaken in 2024.

5. References

Brierly G and Fryirs K (2005) Geomorphology and River Management: Applications of the River Rtyles Framework. Blackwell Publishing, Oxford, UK, 398pp.

GHD (2014) Airly Mine Extension Project: Surface Water Impact Assessment, prepared by GHD Pty Ltd for Centennial Airly Pty Limited.

GHD (2016) Western Operations: Regional Water Management Plan, prepared by GHD Pty Ltd for Centennial Coal Company Limited.

GHD (2020) Airly Mine 2020 Watercourse Stability Monitoring Report, prepared by GHD Pty Ltd for Centennial Airly Pty Limited.

GHD (2018) *Airly Mine: Site specific guideline values,* prepared for Centennial Airly Pty Ltd.

GHD (2023a) Airly Aquatic Ecology Monitoring Annual Report 2022. Report in preparation for Centennial Airly Pty Ltd.

GHD (2023b) 2022 Annual Water Monitoring Report. Prepared by GHD Pty Ltd for Centennial Coal Company Limited.

GHD (2023c) Airly Mine Water Management Plan, (not yet approved) prepared by GHD Pty Ltd for Centennial Airly Pty Limited.

Outhet, D. and Cook, N. (2004). “Definitions of Geomorphic Condition Categories for Streams” Unpublished internal draft paper for use throughout NSW by the Department of Infrastructure, Planning and Natural Resources.

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→ The Power of Commitment

Appendix 8: Airly Mine Aquatic Ecology 2022 Annual Report

Airly Aquatic Ecology

Annual report 2022

Centennial Airly Pty Ltd

3 March 2023

→ **The Power of Commitment**

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Document status

Status Code	Revision	Author	Reviewer		Approved for issue		
			Name	Signature	Name	Signature	Date
S4	0	T. Hopwood	S. Gray		S. Gray		03/03/23

Overarching Review

Statement of Compliance Question	Statement of Compliance Answer
Were all conditions of SSD_5581 and the Airly Mine Water Management Plan relating to aquatic ecosystems and stream health complied with?	Yes – There were no non-compliances relating to aquatic ecology or stream health in the 2022 reporting period

Details of Non-Compliances

Relevant Approval	Condition #	Condition summary	Compliance Status	Comment	Reference # addressed in Annual Review
N/A - No non-compliances relating to aquatic ecosystems or stream health during the 2022 reporting period			Compliant		

Development consent SSD-5581 (Modification 2) performance conditions relating to surface waters

Condition	Condition description	Compliant	Relevant section of this document
Water management performance measures			
Water discharge to Airly Creek			
Schedule 4 12.	Negligible environmental consequences for water quality (i.e. protection to 99% of all species in accordance with ANZECC guidelines) and flow in Airly Creek where it enters the Gardens of Stone National Park and Greater Blue Mountains World Heritage Area.	Yes	See discharge volumes in Section 3.2 and water quality results in Section 3.4.1 and 2022 Annual Water Monitoring Report (GHD 2023a).
Gap and Genowlan Creeks			
Schedule 4 12.	No greater impact than predicted in the EIS for water, flow and quality.	Yes	NA See 2022 Annual Water Monitoring Report (GHD 2023a). Genowlan Creek has not yet been impacted by mining.
Aquatic and riparian ecosystems			
Schedule 4 12.	Maintain or improve baseline channel stability.	Yes	NA See watercourse stability assessment (GHD 2023c).
	Develop site-specific water quality objectives in accordance with ANZECC Guidelines and Using the ANZECC Guidelines and Water Quality Objectives in NSW procedures (DECC 2006) or its latest version.	Yes	SSGVs in Section 2.7.1. Refer to Site Specific Guideline Values document (GHD 2018b). Also refer to Section 6 of WMP (GHD 2023b).
Water management plan			
Schedule 4 13.	Prior to carrying out any development under this consent, unless the Secretary agrees otherwise, the Applicant must prepare a Water Management Plan for the development to the satisfaction of the Secretary. This plan must:		
Schedule 4 13. (a)	Be prepared in consultation with the DoEE, EPA and the Water Division, by suitably qualified and experienced person/s whose appointment has been approved by the Secretary.	Yes	NA Refer to Appendix A and Appendix B of WMP (GHD 2023b).
Schedule 4 13. (b)	Include detailed performance criteria and describe measures to ensure that the Applicant complies with the Water Management Performance Measures (see Table 6).	Yes	NA Refer to Section 6 of WMP (GHD 2023b).

Condition	Condition description	Compliant	Relevant section of this document
Site water balance			
Schedule 4 13. (c) (i)	Details of sources and security of water supply, including contingency supply for future reporting periods.	Yes	NA Refer to Section 3.1 and Section 3.5.1 of the WMP (GHD 2023b).
	Details of water use and management on site.	Yes	NA Refer to Section 3 of WMP (GHD 2023b) and 2022 Annual Water Monitoring Report (GHD 2023a).
	Details of any off-site water discharges.	Yes	NA Refer to Section 3.5.2 of WMP (GHD 2023b) and 2022 Annual Water Monitoring Report (GHD 2023a).
	Reporting procedures, including the preparation of a site water balance for each calendar year.	Yes	NA Refer to 2022 Annual Water Monitoring Report (GHD 2023a) and Section 7.4 of WMP (GHD 2023b).
	Investigates and implements all reasonable and feasible measures to minimise water use on site.	Yes	NA Refer to Section 3.5.1 of WMP (GHD 2023b).
Surface water management plan			
Schedule 4 13. (c) (ii)	Detailed baseline data on water flows and quality in the watercourses that could potentially be affected by the development, including, but not limited to Gap, Genowlan and Airly Creeks.	Yes	Water quality monitoring has been undertaken in conjunction with aquatic ecology monitoring (see Section 0). Also refer to Section 5.1 of WMP (GHD 2023b) and 2022 Annual Water Monitoring Report (GHD 2023a).
Schedule 4 13. (c) (ii)	Continuous flow monitoring at Airly village spring and the Grotto.	Yes	NA Refer to Section 5.1.2 and Section 5.3.1 of WMP (GHD 2023b) and 2022 Annual Water Monitoring Report (GHD 2023a).
	Provisions for the recalculation of site-specific trigger values in relation to water discharges to Airly Creek once a minimum of two years data is obtained from the Airly Creek ‘U/S’ monitoring location in accordance with ANZECC guidelines.	Yes	NA Refer to Site Specific Guideline Values document (GHD 2018b) and Section 6.1.1 of WMP (GHD 2023b).
	The provision and implementation of adaptive management measures to ensure that subsequent water discharges to Airly Creek comply with the recalculated site-specific trigger values derived from the Airly Creek ‘U/S’ monitoring location.	Yes	NA Refer to TARPs in Appendix E of the WMP (GHD 2023b).
	A detailed description of the water management system, including the: – Clean water diversion systems – Erosion and sediment controls (mine water system) – Mine water management systems	Yes	NA Refer to Section 3.2 and Section 3.3 of WMP (GHD 2023b).
	Detailed objectives and performance criteria, including trigger levels for investigating any potentially adverse impacts associated with the development for:		

Condition	Condition description	Compliant	Relevant section of this document
	Downstream surface water quality.	Yes	SSGVs in Section 2.7.1. Also refer to Section 6 of WMP (GHD 2023b) and 2022 Annual Water Monitoring Report (GHD 2023a) and Section 0 of this report.
	Downstream water users, including with respect to any subsidence-related flow reductions in Gap and Genowlan Creeks.	Yes	NA Refer to Section 6 of WMP (GHD 2023b).
	Stream and riparian vegetation health in Gap, Genowlan and Airly Creeks within and immediately outside of the site.	Yes	Performance criteria for instream health outlined in Table 1.1. Also refer to Section 6.2 of WMP (GHD 2023b). Riparian vegetation assessment outlined in Airly Site specific Biodiversity Management Plan (BMP).
Schedule 4 13. (c) (ii)	A program to monitor and report on:		
	Effectiveness of the mine water management system.	Yes	NA Refer to Section 4 of the WMP (GHD 2023b).
	Surface water flows, quality and geomorphology of the watercourses potentially affected by the development within and immediately outside of the site.	Yes	Monitoring program for surface water flows, quality and geomorphology outlined in Section 4 of WMP (GHD 2023b). Monitoring results for water quality and flow addressed in the 2022 Annual Water Monitoring Report (GHD 2023a). Watercourse stability assessment (GHD 2023c).
	The performance measures listed in Table 6 including, but not limited to event-based monitoring of the hydrology, quality, ecotoxicology and chemical composition of water in Airly Creek under discharge conditions at points 5 and 6, or as otherwise determined in consultation with the EPA, to ensure that protection is provided to 99% of all species in the Gardens of Stone National Park and Greater Blue Mountains World Heritage Area in accordance with ANZECC guidelines.	Yes	NA Refer to Section 4 and Appendix E of WMP (GHD 2023b) and 2022 Annual Water Monitoring Report (GHD 2023a).
	Reporting procedures for the results of the monitoring program.	Yes	NA Refer to Section 7.1 of WMP (GHD 2023b) and Regional WMP (GHD 2016).
	A plan to respond to any exceedances of performance measures, and repair, mitigate and/or offset any adverse surface water impacts of the development, including measures to provide compensatory water supply to any affected downstream water user.	Yes	NA Refer to Section 6.3 and Appendix E of WMP (GHD 2023b).

NA – not applicable to this report

Statement of commitments relating to aquatic ecosystems (GHD 2023b)

Commitment	Compliant	Relevant section of this document
Monitor macroinvertebrate ecology in Airly Creek at appropriate upstream and downstream locations biannually (spring and autumn).	Yes	Section 3.6

Stream health performance criteria relating to aquatic ecosystems (GHD 2023b)

Aspect	Criteria	Compliant	Relevant section of this document
Geomorphic condition and watercourse stability (required every two years)			
Bed and bank stability	Negligible environmental consequences to bed and bank stability for Gap and Genowlan Creeks. Maintain or improve baseline channel stability.	Yes	NA Watercourse stability assessment (GHD 2023c). Subsidence monitoring is conducted as outlined the Airly Mine Annual Review.
Incisional processes and instabilities	Occurrence of erosional processes does not occur as a result of subsidence.	Yes	
Stream gradient	Change in stream gradient does not vary beyond predictions of subsidence modelling.	Yes	
Watercourse subsidence	No connective cracking between the surface and underground workings. Subsidence does not vary beyond predictions of modelling.	Yes	
Aquatic ecology (required annually in autumn and spring)			
Instream/riparian vegetation	RCE scores relating to riparian and instream vegetation within historical range and/or consistent with reference sites.	Yes	Observations regarding instream vegetation were collected as part of aquatic ecology monitoring, See Section 3.3 of this document.

Executive summary

Airly Mine has development consent under Section 89E of the Environmental Planning & Assessment Act 1979 for the extension of the mine (approved 15 December 2016) and commenced operations under this consent on 31 January 2017. Since this time, the wording of Development Consent SSD-5581 has been modified to remove restrictions on mining (Modification 1) and to allow the receipt of up to 170 ML/year of water from Charbon Colliery by rail (Modification 2). The development consent requires a program to monitor and report on stream health for waterways that have the potential to be impacted by Airly Mine operations through subsidence or discharge of water. The purpose of this report is to present the results of aquatic ecology monitoring undertaken in 2022. The results of watercourse stability monitoring and stygofauna monitoring have been provided in separate reports (GHD 2022a, GHD 2023c).

Aquatic ecology monitoring has been undertaken biannually since spring 2015 within waterways with the potential to be impacted by Airly Mine. GHD conducted autumn 2022 monitoring between 29 and 31 March and spring 2022 monitoring between 5 and 6 December 2022. The monitoring program involved assessment of seven sites, consisting of three baseline sites, two subsidence impact sites, one background site on Airly Creek upstream from Airly Mine discharges and one impact site on Airly Creek downstream from Airly Mine's licensed discharge points (LDPs). Macroinvertebrate, water and sediment samples were collected from each site in autumn and spring. Instream habitat surveys were also undertaken noting the coverage and condition of riparian and instream vegetation through completion of the riparian, channel and environmental (RCE) inventory (Peterson 1992).

Airly Mine has three LDPs under Environment Protection Licence (EPL) 12374. There were 10 discharge events from LDP1 during 2022, totalling 241.1 ML. There was also one discharge from LDP2 in January 2022. Despite several discharges through 2022, there was no evidence of impacts on water or sediment quality due to Airly Mine operations in 2022. Discharge impact site AIR contained similar water quality to background site AIRUS and other lower altitude sites TOR and DOG, reflecting the influence of surrounding landuse (i.e. grazing), historical land clearing and underlying geology on water quality. The water at higher altitude sites GAP, GEN and GRO was of low ionic strength, which reflects the minimal anthropogenic disturbance and different geology of these areas, although, isolated exceedances of guideline values for chromium and aluminium are also indicative of the lithology.

The macroinvertebrate community condition in 2022 reflected the high rainfall that occurred through the year and contributed to consistent water availability at all sites. Macroinvertebrate community composition reflected the site differences, with samples collected from more pristine, higher altitude sites on Gap and Genowlan Creeks showing similarities, which contrasted to the macroinvertebrate communities observed at lower lying sites in Dog Trap, Torbane and Airly Creeks. There is no evidence of any impacts to macroinvertebrate communities in 2022 from Airly Mine operations. The macroinvertebrate community at impact site AIR was in a good condition in 2022, with sensitive taxa present for the first time since 2014, and the highest taxa richness results of all sites observed.

Panel and pillar mining was undertaken below a small section of the first order headwaters of Torbane Creek in 2019 and Gap Creek between 2020 and 2021. The results of 2022 monitoring do not suggest any impacts to the macroinvertebrate community due to this activity. Macroinvertebrate condition in Torbane Creek in 2022 was the best observed in the 2013 to 2022 monitoring period while macroinvertebrate community condition at GAP in 2022 has shown no decline from previous sampling events. There was no evidence of impacts to flows or water quality in Gap Creek since panel and pillar mining commenced in this catchment. Therefore, there is no evidence of impacts from subsidence on the aquatic biota of Gap Creek.

The next round of aquatic ecology monitoring will be conducted in autumn 2023.

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1. Introduction

1.1 Background

Airly Mine is an underground coal mine located near Capertee, approximately 40 km northwest of Lithgow, owned by Centennial Airly Pty Ltd (Centennial). Airly Mine was granted Development Consent (SSD-5581) for the extension of its underground coal mine on 15 December 2016. Since this time, Development Consent SSD-5581 has been modified to remove restrictions on mining (Modification 1) and to allow the receipt of up to 170 ML/year of water from Charbon Colliery by rail (Modification 2).

Airly Mine currently has approval to extract up to 1.8 million tonnes per annum (Mtpa) of run of mine (ROM) coal from the Lithgow Seam using mining methods that incorporate extraction by first workings, partial pillar extraction or panel and pillar mining. ROM and product coal are transported off site by rail for the export and domestic markets.

Aquatic ecology monitoring was undertaken by Cardno (2014) to support the Environmental Impact Statement (EIS) for the Airly Mine Extension Project. Sampling was undertaken in autumn and spring of 2013 and 2014 at twelve aquatic ecology monitoring sites, located on six creeks (Cardno 2014).

Fifteen rounds of aquatic ecology monitoring have been conducted since the EIS, during autumn and spring each year from spring 2015 to spring 2022. This report outlines the results of the autumn 2022 monitoring conducted between 29 and 31 March 2022 and the spring 2022 monitoring conducted between 5 and 6 December 2022.

1.2 Scope

GHD Pty Ltd (GHD) was engaged by Centennial to undertake autumn and spring 2022 aquatic ecology monitoring in waterways upstream and downstream of Airly Mine as required by the conditions of consent of the extension of the mine (see Section 1.4.2). Aquatic ecology monitoring involved the collection of macroinvertebrate, water and sediment samples in autumn and spring 2022. This report presents the results of autumn and spring 2022 aquatic ecology monitoring and also considers the previous monitoring results to assess the condition of the sites.

1.3 Purpose of this report

The purpose of this report is to present the results of aquatic ecology monitoring undertaken in 2022 and to fulfil the requirements of the development consent conditions outlined in the Airly Mine Water Management Plan (WMP) (GHD 2023b). This report is intended as a supporting document to Airly Mine’s Annual Review.

1.4 Licenced discharges and development consent conditions

1.4.1 Licensed discharges

Airly Mine currently holds environment protection licence (EPL) 12374, with water currently licensed to be discharged from the site through the following licensed discharge points (LDPs):

- LDP1 – Discharge to Airly Creek via the Production Dam
- LDP2 – Discharge to Airly Creek via the Stockpile Dam
- LDP3 – Discharge to Airly Creek via the Train Loader Dam

LDPs are monitored monthly during discharge and tested for several water quality parameters. EPL 12374 stipulates discharge water sampling concentrations limits, however, this report will not assess discharges for compliance to these limits.

1.4.2 Development consent conditions

Airly Mine has development consent under Section 89E of the Environmental Planning & Assessment Act 1979 for the extension of the mine (approved 15 December 2016).

The performance criteria relating to stream health in waterways surrounding Airly Mine is outlined in the Airly Mine Water Management Plan (GHD 2023b) and below in Table 1.1. These criteria have been developed to ensure that potential impacts as a result of mining operations are not greater than those predicted by the environmental impact assessments for the approved Airly Mine Extension Project and subsequent modifications.

Geomorphic condition and watercourse stability monitoring is required every two years and was conducted in 2022. Results for this monitoring has been provided in a separate report (GHD 2023).

Aquatic ecology monitoring is undertaken twice per year in autumn and spring and includes an assessment of riparian and instream vegetation as part of the riparian, channel and environmental (RCE) inventory (Peterson 1992) (see Section 2.2).

Table 1.1 Stream health performance criteria from Airly Mine Water Management Plan (GHD 2019b)

Aspect	Criteria	Addressed in this report
Bed and bank stability	Negligible environmental consequences to bed and bank stability for Gap and Genowlan Creeks.	No – visual watercourse stability monitoring conducted every two years. See GHD (2021b) for results of the most recent monitoring conducted in 2020.
Incisional processes and instabilities	Occurrence of erosional processes does not occur as a result of subsidence.	
Stream gradient	Change in stream gradient does not vary beyond predictions of subsidence modelling.	No – Centennial maintains a subsidence monitoring program which includes visual inspections, physical markers and satellite technology.
Watercourse subsidence	No connective cracking between the surface and underground workings.	
Instream/riparian vegetation	RCE scores relating to riparian and instream vegetation within historical range and/or consistent with reference sites.	Yes – see Section 3.3.

1.5 Assumptions

Historical water quality data and monthly water quality results for Airly Creek sites in 2022 were obtained from ALS. Rainfall records were obtained from Centennial. It is assumed that the data provided to GHD has been collected using suitable methods and procedures to ensure the accuracy of the results.

1.6 Scope and limitations

This report: has been prepared by GHD for Centennial Airly Pty Ltd and may only be used and relied on by Centennial Airly Pty Ltd for the purpose agreed between GHD and Centennial Airly Pty Ltd as set out in section 1.3 of this report.

GHD otherwise disclaims responsibility to any person other than Centennial Airly Pty Ltd arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report (refer section(s) 1.5 of this report). GHD disclaims liability arising from any of the assumptions being incorrect.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions (including the presence of hazardous substances and/or site contamination) may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

2. Methodology

2.1 Study area and site selection

Seven sites near Airly Mine were visited in autumn and spring 2022. The monitoring locations are detailed in Table 2.1 and Figure 2.1. All sites were sampled for water quality, sediment quality and macroinvertebrates in both autumn and spring 2022.

Site DOG on Dog Trap Creek and GRO and GEN on Genowlan Creek are considered to be in a baseline state, as there has been no panel and pillar mining in these areas to date. Panel and pillar mining has been undertaken beneath small headwater sections of Torbane Creek and Gap Creek between 2019 and 2022, although only a very small area was within the Torbane Creek catchment. Under the Airly Mine Plan, additional panel and pillar mining will be undertaken below the headwaters of Gap Creek, Genowlan Creek and Dog Trap Creek in the future, although third order streams and higher will be avoided.

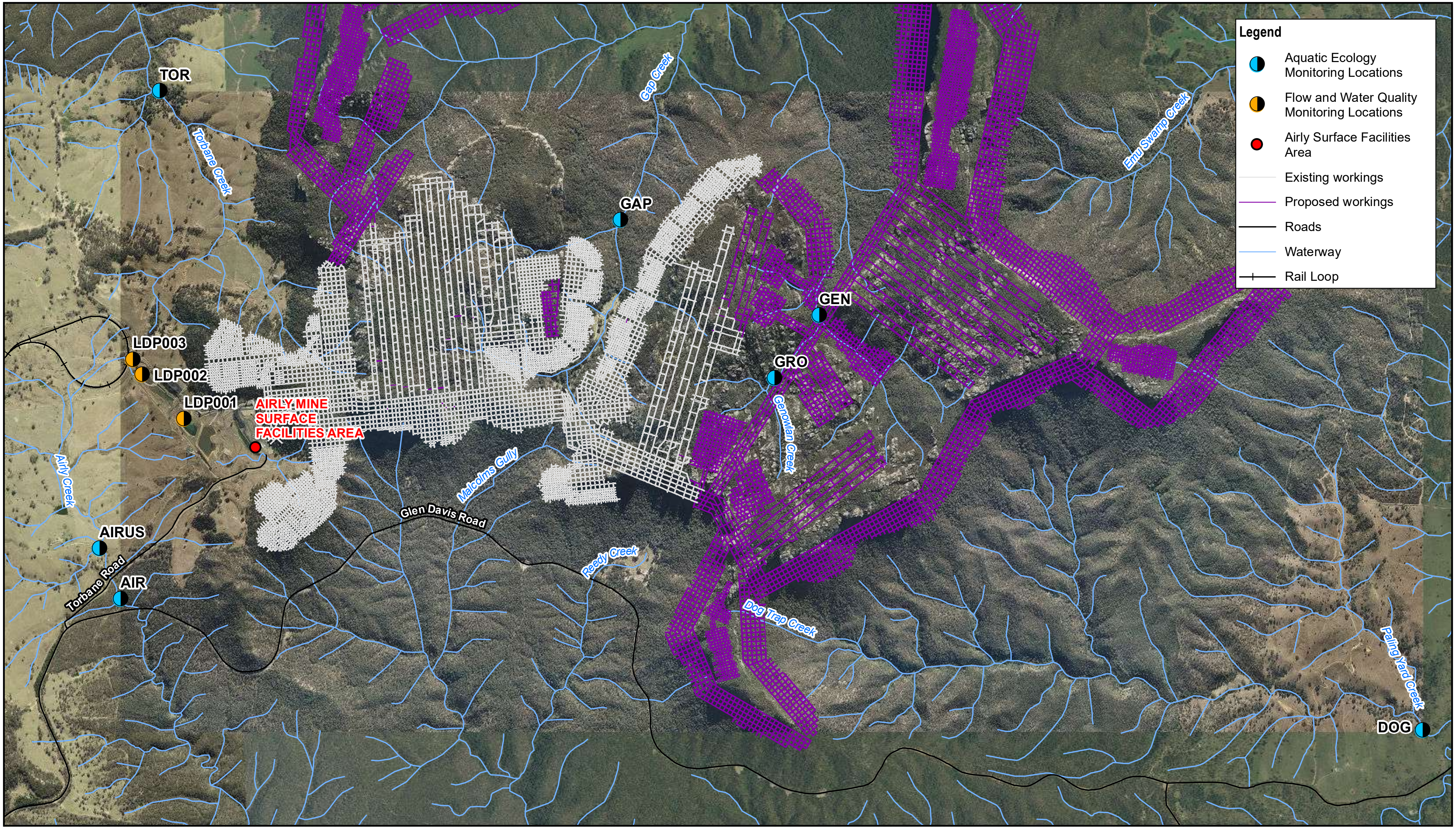
AIR on Airly Creek is classified as an impact site as it is downstream of LDP1, LDP2 and LDP3, and receives infrequent discharges of mine affected water (MAW) from Airly Mine. AIRUS is a background site located on Airly Creek, upstream of the licensed discharges from Airly Mine. Airly Creek will not be undermined.

Table 2.1 Sites sampled in autumn and spring 2022

Site code	Site name	Site type	Dates sampled		Latitude	Longitude	Altitude (m AHD)
			Autumn	Spring			
DOG	Dog Trap Creek	Baseline	29/3/2022	6/12/2022	-33.13475°	150.11087°	401
GAP	Gap Creek	Impact – headwaters undermined*	29/3/2022	5/12/2022	-33.09753°	150.04483°	701
GEN	Genowlan Creek	Baseline	31/3/2022	5/12/2022	-33.10456°	150.06123°	827
GRO	Upper Genowlan Creek	Baseline	30/3/2022	6/12/2022	-33.10860°	150.05760°	890
TOR	Torbane Creek	Impact – headwaters undermined*	31/3/2022	6/12/2022	-33.08764°	150.00706°	666
AIRUS	Airly Creek upstream of Airly Mine	Background (discharge)	29/3/2022	6/12/2022	-33.11967°	150.00018°	715
AIR	Airly Creek downstream of Airly Mine	Impact (discharge)	29/3/2022	6/12/2022	-33.12286°	150.00262°	714

Note: Locations in GDA94.

*Relates to secondary workings (panel and pillar mining)



Paper Size ISO A4

0 0.3 0.6 0.9 1.2

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

Centennial Pty Ltd
Airly Mine
Aquatic Ecology Monitoring Program

Project No.	**12570462**
Revision No.	**0**
Date	**14 Feb 2023**

Aquatic ecology monitoring locations

FIGURE 2-1

G:\22\0105001\GIS\Maps\Deliverables\Western\Airly\12570462\AquaticEcology\12570462_AEM001_MonitoringLocations_0.mxd
Print date: 14 Feb 2023 - 08:35

Data source: Centennial: Mine data, 2021, Aerial Imagery; LPI: DTDB / DCDB, 2017; © Department of Finance, Services & Innovation 2018. Created by: fmackay

2.2 Habitat assessment

Habitat descriptions were made in the field based on visual estimates of characteristics such as stream bed composition (percentage of each substrate category e.g., sand or cobble), aquatic and riparian vegetation cover, amount of instream organic material, type of aquatic habitats and canopy cover. The mean wetted width and sample depth were also estimated.

Assessments of disturbance related to human activities were made for each site following the methodology prescribed by Turak *et al*. (2004), which ranks habitat disturbance based on instream habitat, riparian vegetation and the land-use in the greater catchment area. The assessment also included sketches of the longitudinal and cross-sectional profiles of the river reach.

Assessment of the condition of the aquatic habitat was also conducted using the RCE inventory (Peterson 1992). RCE provides a standardised approach to assess the adjacent land, condition of the banks, channel and bed using 13 indicators. The RCE Inventory has been modified by Chessman et al. (1997) to suit Australian conditions. The scoring system has been simplified to a range of 0 to 4 for each descriptor with 0 indicating the poorest condition. The total score is derived by summing the scores for each descriptor. Scores can be expressed as a percentage of the maximum score of 52.

2.3 Water quality monitoring

2.3.1 *In situ* water quality

Physico-chemical water quality parameters were measured *in situ* at each of the sampling sites using a YSI Pro Plus multi-parameter water quality meter. This meter was calibrated in accordance with Quality System/Quality Assurance (QS/QA) requirements and the manufacturer's specifications prior to its use in the field.

In situ physico-chemical measurements recorded included:

- Temperature (°C)
- pH (pH units)
- Electrical conductivity (µS/cm) – EC
- Dissolved oxygen (mg/L and % saturation) – DO

2.3.2 Laboratory analysis

Water quality samples were collected from the sampling sites shown in Table 2.1 prior to the collection of sediment and macroinvertebrate samples. Disposable nitrile gloves were worn to prevent sample contamination and for staff safety. Samples requiring analysis of dissolved metals were field filtered using a high volume 0.45 µm filter prior to collection in the sample bottle.

The chemical analyses in Table 2.2 were performed by a National Association of Testing Authorities (NATA) accredited laboratory. Ultra-trace analysis was performed in some cases as required for comparison to the relevant ANZG (2018) GVs. Laboratory certificates of analysis (COAs) are presented in Appendix A.

Table 2.2 Analytical testing – water quality

Suite	Analytes
Metals (dissolved and total)	Aluminium, arsenic*, boron, cadmium*, chromium*, copper, iron, lead, manganese, mercury, nickel, selenium*, silver*, zinc*
Anions	Chloride, sulfate, alkalinity
Cations	Calcium, sodium, potassium, magnesium
Nutrients	Ammonia, nitrate, nitrite, Total Kjeldahl Nitrogen (TKN), total nitrogen (TN), total phosphorus (TP) and reactive phosphorus
Other	Total dissolved solids (TDS), dissolved organic carbon (DOC), total suspended solids (TSS), water hardness, turbidity

* denotes that ultra-trace analysis was performed

2.4 Sediment quality monitoring

Sediment grab samples were collected following the sediment-water interface hand corer methods as outlined in the Sediment Quality Assessment guide (Simpson and Batley 2016).

Sediment samples were collected using a plastic trowel. To account for potential variability of sediment quality within a site, sediment was collected from a minimum of two locations at each site and homogenised to produce one composite sediment sample.

The sediment samples were analysed for the parameters presented in Table 2.3 by a NATA accredited laboratory. The laboratory COAs are presented in Appendix B.

Table 2.3 Analytical testing – sediment quality

Suite	Analytes
Metals (totals and 1M HCl extractable)	Aluminium, antimony, arsenic, cadmium, chromium, copper, manganese, nickel, lead, zinc, mercury
Nutrients	Ammonia, nitrite, nitrate, nitrite plus nitrate (NO_x), TKN, TN, TP
Other	Total organic carbon

2.5 Macroinvertebrate monitoring

2.5.1 Field sampling

Field sampling followed Rapid Bioassessment (RBA) protocols in accordance with the NSW AUSRIVAS Sampling and Processing Manual (Turak *et. al.* 2004). The AUSRIVAS program is a nationally recognised, standardised sampling protocol used to assess the health of Australian rivers and was developed for Australia's National River Health Program.

In accordance with the AUSRIVAS protocol, the autumn 2022 macroinvertebrate monitoring was conducted between 15 March and 15 June 29 to 31 March 2022), and spring 2022 macroinvertebrate monitoring was conducted between 15 September and 15 December (5 to 6 December 2022).

Two samples were collected from Edge habitat at each site, per season, except GAP, for which there was only sufficient water for one sample in spring. Edge habitat is defined as areas within 1 m of the edge of the water, in areas of little or no flow. Sampling was conducted using a standard ISO 7828 (1983) design sweep-net with 250 µm mesh. Sampling of the Edge habitat was undertaken by sweeping the net perpendicular to the bank over approximately 10 m of discontinuous edge habitat. All available microhabitats were targeted, including overhanging terrestrial vegetation, snags, backwaters, and macrophyte. The net was washed thoroughly between each sample to remove any invertebrates retained on it.

For each RBA sample, the collected material was placed into a sorting tray and macroinvertebrates picked for a minimum of 40 minutes by experienced aquatic ecologist using forceps and pipettes. If new taxa were found between 30 and 40 minutes, sorting continued for a further 10 minutes. The processing cycle was continued up to a total maximum sorting time of 1 hour.

The objective of the RBA sorting protocol is to obtain a sample containing as diverse a fauna as possible, and hence provide a useful measure of taxa richness. Attempts were made to collect all taxa present in the sample, including rare or cryptic animals. Samples were preserved in 70 percent methylated spirits and clearly labelled with information including site, habitat, sampling method, date and sampler.

2.5.2 Laboratory processing and identification

Macroinvertebrates were examined in a GHD laboratory using Leica MZ 9.5 stereo-dissection microscopes with planachromat objectives and a zoom capability between 6.3-60x. Macroinvertebrates were identified using published taxonomic keys (Hawking 2000), unpublished working keys and an extensive specimen reference collection maintained by GHD.

Most macroinvertebrates were identified to family level with some exceptions following standard conventions of the NSW AUSRIVAS sampling and processing manual (Turak *et al*. 2004). Chironomidae (Diptera) were identified to sub-family (e.g. Orthocladiinae, Chironominae, and Tanypodinae). Groups such as Nematoda, Oligochaeta and Acarina were identified to class or order level. Microcrustacea (Ostracoda, Copepoda and Cladocera) were also identified to the order level but were not included in in richness counts to align with historical results. Microcrustacea were included in the datasets analysed using the AUSRIVAS software. The raw macroinvertebrate counts can be viewed in Appendix C.

Upon completion of identification all samples were returned to 100% ethanol for long-term archiving. GHD will ensure that archived samples are retained for the life of the project. Reference specimens will remain the property of GHD.

2.5.3 Scientific collection permit

GHD has a current NSW Department of Primary Industries Scientific Collection Permit (SCP) P07/0412.5 (Exp. 31/10/2023) to conduct macroinvertebrate sampling in NSW rivers and streams. All sampling for this project was conducted in accordance with this SCP.

2.6 Quality assurance

In accordance with GHD’s Quality Assurance (QA) protocol, one duplicate water and sediment sample was collected from autumn and spring 2022 at the same time as primary sample collection. The collection of a duplicate sample allows for the assessment of the potential level of uncertainty associated with the sampling method, preservation, transport, or laboratory analysis, as well as the intra-site variability. The results of the primary and duplicate water and sediment samples are presented in Appendix D and Appendix E, respectively.

One sample was examined by a second taxonomist to check the accuracy of identification, the results of which can be seen in Appendix F.

2.7 Data analysis

2.7.1 Water quality

Water quality results for all baseline sites (DOG, GAP, GEN, GRO and TOR) were compared to the default guideline values (DGVs) in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality as detailed below:

- DGV ranges for physical and chemical stressors outlined in Table 3.3.2 of the ANZECC (2000) guidelines.
- DGV ranges for EC and turbidity outlined in Table 3.3.3 of the ANZECC (2000) guidelines.
- Toxicant DGVs for protection of 99 percent of freshwater species as outlined in ANZG (2018).

The 99 percent species protection level was used in this analysis due to the proximity of Airly Mine to State Conservation Areas and National Parks and the conditions of consent (refer Section 1.4.2).

Water quality results for AIRUS and AIR were compared to the Site-Specific Guideline Values (SSGVs) for Airly Creek (GHD 2018b) that were derived from the background Airly Creek site AIRUS and the DGVs outlined above (ANZECC 2000; ANZG 2018).

The DGVs and SSGVs are presented in Table 2.4.

Table 2.4 DGVs and SSGVs applicable to Airly sites

Parameter	ANZECC (2000) DGV	ANZG (2018) DGV	SSGV
Physicochemical parameters			
EC (µS/cm)	350	-	2,709
pH (pH units)	6.5-8.0	-	6.5-8.0
TSS (mg/L)	25	-	25
Turbidity (NTU)	25	-	25
Oil and grease (mg/L)	-	-	5
Metals (dissolved)			
Aluminium (mg/L)	-	0.027	0.027
Antimony (mg/L)	-	-	0.001
Arsenic (mg/L)	-	0.0008	-
Barium (mg/L)	-	-	0.017
Beryllium (mg/L)	-	-	0.001
Boron (mg/L)	-	0.34	0.09
Cadmium (mg/L)	-	0.00006	-
Chromium (III+VI) (mg/L)	-	0.00001	-
Cobalt (mg/L)	-	0.0014*	0.001
Copper (mg/L)	-	0.001	0.001
Iron (mg/L)	-	-	0.3
Lead (mg/L)	-	0.001	0.001
Manganese (mg/L)	-	1.2	1.2
Mercury (mg/L)	-	0.00006	-
Molybdenum (mg/L)	-	-	0.001
Nickel (mg/L)	-	0.008	0.008
Selenium (mg/L)	-	0.005	-
Silver (mg/L)	-	0.00002	0.001
Zinc (mg/L)	-	0.0024	0.0076
Nutrients			
Ammonia as N (mg/L)	-	0.32	0.32
Nitrogen (Total) (mg/L)	0.25[1]	-	0.7
Phosphorus (Total) (mg/L)	0.02[1]	-	0.056

* DGV for cobalt is of unknown species protection

Dissolved metal and metalloid concentrations are more applicable for comparison to the water quality DGVs than total metal concentrations, as they are more representative of the bioavailable fractions of metals and metalloids within the water. Therefore, only dissolved concentrations have been assessed against the water quality DGVs/SSGVs.

Hardness modified guideline values (HMGVs) were calculated using the algorithms presented in Table 3.4.3 of ANZECC (2000) and the water hardness values observed during the corresponding sampling event in 2022. HMGVs are applicable to dissolved cadmium, lead, nickel and zinc concentrations in water samples with a water hardness greater than 30 mg/L (as $CaCO_3$). However, HMGVs were only calculated if dissolved concentrations of the relevant metal exceeded the SSGV/DGV.

Multivariate analysis

A Piper plot was created for water samples collected in autumn and spring 2022. A Piper plot is a graphical method of presenting the major ionic chemistry of a water sample. The plot displays water samples in regard to their cation composition in the left triangle, anion composition in the right triangle, and a combination of the two in the centre diamond plot. Convergence of the sample symbols indicates a similar chemical composition.

Historical review

Long-term, time series water quality graphs were created for key analytes at impact site AIR and background site AIRUS and are presented in Appendix G. Analysis of these results allows for assessment of the influence of Airly Mine discharges on water quality in Airly Creek, as well as changes in Airly Creek water quality over time (including pre/post EIS). Data collected monthly by ALS on behalf of Centennial Airly has been graphed, along with data collected by GHD during the biannual aquatic ecology monitoring program. At AIR, data are available for a total collection period from January 2010 to December 2022, while at AIRUS data are available between April 2014 and December 2022.

2.7.2 Sediment quality

Sediment quality results were compared to the revised DGVs for sediment quality outlined in ANZG (2019). The sediment DGVs represent the thresholds above which biological effects are possible. GV-high values are also outlined, which are the thresholds above which there is a high probability of biological effects. It was identified in ANZG (2019) that the <2 mm sediment fraction should be compared to the DGVs for acid-extractable metals. As such, sediment samples collected in 2022 were sieved, and analysis of metals was undertaken on the <2 mm fraction only.

Acid-extractable (1M HCl-extractable) metal and metalloid concentrations are more applicable for comparison to the DGVs than total metals, as they are more representative of the bioavailable fractions of metals and metalloids found in sediments. Therefore, only acid-extractable metals have been assessed against the DGVs / GV-highs.

2.7.3 Macroinvertebrates

Univariate metrics

The following metrics have been calculated to allow for assessment of macroinvertebrate community health:

- Taxa richness
- EPT richness
- SIGNAL-2
- Proportion of sensitive taxa (taxa with SIGNAL-2 score ≥ 8)

Taxa richness

Taxonomic richness refers to the number of different taxa contained in a sample identified to family level, apart from certain taxa which were identified to order/class only (e.g., Oligochaeta) or to sub-family (i.e., members of the family Chironomidae). Rare and common taxa are considered equally, as richness does not take abundance into account.

EPT richness

The EPT richness is the number of Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies) families present in a sample. The animals within these three Orders tend to be sensitive to pollution and other disturbances, making them a useful indicator of instream health.

SIGNAL-2

SIGNAL-2 (Stream Invertebrate Grade Number – Average Level) (Chessman 2003) is a simple scoring system for macroinvertebrates of Australian rivers. SIGNAL-2 is a biotic index based on pollution sensitivity values (grade numbers) assigned to aquatic macroinvertebrates that have been derived from published and unpublished information on their tolerance to pollutants, such as sewage, salinity and nitrification.

Macroinvertebrates are assigned a grade between 1 (most tolerant) and 10 (most sensitive) and grades have been calculated for both the Order and Family taxonomic levels. Families in a sample that have not been assigned a grade are excluded from the analysis and the total number of families that have a SIGNAL-2 grade is the SIGNAL-2 richness. The overall SIGNAL-2 score for each site is calculated by the sum total of the SIGNAL-2 grade for each taxon within a sample divided by the SIGNAL-2 richness. A SIGNAL-2 score was calculated for each replicate from each site.

Proportion of sensitive taxa

The proportion of sensitive taxa is calculated as the percentage of taxa within the sample with a SIGNAL-2 of 8 or higher (Marshall *et al*. 2001). This metric allows for an additional measure of the sensitivity of the macroinvertebrate community at each site.

NSW AUSRIVAS Model

NSW AUSRIVAS Models provide a river health assessment based on predictive models of macroinvertebrate distribution. Physical and chemical data collected at each site is used to determine the predicted (expected) composition of the macroinvertebrate fauna if the site is in an undisturbed or reference condition. The AUSRIVAS assessment compares the macroinvertebrates collected at a site (Observed) to those predicted to occur (Expected) and the ratio derived indicates the band assessment of the sample data and an assessment of the level of impact at a site. The resulting statistic is known as the O/E50 and expresses the ratio of observed taxa to those with a 50% or greater probability of being collected, given the physical / chemical input variables.

The NSW combined-season eastern edge model was used for all sites in 2022. The upper limits for the AUSRIVAS model are provided in Table 2.5, along with the AUSRIVAS band labels, names and descriptions.

Rainfall data required for the AUSRIVAS environmental variables input file were obtained from the Running Stream (Brooklyn) Station (63012), which is the nearest active weather station with long-term data (BOM 2023).

Table 2.5 NSW combined-season eastern edge AUSRIVAS bands and descriptions

Band Label	Upper Limit Combined model (O/E50)	Band Name	Band Description
Band X	Infinity	More biologically diverse than reference sites	More taxa found than expected. Potential biodiversity hot-spot. Possible mild organic enrichment.
Band A	1.17	Reference condition	Most/all of the expected families found. Water quality and/or habitat condition roughly equivalent to reference sites. Impact on water quality and habitat condition does not result in a loss of macroinvertebrate diversity.
Band B	0.82	Significantly impaired	Fewer families than expected. Potential impact either on water quality or habitat quality or both, resulting in loss of taxa.
Band C	0.48	Severely impaired	Many fewer families than expected. Loss of macroinvertebrate biodiversity due to substantial impacts on water and/or habitat quality.
Band D	0.14	Extremely impaired	Few of the expected families remain. Extremely poor water and/or habitat quality. Highly degraded.

Multivariate metrics

Multivariate analyses were conducted to identify spatial and temporal trends in macroinvertebrates. Multivariate analysis allows comparisons between sites based upon macroinvertebrate community composition.

The following multivariate analyses were performed, using PRIMER 7 (Clarke and Gorley 2015) statistical analysis software:

- Non-metric Multi-Dimensional Scaling (nMDS) ordination
- ANalysis Of SIMilarities (ANOSIM)

Initially, the data were transformed to presence/absence as the AUSRIVAS sampling protocol is not a quantitative technique. Bray-Curtis was the resemblance measure used to derive the resemblance matrix between samples, which are suitable for biological data (Bray and Curtis 1957).

A nMDS ordination plot was produced to identify temporal and spatial trends in macroinvertebrate community composition. nMDS plots provide a graphical representation of the relative similarity of entities (i.e., samples) based on their attributes (i.e., macroinvertebrate community composition) within a reduced dimensional space. The more similar samples are to each other, the closer they are located within the ordination space. The nMDS ordination was performed on Bray-Curtis similarity coefficients, which are suitable for biological data (Bray and Curtis 1957). The 2-dimensional ordination plot has been displayed as this is more easily interpreted than the 3-dimensional plot. To determine if the 2-dimensional ordinations accurately represent patterns amongst the samples, the stress levels associated were considered. The stress level is a measure of the distortion produced by compressing multi-dimensional data into a reduced set of dimensions and would increase as the number of axes (i.e., dimensions) is reduced. If the stress is over 0.2, the MDS ordination must be interpreted with caution.

An ANOSIM test was performed on the macroinvertebrate similarity matrix to test whether macroinvertebrate communities were statistically different between sites. This method permutes the observed data and tests the between group similarity observed under this “random” data set. The significance of the test is determined based on whether higher or lower similarity was experienced under the permuted datasets. Interpretation of this technique is based on significance (p<5%) and strength of the relationship, denoted as R.

3. Results

3.1 Environmental conditions

Rainfall during 2022, as recorded by Centennial at Airly Mine, is displayed in Figure 3.1. March was the wettest month with 168.4 mm of rainfall recorded. The driest month was December, during which 22.4 mm of rainfall was recorded.

In the 30 days prior to the autumn sampling event (27 February to 28 April 2022), 155.0 mm of rainfall was recorded, of which 32.8 mm was recorded in the week prior to sampling. During the three days of sampling in autumn 2022 (29 to 31 March 2022), 18.2 mm was recorded. In the 30 days prior to the spring sampling event (5 November to 4 December 2022), 39.6 mm of rainfall was recorded, of which 1.4 mm was recorded in the week prior to sampling. On the final day of sampling in spring 2022 (6 December 2022), 1.6 mm of rainfall was recorded.

Figure 3.2 displays yearly rainfall totals for 2013 to 2022, as recorded by Centennial at Airly Mine. Rainfall data from Running Stream (Brooklyn) BOM station (63012) (BOM 2023) was used for the period January to October 2013 as recording by Centennial began in November 2013. Long-term mean annual rainfall data was sourced from BOM (2023) for a period from 1899 to 2021.

Rainfall in 2022 totalled 1019.4 mm, which the highest rainfall recorded during the 10-year period from 2013 to 2022. Rainfall was close to average in 2020 and 2021. During the 2013 to 2019 period, rainfall only exceeded the yearly average once, in 2016, while rainfall in all other years was below average. The lowest annual rainfall was recorded in 2019, during which 398.4 mm of rainfall was recorded. Rainfall during the 2017 to 2019 period was well below the long-term average for the area which is reflective of the state-wide drought.

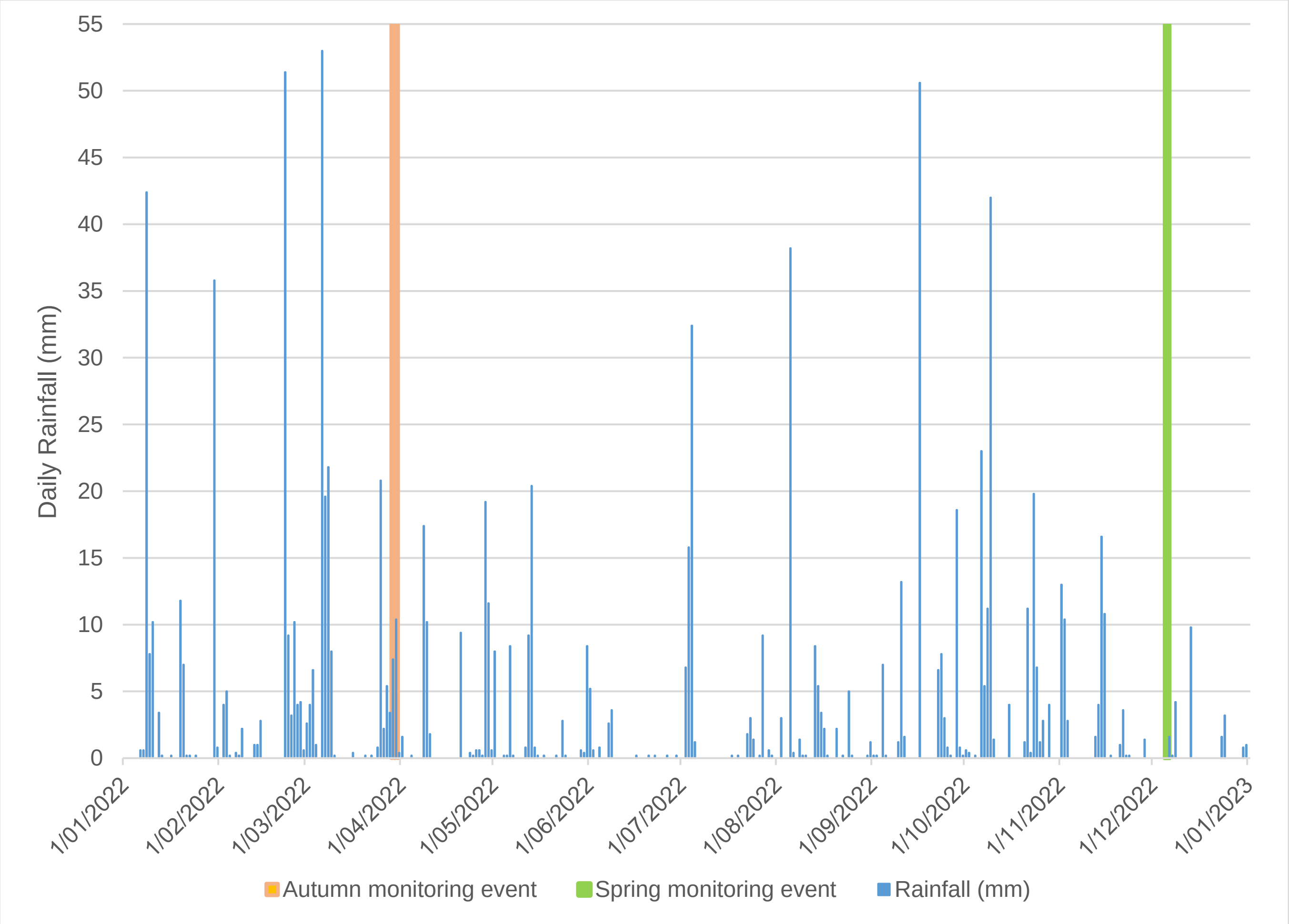


Figure 3.1 *Daily rainfall at Airly Mine in 2022*

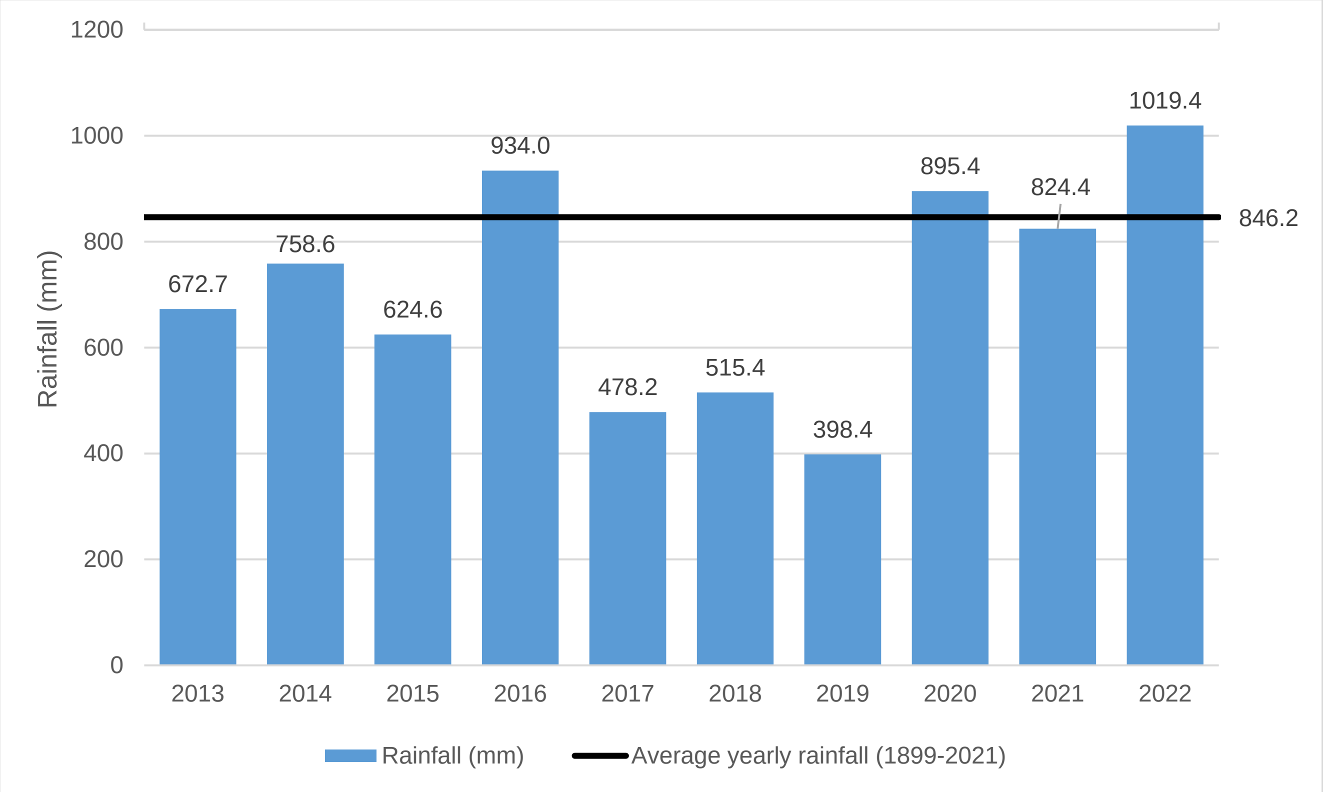


Figure 3.2 Yearly rainfall at Airly Mine from 2013 to 2022, compared to average yearly rainfall (1899-2021)

3.2 Discharges from Airly Mine in 2022

Ten discharge events were recorded from LDP1 in 2022. These events are presented in Table 3.1 and Figure 3.3. There was one discharge event recorded from LDP2 in 2022, on 5 January 2022. No discharges from LDP3 were recorded in 2022.

The discharge event prior to sampling in autumn 2022 concluded on 14 March 2022, 15 days prior to sampling. The volume of water discharged during this event was the highest of all discharge events in 2022, with 57.26 ML discharged over 10 days. The discharge event prior to spring sampling concluded on 27 November 2022, eight days prior to sampling. The volume of water discharged from LDP1 during this event was 14.68 ML over a six-day period, most of which was discharged on 23 November 2022.

Table 3.1 Recorded discharges at LDP1 in 2022

Event period	Number of days	Maximum daily discharge during event (ML/day)	Cumulative discharge during event (ML)
9/1/2022 – 16/01/2022	8	8.5	12.8
25/02/2022 – 28/02/2022	4	4.9	5.5
5/03/2022 – 14/03/2022	10	12.0	57.3
15/04/2022 – 20/04/2022	6	1.2	20.2
17/05/2022 - 23/05/2022	7	9.9	28.3
5/07/2022 - 11/07/2022	7	9.9	18.6
11/08/2022 - 16/08/2022	6	8.6	13.9
17/09/2022 - 26/09/2022	10	8.6	20.8
7/10/2022 – 17/10/2022	11	10.2	49.2
22/11/2022 – 27/11/2022	6	9.1	14.7
Total discharge from LDP1 in 2022			**241.1**

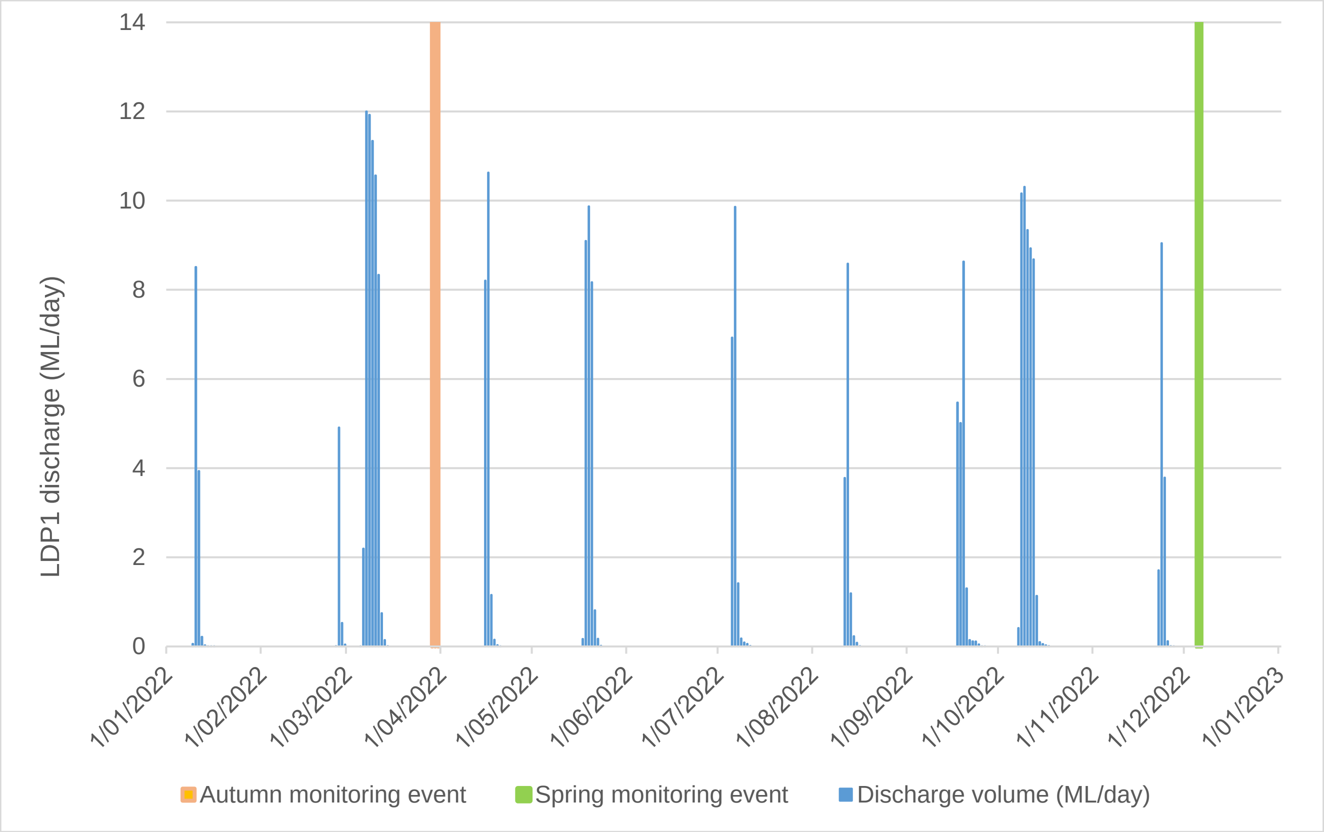


Figure 3.3 ***Daily discharge from LDP1 in 2022***

3.3 Aquatic habitat assessment

Descriptions of the riparian vegetation, stream substrate and key instream habitats observed at each site in autumn and spring 2022 are provided below. The substrate composition and other instream habitat information has been used in interpreting the macroinvertebrate data in Section 3.6. Table 3.2 presents the site photographs taken in autumn and spring 2022.

The higher altitude sites in Genowlan and Gap Creeks are characterised by a narrow and steep series of cascades and shallow pools. These creeks are located in an upland area where riparian vegetation is almost entirely native and includes an abundance of ferns and shrubs overhanging the streams, providing shading and edge habitat for macroinvertebrates. The channels of Dog Trap, Torbane and Airly Creeks are at a lower altitude and exhibit greater disturbance of the stream and riparian vegetation, with potential non-point source pollution from grazing, clearing for agriculture and growth of some exotic vegetation including grasses, blackberry (*Rubus fruticosus*) and willows (*Salix sp.*).

GEN in Genowlan Creek is spring-fed and contained water consistently since early-2020, after having dried completely during the 2019-2020 summer period. A flow gauging weir was installed at the site in early 2019 and a clearing containing groundwater monitoring bores, and historical access track is the only other anthropogenic disturbance near the site, although, there is a foul-wheel-drive track upstream of the site. Aquatic habitats at GEN in 2022 include *Chara sp.*, trailing ferns and grasses and some leaf litter. The substrate is primarily sand in the downstream pool but contains more boulders and cobbles in the narrower upstream channel.

GRO is located in upper Genowlan Creek, but water is from the Grotto. Flow was observed at GRO during all of 2022 (based on observations from monthly groundwater sampling). Riparian habitat at GRO is similar to GEN with abundant native vegetation including overhanging ferns. Some disturbance is present at the site from the maintenance of the adjacent four-wheel-drive track. Aquatic habitats at GRO in 2022 include overhanging ferns, sandy banks, leaf packs and some submerged woody habitat. The substate is mostly sand and some bedrock, which was covered by a layer of brown algae.

GAP is located on Gap Creek, which flows through a steep valley area of large boulders in a native bushland area, with riparian vegetation of *Eucalyptus sp.*, shrubs and grasses. A steep four-wheel drive track runs parallel to Gap Creek, although there is a narrow section of riparian vegetation remaining as a buffer along most of the reach. Gap Creek contains a flow gauging v-notch weir and small, isolated pools between boulders, with a bedrock or sandy substrate. The creek contained water consistently throughout 2022. Aquatic habitats at GAP in 2022 include overhanging *Lomandra sp.* (mat rush) and other grasses, leaf packs and sticks, and the substrate is a mix accumulated sand in amongst pools formed between boulders and cobbles.

DOG is located on Dog Trap Creek which flows through private property that is used for cattle grazing. The riparian vegetation at DOG has shown improvement across recent sampling events, with the emergence of many eucalypt saplings and other native shrubs on the left bank, though the right bank remains mostly bare and the area contains many weeds. Aquatic habitats at DOG in 2022 include *Typha sp.*, *Chara sp.*, emergent grasses and algae. In spring 2022, the site was flowing, and the downstream section of the creek, which had not contained sufficient water to sample since 2016, was sampled. This section of the creek contains a heterogenous substrate including bedrock, cobbles, pebbles and sand, while the substrate in the main pool is primarily silt.

TOR is located on Torbane Creek, which flows though Centennial owned land that is used for cattle grazing. The riparian vegetation consists of native eucalyptus and tea trees, as well as many areas of very dense invasive blackberry growth. Aquatic habitats at TOR in 2022 include submerged and overhanging grasses, as well as sticks and trailing roots. The substrate at the site is mostly sand and gravel in the deeper pools, as well as cobbles in the shallower sections.

AIRUS is located on Airly Creek, upstream of where Airly Mine discharges enter. The catchment area is used for cattle grazing and the riparian vegetation at this site is mostly cleared, except for several patches of willows. Aquatic habitats at the AIRUS in 2022 include macrophytes including *Typha sp.* and rushes, as well as *Chara sp.* and algae. The substrate at AIRUS is mostly silt.

AIR is located on Airly Creek downstream of Airly Mine discharges. The riparian vegetation at AIR is less disturbed than that at AIRUS, and is primarily native, including eucalypts, native shrubs and mat rush, though sections of blackberry are present. Aquatic habitats at AIR in 2022 include *Typha sp.*, trailing grasses and some submerged woody habitat. The substrate was mostly cobbles, and there was very little deposition of silt or other loose sediments.

RCE scores for each site in autumn and spring 2022 are presented in Table 3.3 and have been compared to results from 2022 monitoring, as well as results for monitoring conducted by Cardno prior to the Airly Mine extension EIS (Cardno 2014). Individual category scores were not provided in the EIS and, therefore, comparisons can only be made to the overall scores in the EIS (Cardno 2014). There was little change in the scores for RCE categories relating to riparian vegetation (see Appendix H, category 2, 3, 4) between 2021 and 2022, although, the scores at some sites did change between seasons.

AIR and AIRUS scored higher in both autumn and spring 2022 for aquatic vegetation (category 13) compared to 2021, due to a reduction in algal growth at these sites. There were no other changes to aquatic vegetation observed in 2022.

Overall RCE scores at impact site AIR in 2021 and 2022 were higher than those at background site AIRUS, despite being downstream of LDP1.

The condition of baseline site DOG, as estimated by the overall RCE score, has degraded most since EIS monitoring, though this site is not impacted by mining and degradation is due to impacts from agricultural landuse, including cattle grazing, and the long-term drought which caused dieback of riparian vegetation and altered the waterway hydraulics. During the drought period, water on Dog Trap Creek receded to a single isolated waterhole with poor riparian cover and a substrate dominated by silt. Conversely, during sampling in 2016, there was flow along the entire 100 m reach and water present within sections with bedrock, boulder and good riparian (casuarina) cover. The condition at baseline site GRO has also experienced degradation since EIS monitoring, likely due to damage to the riparian vegetation and accumulation of sand within the channel caused by repair works to the adjacent vehicle track in recent years.

Table 3.2 Site photographs taken in autumn and spring 2022

DOG	
 Autumn 2022	 Spring 2022
GAP	
 Autumn 2022	 Spring 2022
GEN	
 Autumn 2022	 Spring 2022

GRO	
 Autumn 2022	 Spring 2022
TOR	
 Autumn 2022	 Spring 2022
AIRUS	
 Autumn 2022	 Spring 2022

AIR	
 Autumn 2022	 Spring 2022

Table 3.3 RCE scores, 2021-2022

Site	Spring 2022	Autumn 2022	Spring 2021	Autumn 2021	EIS average (Cardno 2014)
DOG	56	63	48	54	71
GAP	88	77	78	80	83
GEN	85	85	85	85	90
GRO	79	85	76	72	90
TOR	71	67	69	69	73
AIRUS	50	54	48	50	NA
AIR	77	81	65	70	75

NA indicates site was not sampled prior to the EIS

3.4 Water quality

3.4.1 Water quality – 2022

The results of *in situ* and laboratory water quality analyses in autumn and spring 2022 are presented in Table 3.4 and Table 3.5 respectively. Results at Airly Creek sites AIRUS and AIR have been compared to the SSGVs, derived by GHD from the 80th percentile value of historical water quality results from AIRUS (GHD 2018b). For parameters where SSGVs did not exist, the ANZG (2018) DGV was applied. Results for potential toxicants at all other sites have been compared to the DGVs (ANZG 2018) for 99% species protection. HMGVs have been calculated, where applicable (see Section 2.7.1). These HMGVs are displayed in Table 3.6.

Parameters measured at concentrations below the laboratory limit of reporting (LOR) at all sites have not been displayed in Table 3.4 and Table 3.5. Laboratory COAs showing data for all measured parameters are provided in Appendix A. Despite ultra-trace analysis, the LOR for chromium and silver are higher than the DGVs. Only values above the LOR will be counted as exceedances, however, it is noted that these may not be reflective of all exceedances of these parameters.

EC exceeded the DGV at baseline site DOG and recently impacted site TOR in both autumn and spring 2022. EC results at both sites were higher in autumn than spring. At the Airly Creek sites AIRUS and AIR, EC was below the SSGV in both autumn and spring 2022, though results were higher than at all other sites, and were therefore above the DGV. EC at both Airly Creek sites was higher in spring than autumn, and was higher at background site AIRUS than impact site AIR in both autumn and spring 2022. EC was below the DGV at background sites GEN and GRO and recently impacted site GAP in both seasons, with results at GRO the lowest of all sites.

pH results were more acidic than the lower DGV at both Genowlan Creek sites (GEN and GRO) in both autumn and spring. The lowest pH result (4.6) was observed at GRO in autumn 2022. pH results at all other sites were within the DGV / SSGV range and were similar between sampling events.

In autumn 2022, DO saturations were below the lower DGV at all sites, with the lowest saturation observed at background site AIRUS (54.1%). In spring 2022, DO saturations were higher at all sites, with only the results at baseline sites DOG (77.6%) and GEN (85.5%) remaining below the lower DGV. The DO saturations at TOR and AIR in spring 2022 were supersaturated (113.6 and 119.3%, respectively), exceeding the upper DGV.

TSS and turbidity result were low at all sites in both autumn and spring, with all results below the DGVs / SSGVs. There was not a strong relationship between TSS and turbidity results. In both seasons, TSS was highest at the Airly Creek sites and DOG, while turbidity was highest at GAP.

Water was very hard at AIRUS, AIR, DOG and TOR in both autumn and spring 2022, with the hardest water observed at the Airly Creek sites. Water was notably harder in spring than autumn at AIRUS, AIR and TOR. Water at GEN and GRO was very soft during both sampling events of 2022.

The Piper plot displays the cation and anion composition of water samples (Figure 3.4). The ionic composition of water was very similar between seasons at every site. Water at GEN and GRO was sodium chloride type, though water was very dilute with low concentrations of all ions. The ionic composition of water at GAP was similar to that at GEN and GRO, but was of mixed chloride/bicarbonate anion type. The ionic composition of water at TOR was similar to Airly Creek sites AIRUS and AIR, and consistent between seasons, with water displaying a calcium/magnesium sulfate ionic composition. Water at DOG was of a similar composition, though contained a stronger dominance of calcium and bicarbonate ions.

There were no exceedances of the SSGVs for any dissolved metal at discharge impact site AIR in autumn or spring 2022, though in autumn 2022 only, concentrations of dissolved chromium and zinc exceeded the DGVs at both AIRUS and AIR. These zinc concentrations, however, were below the calculated HMGVs (see Table 3.6). The chromium concentration was higher at background site AIRUS than at impact site AIR, while concentrations of zinc were the same at both sites. In spring 2022, concentrations of dissolved chromium and zinc had reduced, and were equal to or below the LOR at both sites. Dissolved manganese concentrations were elevated at impact site AIR compared to results from background site AIRUS in both autumn and spring, though results remained well below the DGVs. Concentrations of all other metals were low at both Airly Creek sites in 2022.

At the higher altitude sites (GEN, GRO and GAP) dissolved aluminium concentrations were elevated above the DGV, with the concentrations at GRO in both seasons the highest of all sites. The DGV for aluminium applies to water with a pH of >6.5 only, and therefore does not apply to the exceedances at GEN and GRO, where water was more acidic. However, aluminium is known to be more toxic to aquatic species in acidic water (an interim low reliability value of 0.0008 mg/L has been suggested by ANZECC (2000) for water with pH <6.5).

Dissolved chromium was also elevated at GEN, GRO and GAP, exceeding the DGV in autumn 2022, and at GRO and GAP only in spring 2022. All results were higher in autumn than spring. Dissolved arsenic was also elevated above the DGV at GAP only in autumn 2022, though the concentration in spring 2022 had reduced to below the DGV.

Dissolved zinc concentrations exceeded the DGV at GEN and GAP in autumn and spring 2022, with the result at GEN in both seasons the highest of all sites. HMGVs applied only to the zinc concentration at GAP in spring 2022 (hardness 31 mg/L), as all other hardness concentrations at GEN and GAP in 2022 were below 30 mg/L. The observed zinc concentration at GAP in spring exceeded the HMGV.

The concentration of dissolved nickel at TOR exceeded the DGV in autumn 2022 only. At the lower altitude sites DOG and TOR, there were no exceedances of the DGV for any other metal in either autumn or spring 2022. The dissolved manganese concentration at TOR, though below the DGV, was the highest of all sites in both autumn and spring 2022.

Concentrations of NO_x exceeded the DGV at all sites except GRO and AIRUS in autumn, and all sites except GRO only in spring 2022; however, there is no SSGV for NO_x. The highest NO_x concentration was observed at TOR in autumn 2022, though the concentration had reduced substantially between sampling events and was instead highest at GEN in spring.

Concentrations of total nitrogen exceeded the SSGV at AIRUS and AIR in autumn 2022, which were the only SSGV exceedances for any parameter in 2022. The total nitrogen concentrations at GAP and TOR also exceeded the DGV in autumn 2022, with the result at TOR the highest of all sites. In spring 2022, total nitrogen concentrations at AIRUS and AIR had reduced to below the SSGV and were above the DGV only. Total nitrogen concentrations were also lower in spring than autumn at GAP and TOR, though they remained above the DGV. Total nitrogen also exceeded the DGV at GEN and GRO in spring 2022. Total phosphorus concentrations were below the DGV at all sites in both autumn and spring 2022, except for the result at GAP in autumn.

Oil and grease concentrations were below detection limits at all sites in autumn and spring 2022, except for the result at GAP in autumn 2022.

Table 3.4 Results of laboratory analysis of water samples collected in autumn 2022

Analyte	Units	LOR	Baseline			Headwaters undermined		DGV	Background	Impact	SSGV
			DOG	GEN	GRO	GAP	TOR		AIRUS	AIR	
Date			29/03/22	31/03/22	30/03/22	29/03/22	31/03/22		29/03/22	29/03/22	
Time			14:40	15:00	08:45	15:07	11:00		10:50	08:00	
Physico-chemical parameters											
Temperature^	°C	0.1	19.9	15.4	15.1	17.6	17.6	NA	17.5	17.3	NA
EC^	µS/cm	1	**1111**	59	39	116	**1091**	350	**1293**	**1275**	2709
pH^	pH unit	0.1	7.9	**6.4**	**4.6**	7.4	7.9	6.5 - 8.0	7.6	7.7	6.5 - 8.0
DO^	% sat.	0.1	**69.4**	**60.7**	**81.7**	**86.5**	**66.1**	90 - 110	**54.1**	**73.5**	NA
DO^	mg/L	0.01	6.29	6.07	8.24	8.22	6.29	NA	5.14	7.03	NA
TDS	mg/L	1	754	51	24	76	741	NA	871	864	NA
TSS	mg/L	5	6	<5	<5	<5	<5	25	7	8	25
Turbidity	NTU	0.1	0.9	0.4	3.1	7.3	1.5	25	2.7	3.5	25
Total hardness	mg/L	1	576	4	<1	29	546	NA	681	688	NA
Major ions											
Bicarbonate alkalinity	mg/L	1	335	4	6	29	100	NA	157	128	NA
Total alkalinity	mg/L	1	335	4	6	29	100	NA	157	128	NA
Sulfate as SO4	mg/L	1	291	2	<1	<1	508	NA	601	583	NA
Chloride	mg/L	1	30	13	8	18	27	NA	29	31	NA
Calcium	mg/L	1	130	<1	<1	5	90	NA	111	114	NA
Magnesium	mg/L	1	61	1	<1	4	78	NA	98	98	NA
Potassium	mg/L	1	2	1	<1	4	8	NA	6	6	NA
Sodium	mg/L	1	46	6	5	11	26	NA	38	44	NA
Dissolved metals											
Aluminium	mg/L	0.01	<0.01	**0.07***	**0.49***	**0.09**	<0.01	0.027	0.02	<0.01	0.027

Analyte	Units	LOR	Baseline			Headwaters undermined		DGV	Background	Impact	SSGV
			DOG	GEN	GRO	GAP	TOR		AIRUS	AIR	
Arsenic	mg/L	0.0002	0.0005	<0.0002	<0.0002	**0.0018**	0.0005	0.0008	0.0006	0.0007	NA
Chromium$^+$	mg/L	0.0002	<0.0002	**0.0003**	**0.0012**	**0.0004**	<0.0002	0.00001	**0.0005**	**0.0003**	NA
Cobalt	mg/L	0.001	<0.001	0.001	<0.001	<0.001	<0.001	NA	<0.001	<0.001	0.001
Iron	mg/L	0.05	<0.05	<0.05	0.37	0.26	0.06	NA	0.10	0.05	0.3
Manganese	mg/L	0.001	0.027	0.008	0.006	0.028	0.355	1.2	0.054	0.101	1.2
Nickel	mg/L	0.001	<0.001	0.002	<0.001	0.002	**0.009**	0.008	0.006	0.006	0.008
Selenium	mg/L	0.0002	0.0003	<0.0002	<0.0002	<0.0002	0.0007	0.005	<0.0002	<0.0002	NA
Silver	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.00002	<0.0001	<0.0001	0.001
Zinc	mg/L	0.001	0.002	**0.007**	0.002	**0.004**	0.002	0.0024	**0.003**	**0.003**	0.0076
Nutrients											
Ammonia	mg/L	0.01	<0.01	<0.01	0.02	0.01	<0.01	0.32	<0.01	0.01	0.32
Nitrate	mg/L	0.01	0.08	0.09	<0.01	0.08	0.30	NA	<0.01	0.02	NA
NO$_x$	mg/L	0.01	**0.08**	**0.09**	<0.01	**0.08**	**0.30**	0.015	<0.01	**0.02**	NA
TKN	mg/L	0.1	<0.1	0.1	0.2	0.4	0.7	NA	0.9	0.8	NA
TN	mg/L	0.1	<0.1	0.2	0.2	**0.5**	**1.0**	0.25	**0.9**	**0.8**	0.7
TP	mg/L	0.01	<0.01	<0.01	<0.01	**0.12**	<0.01	0.02	0.01	0.01	0.056
Other parameters											
DOC	mg/L	1	4	2	11	8	10	NA	17	16	NA
Fluoride	mg/L	0.1	0.2	<0.1	<0.1	<0.1	0.5	NA	0.2	0.2	NA
Oil & grease	mg/L	5	<5	<5	<5	7	<5	NA	<5	<5	5

Values in **yellow** indicate exceedances of the DGV and/or SSGV.
Values in **blue** exceed the DGV but are below the relevant SSGV.
Values in **green** exceed the DGV but are below the relevant HMGV (See Table 3.6).
NA = No DGV applies.
* The DGV applies to aluminium concentrations for pH >6.5.
^ Denotes parameter was recorded *in situ.*
$^+$Despite ultra-trace analysis, the LOR for chromium and silver are higher than the DGV.

Table 3.5 Results of laboratory analysis of water samples collected in spring 2022

Analyte	Units	LOR	Baseline			Headwaters undermined		DGV	Background	Impact	SSGV
			DOG	GEN	GRO	GAP	TOR		AIRUS	AIR	
Date			6/12/2022	5/12/2022	5/12/2022	6/12/2022	6/12/2022		6/12/2022	6/12/2022	
Time			07:45	11:30	14:10	10:00	15:30		17:30	13:15	
Physicochemical parameters											
Temperature^	°C	0.1	17.0	13.7	15.0	16.1	23.4	NA	22.5	18.9	NA
EC^	µS/cm	1	**810**	187	35	134	**1066**	350	**1578**	**1450**	2709
pH^	pH unit	0.1	7.6	**6.2**	**6.3**	7.5	8.0	6.5-8.0	7.4	7.6	6.5-8.0
DO^	% sat.	0.1	**77.6**	**85.5**	91.1	94.4	**113.6**	90-110	**119.3**	91.5	NA
DO^	mg/L	0.01	7.05	8.03	8.22	8.49	8.77	NA	9.38	7.70	NA
TDS	mg/L	1	728	34	21	86	832	NA	1180	1160	NA
TSS	mg/L	1	8	<1	1	3	3	25	5	5	25
Turbidity	NTU	0.1	0.5	0.6	0.5	3.6	1.4	25	1.0	1.9	25
Total hardness	mg/L	1	570	<1	<1	31	764	NA	1150	1100	NA
Major ions											
Bicarbonate alkalinity	mg/L	1	352	6	6	32	138	NA	239	236	NA
Total alkalinity	mg/L	1	352	6	6	32	138	NA	239	236	NA
Sulfate	mg/L	1	291	2	<1	3	622	NA	912	884	NA
Chloride	mg/L	1	44	14	8	26	32	NA	35	41	NA
Calcium	mg/L	1	126	<1	<1	6	133	NA	193	187	NA
Magnesium	mg/L	1	62	<1	<1	4	105	NA	162	155	NA
Potassium	mg/L	1	2	1	<1	3	6	NA	3	3	NA
Sodium	mg/L	1	49	7	5	12	34	NA	53	54	NA
Dissolved metals											
Aluminium	mg/L	0.01	<0.01	**0.05***	**0.30***	**0.10**	<0.01	0.027	<0.01	<0.01	0.027
Arsenic	mg/L	0.0002	0.0003	<0.0002	<0.0002	0.0003	0.0004	0.0008	0.0006	0.0004	NA

Analyte	Units	LOR	Baseline			Headwaters undermined		DGV	Background	Impact	SSGV
			DOG	GEN	GRO	GAP	TOR		AIRUS	AIR	
Chromium[+]	mg/L	0.0002	<0.0002	<0.0002	**0.0008**	**0.0002**	<0.0002	0.00001	<0.0002	<0.0002	NA
Iron	mg/L	0.05	<0.05	<0.05	0.21	0.30	0.06	NA	<0.05	<0.05	0.3
Manganese	mg/L	0.001	0.011	0.006	0.006	0.033	0.232	1.2	0.060	0.215	1.2
Nickel	mg/L	0.001	<0.001	0.002	<0.001	0.001	0.006	0.008	0.003	0.006	0.008
Selenium	mg/L	0.0002	0.0004	<0.0002	<0.0002	<0.0002	0.0003	0.005	<0.0002	<0.0002	NA
Silver[+]	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.00002	<0.0001	<0.0001	0.001
Zinc	mg/L	0.001	0.001	**0.008**	0.001	**0.003**	<0.001	0.0024	<0.001	0.001	0.0076
Nutrients											
Ammonia	mg/L	0.01	<0.01	<0.01	<0.01	0.03	0.06	0.32	<0.01	0.01	0.32
Nitrite	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	NA	<0.01	<0.01	NA
Nitrate	mg/L	0.01	0.04	0.14	0.01	0.06	0.07	NA	0.03	0.02	NA
NO_x	mg/L	0.01	**0.04**	**0.14**	0.01	**0.06**	**0.07**	0.015	**0.03**	**0.02**	NA
TKN	mg/L	0.1	0.1	0.2	0.3	0.2	0.4	NA	0.4	0.4	NA
TN	mg/L	0.1	0.1	**0.3**	**0.3**	**0.3**	**0.5**	0.25	**0.4**	**0.4**	0.7
TP	mg/L	0.01	<0.01	<0.01	<0.01	0.01	0.01	0.02	0.01	0.01	0.056
Other parameters											
DOC	mg/L	1	5	3	7	6	7	NA	8	9	NA
Fluoride	mg/L	0.1	0.4	<0.1	0.2	<0.1	0.5	NA	0.4	0.3	NA

Values in **yellow** indicate exceedances of the DGV and/or SSGV.
Values in **blue** exceed the DGV but are below the relevant SSGV.
Values in **green** exceed the DGV but are below the relevant HMGV (See Table 3.6).
NA = No DGV applies.
* The DGV applies to aluminium concentrations for pH >6.5.
^ Denotes parameter was recorded *in situ.*
[+] Despite ultra-trace analysis, the LOR for chromium and silver are higher than the DGV.

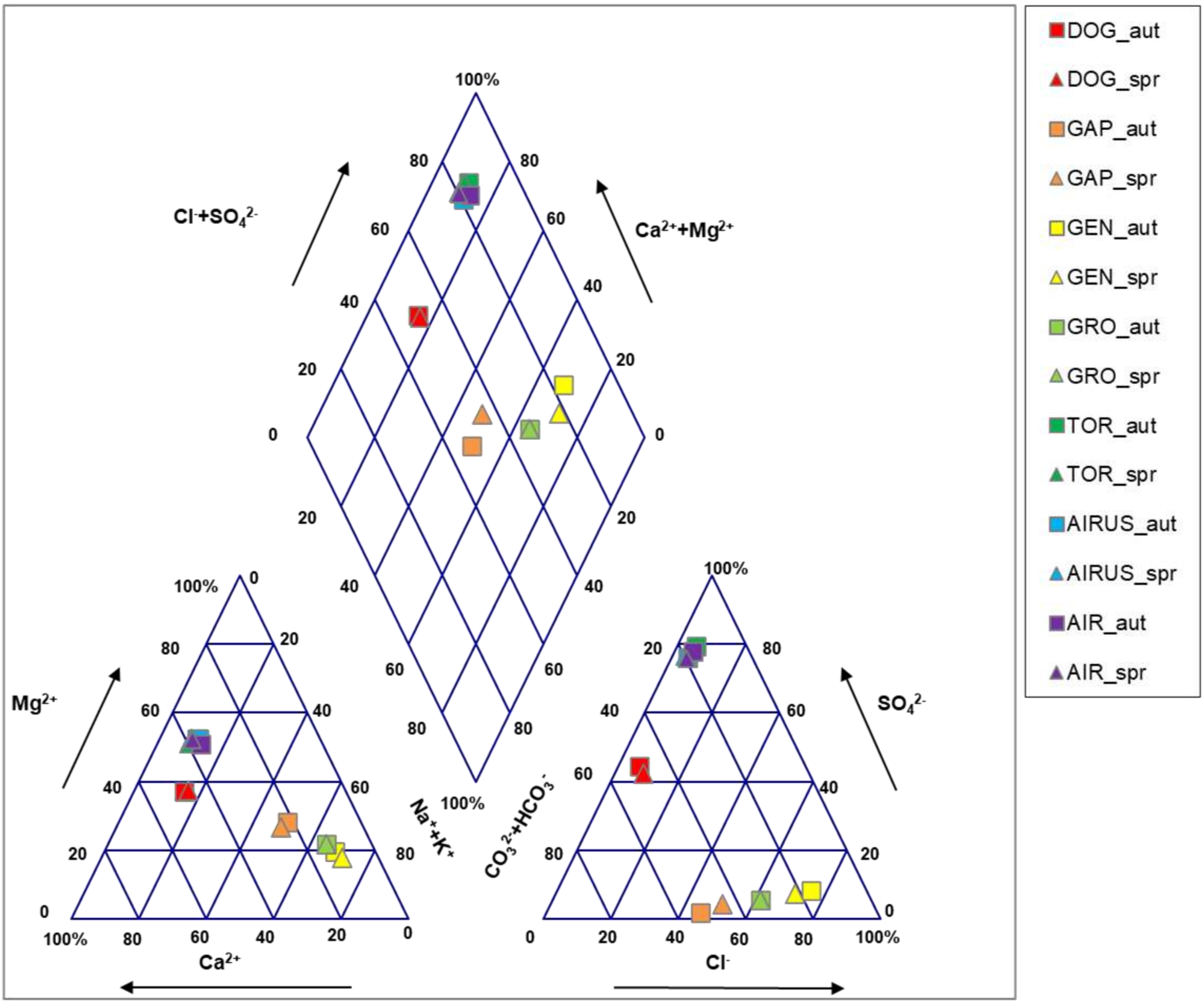


Figure 3.4 Piper plot displaying cation and anion composition of water samples collected in autumn and spring 2022

Table 3.6 HMGVs (in mg/L) for zinc in autumn and spring 2022

Metal	GAP	AIRUS	AIR
Autumn 2022			
Hardness	29	681	688
Zinc (observed concentration)	0.004	0.003	0.003
Zinc (HMGV)	NA	**0.0341**	**0.0344**
Spring 2022			
Hardness	31	1150	1100
Zinc (observed concentration)	0.003	<0.001	0.001
Zinc (HMGV)	**0.0025**	NA	NA

Values in **yellow** indicate exceedances of the HMGVs; values in **green** indicate that the observed value is below the HMGV.

3.4.2 Historical review – Airly Creek

Long-term, time series water quality graphs are provided in Appendix G for key analytes at impact site AIR and background site AIRUS.

During all sampling events in 2022, EC was below the SSGV at both AIR and AIRUS, continuing the mostly decreasing trend in EC observed since 2019. There has been no notable difference observed between the background an impact site during the majority of historical sampling events in which samples were collected from both sites.

In situ pH at both AIR and AIRUS was within the DGV range during all sampling events in 2022. pH was generally higher at AIRUS than AIR, though pH has remained within the DGV range for most of the monitoring period.

TDS concentrations have been variable across the historical monitoring period, though most results have remained within the 1200 to 3000 mg/L range. TDS at AIR in 2019 was generally very high, with concentrations observed well above the previous range of results at the site. Results in 2020 had returned to within the previous range at AIR. There was a general decreasing trend in TDS concentrations between 2019 and 2022, with all results from 2022 at both AIRUS and AIR at the lower end of the usual range of results.

TSS results have been low at AIR and AIRUS since spring 2014, with the majority of results during this time below the DGV, including all results from both AIR and AIRUS throughout 2022.

The majority of dissolved aluminium concentrations have remained below the SSGV at both Airly Creek sites during the historical monitoring period, and there have been no exceedances of the SSGV for dissolved aluminium at either site in since 2019. In April 2019, the highest dissolved aluminium concentration observed to date was recorded at AIR, with this result many times higher than the SSGV, though this elevated aluminium concentration did not persist.

Dissolved cobalt concentrations have been below the SSGV in most samples collected during the historical monitoring period, including all samples collected in 2022. The only exceedances of the SSGV for dissolved cobalt observed during the historical monitoring period were two samples collected from AIR in 2019, when the concentrations were well above the usual range of results for the site.

Dissolved copper concentrations were below detectable limits at both sites in all samples collected in 2022 and were therefore below the SSGV. Dissolved copper concentrations were commonly elevated at AIR during the 2010 to 2015 period, as well as in 2020, while several results from AIRUS were also above the DGV in 2014.

Dissolved iron concentrations at AIR and AIRUS throughout 2022 were below the SSGV in all samples. The majority of iron concentrations since 2010 been below the SSGV at both sites, although, concentrations were elevated above the typical historical range of results during 2017 and 2019. The highest iron concentrations to date at both sites were recorded in 2019.

Dissolved manganese concentrations were below the SSGV during all sampling events between June 2010 and October 2016. In later years, dissolved manganese concentrations at AIR and AIRUS were much higher, with the majority of results between July 2017 and April 2020 exceeding the DGV at both sites, though results were generally higher at AIR than AIRUS. All dissolved manganese concentrations in 2022 were below the SSGV, and most concentrations were higher at AIR than at AIRUS.

Dissolved nickel concentrations at AIR prior to 2019 were generally consistent and remained below or close to the DGV. However, results during 2019 and early-2020 at AIR were elevated above the DGV and the historical range of results. There were no corresponding results at AIRUS for 2019 as the site was dry. Results from April 2020 onward had returned to with the historical range and were generally similar between AIR and AIRUS. In 2022, the only exceedance of the SSGV for nickel was at AIR in February, with the observed result only slightly above the SSGV.

Dissolved zinc concentrations were below the SSGV in all Airly Creek samples collected in 2022 except for the sample collected from AIR during October 2022 sampling. Zinc concentrations were also mostly low in 2021, except for two exceedances at AIR. The highest dissolved zinc concentrations have been recorded at AIR, with the highest concentration recorded in the 2010 to 2022 monitoring period observed at AIR in April 2019. There were frequent exceedances of the dissolved zinc SSGV at both sites between 2012 and 2016, and again in 2019 to 2020.

The ammonia concentration at AIR in April 2019 exceeded the DGV for the only time during the historical monitoring period. All other ammonia concentrations were below the DGV at both sites during all sampling events including samples from 2022. The ammonia concentration observed during monthly monitoring at AIR on 5 December 2022, was the second highest recorded to date; though it is noted that the ammonia concentration in the sample collected during aquatic ecology monitoring on the following day (6 December 2022) was equal to the LOR. Historically, similar concentrations of ammonia have been observed at both AIR and AIRUS.

TN concentrations at Airly Creek sites since 2010 have been generally below the SSGV. In 2022, all TN concentrations were below the SSGV, except the samples collected at both AIRUS and AIR during autumn 2022 only. TN was elevated in concentrations well above the SSGV during 2019, as well as during late-2012 to early 2013. There have been no notable differences between TN levels at AIR and AIRUS during periods in which data were collected for both sites.

TP concentrations throughout 2022 were low, with all results below the SSGV and similar to results from 2021. Exceedances of the SSGV were common between mid-2012 and early-2020, though there have been no exceedances of the SSGV since March 2020. There have been no notable differences in TP concentrations between the AIR and AIRUS sites.

3.5 Sediment quality

Laboratory analysis results for the autumn and spring 2022 sediment samples are presented in Table 3.7 and Table 3.8, respectively, including a comparison to the sediment DGVs in ANZG (2019). Parameters measured at concentrations below the LOR at all sites have not been presented in Table 3.7 and Table 3.8. Laboratory COAs showing data for all measured parameters are provided in Appendix B.

In autumn 2022, concentrations of all sediment metals were highest at background site AIRUS, except for lead and manganese, which were highest at impact site AIR. The only exceedances of any sediment quality parameter in autumn 2022 was acid-extractable nickel, which exceeded the GV-high at background site AIRUS, and the DGV at impact site AIR. Concentrations of all sediment metals were well below all DGVs at baseline and undermined sites, with the lowest concentrations of all sediment metals observed at GRO, where only aluminium was detected in a concentration above the LOR.

In spring 2022, concentrations of all metals were again highest at background site AIRUS, except for antimony, which was detected above the LOR at GEN only. At AIRUS, concentrations of all metals were also higher in spring than autumn, with the nickel concentration again exceeding the GV-high, and the zinc concentration exceeding the DGV. Conversely, the nickel concentration at AIR decreased between the sampling events and was below the DGV in spring 2022. There were no other exceedances of any sediment quality DGV at any site in spring 2022. Concentrations of all metals were again lowest at GRO.

Concentrations of TKN (and TN) and TP were highest at AIRUS in both autumn and spring 2022, as well as ammonia, nitrate in autumn 2022 only. Concentrations of all nutrients were lowest at GRO in both seasons.

Sediment samples from AIRUS in both sampling events also had by far the highest concentrations of TOC of all sites.

Table 3.7 Laboratory analysis of sediment samples collected in autumn 2022

Analyte	Units	LOR	Baseline			Headwaters undermined		Background	Impact	DGV	GV-high
			DOG	GEN	GRO	GAP	TOR	AIRUS	AIR		
1M HCl-extractable metals											
Aluminium	mg/kg	50	310	220	180	370	290	990	620	NA	NA
Arsenic	mg/kg	1	<1.0	<1.0	<1.0	<1.0	<1.0	1.7	1.6	20	70
Cadmium	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	<0.1	1.5	10
Cobalt	mg/kg	0.5	2.8	1.3	<0.5	0.7	3.9	8.9	8.0	NA	NA
Copper	mg/kg	1	3.3	<1.0	<1.0	3.2	1.5	11.9	5.8	65	270
Lead	mg/kg	1	5.2	<1.0	<1.0	5.0	4.1	6.8	7.6	50	220
Manganese	mg/kg	10	231	30	<10	16	379	250	1480	NA	NA
Nickel	mg/kg	1	2.7	<1.0	<1.0	1.6	4.8	**57.9**	**25.4**	21	52
Zinc	mg/kg	1	2.6	1.8	<1.0	7.0	6.7	98.6	52.9	200	410
Nutrients											
Ammonia	mg/kg	20	<20	<20	<20	<20	<20	40	<20	NA	NA
Nitrite	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	NA	NA
Nitrate	mg/kg	0.1	0.1	0.2	0.2	0.1	0.2	0.8	0.9	NA	NA
NO$_x$	mg/kg	0.1	0.1	0.2	0.2	0.1	0.2	0.8	1.0	NA	NA
TKN	mg/kg	20	740	130	60	1140	170	9990	1960	NA	NA
TN	mg/kg	20	740	130	60	1140	170	9990	1960	NA	NA
TP	mg/kg	2	166	36	47	128	100	946	267	NA	NA
Other parameters											
TOC	%	0.02	2.14	0.27	0.09	3.42	0.32	11.9	6.71	NA	NA

Values in **yellow** indicate exceedances of the DGV. Values in **red** exceed the GV-high.

Table 3.8 Laboratory analysis of sediment samples collected in spring 2022

Analyte	Units	LOR	Baseline			Headwaters undermined		Background	Impact	DGV	GV-high
			DOG	GEN	GRO	GAP	TOR	AIRUS	AIR		
			6/12/2022	5/12/2022	5/12/2022	6/12/2022	6/12/2022	6/12/2022	6/12/2022		
1M HCl-extractable metals											
Aluminium	mg/kg	50	420	1050	90	430	740	3120	1420	NA	NA
Antimony	mg/kg	1	<1.0	1.3	<1.0	<1.0	<1.0	<1.0	<1.0	2	25
Arsenic	mg/kg	1	1.5	<1.0	<1.0	1.2	3.2	8.4	2.2	20	70
Cadmium	mg/kg	0.1	0.1	<0.1	<0.1	<0.1	0.3	1.5	0.3	1.5	10
Chromium	mg/kg	1	<1.0	<1.0	<1.0	<1.0	<1.0	1.5	1.1	80	370
Cobalt	mg/L	0.5	3.3	2.7	<0.5	1.5	5.8	19.3	4.6		
Copper	mg/kg	1	4.7	3.0	<1.0	4.6	11.4	25.9	15.1	65	270
Lead	mg/kg	1	6.5	3.1	<1.0	6.6	15.2	16.6	16.9	50	220
Manganese	mg/L	10	121	42	<10	60	183	1380	454		
Nickel	mg/kg	1	3.5	1.7	<1.0	1.8	14.2	**65.3**	16.4	21	52
Zinc	mg/kg	1	5.8	9.1	<1.0	10.3	29.1	**202.0**	42.8	200	410
Nutrients											
Nitrite	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	NA	NA
Nitrate	mg/kg	0.1	<0.1	0.2	0.1	<0.1	0.2	<0.1	0.2	NA	NA
NO_x	mg/kg	0.1	<0.1	0.2	0.1	<0.1	0.2	<0.1	0.2	NA	NA
TKN	mg/kg	20	730	730	60	460	1370	9660	540	NA	NA
TN	mg/kg	20	730	730	60	460	1370	9660	540	NA	NA
TP	mg/kg	2	168	82	17	76	242	771	174	NA	NA
Other parameters											
TOC	%	0.02	1.24	4.80	0.16	1.52	3.27	8.38	0.98	NA	NA

Values in **yellow** indicate exceedances of the DGV. Values in **red** exceed the GV-high.

3.6 Macroinvertebrates

3.6.1 Univariate results – autumn and spring 2022

In 2022, taxa richness results indicated no clear temporal trends, with results at all sites showing a greater difference between replicates in a single sampling event, than between sampling events. In autumn 2022, the highest taxa richness results were observed at impact site AIR, with one replicate sample containing 27 taxa, the most of any sample collected in 2022, and the second containing 22 taxa (Figure 3.5). In spring 2022, taxa richness was highest in one sample collected from background site AIRUS which contained 25 taxa, though the second sample contained only 16 taxa. Taxa richness was also high at AIR in spring, with 22 and 21 taxa collected from the two replicate samples. All taxa richness results from AIR in 2022 were well above the EIS average of 13 taxa.

Taxa richness results were consistently high at baseline site DOG in 2022, with all samples containing between 19 and 21 taxa, though these results were below the EIS average, which was the highest of all sites at 24.5. Taxa richness was lowest in both autumn and spring at baseline site GRO, where richness ranged between 10 and 15, below the EIS average of 16.5. Taxa richness at baseline site GEN and potentially influenced site TOR were similar to or above the pre-EIS averages, while all results at potentially influenced site GAP were below the EIS average, except for one replicate collected in spring, which contained six more taxa than any other GAP sample in 2022.

As with taxa richness, EPT richness showed more variability at most sites within sampling events than between sampling events (Figure 3.6). EPT richness in autumn 2022 was highest at impact site AIR (seven and four EPT taxa), potentially influenced site GAP (seven and five taxa) and baseline site GEN (six and five taxa). In spring 2022 EPT richness was highest in one sample from background site AIRUS (eight taxa) and one sample from baseline site DOG (seven taxa) though the second replicate sample at both of these sites contained many fewer EPT taxa (three at AIRUS and four at DOG). EPT richness in both sampling events was lowest at GRO (one to two EPT taxa).

EPT richness results were well above the EIS average at impact site AIR, as well as upland sites GEN and GAP. at DOG and TOR EPT richness results in 2022 were closer to the EIS average, while at GRO, all results were well below the average.

The highest SIGNAL-2 scores in 2022 were observed at the three higher altitude, less disturbed sites (baseline sites GEN and GRO, and potentially influenced site GAP) (Figure 3.7). Results at GEN were higher in spring than autumn, while SIGNAL-2 results at all other sites showed more variability between replicates than between sampling events. SIGNAL-2 scores were lower at the four lower altitude sites, and similar between the sites. SIGNAL-2 results at potentially influenced site GAP and impact site AIR have shown the largest improvement in SIGNAL-2 scores since the EIS period, while TOR has shown the largest decline, followed by GRO. SIGNAL-2 results at DOG and GEN were generally consistent with the EIS average.

Sensitive taxa (taxa with SIGNAL-2 of 8 or higher) were collected in all samples in spring 2022, but were missing from one sample at TOR and AIR, and in both samples from AIRUS in autumn 2022 (Figure 3.8). The proportion of sensitive taxa were highest at GEN, where results were similar to the EIS average in all but one sample in autumn, in which the proportion of sensitive taxa was much lower. Samples from DOG and GAP generally contained a larger proportion of sensitive taxa than the EIS average, while most samples at GRO contained a smaller proportion than the average. Sensitive taxa were not commonly collected at impact site AIR during the pre-EIS monitoring, based on the very low average.

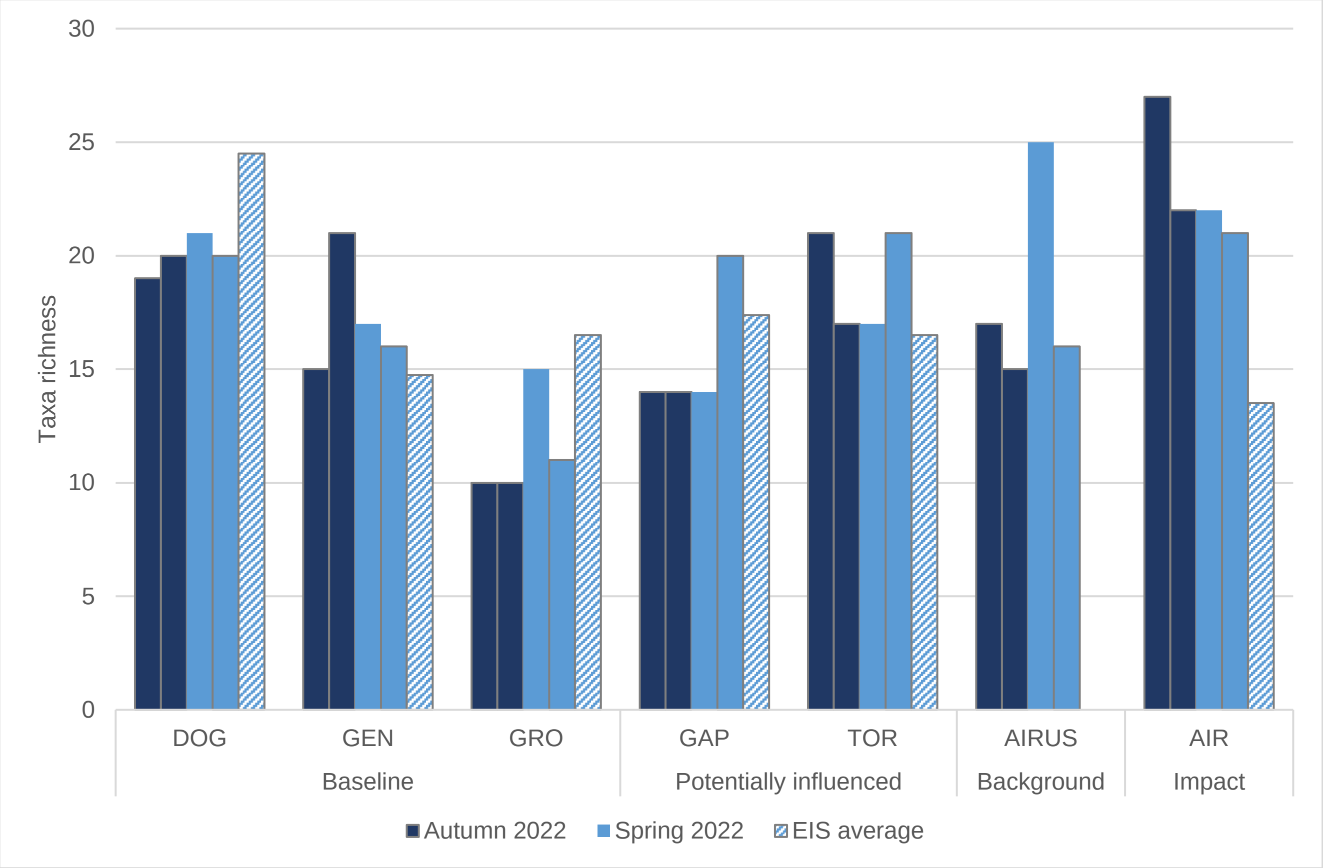


Figure 3.5 *Taxa richness in macroinvertebrate samples, autumn and spring 2022*

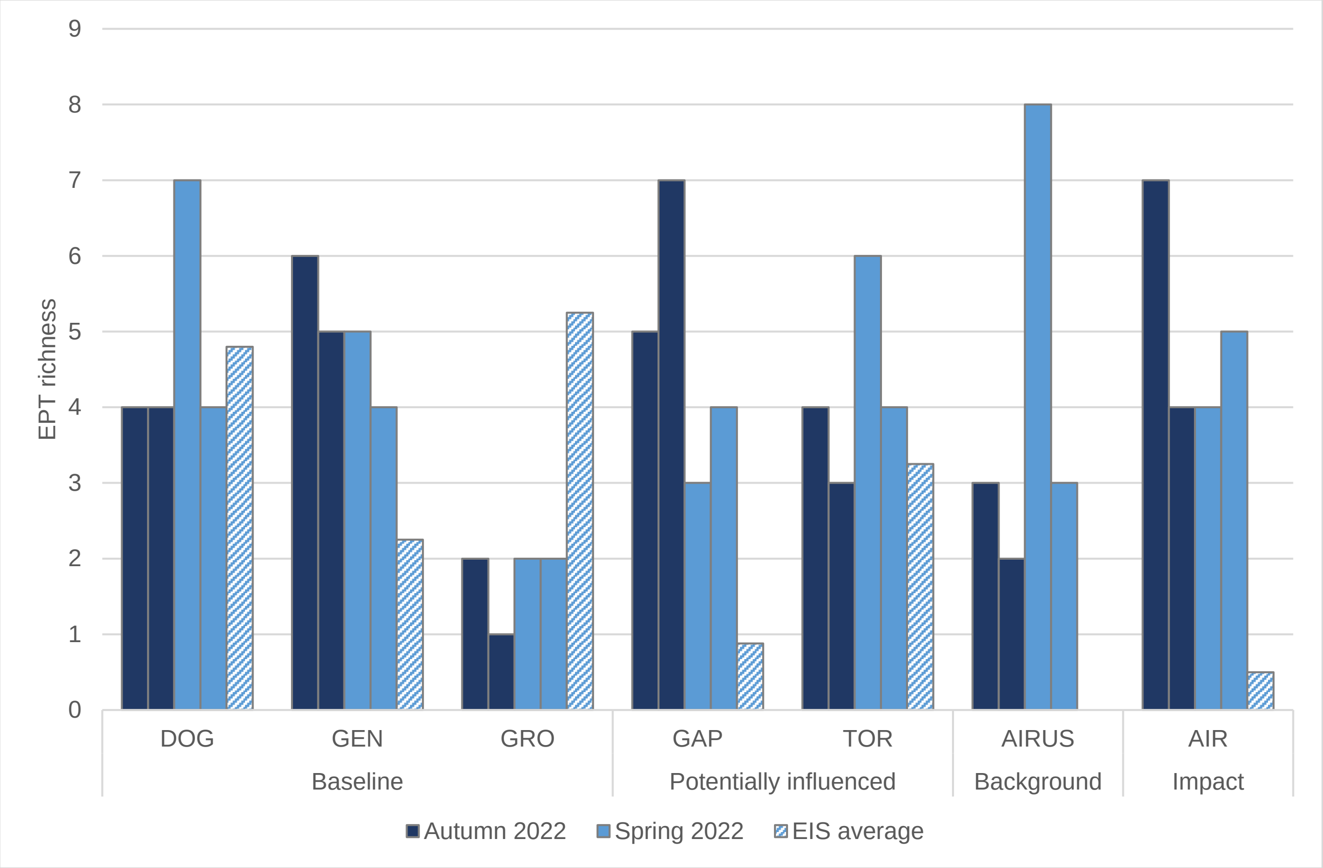


Figure 3.6 *EPT richness in macroinvertebrate samples, autumn and spring 2022*

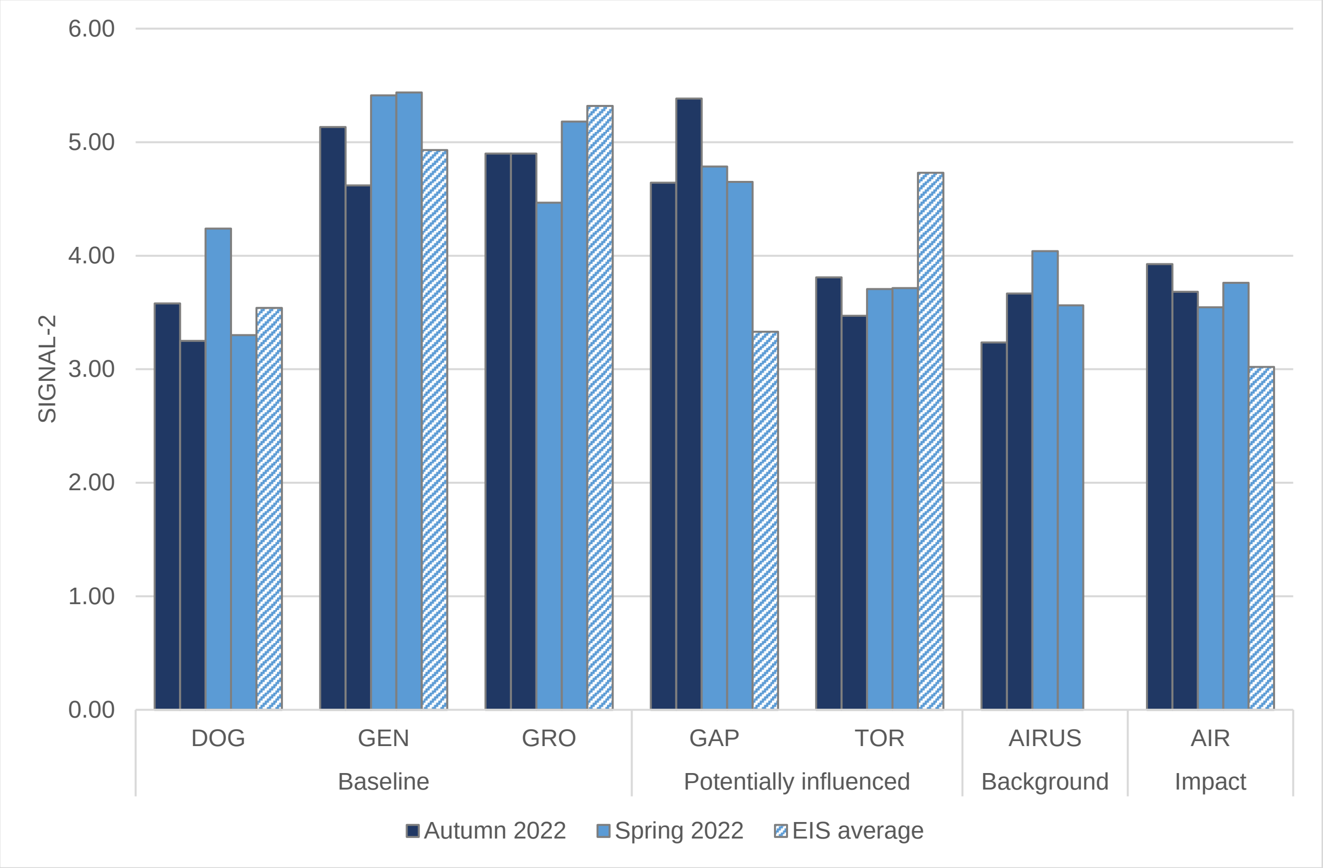


Figure 3.7 *SIGNAL-2 scores for macroinvertebrate samples, autumn and spring 2022*

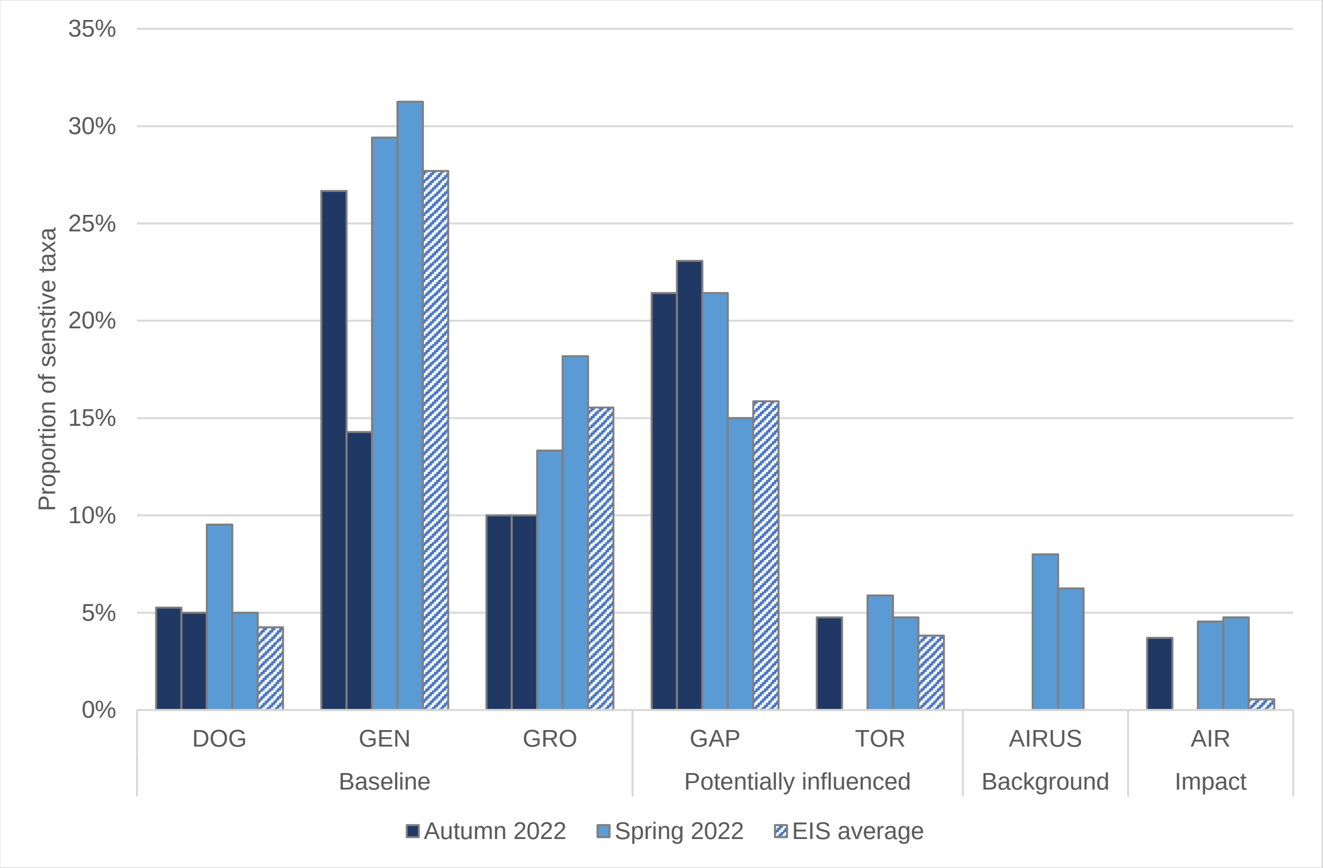


Figure 3.8 *Proportion of sensitive taxa in macroinvertebrate samples, autumn and spring 2022*

3.6.2 AUSRIVAS

The results of AUSRIVAS modelling are presented in Figure 3.9. The NSW combined-season eastern edge model was used for all sites in 2022.

The highest O/E50 results in 2022 were observed at impact site AIR, where both samples received a Band A result, indicating the site was in a reference condition, with most of the expected macroinvertebrate families collected. Samples collected from baseline sites DOG and potentially influenced site TOR also received Band A results. The baseline site GEN and potentially influenced site GAP have been allocated to Band B, indicating some impairment in the macroinvertebrate communities. Background site AIRUS had the largest difference between results, with one sample receiving a Band A result, and the other a Band B result, giving the site an overall B grading, based on AUSRIVAS convention that stipulates that the lowest result denotes the overall result of a site. The lowest O/E50 score was from baseline site GRO, with both samples receiving a Band C result. Band C indicates that the site is severely impaired, with fewer taxa than expected.

Table 3.9 displays the inventory of taxa that were predicted by the AUSRIVAS model to be found at these sites at a probability of 50 percent or greater but were not collected during 2022. Samples from impact site AIR were analysed by the model as missing the fewest (five and six) taxa, along with one sample from background site AIRUS (six taxa). Both results from DOG and TOR, and one sample from GAP were missing between eight and nine taxa. Baseline sites GEN (13 and 14 missing taxa) and GRO (17 and 18 missing taxa) were missing the most taxa that were expected by the model to be collected by the AUSRIVAS model.

Based on the SIGNAL-2 scores of the missing taxa, potentially influenced site GAP was missing more sensitive taxa, with an average SIGNAL-2 score ranging between 5.08 and 5.67 (Table 3.9). Missing taxa at this site included the beetle Elmidae (SIGNAL-2 = 7), the damselfly Synlestidae (SIGNAL-2 = 7), the stonefly Gripopterygidae (SIGNAL-2 = 8) and the caddisfly Calamoceratidae (SIGNAL-2 = 7).

While the impact site AIR had the fewest of missing taxa, it also had the lower SIGNAL-2 of the missing taxa meaning that most of the taxa missing were pollution tolerant. The most sensitive taxa that was expected to be found at AIR but was not collected in 2022 was the dragonfly Gomphidae SIGNAL-2 = 5). The SIGNAL-2 score of missing taxa at this site ranged between 3.17 and 3.80. AIRUS, DOG and TOR were also missing mostly tolerant taxa.

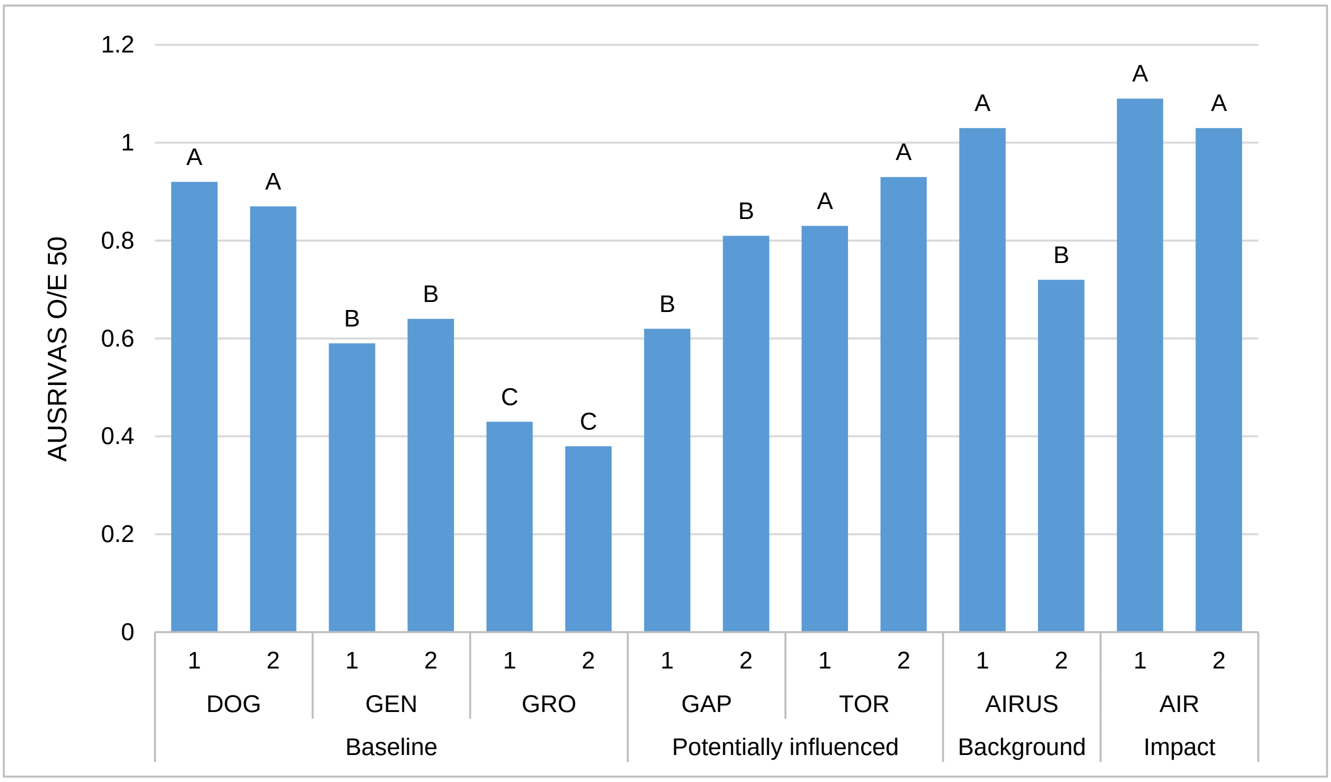


Figure 3.9 AUSRIVAS OE/50 results for 2022

Table 3.9 ***Inventory of macroinvertebrate taxa predicted at ≥50% by AUSRIVAS modelling but not collected in 2022***

Taxon name	**SIGNAL-2**	**Baseline**						**Potentially influenced**				**Background**		**Impact**	
		DOG		**GEN**		**GRO**		**GAP**		**TOR**		**AIRUS**		**AIR**	
		1	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**
Physidae	1	X													
Oligochaeta	2	X								X	X		X		X
Acarina	6		X	X		X	X	X		X	X		X		
Atyidae	3	X	X							X	X	X	X	X	X
Gyrinidae	4			X	X	X	X					X	X	X	
Hydrophilidae	2			X	X	X	X			X					X
Hydraenidae	3	X	X	X		X	X	X		X	X			X	X
Elmidae	7			X	X	X	X	X	X						
Tipulidae	5	X	X									X	X		
Dixidae	7			X	X	X	X		X						
Ceratopogonidae	4			X				X					X		
Simuliidae	5			X	X	X	X	X							
Orthocladiinae	4	X													
Chironominae	3		X												
Baetidae	5			X	X	X	X								
Leptophlebiidae	8					X	X								
Caenidae	4	X	X	X	X	X	X	X					X		
Gerridae	4	X	X	X	X	X	X	X	X	X		X	X	X	X
Corixidae	2				X	X	X	X	X	X					
Notonectidae	1					X	X					X	X		
Synlestidae	7			X	X	X	X	X	X						
Aeshnidae	4			X	X	X	X	X	X						
Gomphidae	5		X			X	X	X	X	X	X	X	X	X	X

Taxon name	SIGNAL-2	Baseline						Potentially influenced				Background		Impact	
		DOG		GEN		GRO		GAP		TOR		AIRUS		AIR	
		1	2	1	2	1	2	1	2	1	2	1	2	1	2
Gripopterygidae	8				X	X	X	X	X	X	X				
Hydroptilidae	4										X		X		
Ecnomidae	4		X										X		
Calamoceratidae	7			X	X		X	X	X						
Total missing taxa		**8**	**9**	**14**	**13**	**17**	**18**	**13**	**9**	**9**	**7**	**6**	**12**	**5**	**6**
Average SIGNAL-2 of missing taxa		**3.25**	**4.11**	**4.93**	**5.08**	**4.82**	**4.94**	**5.08**	**5.67**	**3.89**	**4.43**	**3.67**	**3.83**	**3.80**	**3.17**

3.6.3 Multivariate analysis – 2022

The non-metric MDS plot demonstrates the relative similarity in macroinvertebrate community composition of samples collected in autumn and spring 2022 (Figure 3.10). All macroinvertebrate samples collected in 2022 have been grouped displaying at least 40 percent similarity in community composition.

There are two distinct groupings in the plot, each clustered indicating 50 percent similarity within the samples in these groupings. One group contains all samples collected at the higher altitude sites, including baseline sites GEN and GRO, and potentially influenced site GAP, while the second grouping contains all samples collected from lowland sites, including baseline site DOG, potentially influenced site TOR, background site AIRUS and impact site AIR.

Within the high-altitude site grouping, there are two smaller clusters, one containing all samples from baseline site GRO, and the other containing all samples collected from GEN and GAP. In the lowland grouping, samples are less separated based on site, indicating similarities in the community composition between these sites and site types. They instead show separation based on sampling event, with samples collected in autumn grouping at the bottom of the plot, and samples collected in spring grouping at the top.

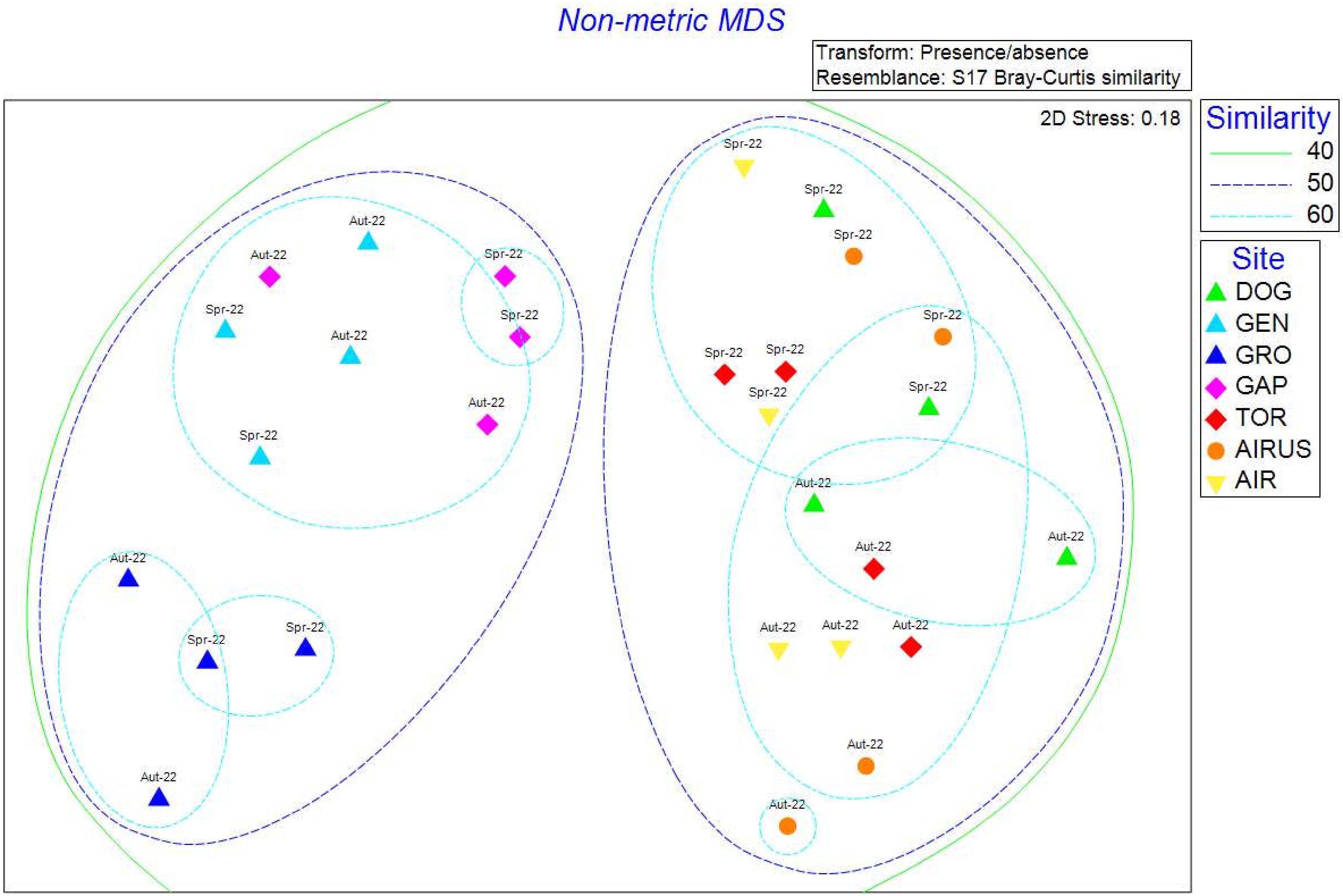


Figure 3.10 *MDS demonstrating relative similarity in community composition between samples, autumn and spring 2022*

3.6.4 Historical review

The non-metric MDS presented as Figure 3.11 shows the relative similarity in the macroinvertebrate community between 2013 and 2022. As the stress level for the MDS exceeded 0.20, the MDS plot should be interpreted with caution. Data from replicate samples were pooled to create a single point for each site and sampling event. It is noted that there were seven occasions during which only one replicate sample was able to be collected, including autumn 2016 at AIR, autumn and spring 2018 at DOG, autumn 2019 and spring 2021 at GAP, and autumn 2016 and autumn 2019 at GRO. These samples have been removed from the analysis. Site GAP, GRO and TOR have been frequently dry accounting for the reduced number of points for these sites. Sites GAP, GRO and GEN were only sampled once during the EIS survey period, and AIRUS was added to the program in spring 2016.

Samples from the higher altitude sites GEN, GAP and GRO are grouped together within the plot, indicating that the composition of macroinvertebrate communities at these sites are similar, and have remained so over time. Similarly, samples from DOG, TOR, AIR and AIRUS are also grouped together in the plot. Variability in the macroinvertebrate composition has been observed over time at some sites, particularly at GAP, TOR and AIR.

Community composition at Torbane Creek site TOR has changed over time with the samples collected from autumn 2014, spring 2015 and autumn 2016, distinct in their community composition, while samples collected in 2021 and 2022 were very similar to samples collected during the same period from Airly Creek and Dog Trap Creek. The macroinvertebrate community composition at AIRUS has also shifted over time, with samples collected in 2021 and 2022 separating in the plot from other AIRUS samples, indicating greater similarity to the macroinvertebrate community at impact site AIR than had previously been observed. The samples collected from GEN, GRO and AIR in 2022 were generally similar to those previously collected at these sites, though the autumn 2022 sample from GAP indicated some difference in community composition to other samples.

ANOSIM detected a significant difference ($p < 0.05$) in community composition between sites. Pairwise tests determined that the macroinvertebrate community composition of all pairs of sites were significantly different ($p < 0.05$) with the exception of the groupings AIRUS and TOR and AIR and AIRUS (Appendix I).

An additional non-metric MDS has been presented as Figure 3.12, which shows the similarity in macroinvertebrate community composition for all samples collected at Airly Creek sites AIR and AIRUS, noting that AIRUS was not sampled prior to spring 2016. As the stress level for the MDS exceeded 0.20, the MDS plot should be interpreted with caution. The plot indicates a minimum of 40 percent similarity between all Airly Creek samples. All samples collected from AIRUS during the 2016 to 2021 monitoring period are plotted within the range of results at AIR, indicating that the between-site variability in community composition is similar to within-site variability or temporal variability. There has been a minor shift in the community composition at AIR over time, with the majority of samples collected from 2013 to 2019 clustering separately from the large grouping which contains all samples collected from AIR and AIRUS in 2020, 2021 and 2022, as well as some samples from previous sampling events. ANOSIM confirmed that there was no significant difference ($p > 0.05$) in community composition between AIR and AIRUS (Appendix I).

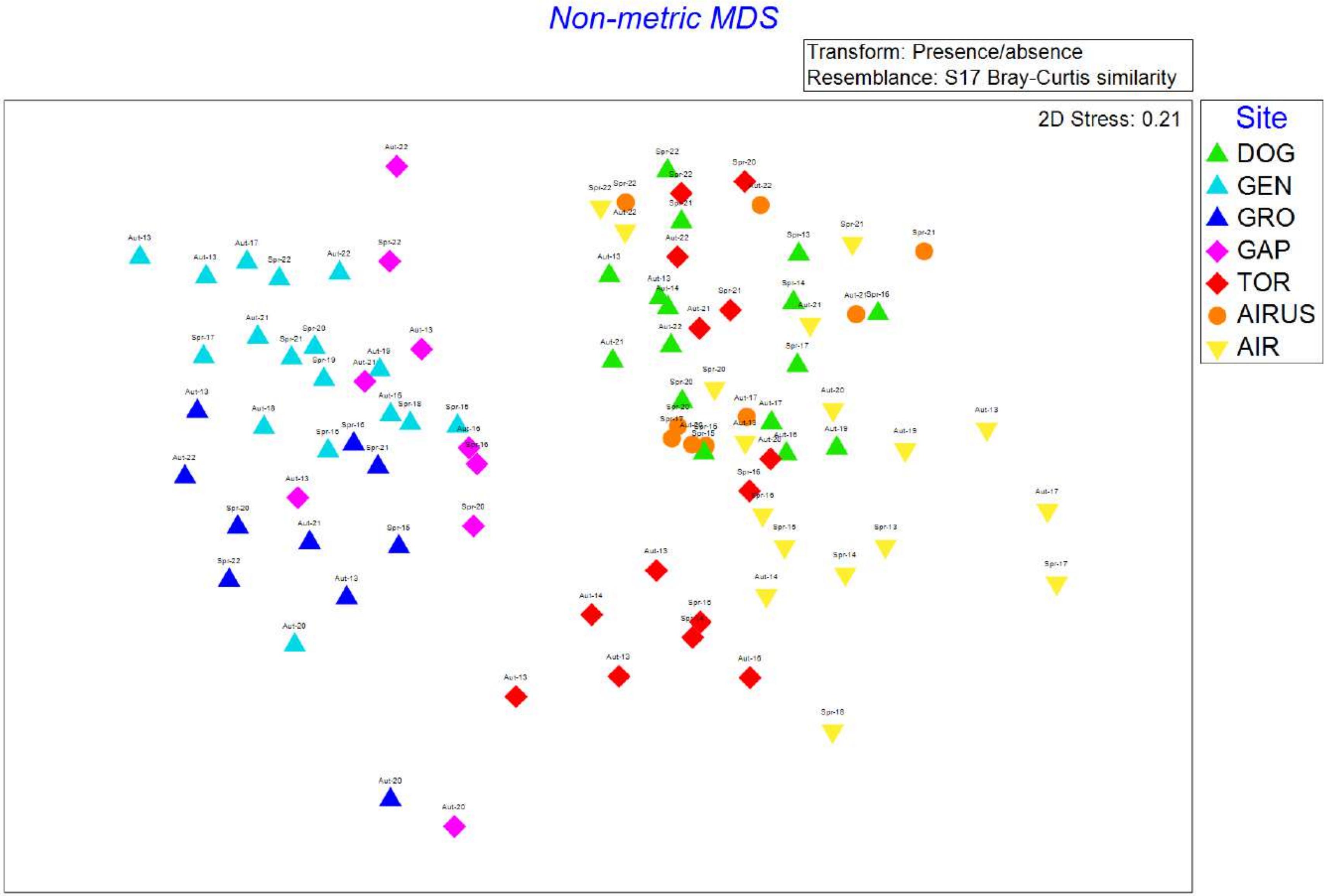


Figure 3.11 MDS demonstrating relative similarity in community composition between sites, 2013-2022

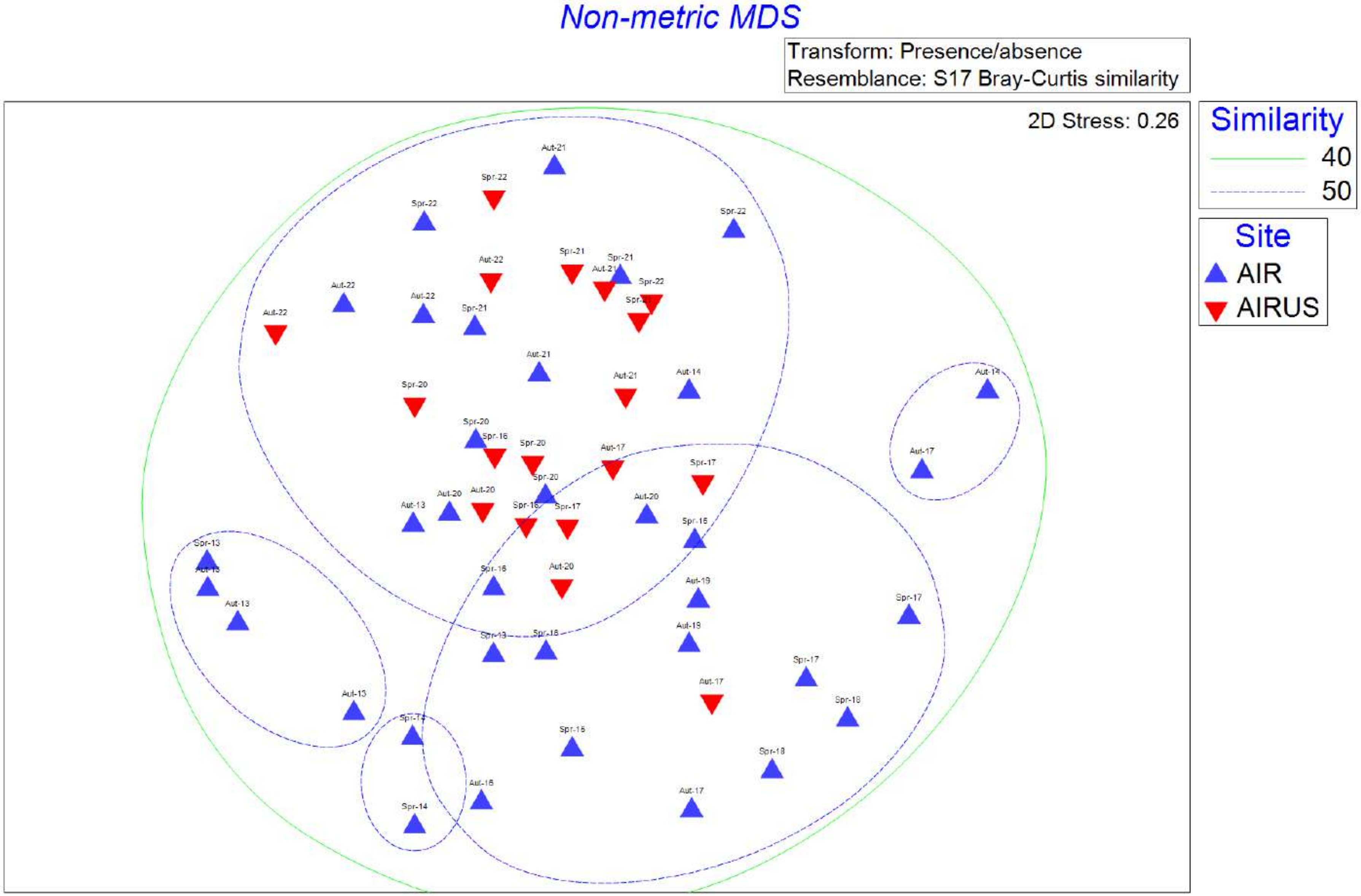


Figure 3.12 *MDS demonstrating relative similarity in community composition between Airly Creek samples, 2013-2022*

4. Discussion

4.1 Water quality

In 2022, there were several discharges from LDP1 into Airly Creek, totalling 241 ML between 9 January and 27 November 2022. Despite these discharges, EC was higher at background site AIRUS than impact site AIR in both autumn and spring 2022, suggesting that discharges from Airly Mine in 2022 were not a notable contributor to salinity in Airly Creek. As well as this, EC was much lower at AIRUS and AIR in autumn and spring 2022 compared to 2021 results (range of 1275 to 1578 µS/cm in 2022, compared with 2496 to 2722 µS/cm in 2021). This is likely due to dilution resulting from the well above average rainfall recorded in 2022.

The water quality monitoring results from 2022 show that the salinity and ionic composition at Airly Creek sites is similar to that at other lower altitude sites on Dog Trap and Torbane Creeks (DOG and TOR). These sites all contained water of elevated salinity, and a dominance of calcium, magnesium and sulfate ions (and bicarbonate at DOG). This contrasts to the dilute sodium chloride type water at the higher altitude sites on Genowlan and Gap Creeks (GEN, GRO and GAP). The higher salinity and ionic composition of the lower altitude sites is instead indicative of the cattle grazing which occurs in the upstream catchments of Airly, Torbane and Dog Trap Creeks, and groundwater inputs to the site from the Shoalhaven Group, which is an early Permian marine formation in which groundwater typically has an elevated EC in the order of 4000 µS/cm (GHD 2023a). The conductivity, whilst notably lower in 2022 than in previous years, is natural to these sites and remains consistently elevated above the ANZECC (2000) DGV, and at this level still has the potential to be a physical stressor to some aquatic organisms.

The long-term plots of monthly water quality for AIRUS and AIR (refer to Appendix G) show that all measured water quality parameters in 2022 at AIR and AIRUS were within or below the historical range of results for the sites. This demonstrates a continued improvement in results from those observed in 2019 when frequent exceedances were recorded. Conditions were very dry in 2019, leading to concentrated runoff from surrounding grazing areas unrelated to mine discharges, and concentration of contaminants in isolated pools due to evaporation. The wetter conditions that began in early-2020, and continued throughout 2022, have provided flushing and dilution of these concentrated agricultural contaminants in Airly Creek.

Dissolved chromium was detected above the LOR in water samples for the first time in 2019 at GAP, GRO and AIRUS, and has persisted since this time. Chromium concentrations exceeded the DGV at baseline sites GEN and GRO, potentially influenced site GAP, background site AIRUS and impact site AIR in autumn 2022, and at GRO and GAP only in spring 2022. These concentrations may cause impacts to aquatic organisms, particularly at baseline site GRO, where concentrations were highest during both sampling events. Given the distribution of chromium across different site types, it is likely that the source of chromium is the local lithology, and Airly Mine is unlikely to be a contributing factor.

The 99% species protection DGV for dissolved zinc was exceeded at baseline site GEN and potentially influenced site GAP in both autumn and spring 2022, as well as both AIRUS and AIR in autumn 2022 only. The concentration observed at GEN was the highest during both seasons. Zinc concentrations have commonly exceeded the DGV at these sites (GHD 2022b, 2021, 2020, 2019, 2018a) suggesting that the zinc originates from the local lithology. The toxicity of zinc is known to be reduced in hard water. Therefore, based on the recorded water hardness in Airly Creek in autumn 2022, it is not predicted that the zinc concentration observed at AIRUS or AIR in autumn 2022 would be likely to cause adverse impacts to aquatic species. Although zinc concentrations were higher, and water hardness was very low at GEN and GAP, as the zinc concentrations observed did not exceed the DGV for the protection of 95% of aquatic species, the potential impact to macroinvertebrates would be limited to the most sensitive taxa at these sites.

Concentrations of dissolved aluminium were also elevated in exceedance of the DGV at GAP, GEN and GRO in both autumn and spring, with the highest concentration observed in both seasons at GRO. As with zinc, this presence of aluminium across all sites, including baseline sites GRO and GEN, indicates that the local lithology is the likely source. Though the DGV applies only to water of pH > 6.5, aluminium is considered likely to be more toxic to aquatic communities when combined with acidic water (ANZG 2022). Given the acidic water observed at GEN and GRO in both autumn and spring 2022, this indicates that the observed concentrations of dissolved aluminium may have had an adverse effect on macroinvertebrate communities, particularly at GRO in autumn, where pH was lowest.

Dissolved oxygen saturations were low at all sites in autumn 2022, which is common for these sites. Lows flows and the consumption of oxygen through the decomposition of detritus are factors which are likely to have contributed to these low dissolved oxygen results. Low dissolved oxygen conditions are considered a physical stressor to aquatic organisms, which may have influenced the macroinvertebrate communities (ANZECC 2000). Dissolved oxygen saturations were higher at all sites during sampling in spring than autumn 2022. The consistently high rainfall throughout 2022 meant that flow was observed at all sites in spring 2022, which is likely to have contributed dissolved oxygen through aeration. There was also some macrophyte and algal growth present within the water body at TOR and AIRUS in spring, which may have contributed to the super saturated dissolved oxygen observed at these sites. Algae and macrophytes can contribute to a diurnal cycle of DO saturations, due to the production of oxygen through photosynthesis during the daytime, and respiration at night (ANZECC 2000). These sites were sampled during the afternoon on a sunny day, in pools that were mostly unshaded, which is likely to have contributed to the higher DO observed at this time.

The only exceedance of any SSGV at Airly Creek sites in 2022 was that of total nitrogen at both sites in autumn 2022. As the concentration was higher at the background site AIRUS, and the similar catchment site TOR, discharges from Airly Mine are not considered the source of this elevated nitrogen. NO_x concentrations were also elevated above the DGV at all sites except GRO and AIRUS in autumn, and all sites except GRO only in spring, though the exceedance observed at impact site AIR was the lowest of all sites in both sampling events. These results are likely to have been influenced by the associated runoff from rainfall in each of the catchments.

Overall, catchment landuse was the primary factor influencing water quality in 2022, and despite several discharges from LDP1 into Airly Creek throughout 2022, water at the Airly Creek impact site AIR was of similar or better quality than at background site AIRUS. Therefore, based on the water quality data collected during 2022 aquatic ecology sampling, Airly has met the EIS prediction of negligible environmental consequences to water quality. There was also no evidence of impacts to flows or water quality in Gap Creek or Torbane Creek due to undermining of some of the headwater streams of these watercourses.

4.2 Sediment quality

In 2022, there were several exceedances of the sediment quality DGVs at Airly Creek sites. In autumn 2022, the concentration of nickel exceeded the DGV at impact site AIR, and the GV-high at background site AIRUS. In spring 2022, the nickel concentration at AIRUS remained above the GV-high, while the zinc concentration exceeded the DGV. The DGV represents the threshold at which impacts to aquatic organisms are possible, while the GV-high values represent the sediment metal concentration at which biological effects are likely. As such, the concentrations of sediment metals observed at Airly Creek sites in 2022, particularly at background site AIRUS, had a high potential to cause adverse impacts aquatic species, including macroinvertebrates.

The concentrations of both nickel and zinc at background site AIRUS increased between sampling events, as well as demonstrating a large increase from concentrations observed in 2021, during which the maximum sediment nickel concentration at AIRUS was 6.8 mg/kg in spring 2021 (compared to 65.3 mg/kg in spring 2022), while the maximum zinc concentration was 15.2 mg/kg in spring 2021 (compared to 202.0 mg/kg in spring 2022) (GHD 2022b). These results suggest an increasing trend at AIRUS that was not reflected in the aqueous concentrations of these metals, and should be monitored for further increases in 2023.

The nickel concentration at impact site AIR reduced between autumn and spring 2022, indicating that the impacts observed at this site due to sediment quality were more temporary. As concentrations of sediment metals were higher at background site AIRUS than at impact site AIR in both autumn and spring 2022, discharges from Airly Mine are not considered to be the major contributing source of the sediment nickel observed at AIR in 2022, and are instead, as stated above, likely due to other influences within the catchment.

Concentrations of all sediment metals were below DGVs at all other sites, indicating that no impact to aquatic organisms due to sediment quality are likely at these sites in 2022.

4.3 Macroinvertebrates

The macroinvertebrate community at impact site AIR was in a good condition in 2022, with the highest taxa richness of all sites, as well as high EPT richness results. These results were also the highest that have been observed at the site since sampling began in 2013. Samples from AIR in 2022 also had higher SIGNAL-2 results than are commonly observed at the site, as well as three of the four samples collected in 2022 containing sensitive taxa (taxa with SIGNAL-2 of 8 or higher). Sensitive taxa had previously been collected from AIR on only one occasion during the historical monitoring period, in spring 2014. The results of AUSRIVAS modelling in 2022 also indicated that the macroinvertebrate community of AIR was in a reference condition, with most of the expected macroinvertebrate families collected from the site, which is a notable improvement from the impaired community observed in 2021. These macroinvertebrate results demonstrate substantial improvement from recent historical results, despite the frequent discharges from LDP1 into Airly Creek that occurred throughout 2022.

As mentioned in Section 4.1, water at AIR in 2022 was of generally improved quality from previous sampling events, with lower EC than has been common historically, few toxicants that may cause concern to aquatic species, and concentrations of all toxicants lower than those observed at background or baseline sites. The above average rainfall recorded in 2022 is likely to have influenced the macroinvertebrate community at AIR through contributing to dilution of salts and toxicants that are naturally present in the water, as well as providing sustained water availability for the colonisation of macroinvertebrate families, and aeration of the water through flow. Consequently, there is no evidence of any adverse impacts to the macroinvertebrate community of Airly Creek in 2022 from Airly Mine discharges.

Rainfall in the 2017 to 2019 period at Airly Mine was below average, with rainfall recorded at the mine in 2017 and 2018 below the fifth and tenth percentiles of annual rainfalls, respectively. In 2019, the rainfall at Airly Mine was less than the lowest historical annual rainfall volume recorded since 1899 at the BOM Running Stream station. These dry conditions resulted in low water levels and many dry sites in the study area, particularly in 2019, and consequently, poor conditions for macroinvertebrates. In 2020, however, rainfall was above the long-term average, and these improved conditions helped to create more favourable conditions for macroinvertebrates (GHD 2021). This trend continued throughout 2021 and 2022, thereby creating a more stable environment to allow for recovery of the macroinvertebrate communities. These results are evident in the number of sensitive taxa (SIGNAL-2 ≥8) collected in 2022.

Sensitive taxa have not been commonly collected during the historical monitoring period, but were collected from all sites in 2022. In 2020 and 2021, sensitive taxa were collected from high altitude sites GEN, GRO and GAP, but were not collected from any lower altitude site. The presence of sensitive taxa at all sites in 2022 further demonstrates the improvements to the macroinvertebrate communities corresponding to the increased rainfall.

In 2022, as well as during recent years of monitoring, samples collected at GEN contained the highest SIGNAL-2 scores, and the highest proportion of sensitive taxa. Located in the headwaters of Genowlan Creek, site GEN is spring fed and contains a heterogenous substrate including boulders, cobbles, gravel, and sand, as well as low proportions of silt and clays blanketing the substrate. The site is also well shaded and contains other aquatic habitats including detritus, small woody debris and algae. Therefore, the site displays good quality and diverse aquatic habitat types and with greater water reliability, can support more sensitive macroinvertebrate taxa than other high-altitude sites.

A small section of the first order headwaters of Torbane Creek was undermined in 2019. The results of the 2020 to 2022 sampling events do not suggest any impacts to the macroinvertebrate community of Torbane Creek as a result. Macroinvertebrate results at potentially influenced site TOR in 2022 showed high taxa richness and high EPT richness, which improved further from the high results observed in 2021, during which samples from TOR contained the highest diversity of taxa of all sites in both the autumn and spring 2021 surveys. These results demonstrate a substantial and continued improvement, likely due to the sustained water availability since 2020, following the extended drought period between 2017 and 2019, during which the site was dry. Similar to GEN, during wetter periods such as those observed in 2022, TOR contains a wide variety of substrates including cobbles, pebble, gravel, and sand, as well as low proportions of silt and clays blanketing the substrate. The site is also well shaded and contains other aquatic habitats including detritus, small woody debris and algae. These good quality and diverse habitats can support a wide range of macroinvertebrate taxa from many functional feeding groups and sensitive taxa. The presence of sensitive taxa at TOR in 2022, that were not observed in 2021 despite the macroinvertebrate community being in an otherwise good condition, is likely due to the improvement in water quality observed in 2022 compared to 2021, attributable to dilution due to rainfall. Water in 2022 at TOR contained much lower salinity and concentrations of all major ions than were observed in 2021, with sulfate concentrations approximately one third of those observed in 2021.

Secondary workings (panel and pillar mining) commenced under the first order stream headwaters of Gap Creek in 2020, with further undermining occurring in 2021. The macroinvertebrate community at GAP in 2022 was in a reasonably good condition, with high results for sensitivity metrics (EPT richness, SIGNAL-2 and proportion of sensitive taxa). These results demonstrate improvement from those of 2021, which were also improved from those observed during 2019 and 2020. Rainfall in 2022 was frequent and meant that flow was sustained through Gap Creek for all of 2022, which likely contributed to this improvement, as GAP was partially dry in 2021, with only one macroinvertebrate sample able to be collected in spring 2021. There has been no evidence of changes to flows in Gap Creek following the undermining, as determined through monthly water quality monitoring and the Gap Creek flow gauge (GHD 2023a), located just upstream of the aquatic ecology monitoring location GAP. The flows in Gap Creek in 2021 and 2022 were increased relative to the pre-mining monitoring history, mirroring the increased rainfall. Therefore, there is no evidence that there is any impact from Airly mining on the aquatic biota of Gap Creek.

As mentioned in section 4.1, the dissolved aluminium concentrations in water were elevated at the baseline sites GEN and GRO, and potentially impacted site GAP in autumn and spring 2022. The highest concentrations were observed at GRO in both surveys. Aluminium is known to be more toxic to aquatic species in acidic waters, such as those observed at GRO (ANZECC 2000), which may have contributed to the poor macroinvertebrate community condition recorded at the site in 2022, and particularly in autumn 2022, when aluminium was highest and pH was lowest. GRO recorded the lowest taxa richness and EPT richness of all sites in 2022. SIGNAL-2 scores were high in 2022 at GRO, though this result is likely to be skewed by the low total number of taxa collected from the site. However, habitat limitations would also be a factor influencing the macroinvertebrate community in this section of Genowlan Creek. Due to previous disturbances from maintenance of the adjacent 4WD track, this site has been reduced to a very narrow section of bedrock covered by ferns, with limited variety of habitat. Despite consistent water at the site throughout 2022, macroinvertebrate community condition is still impaired relative to the EIS sampling period (2013-2014). As the Genowlan Creek catchment has not yet been undermined, the results are unlikely to be associated with Airly Mine operations.

The macroinvertebrate community at lowland sites DOG, TOR, AIRUS and AIR were dominated by tolerant taxa, with very few sensitive taxa collected from these sites. These results were consistent with catchments impacted by grazing and historic land clearing and the lower altitude. Samples collected from these sites commonly contained Baetidae (Ephemeroptera (mayfly), SIGNAL-2 = 5), Coenagrionidae (Odonata (damselfly), SIGNAL-2 = 2), and Aeshnidae (Odonata (dragonfly); SIGNAL-2 = 4), that were not collected from either Genowlan Creek site, and are collected rarely from Gap Creek. Conversely, the upland sites contained sensitive taxa including Telephlebiidae (Odonata (dragonfly), SIGNAL-2 = 9), Athericidae (Diptera (fly), SIGNAL-2 = 8), and Helicopsychidae (Trichoptera (caddisfly), SIGNAL-2 = 8) that were not found any of the lowland, more disturbed, sites. Overall, the greater sensitivity of the taxa observed at the upland sites, as evident by the number of sensitive taxa present and their proportion to the overall number of taxa present at each site, reflects the minimal anthropogenic impacts, and generally improved water and sediment quality, relative to the lowland sites.

These differences in macroinvertebrate sensitivity were also reflected in the non-metric MDS, which indicated similar macroinvertebrate community compositions at lowland sites DOG, TOR, AIR and AIRUS, compared to upland sites GEN, GRO and GAP. The different macroinvertebrate community composition at upland sites would be reflective of number of natural site differences including different ionic composition and different environmental conditions (e.g. altitude, temperature, position in the catchment).

Overall, the results of 2022 aquatic ecology monitoring do not indicate impacts from Airly Mine discharges on Airly Creek or impacts from undermining on Gap Creek or Torbane Creek.

5. Conclusions

There were no impacts to water or sediment quality in 2022 that were attributable to Airly Mine, due to discharges to Airly Creek, or undermining of the Gap Creek or Torbane Creek headwaters. Despite several discharges from LDP1 into Airly Creek in 2022, water quality was improved from recent years of sampling, showing lower salinity and concentrations of major ions, likely due to dilution from the above average rainfall that occurred throughout 2022. There were also no toxicants observed in higher concentrations in Airly Creek downstream of LDP1 than those observed at background or baseline sites. Impacts to water quality observed in Airly Creek, Torbane Creek and Dog Trap Creek, including higher salinity and concentrations of major ions compared to the higher altitude sites on Genowlan and Gap Creeks, were instead indicative of historical land clearing, the agricultural landuse in the catchments, and the influence of saline groundwater from marine-deposited geology on Airly Creek.

The macroinvertebrate community condition in 2022 reflected the high rainfall that occurred through the year and contributed to consistent water availability at all sites. Macroinvertebrate community composition reflected the site differences, with samples collected from more pristine, higher altitude sites on Gap and Genowlan Creeks showing similarities, which contrasted to the macroinvertebrate communities observed at lower lying sites in Dog Trap, Torbane and Airly Creeks. There is no evidence of impacts to macroinvertebrate communities in 2022 from Airly Mine operations. The macroinvertebrate community at the Airly Creek impact site was in a good condition in 2022, with sensitive taxa present for the first time since 2014, and the highest taxa richness results of all sites, despite discharges from LDP1 into Airly Creek throughout 2022. Similarly, there have been no evidence of impacts to flows in Gap Creek following the undermining of its headwaters.

The next round of aquatic ecology monitoring will be conducted in autumn 2023.

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Appendices

Appendix A

Laboratory certificates of analysis (water quality)

CERTIFICATE OF ANALYSIS

Work Order : **ES2210872**
Client : **GHD PTY LTD**
Contact : MS Tegan Hopwood
Address : Level 3, GHD Tower, 24 Honeysuckle Drive
Newcastle 2300
Telephone : 02 4910 7760
Project : 12570462
Order number : Airly autumn 2022
C-O-C number : ----
Sampler : Tegan Hopwood
Site :
Quote number : EN/005
No. of samples received : 1
No. of samples analysed : 1

Page : 1 of 5
Laboratory : Environmental Division Sydney
Contact : Sarah Mathew
Address : 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone : +61-2-8784 8555
Date Samples Received : 29-Mar-2022 09:39
Date Analysis Commenced : 29-Mar-2022
Issue Date : 05-Apr-2022 14:39

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

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

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Senior Chemist - Inorganics	Sydney Inorganics, Smithfield, NSW
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

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

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

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EG020/EG094: It is recognised that total concentration is less than dissolved for some metal analytes. However, the difference is within experimental variation of the methods.
- EK061G:LOR raised due to sample matrix.
- EA016: Calculated TDS is determined from Electrical conductivity using a conversion factor of 0.65.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			*Sample ID*	**GAP**	----	----	----	----
			Sampling date / time	28-Mar-2022 15:00	----	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**ES2210872-001**	--------	--------	--------	--------
				Result	----	----	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**7.43**	----	----	----	----
EA006: Sodium Adsorption Ratio (SAR)								
^ **Sodium Adsorption Ratio**	----	0.01	-	**0.89**	----	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**117**	----	----	----	----
EA016: Calculated TDS (from Electrical Conductivity)								
Total Dissolved Solids (Calc.)	----	1	mg/L	**76**	----	----	----	----
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	<5	----	----	----	----
EA045: Turbidity								
Turbidity	----	0.1	NTU	**7.3**	----	----	----	----
EA065: Total Hardness as CaCO3								
Total Hardness as CaCO3	----	1	mg/L	**29**	----	----	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	----	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	----	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**29**	----	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**29**	----	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	----	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**18**	----	----	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**5**	----	----	----	----
Magnesium	7439-95-4	1	mg/L	**4**	----	----	----	----
Sodium	7440-23-5	1	mg/L	**11**	----	----	----	----
Potassium	7440-09-7	1	mg/L	**4**	----	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.09**	----	----	----	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	----	----	----	----
Copper	7440-50-8	0.001	mg/L	<0.001	----	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	----	----	----	----
Manganese	7439-96-5	0.001	mg/L	**0.028**	----	----	----	----

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			*Sample ID*	**GAP**	----	----	----	----
			Sampling date / time	28-Mar-2022 15:00	----	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**ES2210872-001**	--------	--------	--------	--------
				Result	----	----	----	----
EG020F: Dissolved Metals by ICP-MS - Continued								
Nickel	7440-02-0	0.001	mg/L	**0.002**	----	----	----	----
Boron	7440-42-8	0.05	mg/L	<0.05	----	----	----	----
Iron	7439-89-6	0.05	mg/L	**0.26**	----	----	----	----
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.25**	----	----	----	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	----	----	----	----
Copper	7440-50-8	0.001	mg/L	**0.002**	----	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	----	----	----	----
Manganese	7439-96-5	0.001	mg/L	**0.044**	----	----	----	----
Nickel	7440-02-0	0.001	mg/L	**0.002**	----	----	----	----
Boron	7440-42-8	0.05	mg/L	<0.05	----	----	----	----
Iron	7439-89-6	0.05	mg/L	**0.81**	----	----	----	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.00004	mg/L	<0.00004	----	----	----	----
EG035T: Total Mercury by FIMS								
Mercury	7439-97-6	0.00004	mg/L	<0.00004	----	----	----	----
EG094F: Dissolved Metals in Fresh Water by ORC-ICPMS								
Arsenic	7440-38-2	0.2	µg/L	**1.8**	----	----	----	----
Cadmium	7440-43-9	0.05	µg/L	<0.05	----	----	----	----
Chromium	7440-47-3	0.2	µg/L	**0.4**	----	----	----	----
Selenium	7782-49-2	0.2	µg/L	<0.2	----	----	----	----
Silver	7440-22-4	0.1	µg/L	<0.1	----	----	----	----
Zinc	7440-66-6	1	µg/L	**4**	----	----	----	----
EG094T: Total metals in Fresh water by ORC-ICPMS								
Arsenic	7440-38-2	0.2	µg/L	**0.7**	----	----	----	----
Cadmium	7440-43-9	0.05	µg/L	<0.05	----	----	----	----
Chromium	7440-47-3	0.2	µg/L	**0.7**	----	----	----	----
Selenium	7782-49-2	0.2	µg/L	<0.2	----	----	----	----
Silver	7440-22-4	0.1	µg/L	<0.1	----	----	----	----
Zinc	7440-66-6	1	µg/L	**6**	----	----	----	----
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	<0.1	----	----	----	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.01**	----	----	----	----

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			*Sample ID*	**GAP**	----	----	----	----
			Sampling date / time	28-Mar-2022 15:00	----	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**ES2210872-001**	--------	--------	--------	--------
				Result	----	----	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	----	----	----	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**0.08**	----	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.08**	----	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.4**	----	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	**0.5**	----	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.12**	----	----	----	----
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	----	----	----	----
EN055: Ionic Balance								
ø **Total Anions**	----	0.01	meq/L	**1.09**	----	----	----	----
ø **Total Cations**	----	0.01	meq/L	**1.16**	----	----	----	----
EP002: Dissolved Organic Carbon (DOC)								
Dissolved Organic Carbon	----	1	mg/L	**8**	----	----	----	----
EP020: Oil and Grease (O&G)								
Oil & Grease	----	5	mg/L	**7**	----	----	----	----

CERTIFICATE OF ANALYSIS

Work Order : **ES2211067**
Client : **GHD PTY LTD**
Contact : MS Tegan Hopwood
Address : PO BOX 5403
NEWCASTLE WEST NSW, AUSTRALIA 2302
Telephone : 02 4910 7760
Project : 12570462
Order number : AIRLY AUTUMN 2022
C-O-C number : ----
Sampler : TEGAN HOPWOOD
Site :
Quote number : EN/005
No. of samples received : 4
No. of samples analysed : 4

Page : 1 of 5
Laboratory : Environmental Division Sydney
Contact : Sarah Mathew
Address : 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone : +61-2-8784 8555
Date Samples Received : 30-Mar-2022 12:40
Date Analysis Commenced : 30-Mar-2022
Issue Date : 06-Apr-2022 13:42

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

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

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Senior Chemist - Inorganics	Sydney Inorganics, Smithfield, NSW
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

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

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

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EG094: It is recognised that total concentration is less than dissolved for some metal analytes. However, the difference is within experimental variation of the methods.
- EG020: It is recognised that total concentration is less than dissolved for some metal analytes. However, the difference is within experimental variation of the methods.
- EA016: Calculated TDS is determined from Electrical conductivity using a conversion factor of 0.65.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			*Sample ID*	**AIR**	**AIRUS**	**AIRD**	**DOG**	**----**
			Sampling date / time	29-Mar-2022 07:30	29-Mar-2022 10:30	29-Mar-2022 11:00	29-Mar-2022 15:00	----
Compound	*CAS Number*	*LOR*	*Unit*	**ES2211067-001**	**ES2211067-002**	**ES2211067-003**	**ES2211067-004**	--------
				Result	Result	Result	Result	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**7.77**	**7.85**	**7.90**	**8.09**	----
EA006: Sodium Adsorption Ratio (SAR)								
^ **Sodium Adsorption Ratio**	----	0.01	-	**0.73**	**0.63**	**0.62**	**0.83**	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**1330**	**1340**	**1340**	**1160**	----
EA016: Calculated TDS (from Electrical Conductivity)								
Total Dissolved Solids (Calc.)	----	1	mg/L	**864**	**871**	**871**	**754**	----
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	**8**	**7**	**6**	**6**	----
EA045: Turbidity								
Turbidity	----	0.1	NTU	**3.5**	**2.7**	**3.0**	**0.9**	----
EA065: Total Hardness as CaCO3								
Total Hardness as CaCO3	----	1	mg/L	**688**	**681**	**681**	**576**	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**128**	**157**	**139**	**335**	----
Total Alkalinity as CaCO3	----	1	mg/L	**128**	**157**	**139**	**335**	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**583**	**601**	**612**	**291**	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**31**	**29**	**30**	**30**	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**114**	**111**	**111**	**130**	----
Magnesium	7439-95-4	1	mg/L	**98**	**98**	**98**	**61**	----
Sodium	7440-23-5	1	mg/L	**44**	**38**	**37**	**46**	----
Potassium	7440-09-7	1	mg/L	**6**	**6**	**6**	**2**	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	**0.02**	**0.02**	<0.01	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Manganese	7439-96-5	0.001	mg/L	**0.101**	**0.054**	**0.055**	**0.027**	----

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			Sample ID	**AIR**	**AIRUS**	**AIRD**	**DOG**	**----**
			Sampling date / time	29-Mar-2022 07:30	29-Mar-2022 10:30	29-Mar-2022 11:00	29-Mar-2022 15:00	----
Compound	CAS Number	LOR	Unit	**ES2211067-001**	**ES2211067-002**	**ES2211067-003**	**ES2211067-004**	--------
				Result	Result	Result	Result	----
EG020F: Dissolved Metals by ICP-MS - Continued								
Nickel	7440-02-0	0.001	mg/L	**0.006**	**0.006**	**0.006**	<0.001	----
Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	----
Iron	7439-89-6	0.05	mg/L	**0.05**	**0.10**	**0.09**	<0.05	----
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.10**	**0.06**	**0.07**	**0.04**	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Copper	7440-50-8	0.001	mg/L	<0.001	**0.002**	<0.001	<0.001	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Manganese	7439-96-5	0.001	mg/L	**0.112**	**0.055**	**0.058**	**0.028**	----
Nickel	7440-02-0	0.001	mg/L	**0.007**	**0.007**	**0.007**	<0.001	----
Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	----
Iron	7439-89-6	0.05	mg/L	**0.16**	**0.16**	**0.15**	**0.11**	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.00004	mg/L	<0.00004	<0.00004	<0.00004	<0.00004	----
EG035T: Total Mercury by FIMS								
Mercury	7439-97-6	0.00004	mg/L	<0.00004	<0.00004	<0.00004	<0.00004	----
EG094F: Dissolved Metals in Fresh Water by ORC-ICPMS								
Selenium	7782-49-2	0.2	µg/L	<0.2	<0.2	<0.2	**0.3**	----
Arsenic	7440-38-2	0.2	µg/L	**0.7**	**0.6**	**0.6**	**0.5**	----
Cadmium	7440-43-9	0.05	µg/L	<0.05	<0.05	<0.05	<0.05	----
Chromium	7440-47-3	0.2	µg/L	**0.3**	**0.5**	**0.2**	<0.2	----
Silver	7440-22-4	0.1	µg/L	<0.1	<0.1	<0.1	<0.1	----
Zinc	7440-66-6	1	µg/L	**3**	**3**	**1**	**2**	----
EG094T: Total metals in Fresh water by ORC-ICPMS								
Selenium	7782-49-2	0.2	µg/L	<0.2	<0.2	<0.2	**0.3**	----
Arsenic	7440-38-2	0.2	µg/L	**0.8**	**0.8**	**0.8**	**0.6**	----
Cadmium	7440-43-9	0.05	µg/L	<0.05	<0.05	<0.05	<0.05	----
Chromium	7440-47-3	0.2	µg/L	**0.3**	**0.3**	**0.3**	<0.2	----
Silver	7440-22-4	0.1	µg/L	<0.1	<0.1	<0.1	<0.1	----
Zinc	7440-66-6	1	µg/L	**4**	**2**	**3**	**1**	----
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.2**	**0.2**	**0.2**	**0.2**	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.01**	<0.01	<0.01	<0.01	----

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			*Sample ID*	**AIR**	**AIRUS**	**AIRD**	**DOG**	**----**
			Sampling date / time	29-Mar-2022 07:30	29-Mar-2022 10:30	29-Mar-2022 11:00	29-Mar-2022 15:00	----
Compound	*CAS Number*	*LOR*	*Unit*	**ES2211067-001**	**ES2211067-002**	**ES2211067-003**	**ES2211067-004**	**--------**
				Result	Result	Result	Result	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**0.02**	<0.01	**0.02**	**0.08**	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.02**	<0.01	**0.02**	**0.08**	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.8**	**0.9**	**0.8**	<0.1	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	**0.8**	**0.9**	**0.8**	<0.1	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.01**	**0.01**	**0.02**	<0.01	----
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	----
EN055: Ionic Balance								
ø **Total Anions**	----	0.01	meq/L	**15.6**	**16.5**	**16.4**	**13.6**	----
ø **Total Cations**	----	0.01	meq/L	**15.8**	**15.4**	**15.4**	**13.6**	----
ø **Ionic Balance**	----	0.01	%	**0.80**	**3.32**	**3.14**	**0.14**	----
EP002: Dissolved Organic Carbon (DOC)								
Dissolved Organic Carbon	----	1	mg/L	**16**	**17**	**17**	**4**	----
EP020: Oil and Grease (O&G)								
Oil & Grease	----	5	mg/L	<5	<5	<5	<5	----

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order : **ES2211252**
Client : **GHD PTY LTD**
Contact : MS Tegan Hopwood
Address : Level 3, GHD Tower, 24 Honeysuckle Drive
Newcastle 2300
Telephone : 02 4910 7760
Project : 12570462
Order number : Airly autumn 2022
C-O-C number : ----
Sampler : Tegan Hopwood
Site :
Quote number : EN/005
No. of samples received : 1
No. of samples analysed : 1

Page : 1 of 5
Laboratory : Environmental Division Sydney
Contact : Sarah Mathew
Address : 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone : +61-2-8784 8555
Date Samples Received : 31-Mar-2022 10:15
Date Analysis Commenced : 31-Mar-2022
Issue Date : 07-Apr-2022 14:40

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

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

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Senior Chemist - Inorganics	Sydney Inorganics, Smithfield, NSW

General Comments

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Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key :
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EA016: Calculated TDS is determined from Electrical conductivity using a conversion factor of 0.65.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			*Sample ID*	**GRO**	----	----	----	----
			Sampling date / time	30-Mar-2022 09:00	----	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**ES2211252-001**	--------	--------	--------	--------
				Result	----	----	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**6.13**	----	----	----	----
EA006: Sodium Adsorption Ratio (SAR)								
^ **Sodium Adsorption Ratio**	----	0.01	-	**1.20**	----	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**37**	----	----	----	----
EA016: Calculated TDS (from Electrical Conductivity)								
Total Dissolved Solids (Calc.)	----	1	mg/L	**24**	----	----	----	----
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	<5	----	----	----	----
EA045: Turbidity								
Turbidity	----	0.1	NTU	**3.1**	----	----	----	----
EA065: Total Hardness as CaCO3								
Total Hardness as CaCO3	----	1	mg/L	<1	----	----	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	----	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	----	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**6**	----	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**6**	----	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	----	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**8**	----	----	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	<1	----	----	----	----
Magnesium	7439-95-4	1	mg/L	<1	----	----	----	----
Sodium	7440-23-5	1	mg/L	**5**	----	----	----	----
Potassium	7440-09-7	1	mg/L	<1	----	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.49**	----	----	----	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	----	----	----	----
Copper	7440-50-8	0.001	mg/L	<0.001	----	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	----	----	----	----
Manganese	7439-96-5	0.001	mg/L	**0.006**	----	----	----	----

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			*Sample ID*	**GRO**	----	----	----	----
			Sampling date / time	30-Mar-2022 09:00	----	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**ES2211252-001**	--------	--------	--------	--------
				Result	----	----	----	----
EG020F: Dissolved Metals by ICP-MS - Continued								
Nickel	7440-02-0	0.001	mg/L	<0.001	----	----	----	----
Boron	7440-42-8	0.05	mg/L	<0.05	----	----	----	----
Iron	7439-89-6	0.05	mg/L	**0.37**	----	----	----	----
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.54**	----	----	----	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	----	----	----	----
Copper	7440-50-8	0.001	mg/L	**0.001**	----	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	----	----	----	----
Manganese	7439-96-5	0.001	mg/L	**0.008**	----	----	----	----
Nickel	7440-02-0	0.001	mg/L	<0.001	----	----	----	----
Boron	7440-42-8	0.05	mg/L	<0.05	----	----	----	----
Iron	7439-89-6	0.05	mg/L	**0.41**	----	----	----	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.00004	mg/L	<0.00004	----	----	----	----
EG035T: Total Mercury by FIMS								
Mercury	7439-97-6	0.00004	mg/L	<0.00004	----	----	----	----
EG094F: Dissolved Metals in Fresh Water by ORC-ICPMS								
Arsenic	7440-38-2	0.2	µg/L	<0.2	----	----	----	----
Cadmium	7440-43-9	0.05	µg/L	<0.05	----	----	----	----
Chromium	7440-47-3	0.2	µg/L	**1.2**	----	----	----	----
Selenium	7782-49-2	0.2	µg/L	<0.2	----	----	----	----
Silver	7440-22-4	0.1	µg/L	<0.1	----	----	----	----
Zinc	7440-66-6	1	µg/L	**2**	----	----	----	----
EG094T: Total metals in Fresh water by ORC-ICPMS								
Arsenic	7440-38-2	0.2	µg/L	<0.2	----	----	----	----
Cadmium	7440-43-9	0.05	µg/L	<0.05	----	----	----	----
Chromium	7440-47-3	0.2	µg/L	**1.3**	----	----	----	----
Selenium	7782-49-2	0.2	µg/L	<0.2	----	----	----	----
Silver	7440-22-4	0.1	µg/L	<0.1	----	----	----	----
Zinc	7440-66-6	1	µg/L	**5**	----	----	----	----
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	<0.1	----	----	----	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.02**	----	----	----	----

Analytical Results

Sub-Matrix: **WATER**
(Matrix: **WATER)**

			Sample ID	**GRO**	**----**	**----**	**----**	**----**
			Sampling date / time	30-Mar-2022 09:00	----	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**ES2211252-001**	**--------**	**--------**	**--------**	**--------**
				Result	----	----	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	**----**	**----**	**----**	**----**
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	**----**	**----**	**----**	**----**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	**----**	**----**	**----**	**----**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.2**	**----**	**----**	**----**	**----**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	**0.2**	**----**	**----**	**----**	**----**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	<0.01	**----**	**----**	**----**	**----**
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	**----**	**----**	**----**	**----**
EN055: Ionic Balance								
ø **Total Anions**	----	0.01	meq/L	**0.34**	**----**	**----**	**----**	**----**
ø **Total Cations**	----	0.01	meq/L	**0.22**	**----**	**----**	**----**	**----**
EP002: Dissolved Organic Carbon (DOC)								
Dissolved Organic Carbon	----	1	mg/L	**11**	**----**	**----**	**----**	**----**
EP020: Oil and Grease (O&G)								
Oil & Grease	----	5	mg/L	<5	**----**	**----**	**----**	**----**

ALS Environmental

CERTIFICATE OF ABALYSIS

Work Order : **ES2211444**

Client : **GHD PTY LTD**

Contact : MS Tegan Hopwood

Address : Level 3, GHD Tower, 24 Honeysuckle Drive
Newcastle 2300

Telephone : 02 4910 7760

Project : 12570462

Order number : Airly Auutumn 2022

C-O-C number : ----

Sampler : Tegan Hopwood

Site :

Quote number : EN/005

No. of samples received : 2

No. of samples analysed : 2

Page : 1 of 5

Laboratory : Environmental Division Sydney

Contact : Sarah Mathew

Address : 277-289 Woodpark Road Smithfield NSW Australia 2164

Telephone : +61-2-8784 8555

Date Samples Received : 01-Apr-2022 10:28

Date Analysis Commenced : 02-Apr-2022

Issue Date : 08-Apr-2022 15:09

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

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

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Senior Chemist - Inorganics	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

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

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

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EG094: It is recognised that total concentration is less than dissolved for some metal analytes. However, the difference is within experimental variation of the methods.
- EG020: It is recognised that total concentration is less than dissolved for some metal analytes. However, the difference is within experimental variation of the methods.
- EA016: Calculated TDS is determined from Electrical conductivity using a conversion factor of 0.65.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: **WATER**
(Matrix: **WATER**)

			Sample ID	**TOR**	**GEN**	**----**	**----**	**----**
			Sampling date / time	31-Mar-2022 11:00	31-Mar-2022 15:30	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**ES2211444-001**	**ES2211444-002**	--------	--------	--------
				Result	Result	----	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**7.88**	**6.11**	----	----	----
EA006: Sodium Adsorption Ratio (SAR)								
^ **Sodium Adsorption Ratio**	----	0.01	-	**0.48**	**1.13**	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**1140**	**79**	----	----	----
EA016: Calculated TDS (from Electrical Conductivity)								
Total Dissolved Solids (Calc.)	----	1	mg/L	**741**	**51**	----	----	----
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	<5	<5	----	----	----
EA045: Turbidity								
Turbidity	----	0.1	NTU	**1.5**	**0.4**	----	----	----
EA065: Total Hardness as CaCO3								
Total Hardness as CaCO3	----	1	mg/L	**546**	**4**	----	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**100**	**4**	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**100**	**4**	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**508**	**2**	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**27**	**13**	----	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**90**	<1	----	----	----
Magnesium	7439-95-4	1	mg/L	**78**	**1**	----	----	----
Sodium	7440-23-5	1	mg/L	**26**	**6**	----	----	----
Potassium	7440-09-7	1	mg/L	**8**	**1**	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	**0.07**	----	----	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	**0.001**	----	----	----
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	----	----	----
Manganese	7439-96-5	0.001	mg/L	**0.355**	**0.008**	----	----	----

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			*Sample ID*	**TOR**	**GEN**	**----**	**----**	**----**
			Sampling date / time	31-Mar-2022 11:00	31-Mar-2022 15:30	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**ES2211444-001**	**ES2211444-002**	**--------**	**--------**	**--------**
				Result	Result	----	----	----
EG020F: Dissolved Metals by ICP-MS - Continued								
Nickel	7440-02-0	0.001	mg/L	**0.009**	**0.002**	----	----	----
Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	----	----	----
Iron	7439-89-6	0.05	mg/L	**0.06**	<0.05	----	----	----
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.01**	**0.06**	----	----	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	----	----	----
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	----	----	----
Manganese	7439-96-5	0.001	mg/L	**0.397**	**0.008**	----	----	----
Nickel	7440-02-0	0.001	mg/L	**0.009**	**0.001**	----	----	----
Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	----	----	----
Iron	7439-89-6	0.05	mg/L	**0.23**	<0.05	----	----	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.00004	mg/L	<0.00004	<0.00004	----	----	----
EG035T: Total Mercury by FIMS								
Mercury	7439-97-6	0.00004	mg/L	<0.00004	<0.00004	----	----	----
EG094F: Dissolved Metals in Fresh Water by ORC-ICPMS								
Arsenic	7440-38-2	0.2	µg/L	**0.5**	<0.2	----	----	----
Cadmium	7440-43-9	0.05	µg/L	<0.05	<0.05	----	----	----
Chromium	7440-47-3	0.2	µg/L	<0.2	**0.3**	----	----	----
Selenium	7782-49-2	0.2	µg/L	**0.7**	<0.2	----	----	----
Silver	7440-22-4	0.1	µg/L	<0.1	<0.1	----	----	----
Zinc	7440-66-6	1	µg/L	**2**	**7**	----	----	----
EG094T: Total metals in Fresh water by ORC-ICPMS								
Arsenic	7440-38-2	0.2	µg/L	**0.5**	<0.2	----	----	----
Cadmium	7440-43-9	0.05	µg/L	<0.05	<0.05	----	----	----
Chromium	7440-47-3	0.2	µg/L	**0.3**	**0.2**	----	----	----
Selenium	7782-49-2	0.2	µg/L	**0.6**	<0.2	----	----	----
Silver	7440-22-4	0.1	µg/L	<0.1	<0.1	----	----	----
Zinc	7440-66-6	1	µg/L	**2**	**7**	----	----	----
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.5**	<0.1	----	----	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	<0.01	<0.01	----	----	----

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			Sample ID	**TOR**	**GEN**	**----**	**----**	**----**
			Sampling date / time	31-Mar-2022 11:00	31-Mar-2022 15:30	----	----	----
Compound	CAS Number	LOR	Unit	**ES2211444-001**	**ES2211444-002**	**--------**	**--------**	**--------**
				Result	Result	----	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	**----**	**----**	**----**
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**0.30**	**0.09**	**----**	**----**	**----**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.30**	**0.09**	**----**	**----**	**----**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.7**	**0.1**	**----**	**----**	**----**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	**1.0**	**0.2**	**----**	**----**	**----**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	<0.01	<0.01	**----**	**----**	**----**
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	<0.01	**----**	**----**	**----**
EN055: Ionic Balance								
ø **Total Anions**	----	0.01	meq/L	**13.3**	**0.49**	**----**	**----**	**----**
ø **Total Cations**	----	0.01	meq/L	**12.2**	**0.37**	**----**	**----**	**----**
ø **Ionic Balance**	----	0.01	%	**4.26**	**----**	**----**	**----**	**----**
EP002: Dissolved Organic Carbon (DOC)								
Dissolved Organic Carbon	----	1	mg/L	**10**	**2**	**----**	**----**	**----**
EP020: Oil and Grease (O&G)								
Oil & Grease	----	5	mg/L	<5	<5	**----**	**----**	**----**

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order : **ES2244093**
Client : **GHD PTY LTD**
Contact : MS Tegan Hopwood
Address : Level 3, GHD Tower, 24 Honeysuckle Drive
Newcastle 2300
Telephone : 02 4910 7760
Project : 12570462
Order number : Airly spring 2022
C-O-C number : ----
Sampler : Tegan Hopwood
Site :
Quote number : EN/005
No. of samples received : 8
No. of samples analysed : 8

Page : 1 of 8
Laboratory : Environmental Division Sydney
Contact : Sarah Mathew
Address : 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone : +61-2-8784 8555
Date Samples Received : 07-Dec-2022 10:00
Date Analysis Commenced : 07-Dec-2022
Issue Date : 14-Dec-2022 12:50

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

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

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Senior Chemist - Inorganics	Sydney Inorganics, Smithfield, NSW
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW
Wisam Marassa	Inorganics Coordinator	Sydney Inorganics, Smithfield, NSW

General Comments

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Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contract for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- As per QWI – EN55-3 Data Interpreting Procedures, Ionic balances are typically calculated using Major Anions - Chloride, Alkalinity and Sulfate; and Major Cations - Calcium, Magnesium, Potassium and Sodium. Where applicable and dependent upon sample matrix, the Ionic Balance may also include the additional contribution of Ammonia, Dissolved Metals by ICPMS and H+ to the Cations and Nitrate, SiO2 and Fluoride to the Anions.
- EG094/EG020: It is recognised that total concentration is less than dissolved for some metal analytes. However, the difference is within experimental variation of the methods.
- EA016: Calculated TDS is determined from Electrical conductivity using a conversion factor of 0.65.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: **WATER**
(Matrix: **WATER**)

			Sample ID	**GEN**	**GRO**	**DOG**	**GAP**	**AIR**
			Sampling date / time	05-Dec-2022 11:30	05-Dec-2022 14:00	06-Dec-2022 07:45	06-Dec-2022 10:00	06-Dec-2022 13:00
Compound	*CAS Number*	*LOR*	*Unit*	**ES2244093-001**	**ES2244093-002**	**ES2244093-003**	**ES2244093-004**	**ES2244093-005**
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**6.23**	**5.90**	**7.83**	**7.42**	**7.91**
EA006: Sodium Adsorption Ratio (SAR)								
^ **Sodium Adsorption Ratio**	----	0.01	-	**1.67**	**1.20**	**0.89**	**0.93**	**0.71**
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**53**	**32**	**1120**	**133**	**1780**
EA016: Calculated TDS (from Electrical Conductivity)								
Total Dissolved Solids (Calc.)	----	1	mg/L	**34**	**21**	**728**	**86**	**1160**
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	1	mg/L	<1	**1**	**8**	**3**	**5**
EA045: Turbidity								
Turbidity	----	0.1	NTU	**0.6**	**0.5**	**0.5**	**3.6**	**1.9**
EA065: Total Hardness as CaCO3								
Total Hardness as CaCO3	----	1	mg/L	<1	<1	**570**	**31**	**1100**
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**6**	**6**	**352**	**32**	**236**
Total Alkalinity as CaCO3	----	1	mg/L	**6**	**6**	**352**	**32**	**236**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**2**	<1	**291**	**3**	**884**
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**14**	**8**	**44**	**26**	**41**
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	<1	<1	**126**	**6**	**187**
Magnesium	7439-95-4	1	mg/L	<1	<1	**62**	**4**	**155**
Sodium	7440-23-5	1	mg/L	**7**	**5**	**49**	**12**	**54**
Potassium	7440-09-7	1	mg/L	**1**	<1	**2**	**3**	**3**
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.05**	**0.30**	<0.01	**0.10**	<0.01
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L	**0.006**	**0.006**	**0.011**	**0.033**	**0.215**

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			*Sample ID*	**GEN**	**GRO**	**DOG**	**GAP**	**AIR**
			Sampling date / time	05-Dec-2022 11:30	05-Dec-2022 14:00	06-Dec-2022 07:45	06-Dec-2022 10:00	06-Dec-2022 13:00
Compound	*CAS Number*	*LOR*	*Unit*	**ES2244093-001**	**ES2244093-002**	**ES2244093-003**	**ES2244093-004**	**ES2244093-005**
				Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued								
Nickel	7440-02-0	0.001	mg/L	**0.002**	<0.001	<0.001	**0.001**	**0.006**
Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
Iron	7439-89-6	0.05	mg/L	<0.05	**0.21**	<0.05	**0.30**	<0.05
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.05**	**0.34**	**0.02**	**0.11**	**0.02**
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L	**0.005**	**0.005**	**0.020**	**0.061**	**0.294**
Nickel	7440-02-0	0.001	mg/L	**0.002**	<0.001	<0.001	**0.001**	**0.006**
Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
Iron	7439-89-6	0.05	mg/L	<0.05	**0.25**	**0.06**	**0.35**	**0.20**
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.00004	mg/L	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004
EG035T: Total Mercury by FIMS								
Mercury	7439-97-6	0.00004	mg/L	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004
EG094F: Dissolved Metals in Fresh Water by ORC-ICPMS								
Arsenic	7440-38-2	0.2	µg/L	<0.2	<0.2	**0.3**	**0.3**	**0.4**
Cadmium	7440-43-9	0.05	µg/L	<0.05	<0.05	<0.05	<0.05	<0.05
Chromium	7440-47-3	0.2	µg/L	<0.2	**0.8**	<0.2	**0.2**	<0.2
Selenium	7782-49-2	0.2	µg/L	<0.2	<0.2	**0.4**	<0.2	<0.2
Silver	7440-22-4	0.1	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Zinc	7440-66-6	1	µg/L	**8**	**1**	**1**	**3**	**1**
EG094T: Total metals in Fresh water by ORC-ICPMS								
Arsenic	7440-38-2	0.2	µg/L	<0.2	<0.2	**0.4**	**0.3**	**0.5**
Cadmium	7440-43-9	0.05	µg/L	<0.05	<0.05	<0.05	<0.05	<0.05
Chromium	7440-47-3	0.2	µg/L	**0.3**	**0.9**	<0.2	**0.3**	<0.2
Selenium	7782-49-2	0.2	µg/L	<0.2	<0.2	**0.4**	<0.2	<0.2
Silver	7440-22-4	0.1	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Zinc	7440-66-6	1	µg/L	**7**	**1**	**1**	**2**	**2**
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	<0.1	**0.2**	**0.4**	<0.1	**0.3**
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	<0.01	<0.01	<0.01	**0.03**	**0.01**

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			*Sample ID*	**GEN**	**GRO**	**DOG**	**GAP**	**AIR**
			Sampling date / time	05-Dec-2022 11:30	05-Dec-2022 14:00	06-Dec-2022 07:45	06-Dec-2022 10:00	06-Dec-2022 13:00
Compound	*CAS Number*	*LOR*	*Unit*	**ES2244093-001**	**ES2244093-002**	**ES2244093-003**	**ES2244093-004**	**ES2244093-005**
				Result	Result	Result	Result	Result
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**0.14**	**0.01**	**0.04**	**0.06**	**0.02**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.14**	**0.01**	**0.04**	**0.06**	**0.02**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.2**	**0.3**	**0.1**	**0.2**	**0.4**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	**0.3**	**0.3**	**0.1**	**0.3**	**0.4**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	<0.01	<0.01	<0.01	**0.01**	**0.01**
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EN055: Ionic Balance								
ø **Total Anions**	----	0.01	meq/L	**0.56**	**0.34**	**14.3**	**1.44**	**24.3**
ø **Total Cations**	----	0.01	meq/L	**0.33**	**0.22**	**13.6**	**1.23**	**24.5**
ø **Ionic Balance**	----	0.01	%	**----**	**----**	**2.72**	**----**	**0.48**
EP002: Dissolved Organic Carbon (DOC)								
Dissolved Organic Carbon	----	1	mg/L	**3**	**7**	**5**	**6**	**9**
EP020: Oil and Grease (O&G)								
Oil & Grease	----	5	mg/L	<5	<5	<5	<5	<5

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			*Sample ID*	**AIRUS**	**TOR**	**AIRD**	**----**	**----**
			Sampling date / time	06-Dec-2022 17:15	06-Dec-2022 16:00	06-Dec-2022 08:00	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**ES2244093-006**	**ES2244093-007**	**ES2244093-008**	**--------**	**--------**
				Result	Result	Result	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**8.05**	**8.06**	**7.97**	----	----
EA006: Sodium Adsorption Ratio (SAR)								
^ **Sodium Adsorption Ratio**	----	0.01	-	**0.68**	**0.53**	**0.91**	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**1820**	**1280**	**1100**	----	----
EA016: Calculated TDS (from Electrical Conductivity)								
Total Dissolved Solids (Calc.)	----	1	mg/L	**1180**	**832**	**715**	----	----
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	1	mg/L	**5**	**3**	**4**	----	----
EA045: Turbidity								
Turbidity	----	0.1	NTU	**1.0**	**1.4**	**0.4**	----	----
EA065: Total Hardness as CaCO3								
Total Hardness as CaCO3	----	1	mg/L	**1150**	**764**	**597**	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**239**	**138**	**357**	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**239**	**138**	**357**	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**912**	**622**	**295**	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**35**	**32**	**44**	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**193**	**133**	**132**	----	----
Magnesium	7439-95-4	1	mg/L	**162**	**105**	**65**	----	----
Sodium	7440-23-5	1	mg/L	**53**	**34**	**51**	----	----
Potassium	7440-09-7	1	mg/L	**3**	**6**	**2**	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Manganese	7439-96-5	0.001	mg/L	**0.060**	**0.232**	**0.011**	----	----

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			*Sample ID*	**AIRUS**	**TOR**	**AIRD**	**----**	**----**
			Sampling date / time	06-Dec-2022 17:15	06-Dec-2022 16:00	06-Dec-2022 08:00	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**ES2244093-006**	**ES2244093-007**	**ES2244093-008**	**--------**	**--------**
				Result	Result	Result	----	----
EG020F: Dissolved Metals by ICP-MS - Continued								
Nickel	7440-02-0	0.001	mg/L	**0.003**	**0.006**	<0.001	----	----
Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	<0.05	----	----
Iron	7439-89-6	0.05	mg/L	<0.05	**0.06**	<0.05	----	----
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	**0.01**	<0.01	----	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Manganese	7439-96-5	0.001	mg/L	**0.126**	**0.245**	**0.012**	----	----
Nickel	7440-02-0	0.001	mg/L	**0.004**	**0.007**	<0.001	----	----
Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	<0.05	----	----
Iron	7439-89-6	0.05	mg/L	**0.13**	**0.18**	<0.05	----	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.00004	mg/L	<0.00004	<0.00004	<0.00004	----	----
EG035T: Total Mercury by FIMS								
Mercury	7439-97-6	0.00004	mg/L	<0.00004	<0.00004	<0.00004	----	----
EG094F: Dissolved Metals in Fresh Water by ORC-ICPMS								
Arsenic	7440-38-2	0.2	µg/L	**0.6**	**0.4**	**0.3**	----	----
Cadmium	7440-43-9	0.05	µg/L	<0.05	<0.05	<0.05	----	----
Chromium	7440-47-3	0.2	µg/L	<0.2	<0.2	<0.2	----	----
Selenium	7782-49-2	0.2	µg/L	<0.2	**0.3**	**0.4**	----	----
Silver	7440-22-4	0.1	µg/L	<0.1	<0.1	<0.1	----	----
Zinc	7440-66-6	1	µg/L	<1	<1	**3**	----	----
EG094T: Total metals in Fresh water by ORC-ICPMS								
Arsenic	7440-38-2	0.2	µg/L	**0.6**	**0.4**	**0.5**	----	----
Cadmium	7440-43-9	0.05	µg/L	<0.05	<0.05	<0.05	----	----
Chromium	7440-47-3	0.2	µg/L	<0.2	<0.2	<0.2	----	----
Selenium	7782-49-2	0.2	µg/L	<0.2	**0.2**	**0.5**	----	----
Silver	7440-22-4	0.1	µg/L	<0.1	<0.1	<0.1	----	----
Zinc	7440-66-6	1	µg/L	<1	**2**	**4**	----	----
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.4**	**0.5**	**0.4**	----	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	<0.01	**0.06**	<0.01	----	----

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			*Sample ID*	**AIRUS**	**TOR**	**AIRD**	**----**	**----**
			Sampling date / time	06-Dec-2022 17:15	06-Dec-2022 16:00	06-Dec-2022 08:00	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**ES2244093-006**	**ES2244093-007**	**ES2244093-008**	**--------**	**--------**
				Result	Result	Result	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	----	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**0.03**	**0.07**	**0.04**	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.03**	**0.07**	**0.04**	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.4**	**0.4**	**0.1**	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	**0.4**	**0.5**	**0.1**	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.01**	**0.01**	<0.01	----	----
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	<0.01	<0.01	----	----
EN055: Ionic Balance								
ø **Total Anions**	----	0.01	meq/L	**24.8**	**16.6**	**14.5**	----	----
ø **Total Cations**	----	0.01	meq/L	**25.3**	**16.9**	**14.2**	----	----
ø **Ionic Balance**	----	0.01	%	**1.19**	**0.90**	**1.08**	----	----
EP002: Dissolved Organic Carbon (DOC)								
Dissolved Organic Carbon	----	1	mg/L	**8**	**7**	**2**	----	----
EP020: Oil and Grease (O&G)								
Oil & Grease	----	5	mg/L	<5	<5	<5	----	----

Appendix B

Laboratory certificates of analysis (sediment quality)

CERTIFICATE OF ANALYSIS

Work Order	: **ES2210874**	Page	: 1 of 4
Client	: **GHD PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MS Tegan Hopwood	Contact	: Sarah Mathew
Address	: Level 3, GHD Tower, 24 Honeysuckle Drive Newcastle 2300	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: 02 4910 7760	Telephone	: +61-2-8784 8555
Project	: 12570462	Date Samples Received	: 29-Mar-2022 09:39
Order number	: Airly autumn 2022	Date Analysis Commenced	: 30-Mar-2022
C-O-C number	: ----	Issue Date	: 12-Apr-2022 12:16
Sampler	: Tegan Hopwood		
Site	:		
Quote number	: EN/005		
No. of samples received	: 2		
No. of samples analysed	: 2		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

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

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Senior Chemist - Inorganics	Sydney Inorganics, Smithfield, NSW
Kim McCabe	Senior Inorganic Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

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

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

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EG005T (Total Metals by ICP-AES): EB2209481-001 shows poor duplicate results due to sample heterogeneity. This has been confirmed by visual inspection.
- EG005SDH (1M HCl Extractable Metals by ICP-AES): The high failing laboratory control standard is deemed acceptable as all results are less than the limit of reporting.

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			*Sample ID*	**GAP**	**GAP <2000µm**	**----**	**----**	**----**
			Sampling date / time	28-Mar-2022 15:00	28-Mar-2022 15:00	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**ES2210874-001**	**ES2210874-002**	**--------**	**--------**	**--------**
				Result	Result	----	----	----
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	**30.5**	----	----	----	----
EG005(ED093)-SDH: 1M HCl-Extractable Metals by ICPAES								
Aluminium	7429-90-5	50	mg/kg	----	**370**	----	----	----
Antimony	7440-36-0	1.0	mg/kg	----	<1.0	----	----	----
Arsenic	7440-38-2	1.0	mg/kg	----	<1.0	----	----	----
Cadmium	7440-43-9	0.1	mg/kg	----	<0.1	----	----	----
Cobalt	7440-48-4	0.5	mg/kg	----	**0.7**	----	----	----
Chromium	7440-47-3	1.0	mg/kg	----	<1.0	----	----	----
Copper	7440-50-8	1.0	mg/kg	----	**3.2**	----	----	----
Lead	7439-92-1	1.0	mg/kg	----	**5.0**	----	----	----
Manganese	7439-96-5	10	mg/kg	----	**16**	----	----	----
Nickel	7440-02-0	1.0	mg/kg	----	**1.6**	----	----	----
Silver	7440-22-4	1.0	mg/kg	----	<1.0	----	----	----
Zinc	7440-66-6	1.0	mg/kg	----	**7.0**	----	----	----
EG005(ED093)T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	----	**1500**	----	----	----
Antimony	7440-36-0	5	mg/kg	----	<5	----	----	----
Arsenic	7440-38-2	5	mg/kg	----	<5	----	----	----
Cadmium	7440-43-9	1	mg/kg	----	<1	----	----	----
Chromium	7440-47-3	2	mg/kg	----	<2	----	----	----
Cobalt	7440-48-4	2	mg/kg	----	<2	----	----	----
Copper	7440-50-8	5	mg/kg	----	**5**	----	----	----
Lead	7439-92-1	5	mg/kg	----	**6**	----	----	----
Manganese	7439-96-5	5	mg/kg	----	**23**	----	----	----
Nickel	7440-02-0	2	mg/kg	----	**3**	----	----	----
Silver	7440-22-4	2	mg/kg	----	<2	----	----	----
Zinc	7440-66-6	5	mg/kg	----	**16**	----	----	----
EG035-SDH: 1M HCl extractable Mercury by FIMS								
Mercury	7439-97-6	0.10	mg/kg	----	<0.10	----	----	----
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	----	<0.1	----	----	----
EK055: Ammonia as N								
Ammonia as N	7664-41-7	20	mg/kg	<20	----	----	----	----
EK057G: Nitrite as N by Discrete Analyser								

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			Sample ID	**GAP**	**GAP <2000µm**	**----**	**----**	**----**
			Sampling date / time	28-Mar-2022 15:00	28-Mar-2022 15:00	----	----	----
Compound	CAS Number	LOR	Unit	**ES2210874-001**	**ES2210874-002**	**--------**	**--------**	**--------**
				Result	Result	----	----	----
EK057G: Nitrite as N by Discrete Analyser - Continued								
Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg	<0.1	----	----	----	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N (Sol.)	14797-55-8	0.1	mg/kg	**0.1**	----	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	**0.1**	----	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	**1140**	----	----	----	----
EK062: Total Nitrogen as N (TKN + NOx)								
^ **Total Nitrogen as N**	----	20	mg/kg	**1140**	----	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	**128**	----	----	----	----
EP003: Total Organic Carbon (TOC) in Soil								
Total Organic Carbon	----	0.02	%	**3.42**	----	----	----	----
GEO26: Sieving								
-2000µm	----	0.01	%	----	**89.4**	----	----	----

Inter-Laboratory Testing

Analysis conducted by ALS Brisbane, NATA accreditation no. 825, site no. 818 (Chemistry) 18958 (Biology).

(SOIL) EP003: Total Organic Carbon (TOC) in Soil

(SOIL) GEO26: Sieving

(SOIL) EG005(ED093)-SDH: 1M HCl-Extractable Metals by ICPAES

(SOIL) EG035-SDH: 1M HCl extractable Mercury by FIMS

Analysis conducted by ALS Brisbane, NATA accreditation no. 825, site no. 818 (Chemistry) 18958 (Biology). Only applies to samples ES2210874 (002).

(SOIL) EG035T: Total Recoverable Mercury by FIMS

(SOIL) EG005(ED093)T: Total Metals by ICP-AES

Environmental

CERTIFICATE OF ANALYSIS

Work Order : **ES2211066**
Client : **GHD PTY LTD**
Contact : MS Tegan Hopwood
Address : PO BOX 5403
NEWCASTLE WEST NSW, AUSTRALIA 2302
Telephone : 02 4910 7760
Project : 12570462
Order number : AIRLY AUTUMN 2022
C-O-C number : ----
Sampler : TEGAN HOPWOOD
Site :
Quote number : EN/005
No. of samples received : 8
No. of samples analysed : 8

Page : 1 of 6
Laboratory : Environmental Division Sydney
Contact : Sarah Mathew
Address : 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone : +61-2-8784 8555
Date Samples Received : 30-Mar-2022 12:40
Date Analysis Commenced : 31-Mar-2022
Issue Date : 14-Apr-2022 21:34

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

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

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Senior Chemist - Inorganics	Sydney Inorganics, Smithfield, NSW
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Satishkumar Trivedi	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

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

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

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key :
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EG035-SDH (1M HCl Extractable Mercury) Sample (ES2211066_006) shows poor matrix spike recovery due to sample heterogeneity. Confirmed via visual inspection.
- EG005-SDH (1M HCl Extractable Metals): Some method blanks are above the limit of reporting but are not considered significant compared to the analyte levels in the sample.
- EG005T (Total Metals by ICP-AES): The high failing laboratory control standard is deemed acceptable as all results are less than the limit of reporting.
- EG005T (Total Metals by ICP-AES): EB2210018-004 shows poor duplicate results due to sample heterogeneity. This has been confirmed by visual inspection.
- EG005T (Total Metals by ICP-AES): EB2210018-008 shows poor matrix spike recovery due to sample heterogeneity. This has been confirmed by visual inspection.

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			*Sample ID*	**AIR**	**AIRUS**	**AIRD**	**DOG**	**AIR -2000um**
			Sampling date / time	29-Mar-2022 07:30	29-Mar-2022 10:30	29-Mar-2022 11:00	29-Mar-2022 15:00	29-Mar-2022 07:30
Compound	*CAS Number*	*LOR*	*Unit*	**ES2211066-001**	**ES2211066-002**	**ES2211066-003**	**ES2211066-004**	**ES2211066-005**
				Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	**55.5**	**77.9**	**77.1**	**29.8**	----
EG005(ED093)-SDH: 1M HCl-Extractable Metals by ICPAES								
Aluminium	7429-90-5	50	mg/kg	----	----	----	----	**620**
Antimony	7440-36-0	1.0	mg/kg	----	----	----	----	<1.0
Arsenic	7440-38-2	1.0	mg/kg	----	----	----	----	**1.6**
Cadmium	7440-43-9	0.1	mg/kg	----	----	----	----	<0.1
Cobalt	7440-48-4	0.5	mg/kg	----	----	----	----	**8.0**
Chromium	7440-47-3	1.0	mg/kg	----	----	----	----	<1.0
Copper	7440-50-8	1.0	mg/kg	----	----	----	----	**5.8**
Iron	7439-89-6	50	mg/kg	----	----	----	----	**3530**
Lead	7439-92-1	1.0	mg/kg	----	----	----	----	**7.6**
Manganese	7439-96-5	10	mg/kg	----	----	----	----	**1480**
Nickel	7440-02-0	1.0	mg/kg	----	----	----	----	**25.4**
Silver	7440-22-4	1.0	mg/kg	----	----	----	----	<1.0
Zinc	7440-66-6	1.0	mg/kg	----	----	----	----	**52.9**
EG005(ED093)T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	----	----	----	----	**1750**
Antimony	7440-36-0	5	mg/kg	----	----	----	----	<5
Cobalt	7440-48-4	2	mg/kg	----	----	----	----	**6**
Iron	7439-89-6	50	mg/kg	----	----	----	----	**15000**
Manganese	7439-96-5	5	mg/kg	----	----	----	----	**489**
Silver	7440-22-4	2	mg/kg	----	----	----	----	<2
Arsenic	7440-38-2	5	mg/kg	----	----	----	----	<5
Cadmium	7440-43-9	1	mg/kg	----	----	----	----	<1
Chromium	7440-47-3	2	mg/kg	----	----	----	----	**9**
Copper	7440-50-8	5	mg/kg	----	----	----	----	**5**
Lead	7439-92-1	5	mg/kg	----	----	----	----	**7**
Nickel	7440-02-0	2	mg/kg	----	----	----	----	**15**
Zinc	7440-66-6	5	mg/kg	----	----	----	----	**41**
EG035-SDH: 1M HCl extractable Mercury by FIMS								
Mercury	7439-97-6	0.10	mg/kg	----	----	----	----	<0.10
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	----	----	----	----	<0.1
EK055: Ammonia as N								

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			*Sample ID*	**AIR**	**AIRUS**	**AIRD**	**DOG**	**AIR -2000um**
			Sampling date / time	29-Mar-2022 07:30	29-Mar-2022 10:30	29-Mar-2022 11:00	29-Mar-2022 15:00	29-Mar-2022 07:30
Compound	*CAS Number*	*LOR*	*Unit*	**ES2211066-001**	**ES2211066-002**	**ES2211066-003**	**ES2211066-004**	**ES2211066-005**
				Result	Result	Result	Result	Result
EK055: Ammonia as N - Continued								
Ammonia as N	7664-41-7	20	mg/kg	<20	**40**	**20**	<20	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg	**0.1**	<0.1	<0.1	<0.1	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N (Sol.)	14797-55-8	0.1	mg/kg	**0.9**	**0.8**	**0.4**	**0.1**	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	**1.0**	**0.8**	**0.4**	**0.1**	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	**1960**	**9990**	**9900**	**740**	----
EK062: Total Nitrogen as N (TKN + NOx)								
^ **Total Nitrogen as N**	----	20	mg/kg	**1960**	**9990**	**9900**	**740**	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	**267**	**946**	**969**	**166**	----
EP003: Total Organic Carbon (TOC) in Soil								
Total Organic Carbon	----	0.02	%	**6.71**	**11.9**	**14.2**	**2.14**	----
GEO26: Sieving								
-2000µm	----	0.01	%	----	----	----	----	**66.8**

Analytical Results

Sub-Matrix: **SOIL**
(Matrix: **SOIL**)

			Sample ID	**AIRUS -2000um**	**AIRD -2000um**	**DOG -2000um**	**----**	**----**
			Sampling date / time	29-Mar-2022 10:30	29-Mar-2022 11:00	29-Mar-2022 03:00	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**ES2211066-006**	**ES2211066-007**	**ES2211066-008**	**--------**	**--------**
				Result	Result	Result	----	----
EG005(ED093)-SDH: 1M HCl-Extractable Metals by ICPAES								
Aluminium	7429-90-5	50	mg/kg	**990**	**1080**	**310**	----	----
Antimony	7440-36-0	1.0	mg/kg	<1.0	<1.0	<1.0	----	----
Arsenic	7440-38-2	1.0	mg/kg	**1.7**	**1.8**	<1.0	----	----
Cadmium	7440-43-9	0.1	mg/kg	**0.2**	**0.2**	<0.1	----	----
Cobalt	7440-48-4	0.5	mg/kg	**8.9**	**11.2**	**2.8**	----	----
Chromium	7440-47-3	1.0	mg/kg	<1.0	<1.0	<1.0	----	----
Copper	7440-50-8	1.0	mg/kg	**11.9**	**12.4**	**3.3**	----	----
Iron	7439-89-6	50	mg/kg	**4140**	**5750**	**970**	----	----
Lead	7439-92-1	1.0	mg/kg	**6.8**	**6.7**	**5.2**	----	----
Manganese	7439-96-5	10	mg/kg	**250**	**160**	**231**	----	----
Nickel	7440-02-0	1.0	mg/kg	**57.9**	**59.4**	**2.7**	----	----
Silver	7440-22-4	1.0	mg/kg	<1.0	<1.0	<1.0	----	----
Zinc	7440-66-6	1.0	mg/kg	**98.6**	**98.9**	**2.6**	----	----
EG005(ED093)T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	**820**	**1020**	**1240**	----	----
Antimony	7440-36-0	5	mg/kg	<5	<5	<5	----	----
Cobalt	7440-48-4	2	mg/kg	**3**	**4**	**3**	----	----
Iron	7439-89-6	50	mg/kg	**2090**	**2670**	**7070**	----	----
Manganese	7439-96-5	5	mg/kg	**103**	**43**	**230**	----	----
Silver	7440-22-4	2	mg/kg	<2	<2	<2	----	----
Arsenic	7440-38-2	5	mg/kg	<5	<5	<5	----	----
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	----	----
Chromium	7440-47-3	2	mg/kg	<2	**2**	**4**	----	----
Copper	7440-50-8	5	mg/kg	<5	<5	<5	----	----
Lead	7439-92-1	5	mg/kg	<5	<5	**5**	----	----
Nickel	7440-02-0	2	mg/kg	**15**	**22**	**6**	----	----
Zinc	7440-66-6	5	mg/kg	**25**	**32**	**13**	----	----
EG035-SDH: 1M HCl extractable Mercury by FIMS								
Mercury	7439-97-6	0.10	mg/kg	<0.10	<0.10	<0.10	----	----
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	----	----
GEO26: Sieving								
-2000µm	----	0.01	%	**70.9**	**75.2**	**96.6**	----	----

Inter-Laboratory Testing

Analysis conducted by ALS Brisbane, NATA accreditation no. 825, site no. 818 (Chemistry) 18958 (Biology).

(SOIL) EP003: Total Organic Carbon (TOC) in Soil

(SOIL) GEO26: Sieving

(SOIL) EG005(ED093)T: Total Metals by ICP-AES

(SOIL) EG035T: Total Recoverable Mercury by FIMS

(SOIL) EG005(ED093)-SDH: 1M HCl-Extractable Metals by ICPAES

(SOIL) EG035-SDH: 1M HCl extractable Mercury by FIMS

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order : **ES2211251**
Client : **GHD PTY LTD**
Contact : MS Tegan Hopwood
Address : Level 3, GHD Tower, 24 Honeysuckle Drive
Newcastle 2300
Telephone : 02 4910 7760
Project : 12570462
Order number : Airly autumn 2022
C-O-C number : ----
Sampler : Tegan Hopwood
Site :
Quote number : EN/005
No. of samples received : 2
No. of samples analysed : 2

Page : 1 of 4
Laboratory : Environmental Division Sydney
Contact : Sarah Mathew
Address : 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone : +61-2-8784 8555
Date Samples Received : 31-Mar-2022 10:15
Date Analysis Commenced : 01-Apr-2022
Issue Date : 14-Apr-2022 21:35

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

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

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Senior Chemist - Inorganics	Sydney Inorganics, Smithfield, NSW
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

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

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

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^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EG035-SDH (1M HCl Extractable Mercury) Sample (ES2211066_006) shows poor matrix spike recovery due to sample heterogeneity. Confirmed via visual inspection.
- EG005-SDH (1M HCl Extractable Metals): Some method blanks are above the limit of reporting but are not considered significant compared to the analyte levels in the sample.
- EG005T (Total Metals by ICP-AES): Some method blanks are above the limit of reporting but are not considered significant compared to the analyte levels in the sample.
- EG005T (Total Metals by ICP-AES): The high failing laboratory control standard is deemed acceptable as all results are less than the limit of reporting.
- EG005T (Total Metals by ICP-AES): EB2210018-004 shows poor duplicate results due to sample heterogeneity. This has been confirmed by visual inspection.
- EG005T (Total Metals by ICP-AES): EB2210018-008 shows poor matrix spike recovery due to sample heterogeneity. This has been confirmed by visual inspection.

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			*Sample ID*	**GRO**	**GRO -2000µm**	----	----	----
			Sampling date / time	30-Mar-2022 09:00	30-Mar-2022 09:00	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**ES2211251-001**	**ES2211251-002**	--------	--------	--------
				Result	Result	----	----	----
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	**22.5**	----	----	----	----
EG005(ED093)-SDH: 1M HCl-Extractable Metals by ICPAES								
Aluminium	7429-90-5	50	mg/kg	----	**180**	----	----	----
Antimony	7440-36-0	1.0	mg/kg	----	<1.0	----	----	----
Arsenic	7440-38-2	1.0	mg/kg	----	<1.0	----	----	----
Cadmium	7440-43-9	0.1	mg/kg	----	<0.1	----	----	----
Cobalt	7440-48-4	0.5	mg/kg	----	<0.5	----	----	----
Chromium	7440-47-3	1.0	mg/kg	----	<1.0	----	----	----
Copper	7440-50-8	1.0	mg/kg	----	<1.0	----	----	----
Lead	7439-92-1	1.0	mg/kg	----	<1.0	----	----	----
Manganese	7439-96-5	10	mg/kg	----	<10	----	----	----
Nickel	7440-02-0	1.0	mg/kg	----	<1.0	----	----	----
Silver	7440-22-4	1.0	mg/kg	----	<1.0	----	----	----
Zinc	7440-66-6	1.0	mg/kg	----	<1.0	----	----	----
EG005(ED093)T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	----	**400**	----	----	----
Antimony	7440-36-0	5	mg/kg	----	<5	----	----	----
Arsenic	7440-38-2	5	mg/kg	----	<5	----	----	----
Cadmium	7440-43-9	1	mg/kg	----	<1	----	----	----
Chromium	7440-47-3	2	mg/kg	----	<2	----	----	----
Cobalt	7440-48-4	2	mg/kg	----	<2	----	----	----
Copper	7440-50-8	5	mg/kg	----	<5	----	----	----
Lead	7439-92-1	5	mg/kg	----	<5	----	----	----
Manganese	7439-96-5	5	mg/kg	----	<5	----	----	----
Nickel	7440-02-0	2	mg/kg	----	<2	----	----	----
Silver	7440-22-4	2	mg/kg	----	<2	----	----	----
Zinc	7440-66-6	5	mg/kg	----	<5	----	----	----
EG035-SDH: 1M HCl extractable Mercury by FIMS								
Mercury	7439-97-6	0.10	mg/kg	----	<0.10	----	----	----
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	----	<0.1	----	----	----
EK055: Ammonia as N								
Ammonia as N	7664-41-7	20	mg/kg	<20	----	----	----	----
EK057G: Nitrite as N by Discrete Analyser								

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			*Sample ID*	**GRO**	**GRO** **-2000µm**	**----**	**----**	**----**
			Sampling date / time	30-Mar-2022 09:00	30-Mar-2022 09:00	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**ES2211251-001**	**ES2211251-002**	**--------**	**--------**	**--------**
				Result	Result	----	----	----
EK057G: Nitrite as N by Discrete Analyser - Continued								
Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg	<0.1	----	----	----	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N (Sol.)	14797-55-8	0.1	mg/kg	**0.2**	----	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	**0.2**	----	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	**60**	----	----	----	----
EK062: Total Nitrogen as N (TKN + NOx)								
^ **Total Nitrogen as N**	----	20	mg/kg	**60**	----	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	**47**	----	----	----	----
EP003: Total Organic Carbon (TOC) in Soil								
Total Organic Carbon	----	0.02	%	**0.09**	----	----	----	----
GEO26: Sieving								
-2000µm	----	0.01	%	----	**89.1**	----	----	----

Inter-Laboratory Testing

Analysis conducted by ALS Brisbane, NATA accreditation no. 825, site no. 818 (Chemistry) 18958 (Biology).

(SOIL) EG005(ED093)-SDH: 1M HCl-Extractable Metals by ICPAES

(SOIL) EG035-SDH: 1M HCl extractable Mercury by FIMS

(SOIL) EG005(ED093)T: Total Metals by ICP-AES

(SOIL) EG035T: Total Recoverable Mercury by FIMS

(SOIL) EP003: Total Organic Carbon (TOC) in Soil

(SOIL) GEO26: Sieving

CERTIFICATE OF ANALYSIS

Work Order	: **ES2211445**	Page	: 1 of 4
Client	: **GHD PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MS Tegan Hopwood	Contact	: Sarah Mathew
Address	: Level 3, GHD Tower, 24 Honeysuckle Drive Newcastle 2300	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: 02 4910 7760	Telephone	: +61-2-8784 8555
Project	: 12570462	Date Samples Received	: 01-Apr-2022 10:28
Order number	: Airly autumn 2022	Date Analysis Commenced	: 04-Apr-2022
C-O-C number	: ----	Issue Date	: 20-Apr-2022 16:52
Sampler	: Tegan Hopwood		
Site	:		
Quote number	: EN/005		
No. of samples received	: 4		
No. of samples analysed	: 4		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

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

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Senior Chemist - Inorganics	Sydney Inorganics, Smithfield, NSW
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

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

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

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EG005SDH (1M HCl Extractable Metals by ICP-AES): The high failing laboratory control standard is deemed acceptable as all results are less than the limit of reporting.
- EG005SDH (1M HCl Extractable Metals by ICP-AES): Some method blanks are above the limit of reporting but are not considered significant compared to the analyte levels in the sample.

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			*Sample ID*	**TOR**	**TOR <2000µm**	**GEN**	**GEN <2000µm**	**----**
			Sampling date / time	31-Mar-2022 11:00	31-Mar-2022 11:00	31-Mar-2022 15:30	31-Mar-2022 15:30	----
Compound	*CAS Number*	*LOR*	*Unit*	**ES2211445-001**	**ES2211445-002**	**ES2211445-003**	**ES2211445-004**	**--------**
				Result	Result	Result	Result	----
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	**20.2**	----	**20.7**	----	----
EG005(ED093)-SDH: 1M HCl-Extractable Metals by ICPAES								
Aluminium	7429-90-5	50	mg/kg	----	**290**	----	**220**	----
Antimony	7440-36-0	1.0	mg/kg	----	<1.0	----	<1.0	----
Arsenic	7440-38-2	1.0	mg/kg	----	<1.0	----	<1.0	----
Cadmium	7440-43-9	0.1	mg/kg	----	<0.1	----	<0.1	----
Cobalt	7440-48-4	0.5	mg/kg	----	**3.9**	----	**1.3**	----
Chromium	7440-47-3	1.0	mg/kg	----	<1.0	----	<1.0	----
Copper	7440-50-8	1.0	mg/kg	----	**1.5**	----	<1.0	----
Lead	7439-92-1	1.0	mg/kg	----	**4.1**	----	<1.0	----
Manganese	7439-96-5	10	mg/kg	----	**379**	----	**30**	----
Nickel	7440-02-0	1.0	mg/kg	----	**4.8**	----	<1.0	----
Silver	7440-22-4	1.0	mg/kg	----	<1.0	----	<1.0	----
Zinc	7440-66-6	1.0	mg/kg	----	**6.7**	----	**1.8**	----
EG005(ED093)T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	----	**2290**	----	**570**	----
Antimony	7440-36-0	5	mg/kg	----	<5	----	<5	----
Arsenic	7440-38-2	5	mg/kg	----	**5**	----	<5	----
Cadmium	7440-43-9	1	mg/kg	----	<1	----	<1	----
Chromium	7440-47-3	2	mg/kg	----	**7**	----	<2	----
Cobalt	7440-48-4	2	mg/kg	----	**8**	----	<2	----
Copper	7440-50-8	5	mg/kg	----	<5	----	<5	----
Lead	7439-92-1	5	mg/kg	----	**7**	----	<5	----
Manganese	7439-96-5	5	mg/kg	----	**841**	----	**41**	----
Nickel	7440-02-0	2	mg/kg	----	**14**	----	<2	----
Silver	7440-22-4	2	mg/kg	----	<2	----	<2	----
Zinc	7440-66-6	5	mg/kg	----	**28**	----	<5	----
EG035-SDH: 1M HCl extractable Mercury by FIMS								
Mercury	7439-97-6	0.10	mg/kg	----	<0.10	----	<0.10	----
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	----	<0.1	----	<0.1	----
EK055: Ammonia as N								
Ammonia as N	7664-41-7	20	mg/kg	<20	----	<20	----	----
EK057G: Nitrite as N by Discrete Analyser								

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			*Sample ID*	**TOR**	**TOR <2000µm**	**GEN**	**GEN <2000µm**	**----**
			Sampling date / time	31-Mar-2022 11:00	31-Mar-2022 11:00	31-Mar-2022 15:30	31-Mar-2022 15:30	----
Compound	*CAS Number*	*LOR*	*Unit*	**ES2211445-001**	**ES2211445-002**	**ES2211445-003**	**ES2211445-004**	**--------**
				Result	Result	Result	Result	----
EK057G: Nitrite as N by Discrete Analyser - Continued								
Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg	<0.1	**----**	<0.1	**----**	**----**
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N (Sol.)	14797-55-8	0.1	mg/kg	**0.2**	**----**	**0.2**	**----**	**----**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	**0.2**	**----**	**0.2**	**----**	**----**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	**170**	**----**	**130**	**----**	**----**
EK062: Total Nitrogen as N (TKN + NOx)								
^ **Total Nitrogen as N**	----	20	mg/kg	**170**	**----**	**130**	**----**	**----**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	**100**	**----**	**36**	**----**	**----**
EP003: Total Organic Carbon (TOC) in Soil								
Total Organic Carbon	----	0.02	%	**0.32**	**----**	**0.27**	**----**	**----**
GEO26: Sieving								
-2000µm	----	0.01	%	**----**	**67.3**	**----**	**99.6**	**----**

Inter-Laboratory Testing

Analysis conducted by ALS Brisbane, NATA accreditation no. 825, site no. 818 (Chemistry) 18958 (Biology).

(SOIL) EP003: Total Organic Carbon (TOC) in Soil

(SOIL) GEO26: Sieving

(SOIL) EG005(ED093)-SDH: 1M HCl-Extractable Metals by ICPAES

(SOIL) EG035T: Total Recoverable Mercury by FIMS

(SOIL) EG005(ED093)T: Total Metals by ICP-AES

(SOIL) EG035-SDH: 1M HCl extractable Mercury by FIMS

CERTIFICATE OF ANALYSIS

Work Order : **ES2244094**
Amendment : **3**
Client : **GHD PTY LTD**
Contact : MS Tegan Hopwood
Address : Level 3, GHD Tower, 24 Honeysuckle Drive
Newcastle 2300
Telephone : 02 4910 7760
Project : 12570462
Order number : Airly sediment 2022
C-O-C number : ----
Sampler : Tegan Hopwood
Site :
Quote number : EN/005
No. of samples received : 16
No. of samples analysed : 16

Page : 1 of 9
Laboratory : Environmental Division Sydney
Contact : Sarah Mathew
Address : 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone : +61-2-8784 8555
Date Samples Received : 07-Dec-2022 10:00
Date Analysis Commenced : 12-Dec-2022
Issue Date : 28-Feb-2023 21:32

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

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- Analytical Results

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Signatories

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

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Senior Chemist - Inorganics	Sydney Inorganics, Smithfield, NSW
Beatriz Llarinas	Senior Chemist - Inorganics	Brisbane Inorganics, Stafford, QLD
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Franco Lentini	LCMS Coordinator	Sydney Inorganics, Smithfield, NSW
Kim McCabe	Senior Inorganic Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Wisam Marassa	Inorganics Coordinator	Sydney Inorganics, Smithfield, NSW

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LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- Amendment (16/02/23): This report has been amended and re-released to allow the reporting of additional analytical data, specifically method (Al, Co and Mn analysis added to sample 9-16.
- Amendment (28/02/2023): This report has been amended and re-released to allow the reporting of additional analytical data, specifically method EG005-SDH: Al, Mn, Co for Sample ES2244094-009 to -016.
- Amendment (29/12/22):This report has been amended to added EG005T to sample 9 to 16
- EG005T (Total Metals by ICP-AES): EB2238813-001 shows poor duplicate results due to sample heterogeneity. This has been confirmed by visual inspection.
- EG005T (Total Metals by ICP-AES): DOG (ES2244094-011) shows poor duplicate results due to sample heterogeneity. This has been confirmed by visual inspection.

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			*Sample ID*	**GEN**	**GRO**	**DOG**	**GAP**	**AIR**
			Sampling date / time	05-Dec-2022 00:00	05-Dec-2022 00:00	06-Dec-2022 00:00	06-Dec-2022 00:00	06-Dec-2022 00:00
Compound	*CAS Number*	*LOR*	*Unit*	**ES2244094-001**	**ES2244094-002**	**ES2244094-003**	**ES2244094-004**	**ES2244094-005**
				Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	**30.7**	**18.2**	**26.8**	**25.0**	**26.0**
EG005(ED093)T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	**3020**	**300**	**3220**	**2080**	**7880**
Antimony	7440-36-0	5	mg/kg	<5	<5	<5	<5	<5
Arsenic	7440-38-2	5	mg/kg	<5	<5	**6**	<5	**12**
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg	**2**	<2	**7**	**3**	**27**
Cobalt	7440-48-4	2	mg/kg	**5**	<2	**5**	**2**	**6**
Copper	7440-50-8	5	mg/kg	<5	<5	**6**	<5	**27**
Lead	7439-92-1	5	mg/kg	**5**	<5	**9**	**6**	**32**
Manganese	7439-96-5	5	mg/kg	**62**	<5	**296**	**79**	**714**
Nickel	7440-02-0	2	mg/kg	**3**	<2	**10**	**3**	**65**
Silver	7440-22-4	2	mg/kg	<2	<2	<2	<2	<2
Zinc	7440-66-6	5	mg/kg	**14**	<5	**21**	**16**	**68**
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
EK055: Ammonia as N								
Ammonia as N	7664-41-7	20	mg/kg	<20	<20	<20	<20	<20
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N (Sol.)	14797-55-8	0.1	mg/kg	**0.2**	**0.1**	<0.1	<0.1	**0.2**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	**0.2**	**0.1**	<0.1	<0.1	**0.2**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	**730**	**60**	**730**	**460**	**540**
EK062: Total Nitrogen as N (TKN + NOx)								
^ **Total Nitrogen as N**	----	20	mg/kg	**730**	**60**	**730**	**460**	**540**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	**82**	**17**	**168**	**76**	**174**
EP003: Total Organic Carbon (TOC) in Soil								
Total Organic Carbon	----	0.02	%	**4.80**	**0.16**	**1.24**	**1.52**	**0.98**

Analytical Results

Sub-Matrix: **SOIL**
(Matrix: **SOIL**)

			Sample ID	**AIRUS**	**TOR**	**AIRD**	**GEN -2000µ**	**GRO -2000µ**
			Sampling date / time	06-Dec-2022 00:00	06-Dec-2022 00:00	06-Dec-2022 00:00	05-Dec-2022 00:00	05-Dec-2022 00:00
Compound	*CAS Number*	*LOR*	*Unit*	**ES2244094-006**	**ES2244094-007**	**ES2244094-008**	**ES2244094-009**	**ES2244094-010**
				Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	**72.0**	**39.8**	**22.0**	----	----
EG005(ED093)-SD: Total Metals in Sediments by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	----	----	----	**2100**	**210**
EG005(ED093)-SDH: 1M HCl-Extractable Metals by ICPAES								
Aluminium	7429-90-5	50	mg/kg	----	----	----	**1050**	**90**
Antimony	7440-36-0	1.0	mg/kg	----	----	----	**1.3**	<1.0
Arsenic	7440-38-2	1.0	mg/kg	----	----	----	<1.0	<1.0
Cadmium	7440-43-9	0.1	mg/kg	----	----	----	<0.1	<0.1
Cobalt	7440-48-4	0.5	mg/kg	----	----	----	**2.7**	<0.5
Chromium	7440-47-3	1.0	mg/kg	----	----	----	<1.0	<1.0
Copper	7440-50-8	1.0	mg/kg	----	----	----	**3.0**	<1.0
Lead	7439-92-1	1.0	mg/kg	----	----	----	**3.1**	<1.0
Manganese	7439-96-5	10	mg/kg	----	----	----	**42**	<10
Nickel	7440-02-0	1.0	mg/kg	----	----	----	**1.7**	<1.0
Silver	7440-22-4	1.0	mg/kg	----	----	----	<1.0	<1.0
Zinc	7440-66-6	1.0	mg/kg	----	----	----	**9.1**	<1.0
EG005(ED093)T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	**8250**	**3610**	**2770**	**2170**	**240**
Antimony	7440-36-0	5	mg/kg	<5	<5	<5	<5	<5
Arsenic	7440-38-2	5	mg/kg	**6**	**7**	**5**	<5	<5
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg	**14**	**9**	**6**	**2**	<2
Cobalt	7440-48-4	2	mg/kg	**16**	**8**	**4**	**4**	<2
Copper	7440-50-8	5	mg/kg	**16**	**14**	**6**	<5	<5
Lead	7439-92-1	5	mg/kg	**12**	**19**	**8**	<5	<5
Manganese	7439-96-5	5	mg/kg	**1020**	**248**	**128**	**52**	<5
Nickel	7440-02-0	2	mg/kg	**53**	**26**	**8**	**2**	<2
Silver	7440-22-4	2	mg/kg	<2	<2	<2	<2	<2
Zinc	7440-66-6	5	mg/kg	**118**	**50**	**19**	**12**	<5
EG020-SD: Total Metals in Sediments by ICPMS								
Cobalt	7440-48-4	0.5	mg/kg	----	----	----	**3.4**	<0.5
Manganese	7439-96-5	10	mg/kg	----	----	----	**50**	<10
EG035-SDH: 1M HCl extractable Mercury by FIMS								
Mercury	7439-97-6	0.10	mg/kg	----	----	----	<0.10	<0.10

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			*Sample ID*	**AIRUS**	**TOR**	**AIRD**	**GEN -2000µ**	**GRO -2000µ**
			Sampling date / time	06-Dec-2022 00:00	06-Dec-2022 00:00	06-Dec-2022 00:00	05-Dec-2022 00:00	05-Dec-2022 00:00
Compound	*CAS Number*	*LOR*	*Unit*	**ES2244094-006**	**ES2244094-007**	**ES2244094-008**	**ES2244094-009**	**ES2244094-010**
				Result	Result	Result	Result	Result
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
EK055: Ammonia as N								
Ammonia as N	7664-41-7	20	mg/kg	<20	<20	<20	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg	<0.1	<0.1	<0.1	----	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N (Sol.)	14797-55-8	0.1	mg/kg	<0.1	**0.2**	<0.1	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	<0.1	**0.2**	<0.1	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	**9660**	**1370**	**530**	----	----
EK062: Total Nitrogen as N (TKN + NOx)								
^ **Total Nitrogen as N**	----	20	mg/kg	**9660**	**1370**	**530**	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	**771**	**242**	**149**	----	----
EP003: Total Organic Carbon (TOC) in Soil								
Total Organic Carbon	----	0.02	%	**8.38**	**3.27**	**1.55**	----	----
GEO26: Sieving								
-2000µm	----	0.01	%	----	----	----	**95.4**	**77.4**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			*Sample ID*	**DOG -2000µ**	**GAP -2000µ**	**AIR -2000µ**	**AIRUS -2000µ**	**TOR -2000µ**
			Sampling date / time	06-Dec-2022 00:00	06-Dec-2022 00:00	06-Dec-2022 00:00	06-Dec-2022 00:00	06-Dec-2022 00:00
Compound	*CAS Number*	*LOR*	*Unit*	**ES2244094-011**	**ES2244094-012**	**ES2244094-013**	**ES2244094-014**	**ES2244094-015**
				Result	Result	Result	Result	Result
EG005(ED093)-SD: Total Metals in Sediments by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	**2140**	**1880**	**6020**	**8880**	**2930**
EG005(ED093)-SDH: 1M HCl-Extractable Metals by ICPAES								
Aluminium	7429-90-5	50	mg/kg	**420**	**430**	**1420**	**3120**	**740**
Antimony	7440-36-0	1.0	mg/kg	<1.0	<1.0	<1.0	<1.0	<1.0
Arsenic	7440-38-2	1.0	mg/kg	**1.5**	**1.2**	**2.2**	**8.4**	**3.2**
Cadmium	7440-43-9	0.1	mg/kg	**0.1**	<0.1	**0.3**	**1.5**	**0.3**
Cobalt	7440-48-4	0.5	mg/kg	**3.3**	**1.5**	**4.6**	**19.3**	**5.8**
Chromium	7440-47-3	1.0	mg/kg	<1.0	<1.0	**1.1**	**1.5**	<1.0
Copper	7440-50-8	1.0	mg/kg	**4.7**	**4.6**	**15.1**	**25.9**	**11.4**
Lead	7439-92-1	1.0	mg/kg	**6.5**	**6.6**	**16.9**	**16.6**	**15.2**
Manganese	7439-96-5	10	mg/kg	**121**	**60**	**454**	**1380**	**183**
Nickel	7440-02-0	1.0	mg/kg	**3.5**	**1.8**	**16.4**	**65.3**	**14.2**
Silver	7440-22-4	1.0	mg/kg	<1.0	<1.0	<1.0	<1.0	<1.0
Zinc	7440-66-6	1.0	mg/kg	**5.8**	**10.3**	**42.8**	**202**	**29.1**
EG005(ED093)T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	**1730**	**1510**	**5880**	**10800**	**3370**
Antimony	7440-36-0	5	mg/kg	<5	<5	<5	<5	<5
Arsenic	7440-38-2	5	mg/kg	**7**	<5	**11**	**14**	**10**
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	**1**	<1
Chromium	7440-47-3	2	mg/kg	**6**	**3**	**16**	**25**	**12**
Cobalt	7440-48-4	2	mg/kg	**4**	**2**	**9**	**27**	**10**
Copper	7440-50-8	5	mg/kg	**7**	**6**	**19**	**32**	**16**
Lead	7439-92-1	5	mg/kg	**8**	**8**	**20**	**22**	**20**
Manganese	7439-96-5	5	mg/kg	**121**	**104**	**453**	**1410**	**242**
Nickel	7440-02-0	2	mg/kg	**8**	**3**	**30**	**84**	**27**
Silver	7440-22-4	2	mg/kg	<2	<2	<2	<2	<2
Zinc	7440-66-6	5	mg/kg	**20**	**16**	**103**	**229**	**60**
EG020-SD: Total Metals in Sediments by ICPMS								
Cobalt	7440-48-4	0.5	mg/kg	**4.2**	**1.8**	**9.4**	**23.3**	**9.8**
Manganese	7439-96-5	10	mg/kg	**110**	**61**	**491**	**1230**	**218**
EG035-SDH: 1M HCl extractable Mercury by FIMS								
Mercury	7439-97-6	0.10	mg/kg	<0.10	<0.10	<0.10	<0.10	<0.10
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	**0.1**	<0.1

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			*Sample ID*	**DOG -2000µ**	**GAP -2000µ**	**AIR -2000µ**	**AIRUS -2000µ**	**TOR -2000µ**
			Sampling date / time	06-Dec-2022 00:00	06-Dec-2022 00:00	06-Dec-2022 00:00	06-Dec-2022 00:00	06-Dec-2022 00:00
Compound	*CAS Number*	*LOR*	*Unit*	**ES2244094-011**	**ES2244094-012**	**ES2244094-013**	**ES2244094-014**	**ES2244094-015**
				Result	Result	Result	Result	Result
GEO26: Sieving								
-2000µm	----	0.01	%	**95.8**	**73.7**	**26.3**	**90.4**	**95.0**

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			*Sample ID*	**AIRD -2000μ**	----	----	----	----
			Sampling date / time	06-Dec-2022 00:00	----	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**ES2244094-016**	--------	--------	--------	--------
				Result	----	----	----	----
EG005(ED093)-SD: Total Metals in Sediments by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	**2630**	----	----	----	----
EG005(ED093)-SDH: 1M HCl-Extractable Metals by ICPAES								
Aluminium	7429-90-5	50	mg/kg	**610**	----	----	----	----
Antimony	7440-36-0	1.0	mg/kg	<1.0	----	----	----	----
Arsenic	7440-38-2	1.0	mg/kg	**2.5**	----	----	----	----
Cadmium	7440-43-9	0.1	mg/kg	**0.2**	----	----	----	----
Cobalt	7440-48-4	0.5	mg/kg	**3.8**	----	----	----	----
Chromium	7440-47-3	1.0	mg/kg	**1.4**	----	----	----	----
Copper	7440-50-8	1.0	mg/kg	**6.6**	----	----	----	----
Lead	7439-92-1	1.0	mg/kg	**8.4**	----	----	----	----
Manganese	7439-96-5	10	mg/kg	**182**	----	----	----	----
Nickel	7440-02-0	1.0	mg/kg	**4.7**	----	----	----	----
Silver	7440-22-4	1.0	mg/kg	<1.0	----	----	----	----
Zinc	7440-66-6	1.0	mg/kg	**11.5**	----	----	----	----
EG005(ED093)T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	**2730**	----	----	----	----
Antimony	7440-36-0	5	mg/kg	<5	----	----	----	----
Arsenic	7440-38-2	5	mg/kg	**10**	----	----	----	----
Cadmium	7440-43-9	1	mg/kg	<1	----	----	----	----
Chromium	7440-47-3	2	mg/kg	**9**	----	----	----	----
Cobalt	7440-48-4	2	mg/kg	**6**	----	----	----	----
Copper	7440-50-8	5	mg/kg	**10**	----	----	----	----
Lead	7439-92-1	5	mg/kg	**11**	----	----	----	----
Manganese	7439-96-5	5	mg/kg	**240**	----	----	----	----
Nickel	7440-02-0	2	mg/kg	**12**	----	----	----	----
Silver	7440-22-4	2	mg/kg	<2	----	----	----	----
Zinc	7440-66-6	5	mg/kg	**33**	----	----	----	----
EG020-SD: Total Metals in Sediments by ICPMS								
Cobalt	7440-48-4	0.5	mg/kg	**7.0**	----	----	----	----
Manganese	7439-96-5	10	mg/kg	**280**	----	----	----	----
EG035-SDH: 1M HCl extractable Mercury by FIMS								
Mercury	7439-97-6	0.10	mg/kg	<0.10	----	----	----	----
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	----	----	----	----

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL)**			Sample ID	**AIRD** **-2000µ**	**----**	**----**	**----**	**----**
			Sampling date / time	06-Dec-2022 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit	**ES2244094-016**	**--------**	**--------**	**--------**	**--------**
				Result	----	----	----	----
GEO26: Sieving								
-2000µm	----	0.01	%	**93.4**	**----**	**----**	**----**	**----**

Inter-Laboratory Testing

Analysis conducted by ALS Brisbane, NATA accreditation no. 825, site no. 818 (Chemistry) 18958 (Biology).

(SOIL) EP003: Total Organic Carbon (TOC) in Soil

(SOIL) GEO26: Sieving

(SOIL) EG005(ED093)-SDH: 1M HCl-Extractable Metals by ICPAES

(SOIL) EG035-SDH: 1M HCl extractable Mercury by FIMS

(SOIL) EG020-SD: Total Metals in Sediments by ICPMS

(SOIL) EG005(ED093)-SD: Total Metals in Sediments by ICP-AES

Analysis conducted by ALS Brisbane, NATA accreditation no. 825, site no. 818 (Chemistry) 18958 (Biology). Only applies to samples ES2244094 (009, 010, 011, 012, 013, 014, 015, 016).

(SOIL) EG035T: Total Recoverable Mercury by FIMS

(SOIL) EG005(ED093)T: Total Metals by ICP-AES

Appendix C

Raw macroinvertebrate data

Autumn 2022

Class/Order	Lowest taxon	SIGNAL-2	Baseline						Headwaters undermined				Background		Impact	
			DOG		GEN		GRO		GAP		TOR		AIRUS		AIR	
			1	2	1	2	1	2	1	2	1	2	1	2	1	2
Acarina	Acarina sp.	6	1			1									1	1
Coleoptera	Dytiscidae	2	7	3	5	6		1	2	2	7	6	1	1	3	1
Coleoptera	Gyrinidae	4		1							1	2				
Coleoptera	Haliplidae	2											1			
Coleoptera	Hydraenidae	3				2										
Coleoptera	Hydrophilidae	2	4	2												
Coleoptera	Scirtidae	6			3	2	5	5	3	2				1	5	6
Crustacea	Copepoda sp.						1					1			1	
Crustacea	Ostracoda sp.		4	9	1				4	2	1	4	7	1	2	6
Decapoda	Parastacidae	4													1	
Diptera	Athericidae	8						1								
Diptera	Ceratopogonidae	4	1	1			1	2			1	1			1	1
Diptera	Chironominae	3	1		5	5	10	2	9	5	7	8	5	2	14	10
Diptera	Culicidae	1									2		1			1
Diptera	Dixidae	7									2	1		1	3	2
Diptera	Orthocladiinae	4				1		2		1	1		6	4	5	2
Diptera	Simuliidae	5									2		1		1	1
Diptera	Stratiomyidae	2	3	3							1	2	1	3	3	6
Diptera	Tanypodinae	4	2		3	3	6	8	9	7		1	1		1	
Diptera	Tipulidae	5				1	1	1		2						1
Ephemeroptera	Baetidae	5	4	2					3	2	9	3	8	2	12	6
Ephemeroptera	Caenidae	4								1			1		3	

Class/Order	Lowest taxon	SIGNAL-2	Baseline						Headwaters undermined				Background		Impact	
			DOG		GEN		GRO		GAP		TOR		AIRUS		AIR	
			1	2	1	2	1	2	1	2	1	2	1	2	1	2
Ephemeroptera	Leptophlebiidae	8	4	1	9	8			3	4						
Gastropoda	Ancylidae	4	1	2									4	2		
Gastropoda	Gastropoda sp.												2	2		1
Gastropoda	Lymnaeidae	1												1	1	
Gastropoda	Physidae	1									2					
Gastropoda	Planorbidae	2				1					1	3	6		2	1
Hemiptera	Gerridae	4										1				
Hemiptera	Hemiptera sp.											1				
Hemiptera	Hydrometridae	3		1											1	2
Hemiptera	Micronectidae	2	1	1	1							2		1	5	6
Hemiptera	Notonectidae	1	1	2	1	1			1		2	4			1	1
Hemiptera	Veliidae	3	1	1	6	2	2		1		4	3	1		3	3
Mecoptera	Nannochoristidae	9					1									
Megaloptera	Corydalidae	7			2	4		1	1		1					
Odonata	Aeshnidae	4	1	3							1	2	1	2	5	3
Odonata	Corduliidae	5									2			2		
Odonata	Epiprocta sp.		7	4	1					2		2	10	3	1	1
Odonata	Libellulidae	4	1	2												
Odonata	Synthemistidae	2				1										
Odonata	Telephlebiidae	9			4	2										
Odonata	Argiolestidae	5				1										
Odonata	Coenagrionidae	2	1	2					1		3	2	2	3	2	4
Odonata	Lestidae	1		1												
Odonata	Zygoptera sp.		6	2					1				5	7	2	4

Class/Order	Lowest taxon	SIGNAL-2	Baseline						Headwaters undermined				Background		Impact	
			DOG		GEN		GRO		GAP		TOR		AIRUS		AIR	
			1	2	1	2	1	2	1	2	1	2	1	2	1	2
Oligochaeta	Oligochaeta sp.	2		2									1		1	
Plecoptera	Notonemouridae	6			1										1	
Trichoptera	Calamoceratidae	7					1									
Trichoptera	Ecnomidae	4										1				1
Trichoptera	Helicopsychidae	8			1	2			1	2						
Trichoptera	Hydrobiosidae	8			3				2	1	1				2	
Trichoptera	Hydropsychidae	6													1	
Trichoptera	Hydroptilidae	4	1	1	1	1					1				1	3
Trichoptera	Leptoceridae	6	2	3	8	5	7	3	5	3	6	3	8	9	5	5
Trichoptera	Polycentropodidae	7				1				1						
Trichoptera	Trichoptera sp.					1							1		1	
Turbellaria	Dugesiidae	2	4	6		1	1		2					1		

Spring 2022

Class/Order	Lowest taxon	SIGNAL-2	Baseline						Headwaters undermined				Background		Impact	
			DOG		GEN		GRO		GAP		TOR		AIRUS		AIR	
			1	2	1	2	1	2	1	2	1	2	1	2	1	2
Acarina	Acarina sp.		1							1			1			
Coleoptera	Dytiscidae	2	2	2	2	5	4	5	4	1	5	5	4	3	7	5
Coleoptera	Gyrinidae	4	1						2	1	1	2				1
Coleoptera	Hydraenidae	3								1			1	1		
Coleoptera	Hydrophilidae	2	1	3					1	1		1	1	1	1	
Coleoptera	Scirtidae	6			2	2	4		1	2		1			2	
Crustacea	Cladocera sp.									1						

Class/Order	Lowest taxon	SIGNAL-2	Baseline						Headwaters undermined				Background		Impact	
			DOG		GEN		GRO		GAP		TOR		AIRUS		AIR	
			1	2	1	2	1	2	1	2	1	2	1	2	1	2
Crustacea	Copepoda sp.				1	1	2	1							2	1
Crustacea	Ostracoda sp.		2	5					3	3			4	7	5	5
Decapoda	Parastacidae	4														1
Diptera	Athericidae	8			1	1										
Diptera	Ceratopogonidae	4				1	1	2		2			1			1
Diptera	Chironomidae sp.	3					1			2						
Diptera	Chironominae	3	1		10	6	21	1	7	6	15	13	11	8	6	8
Diptera	Culicidae	1											1	3	2	
Diptera	Dixidae	7	3						1				1	3	2	1
Diptera	Orthocladiinae	4		1	3	7	7	4	2	3	2	4	3	2		1
Diptera	Podonominae	6					1									
Diptera	Simuliidae	5								1			1			
Diptera	Stratiomyidae	2		1												
Diptera	Tanypodinae	4	2	2	10	9	5	8	11	13	3	3		3	5	1
Diptera	Tipulidae	5			3	1									1	
Ephemeroptera	Baetidae	5	3	5						1	2	4	3	4		2
Ephemeroptera	Caenidae	4									1	1	1			1
Ephemeroptera	Leptophlebiidae	8	2	2	6	6			6	3	1	1	1	2	3	2
Gastropoda	Ancylidae	4	2	3												
Gastropoda	Gastropoda sp.			1							1	3	1			
Gastropoda	Physidae	1		1							2	4	1	3	1	3
Gastropoda	Planorbidae	2		2							3		1			
Hemiptera	Corixidae	2	2	3										3	1	
Hemiptera	Hydrometridae	3		1								1				

Class/Order	Lowest taxon	SIGNAL-2	Baseline						Headwaters undermined				Background		Impact	
			DOG		GEN		GRO		GAP		TOR		AIRUS		AIR	
			1	2	1	2	1	2	1	2	1	2	1	2	1	2
Hemiptera	Micronectidae											1	1		3	3
Hemiptera	Notonectidae	1	2	1	2				1	1	3	3			1	2
Hemiptera	Veliidae	3	2	5	1	2	1	2	2	5		4	2	4	3	1
Hirudinea	Hirudinidae	4													1	
Mecoptera	Nannochoristidae	9						1								
Megaloptera	Corydalidae	7				1		1		1						
Odonata	Aeshnidae	4		1								1	2	2	1	1
Odonata	Corduliidae	5		1	3		2				1	1	1			1
Odonata	Epiprocta sp.		1	2	1	1						1	2	2	2	2
Odonata	Gomphidae	5	1													
Odonata	Telephlebiidae	9			4	3	3	2	3	5						
Odonata	Argiolestidae	5			1										1	
Odonata	Coenagrionidae	2	3	4							2	2	1	4	2	1
Odonata	Synlestidae	7										1				
Odonata	Zygoptera sp.											1		1	1	
Oligochaeta	Oligochaeta sp.						1									
Plecoptera	Gripopterygidae	8			1											
Plecoptera	Notonemouridae	6						1			1		3			
Trichoptera	Calamoceratidae	7	3													
Trichoptera	Ecnomidae	4	1										1		2	
Trichoptera	Helicopsychidae	8			1	1										
Trichoptera	Hydrobiosidae	8	3			2	2		8	4			1			
Trichoptera	Hydroptilidae	4	2	5							2		1		3	2
Trichoptera	Leptoceridae	6	3	3	6	5	6	2	3	7	4	8	5	2	3	1

Class/Order	Lowest taxon	SIGNAL-2	Baseline						Headwaters undermined				Background		Impact	
			DOG		GEN		GRO		GAP		TOR		AIRUS		AIR	
			1	2	1	2	1	2	1	2	1	2	1	2	1	2
Trichoptera	Polycentropodidae	7			1											
Trichoptera	Trichoptera sp.				6	3	2		1	6	1	1			3	3
Turbellaria	Dugesiidae	2	2	1		1	1				4	2			1	1

Appendix D

Water quality QA

Autumn 2022 (29 March 2022)

Analyte	Units	LOR	AIRUS	Duplicate
Physicochemical parameters				
TDS	mg/L	1	871	871
TSS	mg/L	5	7	6
Turbidity	NTU	0.1	2.7	3
Total hardness	mg/L	1	681	681
Major ions				
Bicarbonate Alkalinity as $CaCO_3$	mg/L	1	157	139
Carbonate Alkalinity as $CaCO_3$	mg/L	1	<1	<1
Hydroxide Alkalinity as $CaCO_3$	mg/L	1	<1	<1
Total Alkalinity as $CaCO_3$	mg/L	1	157	139
Sulfate as SO_4 - Turbidimetric	mg/L	1	601	612
Chloride	mg/L	1	29	30
Calcium	mg/L	1	111	111
Magnesium	mg/L	1	98	98
Potassium	mg/L	1	6	6
Sodium	mg/L	1	38	37
Dissolved metals				
Aluminium	mg/L	0.01	0.02	0.02
Arsenic	mg/L	0.0002	0.0006	0.0006
Boron	mg/L	0.05	<0.05	<0.05
Cadmium	mg/L	0.00005	<0.00005	<0.00005
Chromium	mg/L	0.0002	0.0005	0.0002
Cobalt	mg/L	0.001	<0.001	<0.001
Copper	mg/L	0.001	<0.001	<0.001
Iron	mg/L	0.05	0.1	0.09
Lead	mg/L	0.001	<0.001	<0.001
Manganese	mg/L	0.001	0.054	0.055
Mercury	mg/L	0.00004	<0.00004	<0.00004
Nickel	mg/L	0.001	0.006	0.006
Selenium	mg/L	0.0002	<0.0002	<0.0002
Silver	mg/L	0.0001	<0.0001	<0.0001
Zinc	mg/L	0.001	0.003	0.001
Total metals				
Aluminium	mg/L	0.01	0.06	0.07
Arsenic	mg/L	0.0002	0.0008	0.0008
Boron	mg/L	0.05	<0.05	<0.05
Cadmium	mg/L	0.00005	<0.00005	<0.00005
Chromium	mg/L	0.0002	0.0003	0.0003
Cobalt	mg/L	0.001	<0.001	<0.001

Analyte	Units	LOR	AIRUS	Duplicate
Copper	mg/L	0.001	0.002	<0.001
Iron	mg/L	0.05	0.16	0.15
Lead	mg/L	0.001	<0.001	<0.001
Manganese	mg/L	0.001	0.055	0.058
Mercury	mg/L	0.00004	<0.00004	<0.00004
Nickel	mg/L	0.001	0.007	0.007
Selenium	mg/L	0.0002	<0.0002	<0.0002
Silver	mg/L	0.0001	<0.0001	<0.0001
Zinc	mg/L	0.001	0.002	0.003
Nutrients				
Ammonia as N	mg/L	0.01	<0.01	<0.01
Nitrite as N	mg/L	0.01	<0.01	<0.01
Nitrate as N	mg/L	0.01	<0.01	0.02
NO_x	mg/L	0.01	<0.01	0.02
TKN	mg/L	0.1	0.9	0.8
TN	mg/L	0.1	0.9	0.8
TP	mg/L	0.01	0.01	0.02
RP	mg/L	0.01	<0.01	<0.01
Other parameters				
DOC	mg/L	1	17	17
Oil & Grease	mg/L	5	<5	<5
Fluoride	mg/L	0.1	0.2	0.2

Spring 2022 (6 December 2022)

Analyte	Units	LOR	DOG	Duplicate
Physicochemical parameters				
TDS	mg/L	1	728	715
TSS	mg/L	1	8	4
Turbidity	NTU	0.1	0.5	0.4
Total Hardness as $CaCO_3$	mg/L	1	570	597
Major ions				
Bicarbonate Alkalinity as $CaCO_3$	mg/L	1	352	357
Carbonate Alkalinity as $CaCO_3$	mg/L	1	<1	<1
Hydroxide Alkalinity as $CaCO_3$	mg/L	1	<1	<1
Total Alkalinity as $CaCO_3$	mg/L	1	352	357
Sulfate as SO_4 - Turbidimetric	mg/L	1	291	295
Chloride	mg/L	1	44	44
Calcium	mg/L	1	126	132
Magnesium	mg/L	1	62	65
Potassium	mg/L	1	2	2
Sodium	mg/L	1	49	51

Analyte	Units	LOR	DOG	Duplicate
Dissolved metals				
Aluminium	mg/L	0.01	<0.01	<0.01
Arsenic	mg/L	0.0002	0.0003	0.0003
Boron	mg/L	0.05	<0.05	<0.05
Cadmium	mg/L	0.00005	<0.00005	<0.00005
Chromium	mg/L	0.0002	<0.0002	<0.0002
Cobalt	mg/L	0.001	<0.001	<0.001
Copper	mg/L	0.001	<0.001	<0.001
Iron	mg/L	0.05	<0.05	<0.05
Lead	mg/L	0.001	<0.001	<0.001
Manganese	mg/L	0.001	0.011	0.011
Mercury	mg/L	0.00004	<0.00004	<0.00004
Nickel	mg/L	0.001	<0.001	<0.001
Selenium	mg/L	0.0002	0.0004	0.0004
Silver	mg/L	0.0001	<0.0001	<0.0001
Zinc	mg/L	0.001	0.001	0.003
Total metals				
Aluminium	mg/L	0.01	0.02	<0.01
Arsenic	mg/L	0.0002	0.0004	0.0005
Boron	mg/L	0.05	<0.05	<0.05
Cadmium	mg/L	0.00005	<0.00005	<0.00005
Chromium	mg/L	0.0002	<0.0002	<0.0002
Cobalt	mg/L	0.001	<0.001	<0.001
Copper	mg/L	0.001	<0.001	<0.001
Iron	mg/L	0.05	0.06	<0.05
Lead	mg/L	0.001	<0.001	<0.001
Manganese	mg/L	0.001	0.02	0.012
Mercury	mg/L	0.00004	<0.00004	<0.00004
Nickel	mg/L	0.001	<0.001	<0.001
Selenium	mg/L	0.0002	0.0004	0.0005
Silver	mg/L	0.0001	<0.0001	<0.0001
Zinc	mg/L	0.001	0.001	0.004
Nutrients				
Ammonia as N	mg/L	0.01	<0.01	<0.01
Nitrite as N	mg/L	0.01	<0.01	<0.01
Nitrate as N	mg/L	0.01	0.04	0.04
NO_x	mg/L	0.01	0.04	0.04
TKN	mg/L	0.1	0.1	0.1
TN	mg/L	0.1	0.1	0.1
TP	mg/L	0.01	<0.01	<0.01
RP	mg/L	0.01	<0.01	<0.01

Analyte	Units	LOR	DOG	Duplicate
Other parameters				
DOC	mg/L	1	5	2
Oil & Grease	mg/L	5	<5	<5
Fluoride	mg/L	0.1	0.4	0.4

Appendix E

Sediment quality QA

Autumn 2022 (29 March 2022)

Analyte	Units	LOR	AIRUS	Duplicate
1M HCl-extractable metals				
Aluminium	mg/kg	50	990	1080
Antimony	mg/kg	1	<1.0	<1.0
Arsenic	mg/kg	1	1.7	1.8
Cadmium	mg/kg	0.1	0.2	0.2
Cobalt	mg/kg	0.5	8.9	11.2
Chromium	mg/kg	1	<1.0	<1.0
Copper	mg/kg	1	11.9	12.4
Iron	mg/kg	50	4140	5750
Lead	mg/kg	1	6.8	6.7
Manganese	mg/kg	10	250	160
Mercury	mg/kg	0.1	<0.10	<0.10
Nickel	mg/kg	1	57.9	59.4
Silver	mg/kg	1	<1.0	<1.0
Zinc	mg/kg	1	98.6	98.9
Total metals				
Aluminium	mg/kg	50	820	1020
Antimony	mg/kg	5	<5	<5
Arsenic	mg/kg	5	<5	<5
Cadmium	mg/kg	1	<1	<1
Chromium	mg/kg	2	<2	2
Cobalt	mg/kg	2	3	4
Copper	mg/kg	5	<5	<5
Iron	mg/kg	50	2090	2670
Lead	mg/kg	5	<5	<5
Manganese	mg/kg	5	103	43
Nickel	mg/kg	2	15	22
Silver	mg/kg	2	<2	<2
Zinc	mg/kg	5	25	32
Nutrients				
Ammonia as N	mg/kg	20	40	20
Nitrite as N (Sol.)	mg/kg	0.1	<0.1	<0.1
Nitrate as N (Sol.)	mg/kg	0.1	0.8	0.4
Nitrite + Nitrate as N (Sol.)	mg/kg	0.1	0.8	0.4
Total Kjeldahl Nitrogen as N	mg/kg	20	9990	9900
Total Nitrogen as N	mg/kg	20	9990	9900
Total Phosphorus as P	mg/kg	2	946	969
Other parameters				
TOC	%	0.02	11.9	14.2

Spring 2022 (6 December 2022)

Analyte	Units	LOR	DOG	Duplicate
1M HCl-extractable metals				
Antimony	mg/kg	1	<1.0	<1.0
Arsenic	mg/kg	1	1.5	2.5
Cadmium	mg/kg	0.1	0.1	0.2
Chromium	mg/kg	1	<1.0	1.4
Copper	mg/kg	1	4.7	6.6
Lead	mg/kg	1	6.5	8.4
Mercury	mg/kg	0.1	<0.10	<0.10
Nickel	mg/kg	1	3.5	4.7
Silver	mg/kg	1	<1.0	<1.0
Zinc	mg/kg	1	5.8	11.5
Total metals				
Aluminium	mg/kg	50	3220	2770
Aluminium	mg/kg	50	2140	2630
Antimony	mg/kg	5	<5	<5
Arsenic	mg/kg	5	6	5
Cadmium	mg/kg	1	<1	<1
Chromium	mg/kg	2	7	6
Cobalt	mg/kg	0.5	4.2	7
Cobalt	mg/kg	2	5	4
Copper	mg/kg	5	6	6
Lead	mg/kg	5	9	8
Manganese	mg/kg	10	110	280
Manganese	mg/kg	5	296	128
Mercury	mg/kg	0.1	<0.1	<0.1
Nickel	mg/kg	2	10	8
Silver	mg/kg	2	<2	<2
Zinc	mg/kg	5	21	19
Nutrients				
Ammonia as N	mg/kg	20	<20	<20
Nitrite as N (Sol.)	mg/kg	0.1	<0.1	<0.1
Nitrate as N (Sol.)	mg/kg	0.1	<0.1	<0.1
Nitrite + Nitrate as N (Sol.)	mg/kg	0.1	<0.1	<0.1
Total Kjeldahl Nitrogen as N	mg/kg	20	730	530
Total Nitrogen as N	mg/kg	20	730	530
Total Phosphorus as P	mg/kg	2	168	149
Other parameters				
TOC	%	0.02	1.24	1.55

Appendix F

Macroinvertebrate taxonomy QA

Macroinvertebrate Identification QA/QC Data Sheet

Identifier: TL **Processing Date:**

Project #: 12570462 **LIMS/Sample #:** 117326 **Sample Code:** 119A1RP1

Site Name: **Site Code:** A1R

Collection Date: 29.3.2022 **Method/Habitat:** Edge **Collected By:**

Taxonomic Id Level: Family **Pass/Fail Rate:** 95% **QA/QC By:** ZB

Incorrect Identification	Correct Identification	Error Code

Number of Taxa (species/families): 26
Number Identified Incorrectly: 0
Percentage Correct: 100%
Pass or Fail: Pass

Training Received For Incorrect Taxa? (Yes/[✓ No]) **QA Date:** 25.01.23

Senior Taxonomist Identifier

Notes:
Please refer to .\General\Ecology Files\Quality Assurance\Quality Assurance for the Victorian River Health Program.pdf for an explanation of how rates are calculated.

Error Codes:
1. **ID adult/larvae not identified**
2. **Complete misidentification**
3. **Could *reasonably* be identified to a finer taxonomic resolution**
4. **Identification has been taken too far based on specimen condition (small or damaged)***
5. **Miscount***
6. **Taxon not recorded on the data sheet**
7. **Inappropriate Identification based on larval exuviae, shells or if the specimen was obviously dead when collected**

* These are NOT included in error rate calculations

Macroinvertebrate Identification QA/QC Data Sheet

Identifier: TL
Processing Date: 17. 1-23
Project #: 12570462
LIMS/Sample #: 117679
Sample Code: 120ToRP1
Site Name:
Site Code: ToR
Collection Date: 6.12.22
Method/Habitat: Edge
Collected By: ZC
Taxonomic Id Level: Family
Pass/Fail Rate: 95%.
QA/QC By: ZB

Incorrect Identification	Correct Identification	Error Code

Number of Taxa (species/families): 21
Number Identified Incorrectly: 0
Percentage Correct: 100%.
Pass or Fail: Pass

Training Received For Incorrect Taxa? (Yes/No)
QA Date: 19. 1. 23

Senior Taxonomist
Identifier

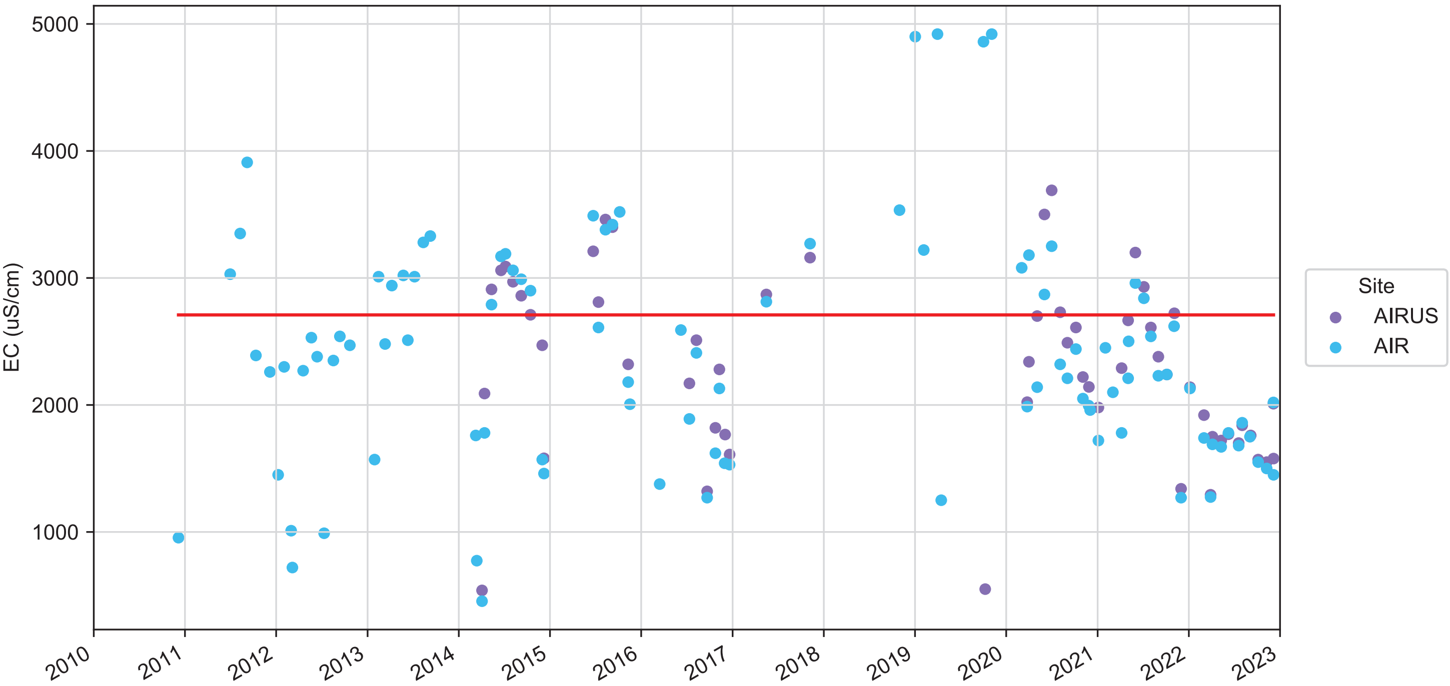
Notes:
Please refer to .\General\Ecology Files\Quality Assurance\Quality Assurance for the Victorian River Health Program.pdf for an explanation of how rates are calculated.

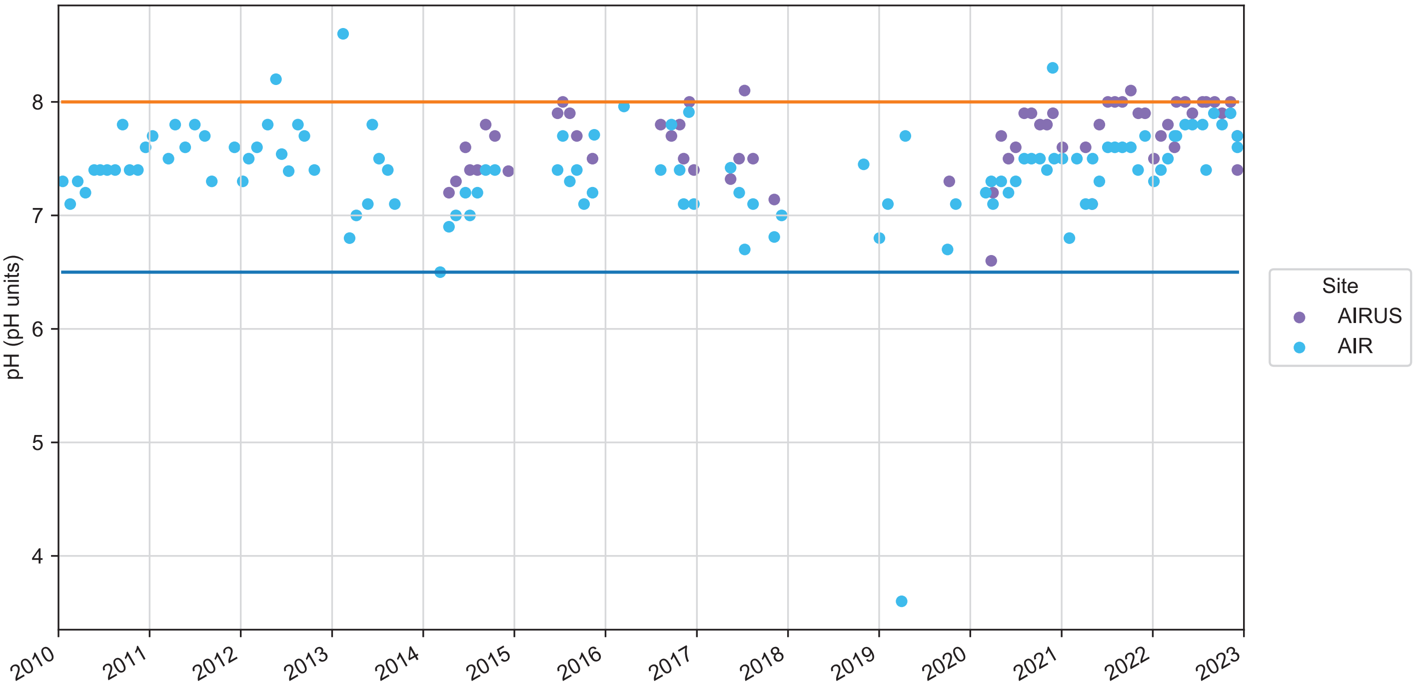
Error Codes:
1. **ID adult/larvae not identified**
2. **Complete misidentification**
3. **Could *reasonably* be identified to a finer taxonomic resolution**
4. **Identification has been taken too far based on specimen condition (small or damaged)***
5. **Miscount***
6. **Taxon not recorded on the data sheet**
7. **Inappropriate Identification based on larval exuviae, shells or if the specimen was obviously dead when collected**

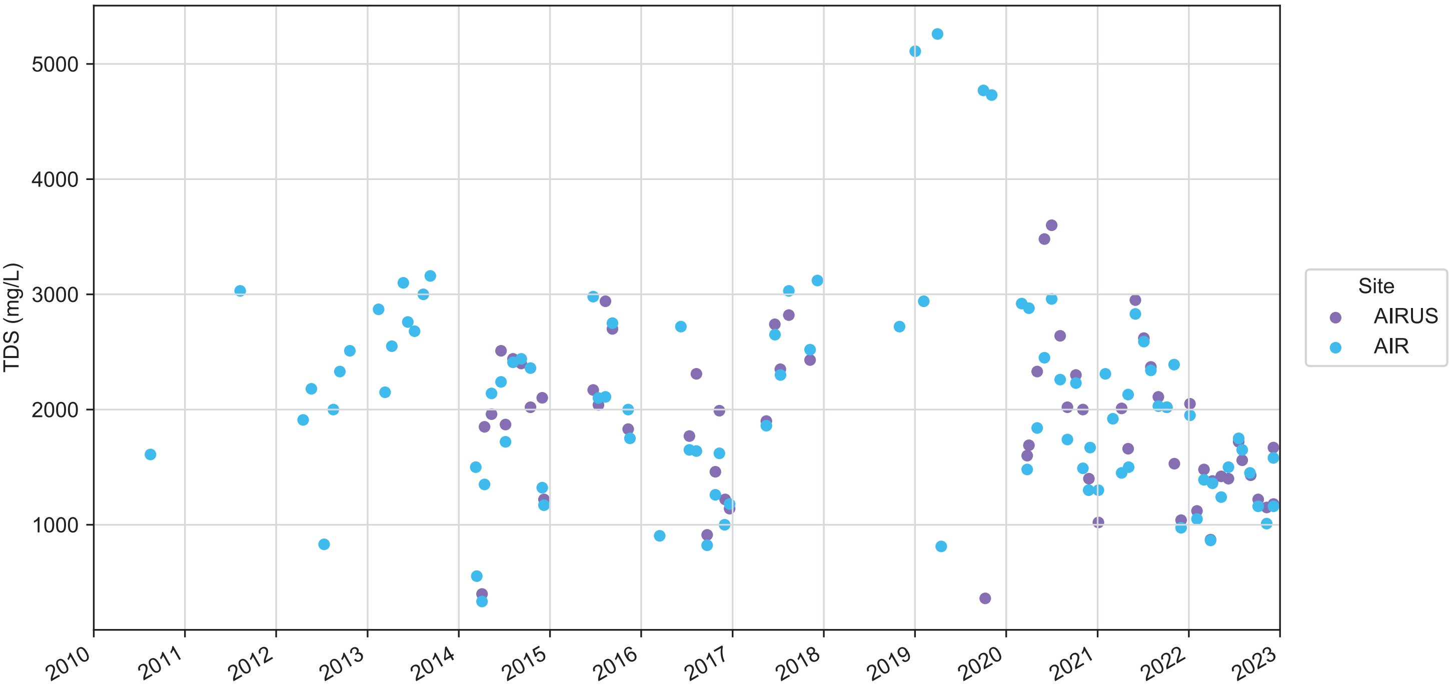
* These are NOT included in error rate calculations

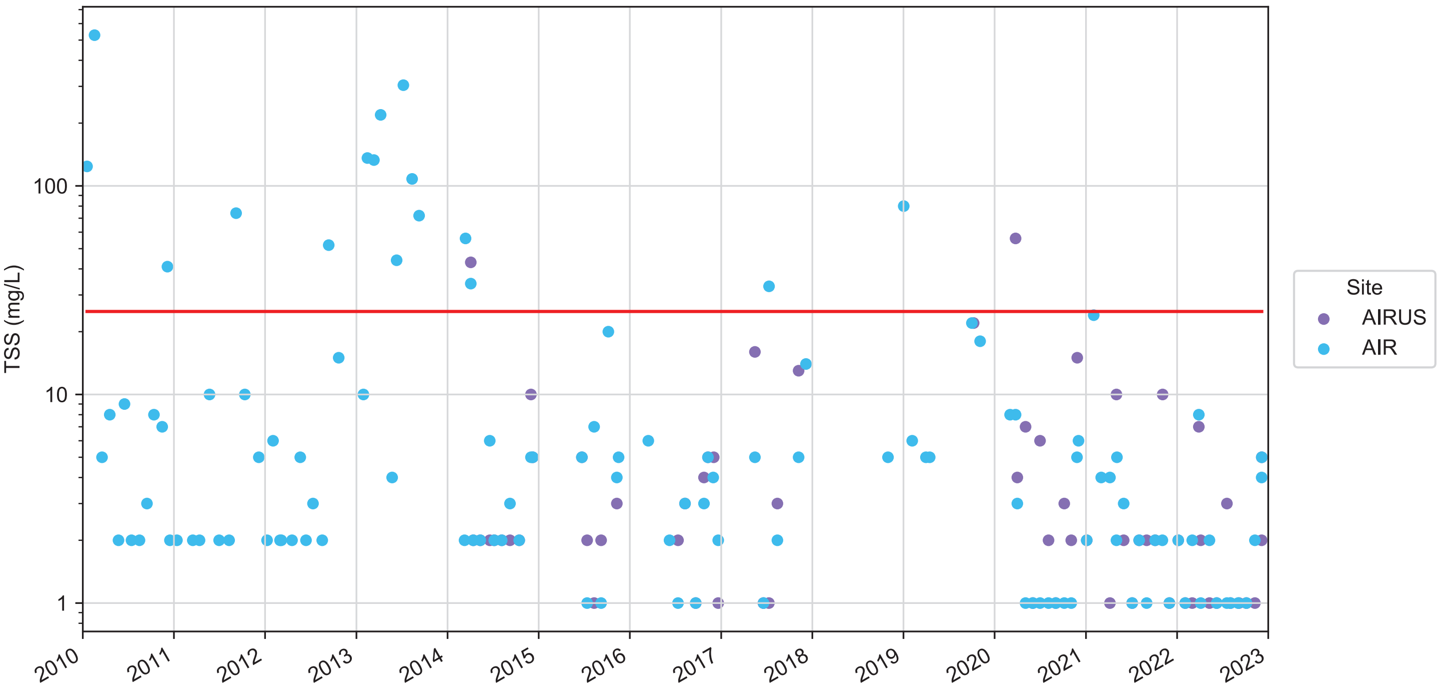
Appendix G

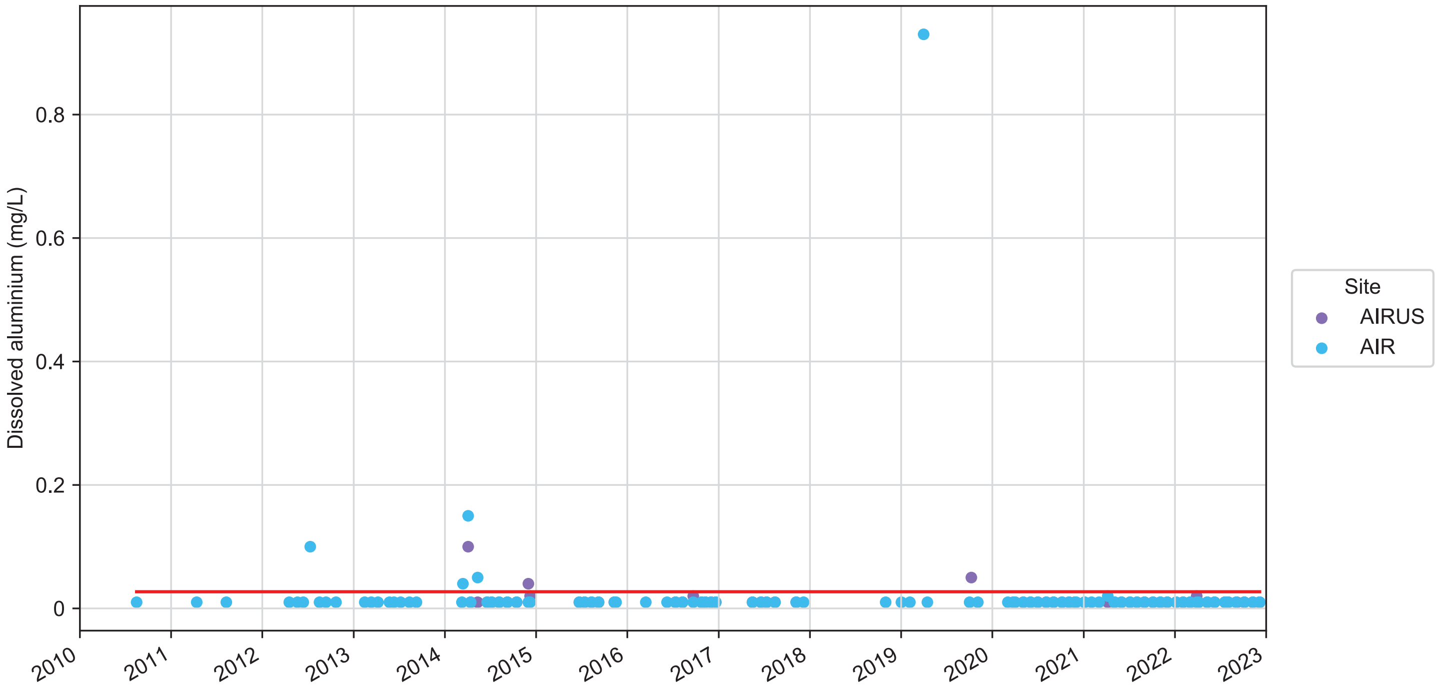
Long term water quality figures

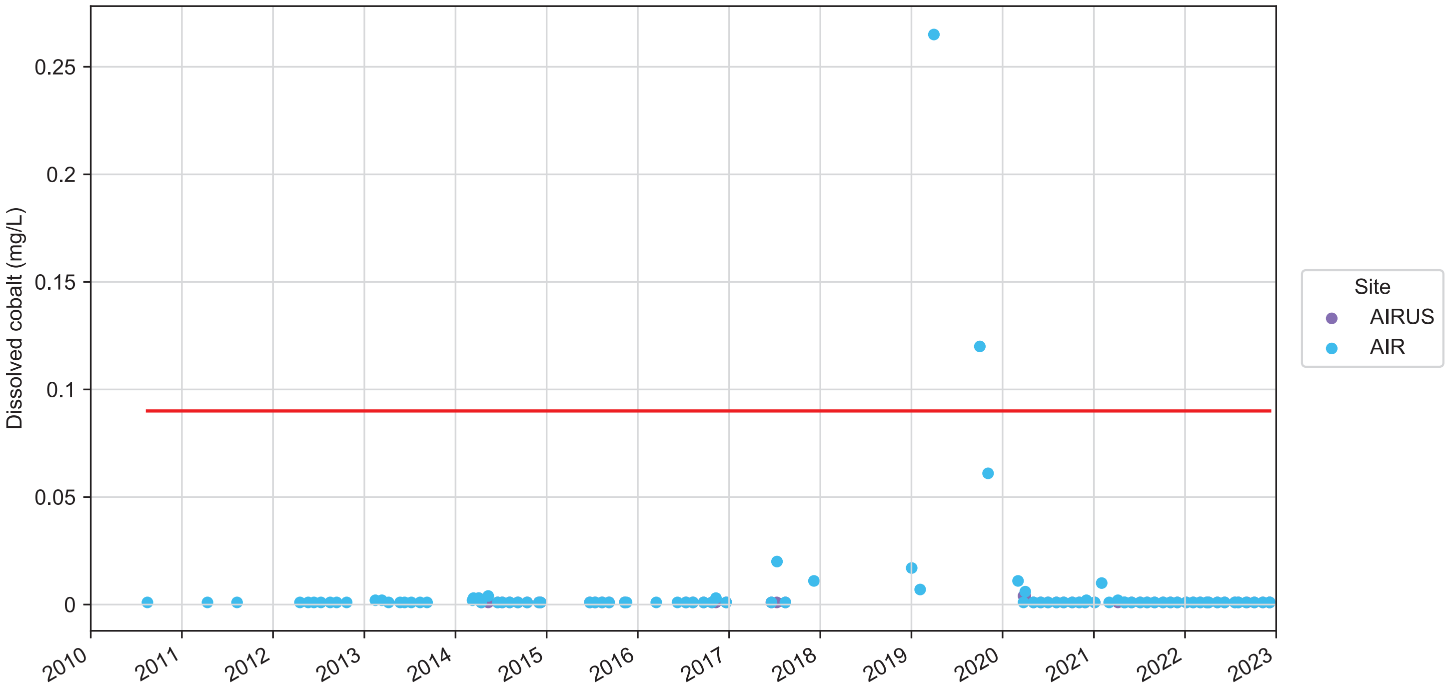

EC (uS/cm)
5000
4000
3000
2000
1000
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
Site
AIRUS
AIR

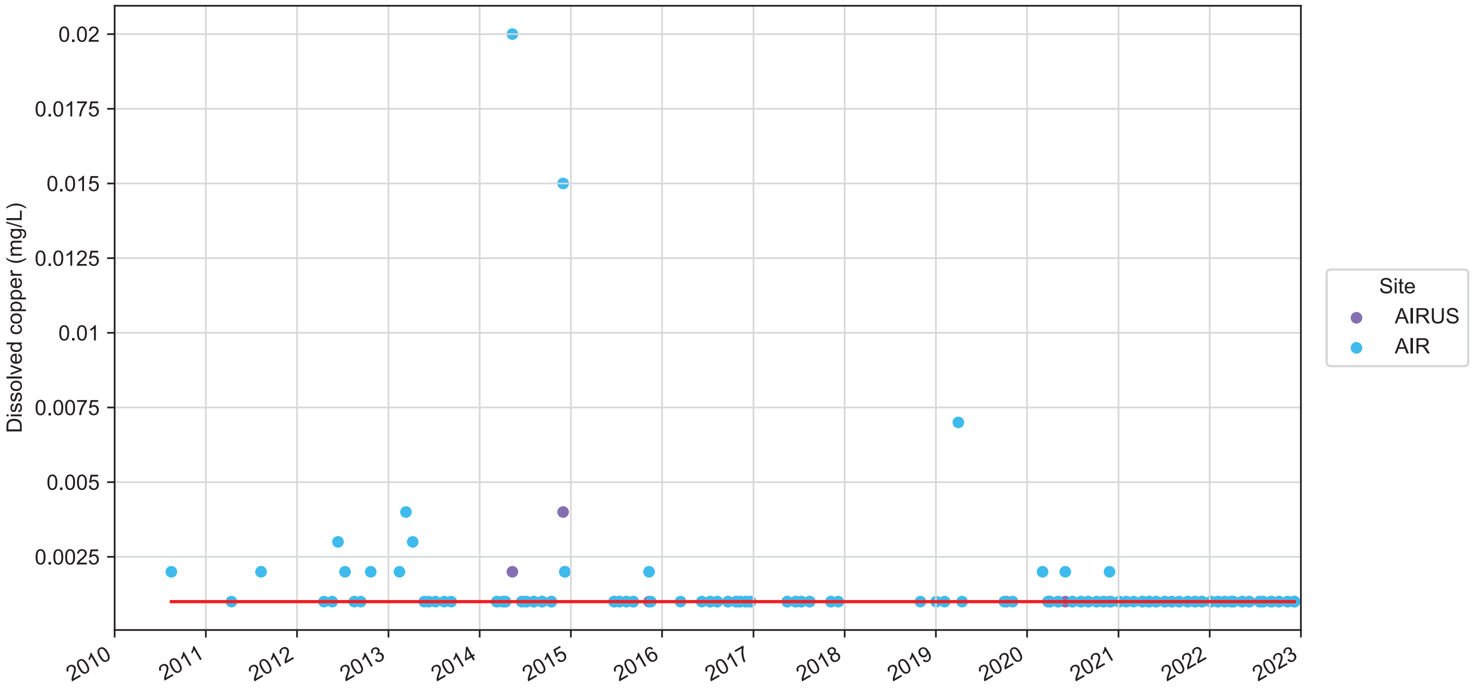

pH (pH units)
8
7
6
5
4
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
Site
AIRUS
AIR

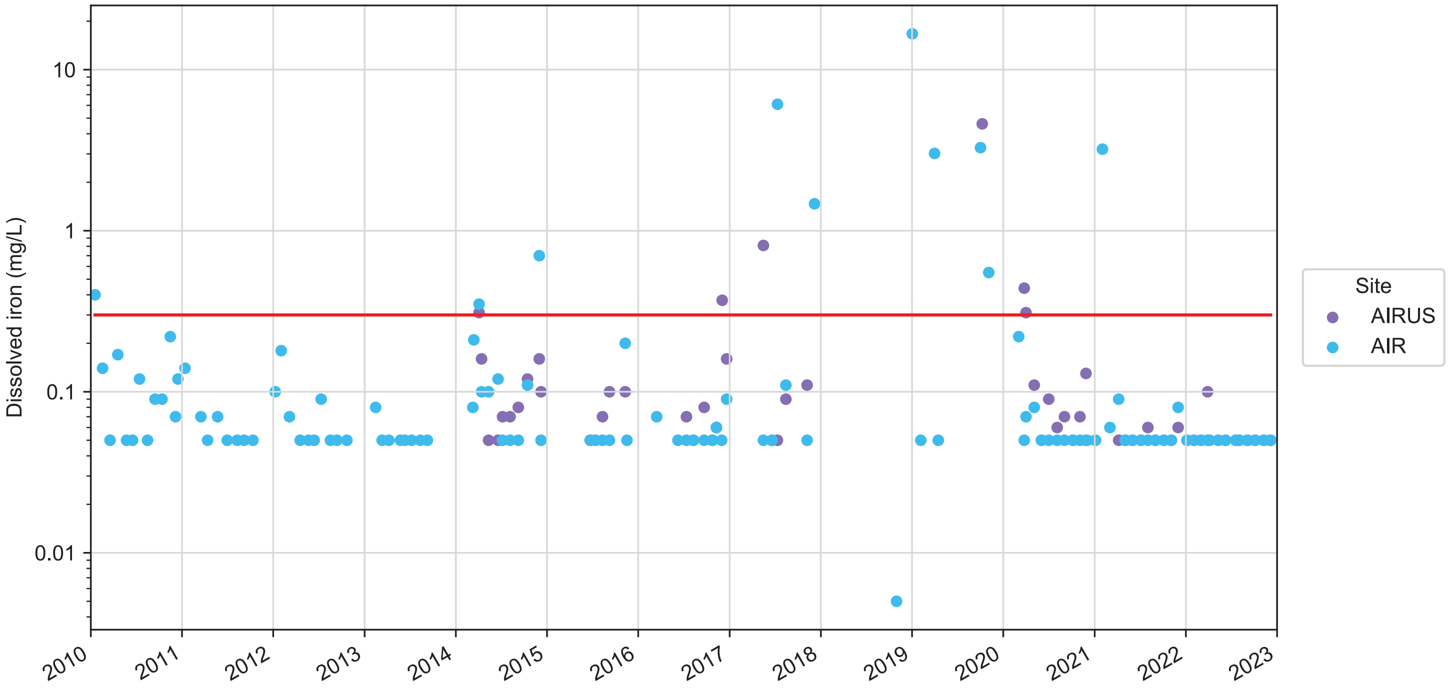

TDS (mg/L)
5000
4000
3000
2000
1000
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
Site
AIRUS
AIR

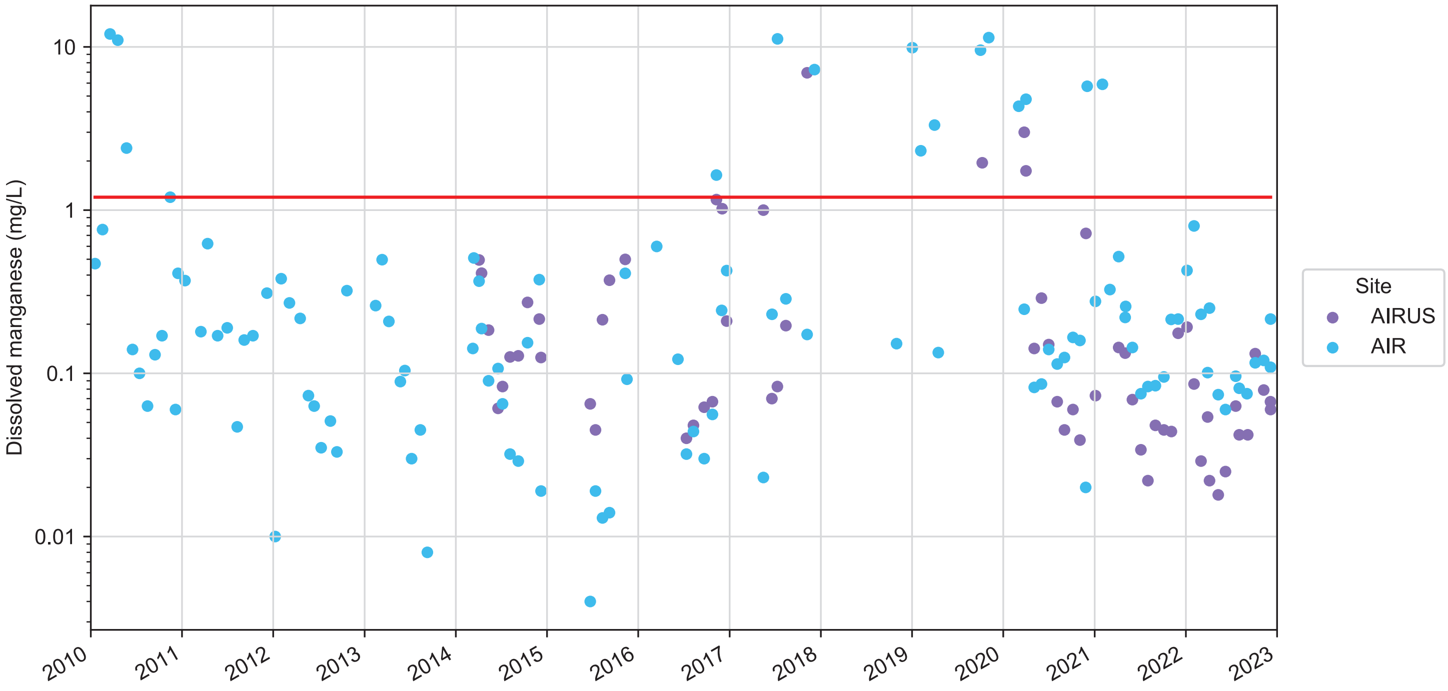

TSS (mg/L)
100
10
1
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
Site
● AIRUS
● AIR

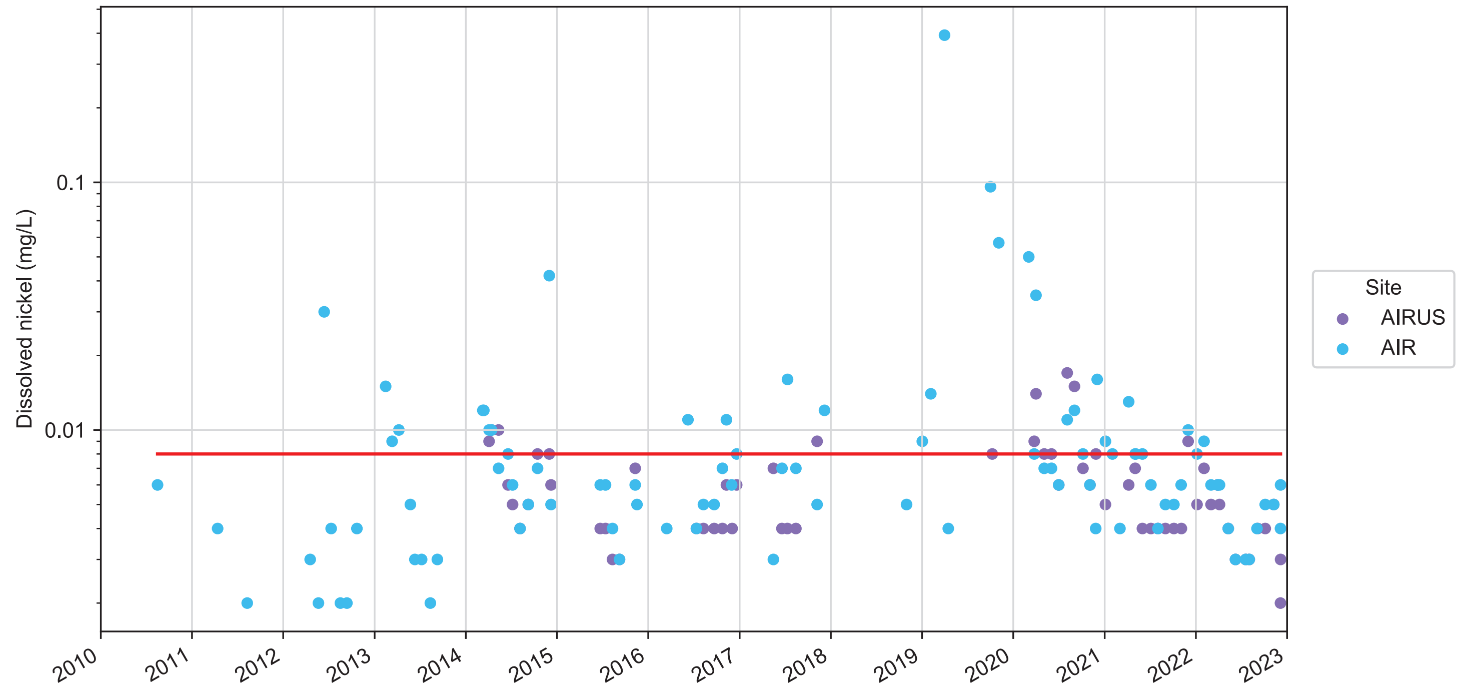

Dissolved aluminium (mg/L)
0.8
0.6
0.4
0.2
0
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
Site
● AIRUS
● AIR

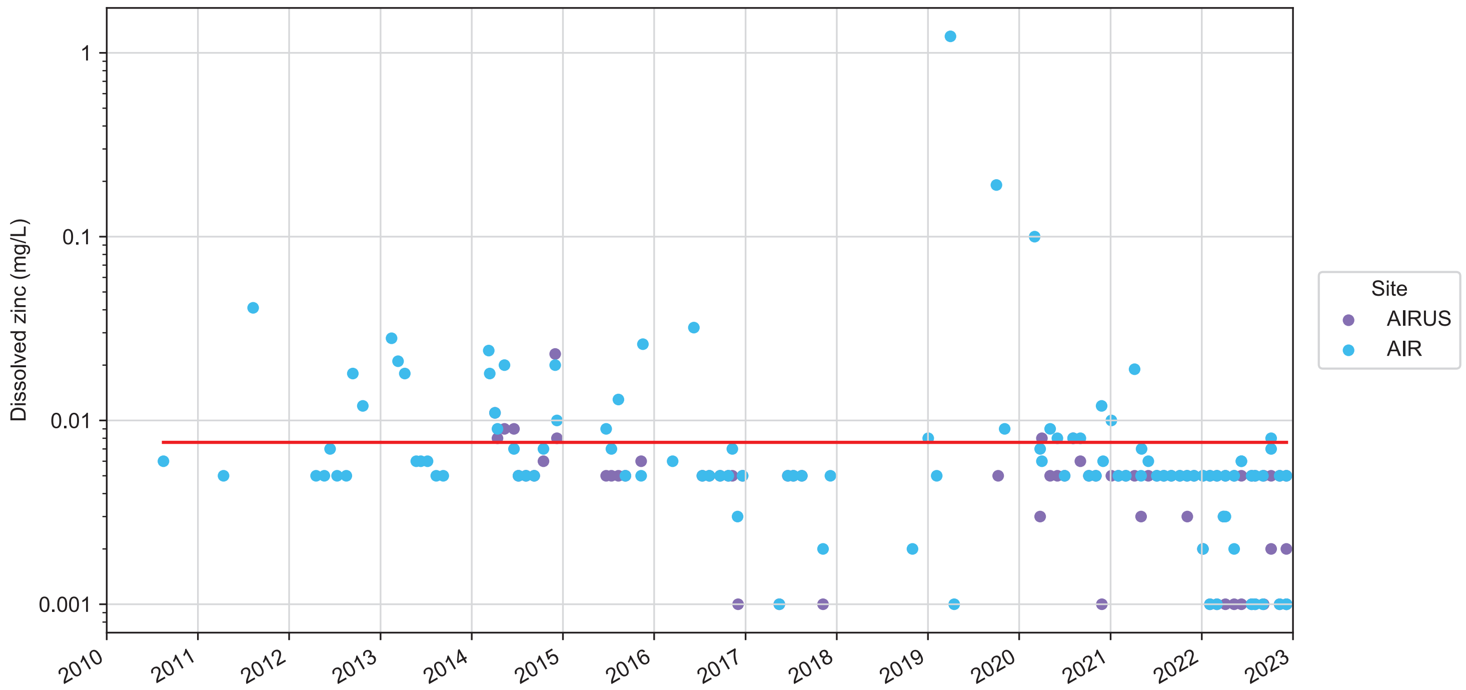

Dissolved cobalt (mg/L)
0.25
0.2
0.15
0.1
0.05
0
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
Site
● AIRUS
● AIR

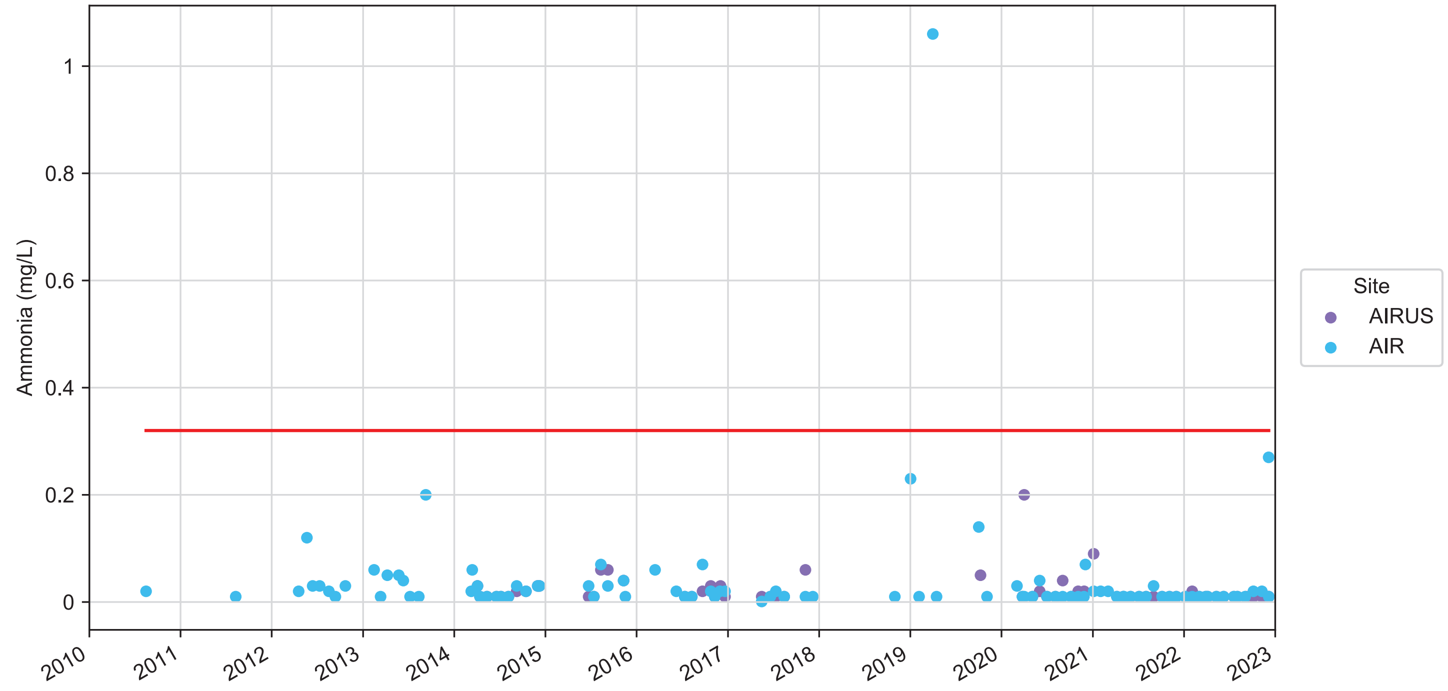

Dissolved copper (mg/L)
0.02
0.0175
0.015
0.0125
0.01
0.0075
0.005
0.0025
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
Site
AIRUS
AIR

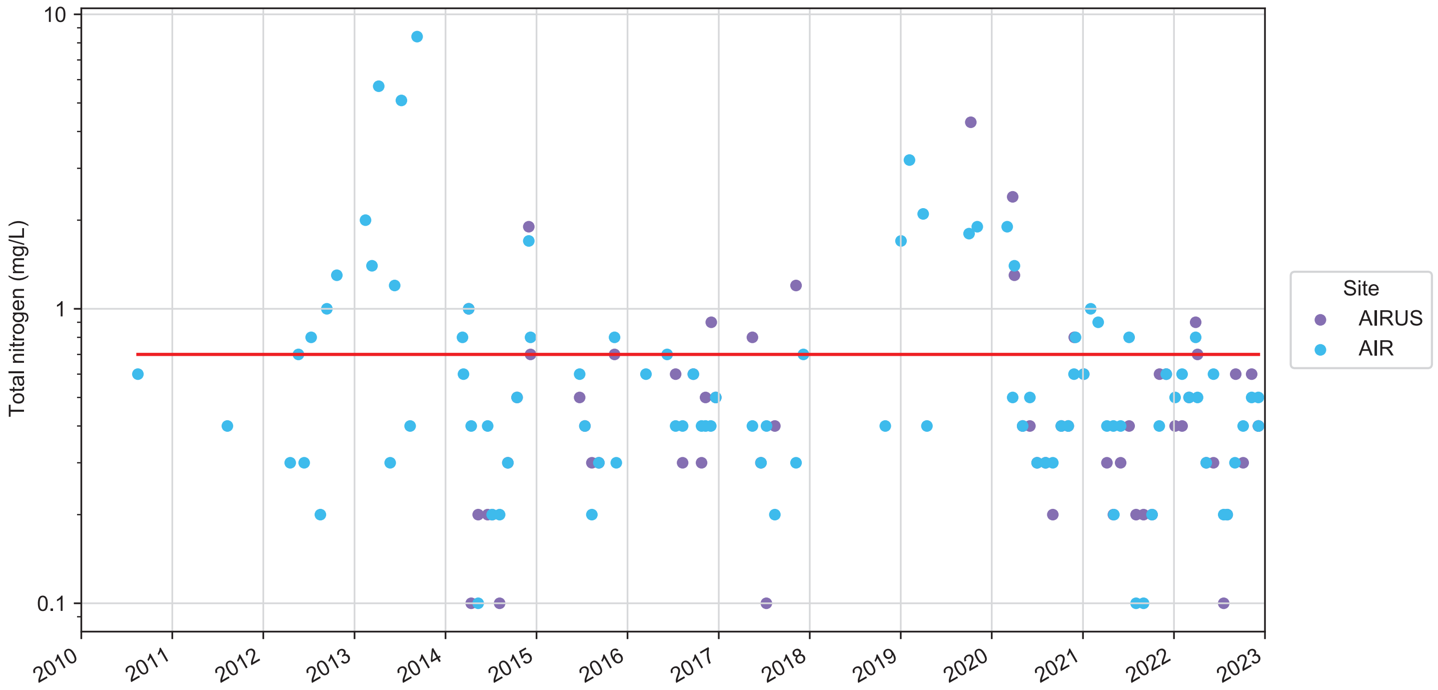

Dissolved iron (mg/L)
10
1
0.1
0.01
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
Site
AIRUS
AIR

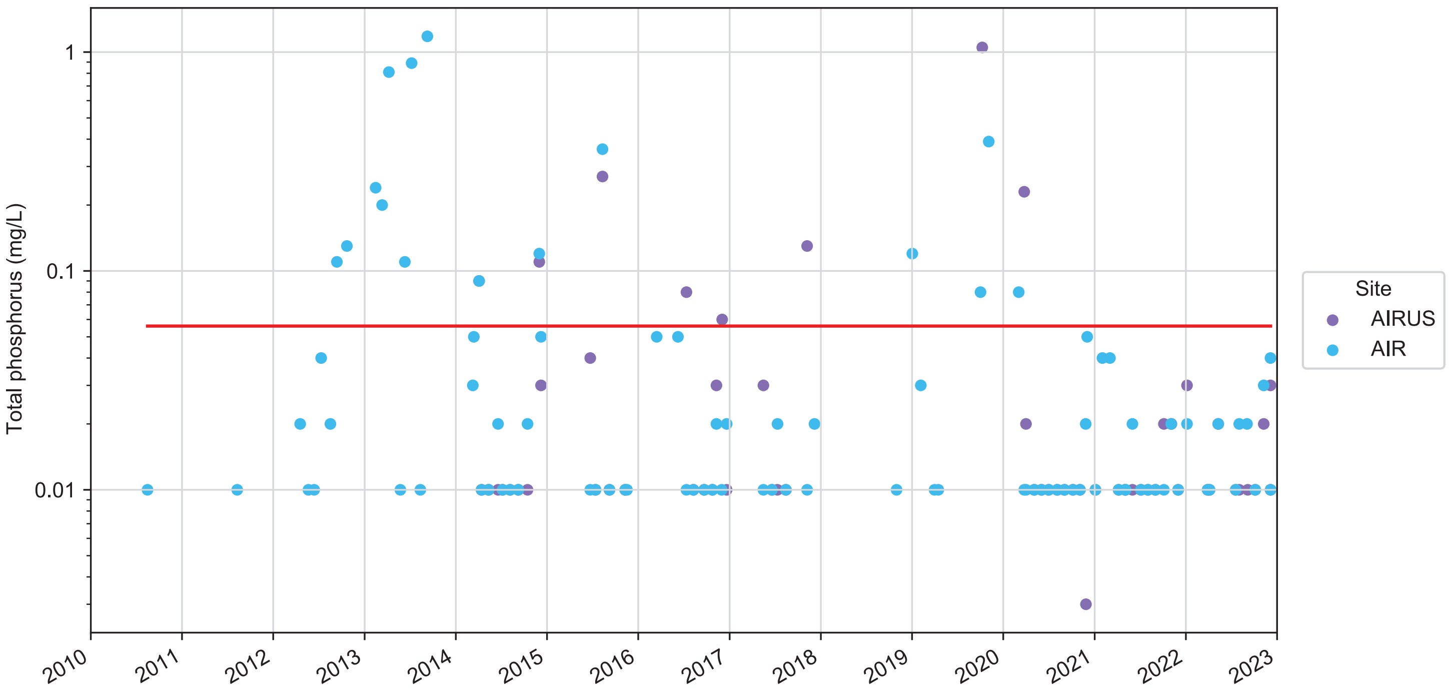

Dissolved manganese (mg/L)
10
1
0.1
0.01
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
Site
AIRUS
AIR


Dissolved nickel (mg/L)
0.1
0.01
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
Site
AIRUS
AIR


Dissolved zinc (mg/L)
1
0.1
0.01
0.001
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
Site
AIRUS
AIR


Ammonia (mg/L)
1
0.8
0.6
0.4
0.2
0
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
Site
AIRUS
AIR


Total nitrogen (mg/L)
10
1
0.1
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
Site
AIRUS
AIR


Total phosphorus (mg/L)
1
0.1
0.01
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
Site
AIRUS
AIR

Appendix H

RCE Scores, 2021-2022

RCE scores – 2021 to 2022, GAP, GEN, GRO

Site	**GAP**				**GEN**				**GRO**			
Category	**Spr-22**	**Aut-22**	**Spr-21**	**Aut-21**	**Spr-22**	**Aut-22**	**Spr-21**	**Aut-21**	**Spr-22**	**Aut-22**	**Spr-21**	**Aut-21**
1. Land use pattern beyond immediate riparian zone	3	3	4	4	4	4	4	4	4	4	4	4
2. Width of riparian strip of woody vegetation	4	3	4	4	4	3	3	4	4	3	3	3
3. Completeness of riparian strip of woody vegetation	3	4	4	4	3	4	4	4	2	4	3	3
4. Vegetation of riparian zone within 10 m of channel	4	3	4	3	4	4	4	4	4	4	4	4
5. Stream bank structure	3	2	1	3	4	4	4	4	3	3	2	2
6. Bank undercutting	4	3	4	3	3	3	4	3	3	2	1	2
7. Channel form	3	3	3	3	4	4	3	3	2	4	4	3
8. Riffle/pool sequence	3	2	2	4	3	3	4	3	4	3	3	4
9. Retention devices in stream	4	3	4	4	3	3	4	4	3	4	4	4
10. Channel sediment accumulations	3	3	2	2	2	2	2	3	2	2	2	2
11. Stream bottom	4	4	3	2	3	4	3	3	2	3	3	1
12. Stream detritus	4	3	3	3	3	2	4	3	4	4	4	4
13. Aquatic vegetation	4	4	4	4	4	4	3	4	4	4	4	3
RCE score	**46**	**40**	**42**	**43**	**44**	**44**	**46**	**46**	**41**	**44**	**41**	**39**
RCE percentage (%)	**88%**	**77%**	**81%**	**83%**	**85%**	**85%**	**88%**	**88%**	**79%**	**85%**	**79%**	**75%**

RCE scores – 2021 to 2022, TOR, DOG

Site	**TOR**				**DOG**			
Category	**Spr-22**	**Aut-22**	**Spr-21**	**Aut-21**	**Spr-22**	**Aut-22**	**Spr-21**	**Aut-21**
1. Land use pattern beyond immediate riparian zone	3	2	2	2	3	3	2	2
2. Width of riparian strip of woody vegetation	4	3	4	4	2	3	2	2
3. Completeness of riparian strip of woody vegetation	3	4	4	4	1	3	1	1
4. Vegetation of riparian zone within 10 m of channel	3	3	3	3	3	3	4	3
5. Stream bank structure	4	2	3	3	3	3	3	3
6. Bank undercutting	2	2	3	2	3	4	3	4
7. Channel form	3	4	4	3	3	4	3	3
8. Riffle/pool sequence	3	3	2	2	3	2	2	2
9. Retention devices in stream	2	2	2	1	2	2	1	2
10. Channel sediment accumulations	2	2	2	3	2	0	0	0
11. Stream bottom	2	1	3	3	0	2	0	2
12. Stream detritus	2	3	3	3	2	3	3	3
13. Aquatic vegetation	4	4	2	4	2	1	2	2
RCE score	**37**	**35**	**37**	**37**	**29**	**33**	**26**	**29**
RCE percentage (%)	**71%**	**67%**	**71%**	**71%**	**56%**	**63%**	**50%**	**56%**

RCE scores – 2021 to 2022, AIRUS, AIR

Site	**AIRUS**				**AIR**			
Category	**Spr-22**	**Aut-22**	**Spr-21**	**Aut-21**	**Spr-22**	**Aut-22**	**Spr-21**	**Aut-21**
1. Land use pattern beyond immediate riparian zone	2	2	2	2	3	3	3	2
2. Width of riparian strip of woody vegetation	2	2	2	2	3	3	3	3
3. Completeness of riparian strip of woody vegetation	0	1	1	1	2	2	2	3
4. Vegetation of riparian zone within 10 m of channel	2	3	2	2	3	3	3	3
5. Stream bank structure	3	3	3	3	3	4	3	3
6. Bank undercutting	2	3	3	4	3	3	2	2
7. Channel form	4	4	4	4	4	4	3	4
8. Riffle/pool sequence	2	2	2	2	3	3	2	4
9. Retention devices in stream	1	1	3	3	2	3	2	3
10. Channel sediment accumulations	1	0	0	0	4	4	4	3
11. Stream bottom	2	2	0	0	3	3	3	3
12. Stream detritus	2	2	2	3	3	3	2	2
13. Aquatic vegetation	3	3	2	1	4	4	3	3
RCE score	**26**	**28**	**26**	**27**	**40**	**42**	**35**	**38**
RCE percentage (%)	**50%**	**54%**	**50%**	**52%**	**77%**	**81%**	**67%**	**73%**

Appendix I

ANOSIM Output

ANOSIM

Analysis of Similarities

One-Way - A

Resemblance worksheet
Name: Resem4
Data type: Similarity
Selection: All

Factors

```
Place Name Type      Levels
A     Site Unordered      7
```

Site levels
AIR
AIRUS
DOG
GAP
GEN
GRO
TOR

Tests for differences between unordered Site groups
Global Test
Sample statistic (R): 0.51
Significance level of sample statistic: 0.01%
Number of permutations: 9999 (Random sample from a large number)
Number of permuted statistics greater than or equal to R: 0

Pairwise Tests

```
                   R  Significance      Possible       Actual  Number >=
Groups     Statistic       Level %  Permutations Permutations   Observed
AIR, AIRUS    -0.056          86.2    Very large         9999       8619
AIR, DOG       0.267          0.01    Very large         9999          0
AIR, GAP        0.54          0.01    Very large         9999          0
AIR, GEN       0.773          0.01    Very large         9999          0
AIR, GRO       0.737          0.01    Very large         9999          0
AIR, TOR       0.063           2.6    Very large         9999        256
AIRUS, DOG     0.331          0.01    Very large         9999          0
AIRUS, GAP     0.686          0.01    Very large         9999          0
AIRUS, GEN     0.844          0.01    Very large         9999          0
AIRUS, GRO     0.831          0.01    Very large         9999          0
AIRUS, TOR     0.038          17.2    Very large         9999       1720
DOG, GAP       0.751          0.01    Very large         9999          0
DOG, GEN       0.868          0.01    Very large         9999          0
DOG, GRO       0.911          0.01    Very large         9999          0
DOG, TOR       0.307          0.01    Very large         9999          0
GAP, GEN       0.233          0.02    Very large         9999          1
GAP, GRO        0.28          0.01    Very large         9999          0
GAP, TOR       0.446          0.01    Very large         9999          0
GEN, GRO       0.337          0.01    Very large         9999          0
GEN, TOR       0.712          0.01    Very large         9999          0
GRO, TOR       0.643          0.01    Very large         9999          0
```

Outputs
Plot: Graph21

ANOSIM
Analysis of Similarities

One-Way - A

Resemblance worksheet
Name: Resem3
Data type: Similarity
Selection: All

Factors
```
Place Name Type       Levels
A     Site Unordered       2
```

Site levels
AIR
AIRUS

Tests for differences between unordered Site groups
Global Test
Sample statistic (R): -0.056
Significance level of sample statistic: 86.4%
Number of permutations: 9999 (Random sample from a large number)
Number of permuted statistics greater than or equal to R: 8642

Outputs
Plot: Graph19

ghd.com

→ The Power of Commitment

Appendix 9: Airly Mine Stygofauna Monitoring Report 2022

Airly Mine Ecology Monitoring 2022

Airly Stygofauna Monitoring Report 2022

Centennial Airly Pty Ltd

03 March 2023

→ **The Power of Commitment**

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Document status

Status Code	Revision	Author	Reviewer		Approved for issue		
			Name	Signature	Name	Signature	Date
S4	0	T Hopwood K Tyler	Z Lagerroth		Z Lagerroth		03/03/23

Overarching Review

Statement of Compliance Question	Statement of Compliance Answer
Were all conditions of SSD_5581 and the Airly Mine Water Management Plan relating to stygofauna complied with?	Yes – There were no non-compliances relating to stygofauna monitoring in the 2022 reporting period

Details of Non-Compliances

Relevant Approval	Condition #	Condition summary	Compliance Status	Comment	Reference # addressed in Annual Review
N/A - No non-compliances relating to stygofauna during the 2022 reporting period			Compliant		

Development consent SSD-5581 (Modification 2) performance conditions relating to groundwater

Condition	Condition description	Compliant	Document
Water management plan			
Schedule 4 13.	Prior to carrying out any development under this consent, unless the Secretary agrees otherwise, the Applicant must prepare a Water Management Plan for the development to the satisfaction of the Secretary. This plan must:		
Schedule 4 13. (a)	Be prepared in consultation with the DoEE, EPA and the Water Division, by suitably qualified and experienced person/s whose appointment has been approved by the Secretary.	Yes	NA Refer to Appendix A and Appendix B of WMP (GHD 2021)
Schedule 4 13. (b)	Include detailed performance criteria and describe measures to ensure that the Applicant complies with the Water Management Performance Measures (see Table 6).	Yes	NA Refer to Section 6.1.3 of WMP (GHD 2021)
Groundwater management plan			
Schedule 4 13. (c) (iii)	Groundwater Management Plan, which is consistent with the NSW Government guideline entitled Groundwater Monitoring and Modelling Plans – Introduction for prospective mining and petroleum activities, and includes:		
	Detailed baseline data of groundwater levels, yield and quality in the region that could be affected by the development, including licensed privately-owned groundwater bores and a detailed survey/schedule of groundwater dependent ecosystems (including springs and their discharge quantity and quality).	Yes	Refer to Section 5 of the WMP (GHD 2021)
Schedule 4 13. (c) (iii)	Consultation with the Water Division on the installation of all new monitoring bores, the scheduled sampling and quality determination of parameters for monitoring bores.	Yes	NA Refer to Section 4.4 of the WMP (GHD 2021)

Condition	Condition description	Compliant	Document
Schedule 4 13. (c) (iii)	Groundwater assessment criteria including trigger levels for investigating any potentially adverse groundwater impacts.	Yes	Refer to Section 6 of the WMP (GHD 2021)
	A program to monitor and report on: – Springs and their discharge quantity and quality. – Groundwater inflows transferred to the surface water management system. – The seepage/leachate from water storages and emplacements. – Impacts of the development on: • Regional and local (including alluvial) aquifers. • Groundwater supply of potentially affected landowners. • Groundwater dependent ecosystems (including rules for the management of groundwater level impacts to protect GDEs), and riparian vegetation.	TBC	Refer to: – Annual Water Monitoring Report (2022 report to be produced in early 2023) – Sections 4.4 and 4.5 of the WMP (GHD 2021) – Annual flora and fauna monitoring report
	A program to monitor and report on stygofauna and hyporheic fauna.	Yes	This report
	A program to review and validate the groundwater model for the development, including independent expert review.	Yes	NA Refer to Section 7.5 of the WMP (GHD 2021)
	A plan to respond to any exceedances of the performance measures.	Yes	NA Refer to Appendix E of the WMP (GHD 2021)

NA – not applicable to this report

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1. Introduction

1.1 Background

Airly Mine is an underground coal mine located near Capertee, approximately 40 km northwest of Lithgow, and owned by Centennial Airly Pty Ltd (Centennial). Airly Mine was granted Development Consent (SSD_5581) for the extension of its underground coal mine on 15 December 2016. The development consent allows Airly Mine to extract up to 1.8 million tonnes per annum (Mtpa) of run of mine (ROM) coal within the mining lease ML1331, with mining extending east of the lease into an exploration licence area (Authorisation Area 232).

Stygofauna monitoring was undertaken by Cardno (2014) to support the Environmental Impact Statement (EIS) for the Airly Mine Extension Project. A total of six bores were sampled by Cardno over four sampling events between autumn 2013 and winter 2014. No stygofauna were collected from Airly bores during this period.

GHD has undertaken eight rounds of stygofauna monitoring of Airly Mine bores since the EIS: autumn 2016, summer 2016, summer 2017, winter 2017, spring 2018, autumn 2019, spring 2020, autumn 2021 and winter 2022. This report outlines the results of winter 2022 stygofauna monitoring conducted in August 2022.

1.2 Development consent

Airly Mine has development consent under Section 89E of the Environmental Planning & Assessment Act 1979 for the extension of the mine (approved 15 December 2016; NSW Government 2016).

In relation to stygofauna, the development consent states the commitment to comply with the following condition:

- 13 (c) (iii) – a program to monitor and report on stygofauna and hyporheic fauna.

1.3 Scope

GHD Pty Ltd (GHD) was engaged by Centennial to undertake stygofauna monitoring in Airly Mine groundwater bores as required by the conditions of consent of the mine extension (see Section 1.2).

The project scope is as follows:

- Collection of stygofauna samples from available groundwater bores that are suitable for sampling, once annually.
- Identification of animals to Family level or below.
- Provision of a report (annually) summarising the results of stygofauna monitoring.

1.4 Purpose of this report

This report outlines the results of stygofauna monitoring conducted in relation to Airly Mine in 2022. A summary of results from this report will be incorporated into Airly Mine’s Annual Review.

1.5 Assumptions

Data have been obtained from Cardno (2014) in addition to assessments undertaken by GHD. It is assumed that the methods used by Cardno were suitable for collection of stygofauna and executed correctly.

1.6 Limitations

This report has been prepared by GHD for Centennial Airly Pty Ltd and may only be used and relied on by Centennial Airly Pty Ltd for the purpose agreed between GHD and the Centennial Airly Pty Ltd as set out in Section 1.4 of this report.

GHD otherwise disclaims responsibility to any person other than Centennial Airly Pty Ltd arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report (refer Section 1.5 of this report). GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by Centennial Airly Pty Ltd and others who provided information to GHD, which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

GHD has not been involved in the preparation of the annual review and has had no contribution to, or review of, the annual return other than in the completion of the stygofauna report. GHD shall not be liable to any person for any error in, omission from, or false or misleading statement in, any other part of annual return.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

2. Stygofauna

2.1 Types of subterranean fauna

Aquifers host a complex biodiversity of aquatic invertebrates called stygofauna. Stygofauna is a collective term for all groundwater animals (Hancock *et al*. 2005). Stygofauna can have varying levels of dependence on groundwater. A number of specific terms are used to differentiate the types of stygofauna and other subterranean fauna, as follows:

- **Stygoxenes** and **stygophiles** are able to utilise groundwater during at least part of their lifecycle but are not reliant upon it.
- **Stygobites** are obligate groundwater species (Hancock *et al.* 2005).
- **Phreatobites** are a type of stygobite that are specially adapted to live in the interstitial spaces of alluvial aquifers.
- **Troglofauna** are also subterranean animals but are distinct from stygofauna as they are not associated with groundwater (Humphreys 2008) e.g. cave dwelling.
- **Edaphobites** are terrestrial soil dwelling animals which can accidentally or opportunistically colonise subterranean environments.

2.2 Characteristics and risks

Stygofauna are highly endemic, often have ancient lineages with Gondwana (350 million years ago), and typically have narrow environmental tolerance ranges (Serov 2016). Because of the adaptation of stygofauna to the groundwater environment and limited connectivity between favourable habitats, some obligate stygofauna species can have restricted distributions (short range endemism) (Humphreys 2008).

Stygofauna are threatened by activities that change the quality or quantity of groundwater, disrupt the connectivity between different aquifers or between aquifers and surface systems, or remove soil pores. Disturbance of aquifers could potentially result in local population extinctions, loss of genetic diversity and even species extinctions in the case of isolated populations.

2.3 Stygofauna research in Australia

In Australia, stygofauna research has increased greatly over the last two decades, particularly in Western Australia and Queensland, where large scale mining projects have provided the impetus to develop specific guidelines or guidance documents in relation to stygofauna. Comparatively, there has been relatively little research done on stygofauna in NSW, where many large mining leases have been long-established and risks to stygofauna are only addressed in environmental impact assessments for new projects.

2.3.1 Favourable bore attributes for stygofauna

Favourable bore conditions have been defined by Hancock and Boulton (2008), the WA EPA (2007) and unpublished work conducted by GHD. The bore attributes and value ranges that are favourable for stygofauna habitation and/or collection are summarised in Table 2.1. These attributes were used to determine suitable Airly bores for stygofauna monitoring (see Section 3.3 for more detail).

Table 2.1 Favourable bore attributes for stygofauna

Attribute	Favourable values
Lithology	Alluvial (sand and gravel)
Bore depth	<50 m (max <200 m)
Bore diameter	>50 mm (to accommodate sampling equipment)
Bore construction	Preferably cased and slotted/screened through the water column. Vertically aligned (not angled)
Bore use	Observation/monitoring
pH	6.5-8.5
Electrical conductivity (EC)	<2,000 µS/cm (max <5,000 µS/cm)

Note: Preferences based on Hancock and Boulton (2008); WA EPA (2007) and unpublished data collected by GHD.

2.3.2 2016 Review of stygofauna in Australia (Hose *et al.* 2015)

In July 2016, the Commonwealth Scientific and Industrial Research Organisation (CSIRO) published a study funded by the Australian Coal Association Research Program (ACARP) titled *Stygofauna in Australian Groundwater Systems: Extent of knowledge* (Hose *et al.* 2015). The report detailed the current extent of knowledge in terms of factors determining the presence of stygofauna, regional water accounts associated with groundwater use and threats that mining and Coal Seam Gas activities may have on stygofauna. Of most relevance to the Airly stygofauna monitoring is that the CSIRO report details the most up to date knowledge on the characteristics of environments where stygofauna have been collected.

The Hose *et al*. (2015) paper identified that greater numbers and/or diversity of stygofauna are found under the following conditions:

- Coarse gravel/sand dominated alluvium (Korbel and Hose 2015)
- Fractured rock aquifers and unconsolidated sediments with larger pore spaces (Hancock and Boulton 2008)
- “Bores from which large volumes of sediment were removed when sampling (by pump), which may reflect greater hydraulic conductivity and sediment mobility” (Korbel and Hose 2015)
- Shallow bores (< 10 m below ground) rather than deeper areas of aquifers (Hancock and Boulton 2008)

These findings are generally in agreement with the environmental preference information used to select the Airly bores, as detailed in Table 2.1.

3. Project and site background

3.1 Environmental conditions

3.1.1 Geology

The topology of Airly Mine is dominated by Mount Airly and Genowlan Mountain. The Grose sandstone of the Triassic Narrabeen Group outcrops throughout the plateau and cliffs of Mount Airly and Genowlan Mountain with small areas of Tertiary basalt outcrop at the higher elevations. The Triassic strata are up to 200 m thick.

The Permian Illawarra Coal Measures outcrop around the Triassic formations at lower elevations, including the zone between Mount Airly and Genowlan Mountain. The Lithgow Seam, within the lower Illawarra Coal Measures, is the target coal seam at Airly Mine. The seam outcrops completely within the proposed mining area for the Airly Mine Extension Project and is therefore disconnected to the areas of occurrence of this seam located several kilometres to the south and northwest, as shown in Figure 3.1.

3.1.2 Hydrogeology

Local groundwater sources

The alluvium associated with Gap Creek and Genowlan Creek is generally a silty sand material and recharged from rainfall as well as inter-aquifer flow from adjacent (primarily Permian) strata. Alluvial groundwater discharges to connected streams.

The local porous and fractured rock groundwater sources include the Narrabeen Sandstone and coal seams of the Illawarra Coal Measures. These sources are recharged by rainfall via fractures within overlaying strata and seep out of the side of the mountains or directly into watercourses. With the majority of discharge from these sources being to seepage areas, there is minimal inter-aquifer flow to underlying regional groundwater sources.

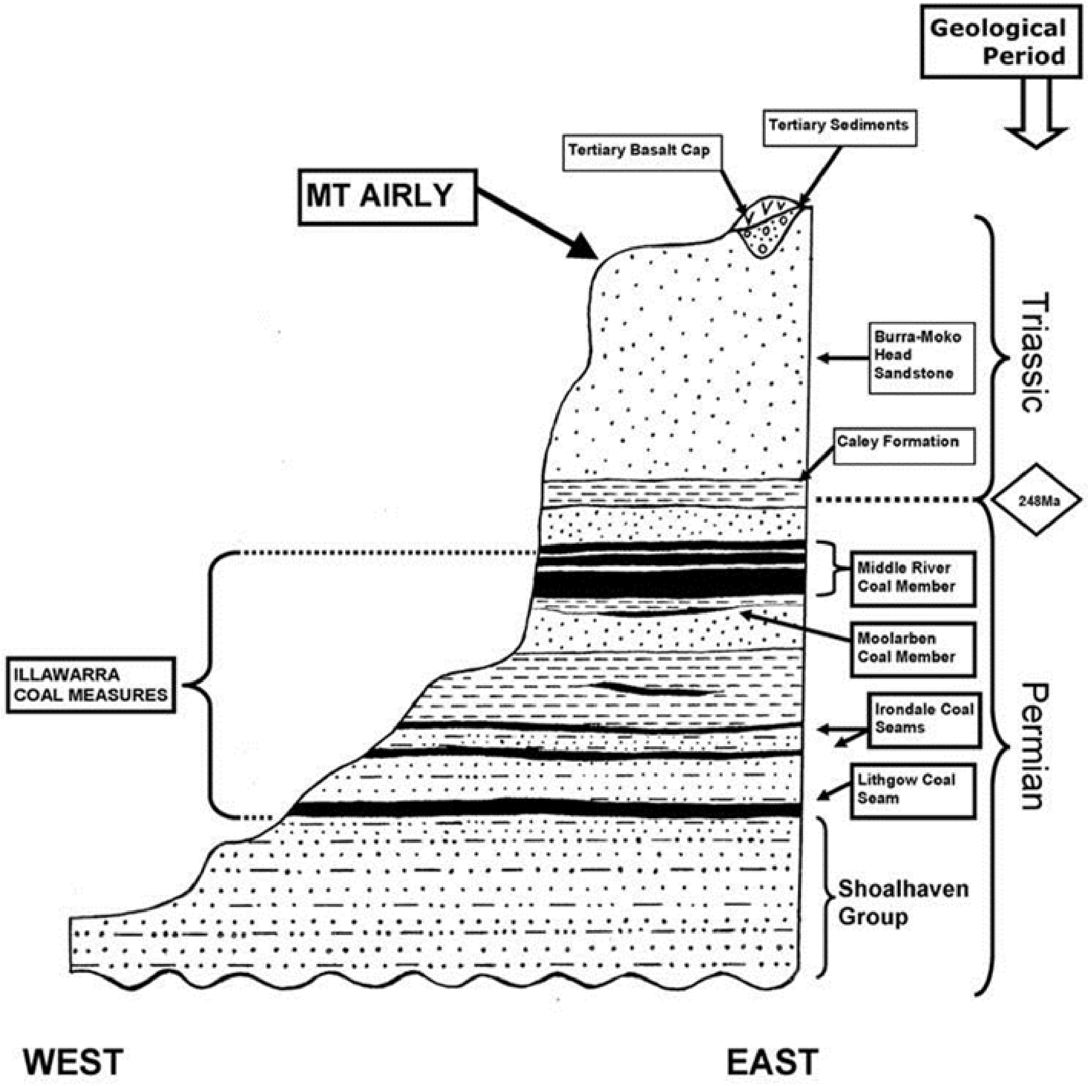
Regional groundwater sources

Regional groundwater sources occur within strata well below the coal measures and extend beyond the Airly Mine lease area.

The upper regional groundwater source occurs within siltstone and sandstone of the Shoalhaven Group. According to the Western Coalfield (Southern Part) Regional Geology 1:100,000 map, this rock formation was deposited in a marine environment and therefore the groundwater is highly brackish to saline. The existing production bore at the Airly Mine surface facilities area is installed within this groundwater source. The recharge area is predominantly to the west of Airly Mine where the Shoalhaven Group outcrops.

The lower regional groundwater source occurs within Devonian metamorphic strata containing shale, sandstone and limestone. The groundwater is slightly brackish and therefore has a lower salt content than the Shoalhaven Group and it is less sulfate dominant. Recharge areas occur to the north, south and east of Airly Mine and groundwater flow is generally to the east.

It is considered that there is minimal inter-aquifer hydraulic connection between the upper and lower regional groundwater sources, based on differences in groundwater chemistry discussed in GHD (2014).



Legend:

- ᵛᵥᵛ Basalt
- ⁘ Gravel and Sand
- ■ Coal
- ⁚ Sandstone
- ═ Siltstone
- ⁝ Interbedded Sandstone and Siltstone

NB: Not to Scale

LOCATION	Airly
SEAM	NA
DRAWN	SM
CHECKED	SG
APPROVED	SG
SCALE	NTS

Airly Mine Extension Project
Hydrogeological Model Report

Geological Cross-Section

Centennial Coal

DATE Dec 2013

Figure 3-1

\\ghdnet\ghd\AU\Newcastle\Projects\22\16787\Visio\Hydrogeological Model Report\Figure2-3_Geological Cross Section.vsd

3.2 Mining operations

Coal mining to date at Airly Mine has been bord and pillar mining within the Lithgow Seam since 2014 as well as panel and pillar mining since June 2019. Observed groundwater drawdown impacts associated with these workings have been isolated to the Lithgow Seam and the underlying Marrangaroo Formation (occurred in late 2015 and early 2016). These impacts are consistent with the predictions approved under SSD_5581.

There are also old shale workings within the Glen Davis Formation, developed between the late 1800s to early 1900s beneath the northern end of the Mount Airly plateau. These workings resulted in some cracking to the surface and the drainage of overlying groundwater sources (primarily Narrabeen Sandstone) into the old workings.

3.3 Stygofauna monitoring assessment program (SMAP)

Airly bores were first sampled by GHD for stygofauna under the regional program known as the stygofauna monitoring assessment program (SMAP). The SMAP was designed by GHD in 2016 to monitor stygofauna across the regional network of Centennial's bores (GHD 2016).

A Multi-Criteria Analysis (MCA) Protocol was used as a bore prioritisation tool to select the bores most likely to contain stygofauna, based on key bore attributes such as water quality, hydrogeological characteristics and bore construction details.

The following was also considered in the selection of bores for the SMAP:

- **Hydrogeology** - Cover all hydrogeological units present[1].
- **Bore location** - Geographically spread across the western region and ideally include reference bores outside the potential zone of impact (i.e. water drawdown zone)[1].
- **Bore age** - Be of varying age, in excess of six months old, and preferably undisturbed (i.e. not regularly pumped or purged)[1].
- **Historical collection of stygofauna -** presence of stygofauna in historical sampling.

The resulting score out of a maximum of five identified the suitability for stygofauna, with 5 being the most suitable. The scores were divided into four categories denoting Very Low, Low, Medium and High priority for stygofauna monitoring. Additional Airly bores have been added since development of the SMAP, as outlined in Section 3.4.

3.4 Historical stygofauna monitoring

3.4.1 Baseline monitoring

Potential impacts to stygofauna from underground mining were assessed as part of the EIS for the Airly Mine Extension Project (Cardno 2014). Stygofauna samples were collected from three bores (ARP05, AM2B, AM2B-1) over three sampling events between May 2013 and December 2013 with an additional three bores sampled in June 2014 (ARP07, ARP08, ARP09) (Cardno 2014). Bores were sampled using bailers or pumping depending on the attributes of the bore (Cardno 2014). Cardno (2014) concluded that the results of this monitoring program may not be representative of the current environment given the small sampling effort and the limited number of available bores.

3.4.2 Post-EIS

Prior to the current monitoring event (winter 2022), GHD had monitored a total of seven bores across eight sampling events between autumn 2016 and autumn 2021. The bores monitored by GHD and Cardno in historical sampling events are outlined in Table 3.1.

---

[1] As required by WA EPA (2007).

ARP07SP and ARP08SP, which were sampled by Cardno in June 2014 as part of the EIS, have not been sampled by GHD. ARP07SP has been consistently dry since installation, as indicated by monthly groundwater sampling. ARP08SP is not sampled as it does not have favourable bore attributes for stygofauna (see Table 2.1), including a narrow bore diameter (40 mm), greater than 200 metre depth below ground level, and very high EC (>6000 µS/cm) and pH (pH > 12). AM2B (production bore), which was also sampled by Cardno, has not been sampled by GHD as the bore is sealed, encasing a permanent logger which prevents sampling. AM2B-1 (old production bore) was historically monitored by GHD but was eliminated from the monitoring program following the winter 2017 monitoring event as conditions within this bore are unsuitable for the presence of stygofauna based on the water chemistry and presence of iron floc (GHD 2018).

Table 3.1 Historical stygofauna sampling events, 2013 to 2021

Sampling event	Month of monitoring	Bores sampled	Company	Purpose
Autumn 2013	May 2013	ARP05, AM2B, AM2B-1	Cardno	Airly Mine Extension EIS
Winter 2013	June 2013	ARP05, AM2B, AM2B-1		
Summer 2013	December 2013	ARP05, AM2B, AM2B-1		
Winter 2014	June 2014	ARP07, ARP08, ARP09		
Autumn 2016	March 2016	ARP09, ARP05, AM2B-1	GHD	Post EIS monitoring
Summer 2016	December 2016	ARP09, ARP05, AM2B-1		
Summer 2017	February 2017	ARP09, ARP05, AM2B-1		
Winter 2017	August 2017	ARP09, ARP05, AM2B-1, ARP11, ARP14, ARP15SP		
Spring 2018	November 2018	ARP05, ARP09, ARP11, ARP13SP ARP14, ARP15SP		
Autumn 2019	March 2019	ARP05, ARP09, ARP11, ARP13SP ARP14, ARP15SP		
Spring 2020	October 2020	ARP05, ARP09, ARP11, ARP13SP ARP14, ARP15SP		
Autumn 2021	April 2021	ARP05, ARP09, ARP11, ARP13SP ARP14, ARP15SP		

3.4.3 Stygofauna observed to 2021

No stygofauna were collected from groundwater bores associated with Airly Mine by Cardno / GHD between autumn 2013 and winter 2017.

In spring 2018, two individuals of one obligate stygofauna group (Cyclopoida) were collected from ARP11. Installed in late 2016, ARP11 is a shallow bore targeting Permian sandstone (Table 3.2). One individual of a Stygoxene (non-obligate) fauna, Gripopterygidae (stonefly), was also observed in ARP13SP in spring 2018 (GHD 2019) which is located close to Genowlan Creek.

In autumn 2019, a total of three animals were collected from ARP15SP (GHD 2020b). All animals were from the Melitidae family of Amphipods. No animals were collected from ARP11, ARP13SP or ARP14 in autumn 2019, which represented a low rainfall period, during which ARP05 and ARP09 were dry.

In spring 2020, a total of nine animals were collected from ARP09 (GHD 2020a). Five were from the Isotomidae family of Entomobryomorpha, three were from the Hypogastruridae family of Poduromorpha and one was from the Cyclopidae family of Copepoda. Two animals were identified in the sample from ARP13SP, one from the Isotomidae family of Entomobryomorpha and one from the Cyclopidae family of Copepoda. A total of 42 animals were collected from ARP14, all from the Parabathynellidae family of Syncarida. 34 obligate stygofauna were collected from ARP15SP: 27 from the Paramelitidae family of Amphipoda, four from the Psammaspididae family of Syncarida and three from the Cyclopidae family of Copepoda. One individual from the Lumbriculidae family of Lumbriculida was also collected in ARP15SP, which was a stygoxene (non-obligate groundwater fauna).

In autumn 2021, one animal was collected from ARP05 in autumn 2021 from the Hypogastruridae family of Poduromorpha (GHD 2022b). A total of six taxa were collected from ARP09, all were also from the Hypogastruridae family of Poduromorpha. A total of seven animals were collected from ARP14: six were from the Parabathynellidae family of Bathynellacea and one was from the Hypogastruridae family of Poduromorpha. A total of 29 animals were collected from ARP15SP in autumn 2021: 24 were from the Cyclopidae family of Cyclopoida, three were from the Neoniphargidae family of Amphipoda and two were from the Psammaspididae family of Anaspidacea.

The obligate stygofauna collected between 2018 and 2021 are summarised in Table 3.2.

Table 3.2 Obligate stygofauna collected from Airly bores between 2018 and 2021

Sampling event	Site	Sampling method	Number of animals (abundance)	Number of taxa (richness)	Taxa collected
Spring 2018	ARP11	50 µm net, 6 hauls	2	1	Cyclopoida (Phreatobite)
Autumn 2019	ARP15SP	50 µm net, 6 hauls	3	1	Amphipoda: Melitidae (Phreatobite)
Spring 2020	ARP09	50 µm net, 6 hauls	9	3	Entomobryomorpha: Isotomidae (Edaphobite) Poduromorpha: Hypogastruridae (Edaphobite) Copepoda: Cyclopidae (Stygobite)
	ARP13SP	50 µm net, 6 hauls	2	2	Entomobryomorpha: Isotomidae (Edaphobite) Copepoda: Cyclopidae (Stygobite)
	ARP14	50 µm net, 6 hauls	42	1	Syncarida: Parabathynellidae (Stygobite)
	ARP15SP	50 µm net, 6 hauls	34	3	Amphipoda: Paramelitidae (Stygobite) Syncarida: Psammaspididae (Stygobite) Copepoda: Cyclopidae (Stygobite)
Autumn 2021	ARP05	50 µm net, 6 hauls	1	1	Poduromorpha: Hypogastruridae (Edaphobite)
	ARP09	50 µm net, 6 hauls	6	1	Poduromorpha: Hypogastruridae (Edaphobite)
	ARP14	50 µm net, 6 hauls	7	2	Bathynellacea: Parabathynellidae Poduromorpha: Hypogastruridae (Edaphobite)
	ARP15SP	50 µm net, 6 hauls	29	3	Copepoda: Cyclopidae (Stygobite) Anaspidacea: Psammaspididae Amphipoda: Neoniphargidae

4. Methods

4.1 Survey bores

Sampling was conducted at six bores on 23 and 24 August 2022 as shown in Table 4.1. The locations of these bores are shown in Figure 4.1.

The priority of some bores are identified in Figure 4.1 based on the attributes of the bore (see Section 2.3.1) as identified in the SMAP. Bores ARP11, ARP13SP, ARP14 and ARP15SP have not been assigned a priority as they were drilled after the SMAP was developed.

Photographs of bores sampled in August 2022 are presented in Appendix A.

Table 4.1 Bores sampled for stygofauna, August 2022

Bore code	Easting	Northing	Approximate bore depth* (EoH, m bgl)	Aquifer	Screen interval (m bgl) if known	Location
	(Zone 56H)					
ARP05	224066	6333269	9.90	Alluvial	8 - 11	Gap Creek
ARP09	225334	6332733	3.98	Alluvial	3 - 4	Genowlan Creek
ARP11	224168	6333547	15.39	Sandstone	1.25 – 15.3	Gap Creek
ARP13SP	225741	6333314	71.56	Coal seam	67.5 – 70.5	Genowlan Creek
ARP14	225738	6333335	1.64	Alluvial	0.5 - 2.3	Genowlan Creek
ARP15SP	226319	6332492	19.87	Sandstone	10 - 16	Upstream of The Oasis

Note: Locations in GDA94.

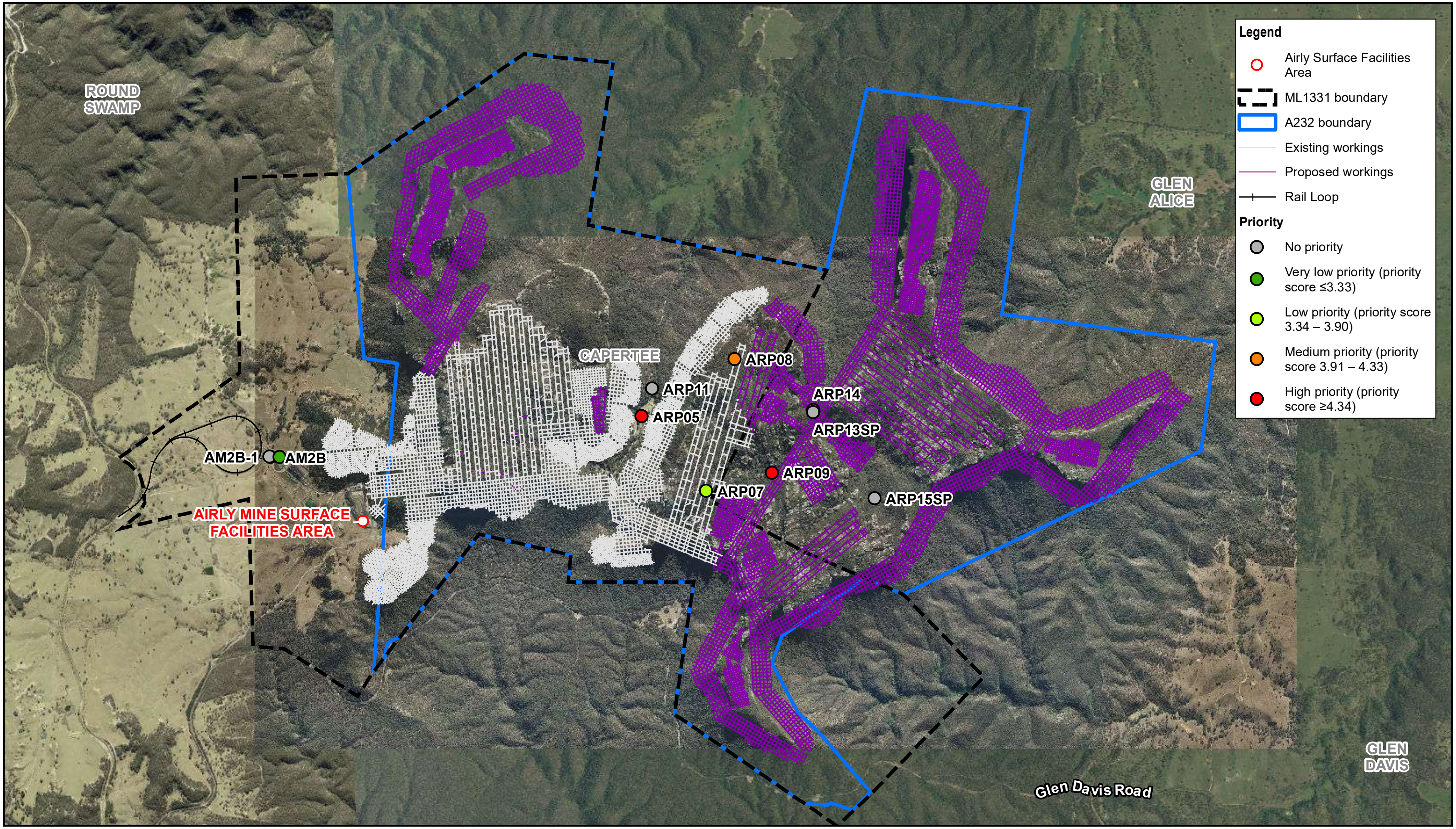
^Depth below ground level

*As measured in August 2022

4.2 Physical observations

The following were collected during the field survey:

- Measurements of standing water level (SWL) and end of hole (EoH) bore depth of each bore using an electronic dip probe. The standing water level is defined as the depth from the ground to the groundwater and is used to calculate the total depth of the water column.
- Recording of bore diameter, construction, purpose of bore, condition, GPS location and bore ID, presence of tree roots, surrounding land use, sampling date, time and sampling team.



CENTENNIAL

Paper Size ISO A4

0 0.35 0.7 1.05 1.4

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

Centennial Pty Ltd
Airly Mine
Stygofauna Monitoring

Project No.	**12570462**
Revision No.	**0**
Date	**14 Feb 2023**

Groundwater bores monitored for stygofauna

FIGURE 4-1

G:\22\0105001\GIS\Maps\Deliverables\Western\Airly\12570462\Stygofauna\12570462_SFM001_MonitoringLocations_0.mxd
Print date: 14 Feb 2023 - 08:53

Data source: Centennial: Mine data, 2021, Aerial Imagery; LPI: DTDB / DCDB, 2017; © Department of Finance, Services & Innovation 2018. Created by: fmackay

4.3 Water quality monitoring

The following *in situ* physical and chemical parameters were measured at each sampling site using a YSI multi-parameter water quality meter:

- Temperature (°C)
- pH (pH units)
- Electrical conductivity (EC) (µS/cm) as specific conductance
- Dissolved oxygen (DO) (mg/L and percent saturation)

The meter was fully calibrated prior to use, in accordance with the manufacturer's specifications. Water was extracted from the bore using a bailer and transferred to the sample cup before collecting the readings. Note that the bore was not purged prior to sampling to minimise interference to the water column. However, water quality sampling of all bores is conducted monthly by GHD.

Turbidity (NTU) was determined through laboratory analysis at a National Association of Testing Authorities (NATA) accredited laboratory.

4.4 Stygofauna

4.4.1 Sample collection

Stygofauna monitoring was undertaken by GHD using methods consistent with the requirements for baseline surveys as defined by the WA EPA (2007; 2013) guidelines.

All sampled bores were 50 mm in diameter and a 40 mm diameter net was used for stygofauna sampling (GHD nets conform to WA EPA guideline (2007; 2013) specifications).

Nets are constructed of 50 µm nybolt mesh material, weighted at the bottom with a brass fixture and with an attached plastic collecting jar. The net was lowered to the bottom of the bore, agitated four times to dislodge resting animals and slowly retrieved. At the top of each haul, the collecting jar was rinsed into a 50 µm mesh brass sieve and the net lowered again.

Six hauls were completed for each bore following water quality sampling. Water remaining in the bailer following water quality sampling is also passed through the sieve to maximise the chance of collecting stygofauna. For each sample, the entire sieve contents were transferred to a labelled sample jar and preserved in 100% AR grade ethanol.

4.4.2 Taxonomy

Family level identification is the requirement under the Springvale Mine Extension Project Development Consent (NSW Government 2015) and has been used as the standard for Airly for consistency. Stygofauna and other animals were identified under a microscope to Family level, where possible. In some cases, the specimens were too immature or damaged to allow for identification to family level and there are some groups for which no key is available. Specimens were preserved in 100% AR grade ethanol, to allow for future genetic sequencing, if necessary.

5. Results

5.1 Environmental conditions

Figure 5.1 displays yearly rainfall totals for 2013 to 19 September 2022, as recorded by Centennial at Airly Mine. Rainfall data from Running Stream (Brooklyn) BOM station (63012) (BOM 2021) were used for the period January to October 2013 as rainfall monitoring by Centennial began in November 2013. Long-term mean annual rainfall data was sourced from BOM (2022) for a period from 1899 to 2021.

The highest annual rainfall during the monitoring period was in 2016, which was well above the average. Rainfall during the 2017 to 2019 period was well below the long-term average for the area, with the lowest annual rainfall of 398.4 mm recorded in 2019. Rainfall in 2020 was high compared to the previous three years, with higher-than-average rainfall recorded. Annual rainfall in 2021 was slightly below average but was the third highest annual rainfall during the monitoring period. While rainfall for 2022 is reported as below average, only data until 19th September were included and it is likely that more rain will fall prior to the end of the year.

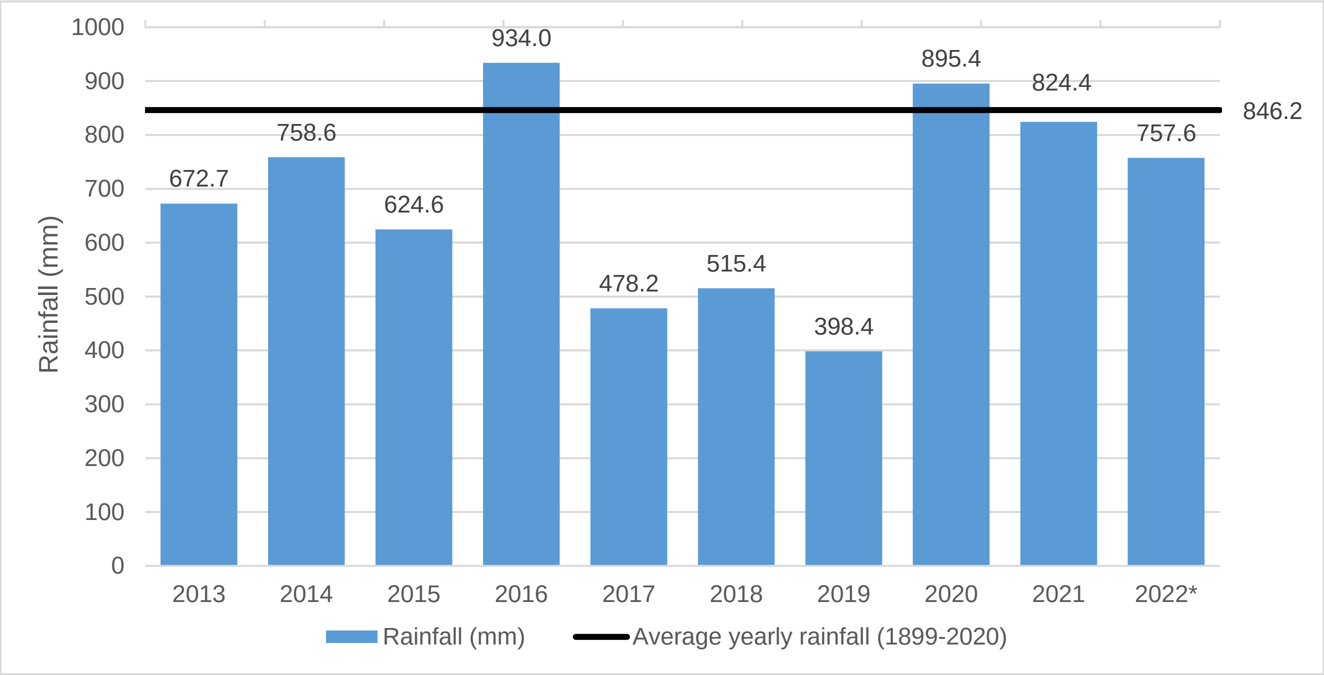


***Figure 5.1** Yearly rainfall at Airly Mine from 2013 to 2022, compared to average yearly rainfall (1899-2021). *Note that 2022 only includes rainfall between 1 January and 19 September 2022.*

5.2 Water quality

Water quality recorded by GHD during stygofauna sampling is summarised in Table 5.1.

EC was below 2000 µS/cm in all six bores in August 2022, which is favourable for stygofauna. The highest EC was observed at ARP11, while EC at ARP13SP was also elevated relative to the shallow bores (other than ARP11). pH was below the prospective range in all bores except at ARP11, where pH was within the favourable range. pH was particularly low (below 5) at ARP09. DO saturations were low in all bores but was highest at ARP05. Turbidity was highest at ARP11 and lowest at ARP05.

Table 5.1 Water quality in Airly bores, August 2022

Site	Depth to water (m)^	Date	Time (24 hr)	Temp (°C)	EC (µS/cm)	pH	DO (% sat)	Turbidity (NTU)~
ARP05	2.08	23/08/22	14:15	11.9	136.1	6.37	30.7	17.0
ARP09	2.27	24/08/22	14:00	10.1	33.7	4.73	27.7	9.1
ARP11	11.88	23/08/22	13:30	14.3	1381.0	6.72	24.7	150.0
ARP13SP	64.57	24/08/22	9:30	15.4	538.7	6.46	16.2	32.0
ARP14	0.25	24/08/22	10:30	9.3	88.3	5.94	20.4	23.0
ARP15SP	11.19	24/08/22	13:00	13.4	62.0	5.26	15.3	21.0
Favourable value*	NA	NA	NA	NA	<2000	6.5-8.5	NA	NA

*Based on criteria outlined in Section 2.3.1.
^Depth below ground level
~ Analyte was analysed in a laboratory

5.3 Fauna

The animals collected from Airly bores in August 2022 are outlined in Table 5.2. Animals were collected from only three of the six bores sampled during the August 2022 monitoring.

A total of two animals were collected from ARP05 in August 2022, one from the Parabathynellidae family of the Bathynellacea sub-order, the other from the Cyclopidae family of the Cyclopoida order.

A total of 24 animals were collected from ARP14. Six were from the Parabathynellidae family of the Bathynellacea order and 16 were from the Haplotaxidae family of the Haplotaxida sub-order.

A total of two animals were collected from ARP15SP in August 2022, both from the Melitidae family of the Amphipoda order.

Table 5.2 Animals collected from Airly bores in August 2022

Site	Sampling method	Order or sub-Order: Family	Type of stygofauna	Abundance	Total number of taxa (richness)	Number of obligate stygofauna (richness)
ARP05	50 µm net, 6 hauls	Bathynellacea: Parabathynellidae	Phreatobite	1	2	2
		Cyclopoida: Cyclopidae	Stygobite	1		
Total				**2**		
ARP14	50 µm net, 6 hauls	Bathynellacea: Parabathynellidae	Phreatobite	6	2	2
		Haplotaxida: Haplotaxidae	Phreatobite	16		
Total				**24**		
ARP15SP	50 µm net, 6 hauls	Amphipoda: Melitidae	Phreatobite	2	1	1
Total				**2**		

6. Discussion

While EC was within the favourable range (see Section 2.3.1) in all bores in August 2022, the pH was below the prospective range in all bores except for ARP11, at which pH was within the prospective range.

Obligate stygofauna were collected from three bores in August 2022. All three of these bores were shallow (<50 m), had low EC and low pH water. No stygofauna were collected from ARP09 in August 2022 despite being previously collected in 2021. Due to there being no significant change to measured water quality parameters, the absence of stygofauna from ARP09 likely demonstrates the patchy distribution and occurrence of these animals (Hahn and Matzke 2005). No stygofauna were collected from ARP11 and ARP13SP. ARP11, which was dry between October 2019 and September 2021, had a comparatively high EC and turbidity, potentially as a result of limited flushing since re-wetting, which may explain the absence of stygofauna in this shallow bore. ARP13SP is not prospective for stygofauna as it is deeper than 50 m (approximately 73 m).

However, in spring 2020, a single individual of the Copepoda family, Cyclopidae, was collected from ARP13SP. Again, as ARP13SP is not prospective for stygofauna due to its depth, it was theorised that the individual may have been transferred to the ARP13SP sample from another bore. The monitoring methods were altered in 2021 to eliminate the possibility of sample contamination. No animals were collected from ARP13SP in autumn 2021, nor again in August 2022, which supports the theory of cross-contamination.

Despite the reduced number of bores where stygofauna were collected and the reduced stygofauna abundance in August 2022 compared to autumn 2021, stygofauna richness was still similar between these two sampling events. The relatively high abundance and richness of stygofauna in 2020 and 2021 samples, and now again in 2022 samples, is likely attributable to the near-average annual rainfall since 2020 and the subsequent recovery of groundwater levels. ARP05, ARP09 and ARP11, which were all previously dry during some or all of the 2017 to 2019 drought period, demonstrated a recovery in water levels in response to rainfall in early 2020. ARP09 has contained almost continuous water since February 2020, while recovery of groundwater at ARP05 (continuously wet since April 2021) and ARP11 (continuously wet since October 2021) was more delayed. Groundwater levels remained elevated in these bores across 2022, due to the continued high rainfall in 2022, with rainfall totals currently on-track to being close to, or exceeding, long-term average rainfall by year’s end.

The highest diversity and abundance of obligate stygofauna was observed in ARP14 in August 2022, with two obligate stygofauna families (Bathynellacea: Parabathynellidae and Haplotaxida: Haplotaxidae) collected. This bore was intermediate between the other two stygofauna-containing bores (ARP05 and ARP15SP) in terms of EC and pH. The primary factors potentially explaining this result are that this bore has a shallower depth, is in closer proximity to a watercourse (Genowlan Creek) and has more reliable water than some of the other shallow bores, such as ARP05, ARP09 and ARP11.

Bathynellacea: Parabathynellidae were the only taxa collected in more than one bore in August 2022, being found at ARP05 and ARP14. This is the first positive detection of this taxa at ARP05, with Bathynellacea: Parabathynellidae only ever collected once before at ARP14 only. ARP05 and ARP14 are both shallow bores located adjacent to waterways, potentially creating similar conditions which may appeal to this type of stygofauna, including strong connectivity to surface waters. In addition, increased groundwater levels due to ongoing rainfall across the last three years since 2020 may have also attributed to these recent detections compared to earlier sampling periods.

The results of the August 2022 survey indicate that stygofauna are prevalent in the shallow aquifers of the Airly mine area. All bores from which stygofauna were collected in August 2022 are installed in the shallow alluvium or shallow sandstone. Groundwater monitoring has shown that there is extensive natural fracturing of the shallow sandstone which results in the seepage of groundwater along the slopes of the mountains. Consequently, there is expected to be limited groundwater within this strata, and negligible drawdown is predicted for the Narrabeen Sandstone due to Airly mining operations (GHD 2014). Similarly, there is not predicted to be impacts to the majority of the shallow alluvium. Surface subsidence cracks have recently been observed at Mount Airly and are potentially associated with mining within the panel and pillar area in 2020 and 2021. The Airly Mine extraction plan has since been updated to reduce the area of panel extraction, and increase the width of the pillars, which is expected to reduce the likelihood of surface cracking. Since these observations and subsequent changes to the extraction plan, no observed impacts on the groundwaters that support the stygofauna identified in shallow alluvial and shallow sandstone are attributable to mining.

7. Conclusion

Obligate stygofauna were collected from three of the six bores surveyed during August 2022 sampling. The bores from which stygofauna were collected intersected the shallow sandstone strata or the shallow alluvium, including ARP14, which has consistently exhibited diverse and abundant stygofauna populations. With the exception of ARP09, bores where stygofauna were not collected in August 2022 were considered less prospective for stygofauna due to either their significant depth (ARP13SP) or recent re-wetting and the potentially associated high EC and turbidity (ARP11). The lack of fauna in ARP09 in August 2022 may simply reflect the patchy distribution and variable abundances of stygofauna. The continued prevalence of stygofauna in Airly bores compared to earlier (pre-2020) surveys is likely due to the continuation of similar rainfall patterns since 2020, whereby the groundwater levels and stygofauna communities in these shallow bores have demonstrated a response to ongoing rainfall since easing of drought conditions in 2020 (GHD 2022a, 2022b, 2020a).

Impacts to the shallow alluvium and sandstone were predicted to be minimal and acceptable in the EIS for Airly Mine (GHD 2014). Although some surface subsidence cracks have been recently identified at Mount Airly that may be related to mining in the panel and pillar area, the mine plan has since been updated to reduce the likelihood of surface cracking. Therefore, the likelihood of impacts from Airly mine operations to the stygofauna inhabiting shallow groundwater aquifers is low.

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Appendix A

Bore photographs and surrounds

Bore	Photograph
ARP05	
ARP09	

Bore	Photograph
ARP11	
ARP13SP	

Bore	Photograph
ARP14	
ARP15SP	

Appendix B

All Fauna Collected from Airly Bores, 2016 - 2022

Results of stygofauna sampling in Airly bores between 2016 and 2022

Sampling event	Bore ID	Date sampled	Phylum	Class	Order	Family	Genus	Habitus	No. of animals
Mar-16	AM2B-1	15/03/16	*Arthropoda*	*Entognatha (Collembola)*	*Entomobryomorpha*	*Isotomidae*	*Isotomodes c.f*	*Edaphobite*	2
Dec-16	AM2B-1	02/12/16							0
Dec-16	ARP09	05/12/16	*Arthropoda*	*Entognatha (Collembola)*	*Entomobryomorpha*	*Isotomidae*	*Isotomodes c.f*	*Edaphobite*	1
Feb-17	AM2B-1	17/02/17							0
Aug-17	ARP05	09/08/17							0
Aug-17	ARP09	08/08/17							0
Aug-17	ARP11	07/08/17							0
Aug-17	ARP14	08/08/17							0
Aug-17	ARP15SP	08/08/17							0
Aug-17	AM2B-1	07/08/17	*Arthropoda*	*Entognatha (Collembola)*	*Entomobryomorpha*	*Isotomidae*		*Edaphobite*	3
Nov-18	ARP11	01/11/18	*Arthropoda*	*Maxillopoda*	*Copepoda: Cyclopoida*			*Phreatobite*	2
Nov-18	ARP13SP	01/11/18	*Arthropoda*	*Insecta*	*Plecoptera*	*Gripopterigidae*		*Stygoxene*	1
Nov-18	ARP14	01/11/18	*Arthropoda*	*Entognatha (Collembola)*	*Entomobryomorpha*	*Isotomidae*		*Edaphobite*	19
Nov-18	ARP14	01/11/18	*Arthropoda*	*Arachnida*	*Trombidiformes*	*Trombidiidae*		*Edaphobite*	1
Nov-18	ARP15SP	01/11/18							0
Mar-19	ARP11	21/03/19							0
Mar-19	ARP13SP	20/03/19							0
Mar-19	ARP14	20/03/19							0
Mar-19	ARP15SP	20/03/19	*Arthropoda*	*Malacostraca*	*Amphipoda*	*Melitidae*		*Phreatobite*	3
Oct-20	ARP09	28/10/20	*Arthropoda*	*Entognatha (Collembola)*	*Entomobryomorpha*	*Isotomidae*		*Edaphobite*	5

Sampling event	Bore ID	Date sampled	Phylum	Class	Order	Family	Genus	Habitus	No. of animals
			Arthropoda	*Entognatha (Collembola)*	*Poduromorpha*	*Hypogastruridae*		*Edaphobite*	3
			Arthropoda	*Crustacea*	*Copepoda*	*Cyclopidae*		*Phreatobite*	1
Oct-20	ARP15SP	28/10/20	*Arthropoda*	*Crustacea*	*Amphipoda*	*Paramelitidae*		*Stygobite*	27
			Arthropoda	*Crustacea*	*Syncarida*	*Psammaspididae*		*Stygobite*	4
			Arthropoda	*Crustacea*	*Copepoda*	*Cyclopidae*		*Phreatobite*	3
			Annelida	*Oligochaeta*	*Lumbriculida*	*Lumbriculidae*		*Stygoxene*	1
Oct-20	ARP13SP	28/10/20	*Arthropoda*	*Entognatha (Collembola)*	*Entomobryomorpha*	*Isotomidae*		*Edaphobite*	1
			Arthropoda	*Crustacea*	*Copepoda*	*Cyclopidae*		*Phreatobite*	1
Oct-20	ARP14	28/10/20	*Arthropoda*	*Crustacea*	*Syncarida*	*Parabathynellidae*		*Stygobite*	42
Apr-21	ARP05	22/04/21	*Arthropoda*	*Collembola*	*Poduromorpha*	*Hypogastruridae*		*Phreatobite*	1
Apr-21	ARP09	22/04/21	*Arthropoda*	*Collembola*	*Poduromorpha*	*Hypogastruridae*		*Phreatobite*	6
Apr-21	ARP13SP	22/04/21							0
Apr-21	ARP14	22/04/21	*Arthropoda*	*Malacostraca*	*Bathynellacea*	*Parabathynellidae*		*Phreatobite*	6
			Arthropoda	*Collembola*	*Poduromorpha*	*Hypogastruridae*		*Phreatobite*	1
Apr-21	ARP15SP	22/04/21	*Arthropoda*	*Maxillopoda*	*Cyclopoida*	*Cyclopidae*		*Phreatobite*	24
			Arthropoda	*Malacostraca*	*Anaspidacea*	*Psammaspididae*		*Phreatobite*	2
			Arthropoda	*Malacostraca*	*Amphipoda*	*Neoniphargidae*		*Phreatobite*	3
Aug-22	ARP05	23/08/22	*Arthropoda*		*Bathynellacea*	*Parabathynellidae*	*Notobathynella*	*Phreatobite*	1
			Arthropoda	*Maxillipoda*	*Cyclopoida*	*Cyclopidae*		*Phreatobite*	1
Aug-22	ARP09	24/08/22							0
Aug-22	ARP11	23/08/22							0
Aug-22	ARP13SP	24/08/22							0

Sampling event	**Bore ID**	**Date sampled**	**Phylum**	**Class**	**Order**	**Family**	**Genus**	**Habitus**	**No. of animals**
Aug-22	ARP14	24/08/22	*Arthropoda*		*Bathynellacea*	*Parabathynellidae*	*Notobathynella*	*Phreatobite*	6
			Annelida	*Oligochaeta*	*Haplotaxida*	*Haplotaxidae*	*Haplotaxis*	*Phreatobite*	16
Aug-22	ARP15SP	24/08/22	*Arthropoda*	*Malacostraca*	*Amphipoda*	*Melitidae*	*Melita*	*Phreatobite*	2

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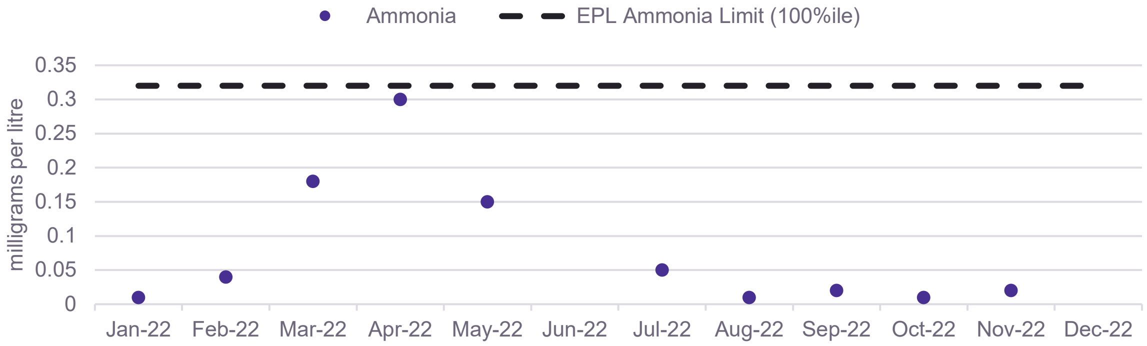
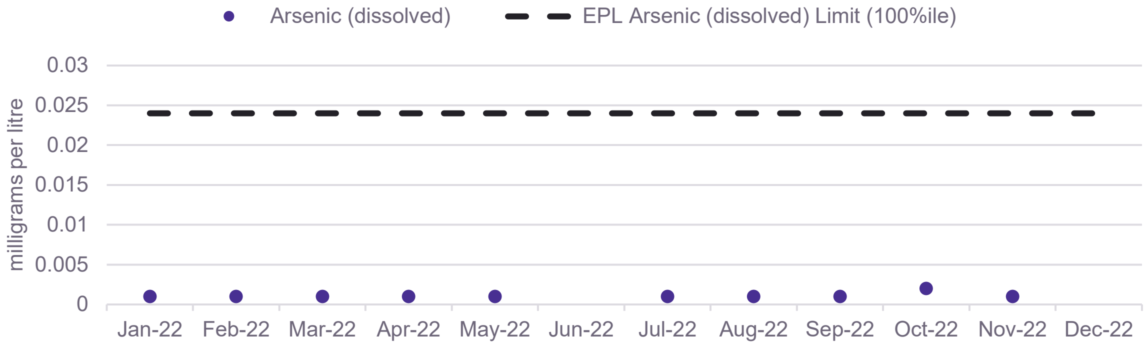
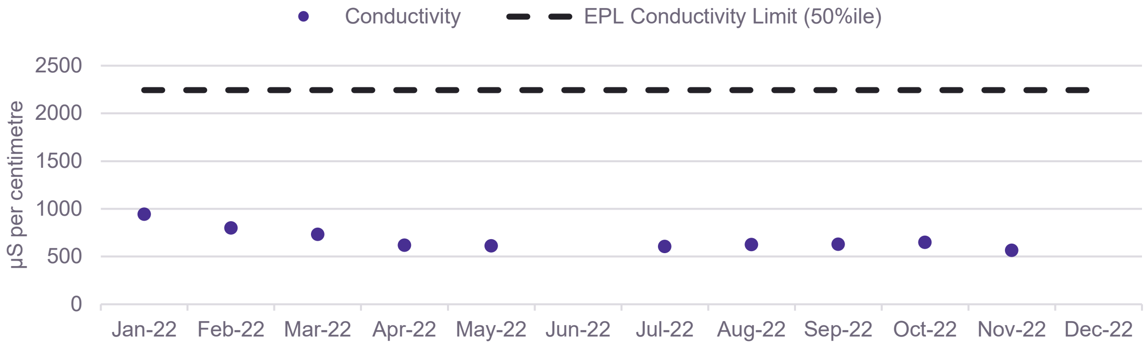
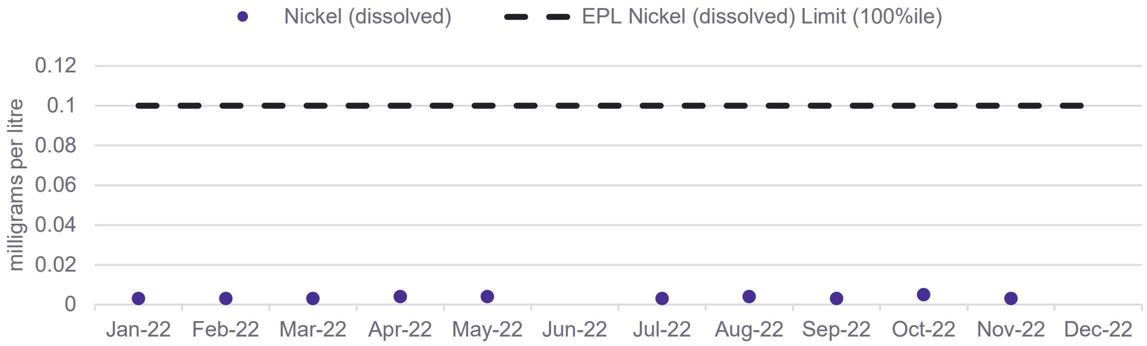
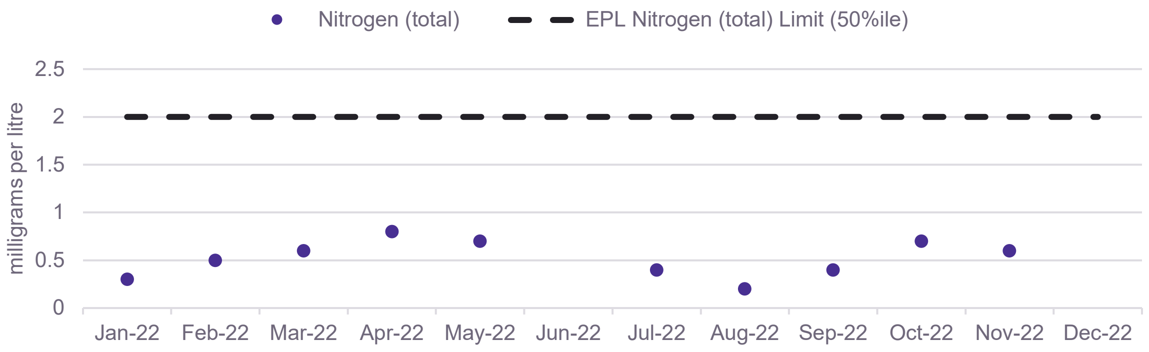
Appendix 10: LDP001 Comparison with Concentration Limits







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EPL Nitrogen (total) Limit (50%ile)
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1.5
1
0.5
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Jan-22
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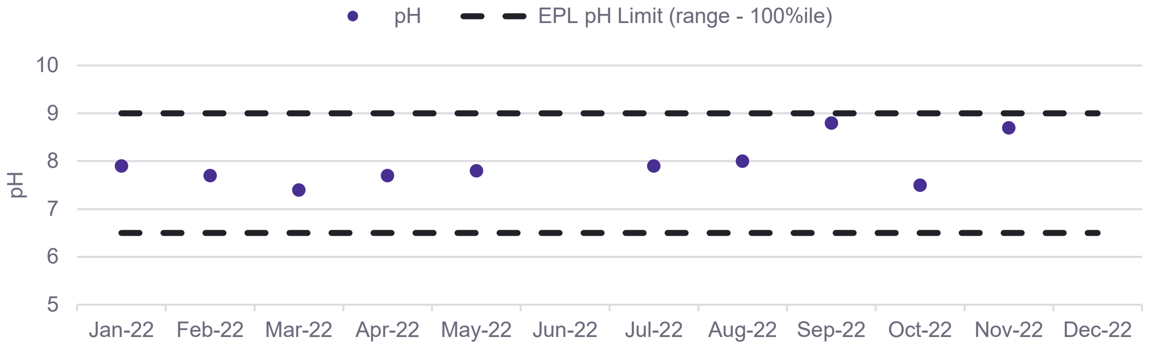
Oct-22
Nov-22
Dec-22


pH
EPL pH Limit (range - 100%ile)
pH
10
9
8
7
6
5
Jan-22
Feb-22
Mar-22
Apr-22
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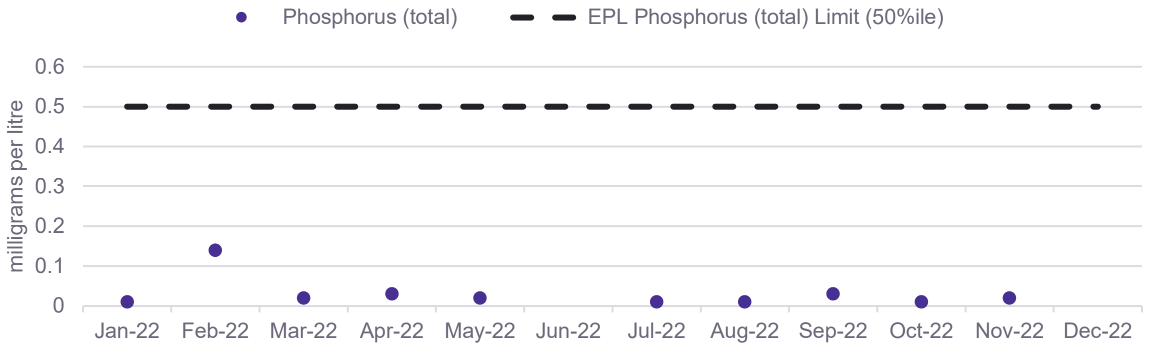
Oct-22
Nov-22
Dec-22


Phosphorus (total)
EPL Phosphorus (total) Limit (50%ile)
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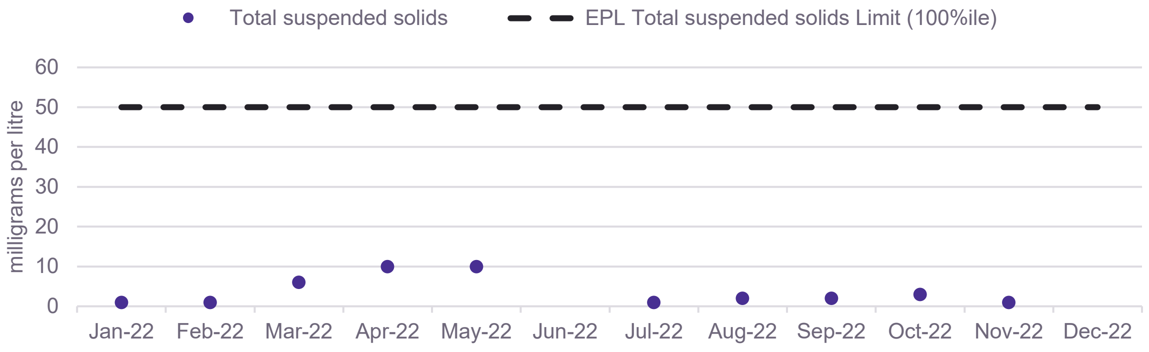
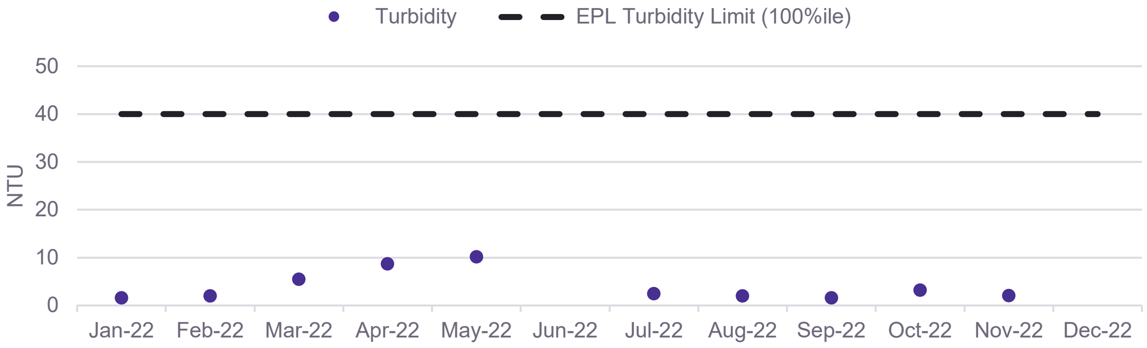
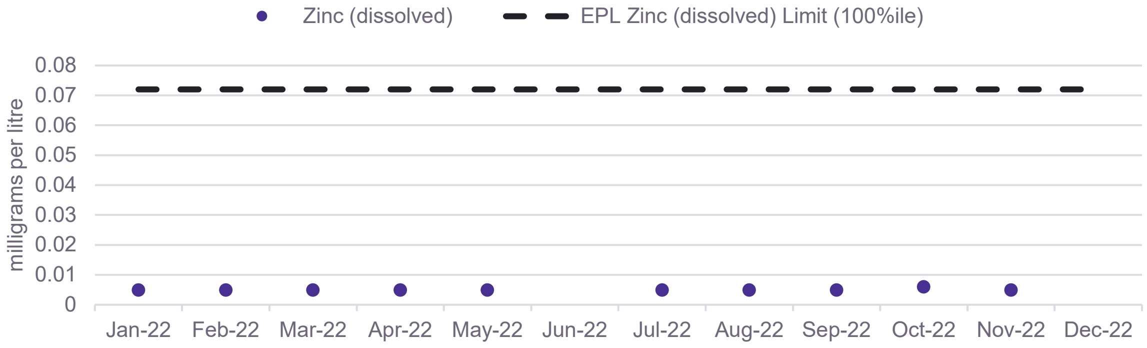
0.5
0.4
0.3
0.2
0.1
0
Jan-22
Feb-22
Mar-22
Apr-22
May-22
Jun-22
Jul-22
Aug-22
Sep-22
Oct-22
Nov-22
Dec-22


Total suspended solids
EPL Total suspended solids Limit (100%ile)
milligrams per litre
60
50
40
30
20
10
0
Jan-22
Feb-22
Mar-22
Apr-22
May-22
Jun-22
Jul-22
Aug-22
Sep-22
Oct-22
Nov-22
Dec-22

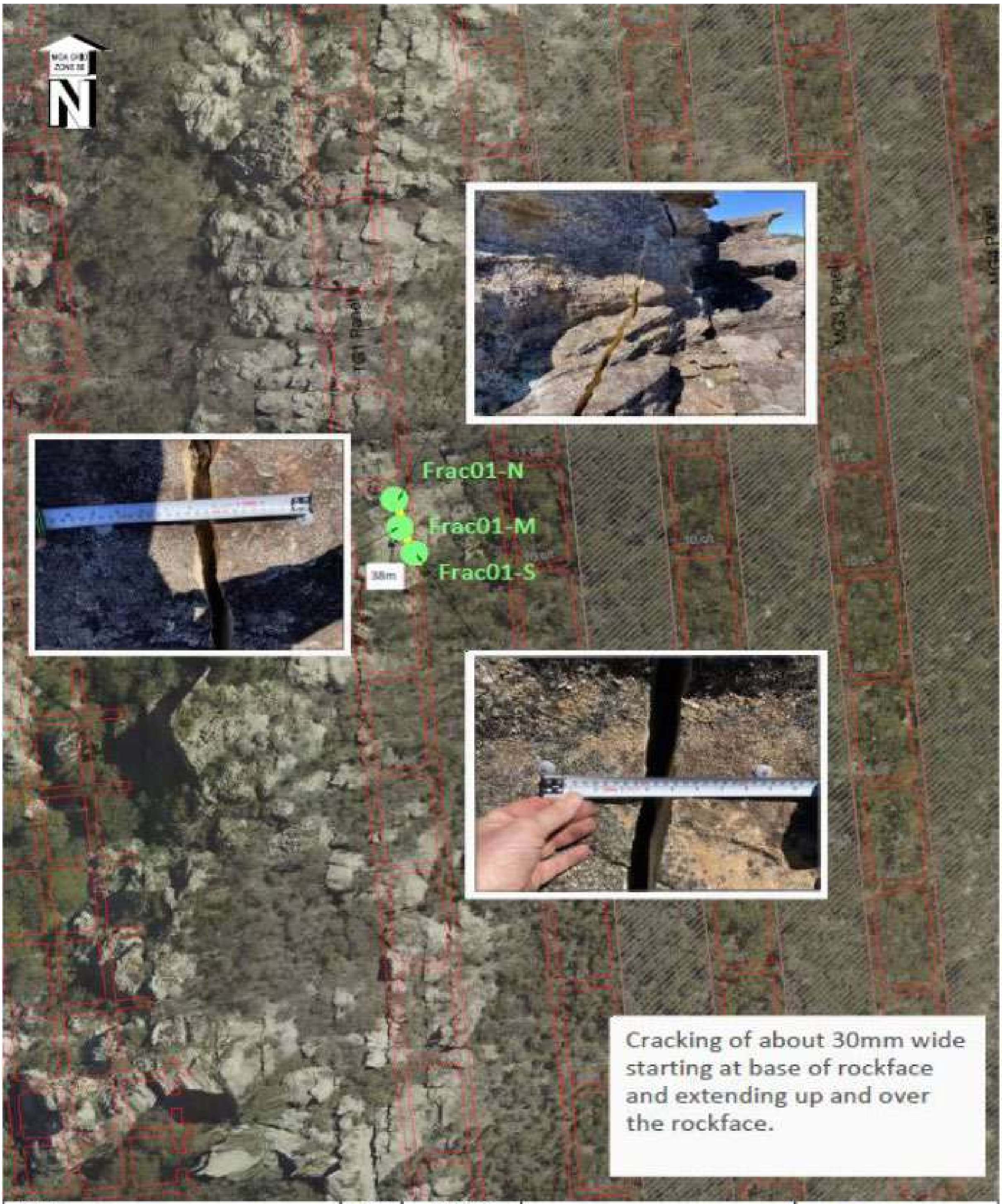


● Turbidity
EPL Turbidity Limit (100%ile)
NTU
50
40
30
20
10
0
Jan-22
Feb-22
Mar-22
Apr-22
May-22
Jun-22
Jul-22
Aug-22
Sep-22
Oct-22
Nov-22
Dec-22



● Zinc (dissolved)
EPL Zinc (dissolved) Limit (100%ile)
milligrams per litre
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
Jan-22
Feb-22
Mar-22
Apr-22
May-22
Jun-22
Jul-22
Aug-22
Sep-22
Oct-22
Nov-22
Dec-22

Appendix 11: Mount Airly Fracture Locations and Descriptions



Cracking of about 30mm wide starting at base of rockface and extending up and over the rockface.

LEGEND

🟢 Monitoring Locations

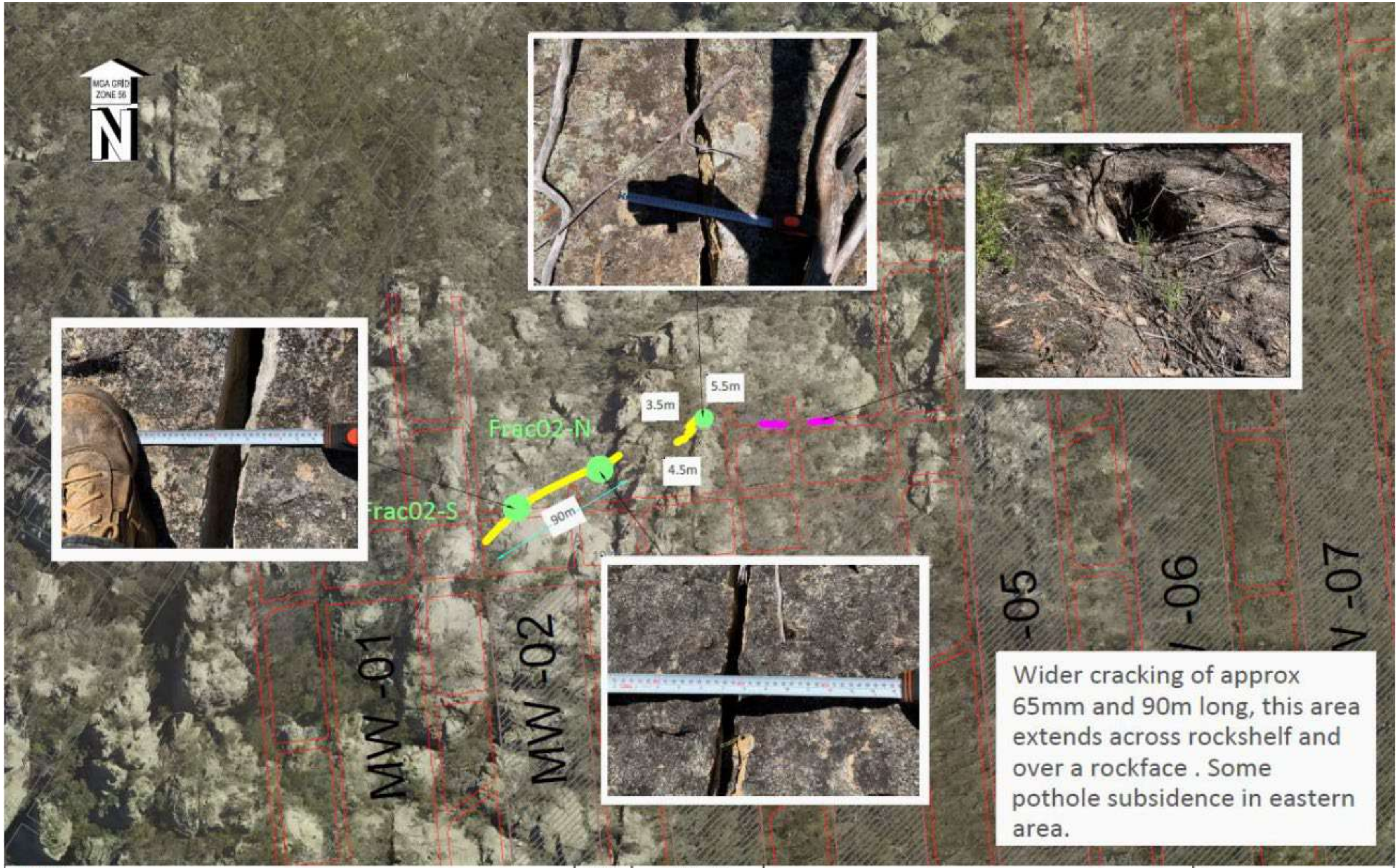
Fracture

DATE	07/04/2022
REFERENCE	
[illegible]	
SCALE	As Shown

Mt Airly Fracture-01

CENTENNIAL AIRLY

DRG. No. AM02981a



Wider cracking of approx 65mm and 90m long, this area extends across rockshelf and over a rockface . Some pothole subsidence in eastern area.

LEGEND

- ● Monitoring Locations
- ╱ Fracture
- ╱ Sink Hole

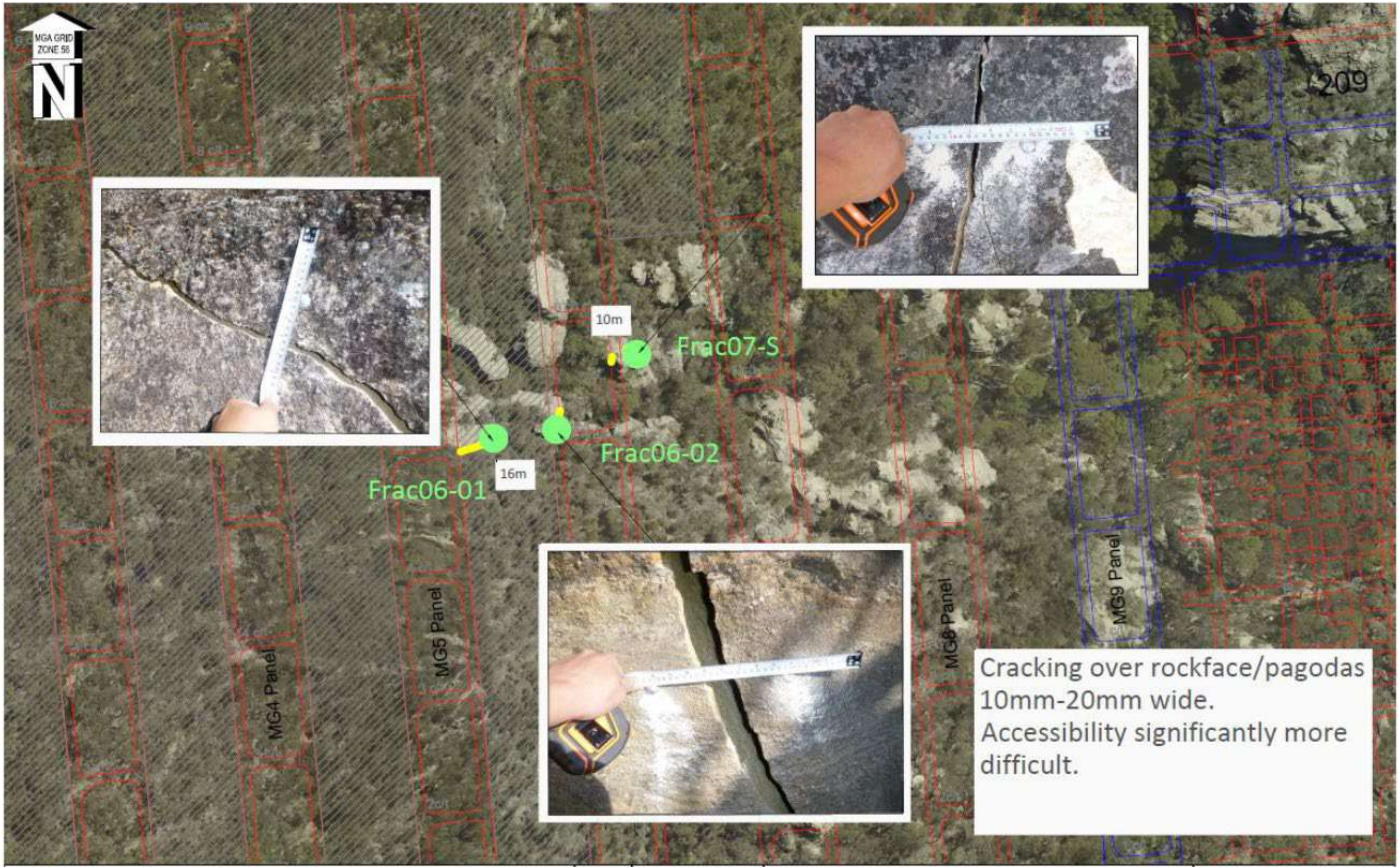
DATE	07/04/2022
REFERENCE	
K:\Survey\1.MGA2020\DWG\SURFACE\Environment\pHOTOS [illegible] Mt Airly Subsidence Offsite Monitoring Locations 20220404.dwg	
SCALE	As Shown

Mt Airly Fracture-02

CENTENNIAL
AIRLY

This drawing is the property of Airly Mine Pty. Ltd.

DRG. No. AM02981b



Cracking over rockface/pagodas 10mm-20mm wide.
Accessibility significantly more difficult.

LEGEND

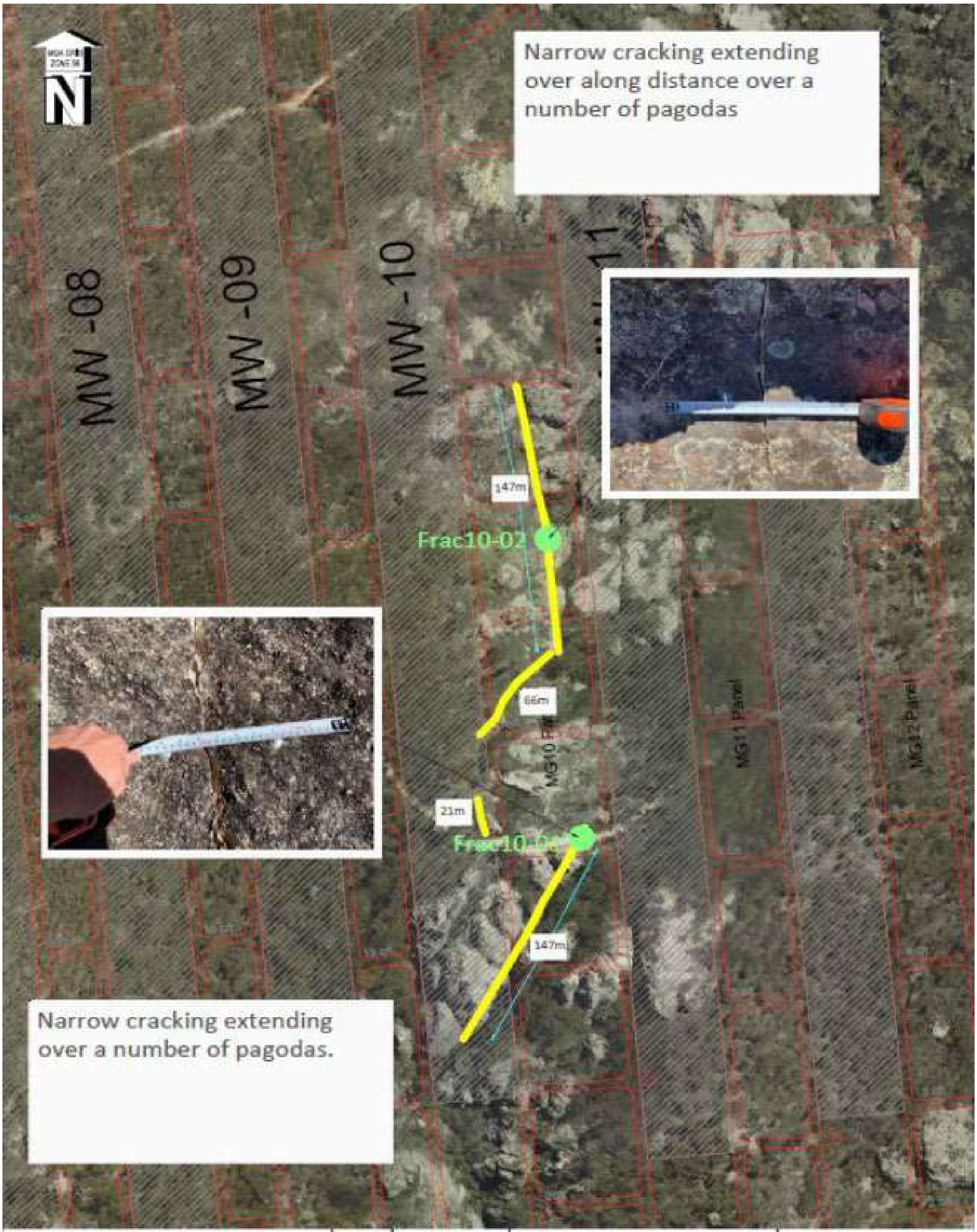
● Monitoring Locations
Fracture
Sink Hole

DATE 07/04/2022
REFERENCE
[illegible]
SCALE As Shown

Mt Airly Fracture-06 & Fracture-07

CENTENNIAL
AIRLY
THIS DRAWING IS THE PROPERTY OF AIRLY MINE PTY. LTD.

DRG. No. AM02981c



Narrow cracking extending over along distance over a number of pagodas

Narrow cracking extending over a number of pagodas.

LEGEND

● Monitoring Locations

Fracture

DATE	07/04/2022
REFERENCE	
[illegible]	
SCALE	As Shown

Mt Airly Fracture-10

CENTENNIAL AIRLY

DRG. No. AM02981d

CENTENNIAL

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